B.3. Program Educational Outcomes and Assessment

In this section program educational outcomes (PEOs), assessment processes and their results are discussed.

- B.3.1. Pre-EC2000 Activities
- B.3.2. Process To Develop Program Educational Outcomes
- B.3.3. Department Of Chemical Engineering Program Educational Outcomes
- B.3.4. Program Educational Objectives And Program Educational Outcomes
- B.3.5. Relationship Of Program Educational Outcomes To EC2000 Criterion 3
- B.3.6. Process Used To Assess Program Outcomes
- B.3.7. Relationship Between Assessment Methods And Program Educational Outcomes
- B.3.8. Processes To Assure That Educational Outcomes Are Achieved
- B.3.9. Improvements To Program Through Assessment Process
- B.3.10. Materials Available For Review To Verify Program Improvement Through Assessment

B.3.1. Pre-EC 2000 Activities

Assessment and improvement of our curriculum has been a central focus for many years. Our efforts in these areas has been critical to several significant revisions to our curriculum with the latest being largely due to the university switching from a quarter-system to a semester-system. As early as 1980, the department faculty established a list of "Curriculum Priorities" that is in remarkable agreement with ABET EC2000 3a-3k. Table 3-1 shows the "Curriculum Goals" (similar to program outcomes) whereas Table 3-2 shows the "Expected Levels of Performance" (similar to measurable assessment data) abstracted from a July 11, 1980 memo entitled *General Guidelines to Follow in Developing the Chemical Engineering Undergraduate Curriculum*. During the 1980's and 1990's the faculty followed these guidelines and attempted to provide individual course improvements. As a result of this earlier involvement, the EC2000 approach to assessment-based curriculum and program development were well received by the faculty as a whole.

Table 3-1 Curriculum Goals

Level of Importance	Curriculum Goals (July 1980)
Highest	1. Ability to think 2. Mastery of fundamental chemical engineering concepts 3. Ability to analyze "real world" problems arriving at feasible solutions. 4. Development of invention, innovation and creativity 5. Foster good communication skills including oral presentations before groups (co-workers, superiors, subordinates) and written communications 6. Develop a positive self-image (reliability, personal esteem, responsibility, professionalism)
Second	1. Ability to learn materials on own 2. Student has ability to work on open-ended research problems including project work, design problems, and individual research 3. Familiarity with analytical techniques and instrumentation 4. Ability to use library resources effectively 5. Ability to apply available computer software to solve routine problems and projects 6. Obtain hands-on experience with large and small equipment (including process control and data acquisition equipment) 7. Develop "common sense" and an understanding of physical reality
Third	1. Acquisition of advanced chemical engineering knowledge 2. Develop a broad educational background including non-chemical engineering technical material, social and philosophical subjects 3. Develop personal behavior management and human relationship skills (learning to recognize the rights and needs of others)

Table 3-2 Expected Levels of Performance

Level	Expected Levels of Performance (July 1980)
Sophomore	1. Proficiency in problem solving skills 2. Develop personal reputation and integrity (academic honesty) 3. Develop a familiarity with standard references (require Chemical Engineers' Handbook) 4. Require membership in Student Chapter of AIChE 5. Homework is to be submitted on time in the standard format 6. Development of good study habits (reading assigned text material, bringing text to class, etc.) 7. Student prepares meaningful notes from class lectures and reviews them as required 8. Student is able to work exams in fashion clear to instructor
Junior	1. As applicable from Sophomore Level 2. Student should be able to analyze physical situations, understand basic phenomena involved, and set up equations that describe the situation 3. Student should be able to eliminate extraneous material added to homework problems and exams 4. Acquire library skills in finding information in chemical engineering and other technical resources 5. Develop report writing skills 6. Perform laboratory experiments primarily involved with conformation of theory 7. Be able to use the computer to solve problems not having analytical solutions 8. Student should possess an understanding of chemical engineering as a profession and his/her role in the profession.
Senior	1. As appropriate from Sophomore and Junior Level 2. Student should be able to solve open-ended problems involving substantial understanding, analysis, and innovation. This will require determining what the problem is and how to come up with an appropriate solution 3. Student should be required to demonstrate independent thinking 4. Lecture courses should introduce the student to design-type problems 5. Student should possess excellent oral and written communication skills 6. Student should possess an understanding of the importance of economics to the chemical engineering profession 7. Student should be an analytical, independent chemical engineering professional

B.3.2. Process To Develop Program Educational Outcomes

The 2000-01 academic year was the first time that an EC2000 type of curriculum assessment process was introduced in the program. Prior to this point, a group of faculty where charged to prepare reports needed for our regional SACS accreditation and assessment activities. With the reorganization of the Department in 2002, an Undergraduate Program Committee (UPC) with a Curriculum and Accreditation Planning and Action Committee (CAPAC) was formed to handle accreditation and assessment activities as well as curriculum development. The UPC was effective in taking the work previously done for SACS and making it appropriate for our ABET accreditation. The program objectives and program educational outcomes were discussed repeatedly with our constituents and faculty before being adopted and finalized during our first faculty retreat (Fall 2002). Since that date, the UPC and CAPAC committees have worked to comprehensively consider all aspects of accreditation, assessment and curriculum development and to bring these matters to the attention of our constituency for their input and approval.

B.3.3. Department Of Chemical Engineering Program Educational Outcomes

The program educational outcomes are grouped into five general areas to identify the nature of the skills and capabilities involved. These groups are:

- Fundamentals – essential capabilities related to traditional scientific and engineering knowledge
- Analysis – creatively working with available data and engineering tools and fundamental knowledge to correctly solve basic problems
- Design – being able to perceive the best solution for both small-scale and large-scale projects by solving all required basic problems
- Ethics, Safety, Society, and Environment – giving appropriate consideration to matters pertaining to professionalism and ethics, safety, local and global society and the environment
- Work Skills – being an effective communicator and effective member of a team and to appreciate the need to continuously acquire skills and abilities

The department developed and adopted a set of eleven program educational outcomes that are presented in Table 3-3. Each outcome is identified with the group it belongs to as well as its relationship to ABET Criteria 3.

Table 3-3 Program Educational Outcomes

1. Our graduates will be able to apply mathematics, chemistry, physics, and engineering principles to solve chemical engineering problems. Although there will be an emphasis on chemical engineering principles, proficiency is also required in various general engineering and science areas as well. ***Fundamentals* (3a, 3b)**
2. Our graduates will be able to identify, formulate, and solve a range of chemical engineering problems employing the skills of critical thinking and creative problem solving in a systematic fashion. ***Analysis* (3e)**
3. Our graduates will be able to design and conduct experiments, as well as analyze and interpret data on chemical and chemical process systems. ***Analysis* (3b)**
4. Our graduates will be able to utilize the techniques, skills, and modern computational tools necessary for contemporary chemical engineering practice. This includes a proficiency in the use of computer hardware and software packages. ***Analysis* (3b, 3e, 3k)**
5. Our graduates will be able to design a system, component, or process to meet desired technical, economic, safety, and environmental criteria. They will be able to perform design calculations for a preliminary stage to full-scale plant design, and to conduct an economic evaluation of the process. ***Design* (3c, 3k)**
6. Our graduates will understand and appreciate the need for professional integrity and ethical decision making in the professional practice of chemical engineering***. Ethics, Safety, Society & Environment* (3f, 3h, 3j)**
7. Our graduates will demonstrate an understanding of contemporary issues encountered in the professional practice of chemical engineering including business practices, environmental, health, and safety issues and other public interests. Our graduates will be aware of the wide reaching effects that engineering decisions have on society, our global community and our natural environment. ***Ethics, Safety, Society & Environment* (3f, 3h)**
8. Our graduates will demonstrate an acceptable level of proficiency in written communications. ***Work Skills* (3g)**
9. Our graduates will demonstrate an acceptable level of proficiency in oral communications. ***Work Skills* (3g)**
10. Our graduates will be able to function successfully as a member of a multi-disciplinary team. They will be aware of leadership and group dynamics issues and exhibit a level of cooperation that allows for team productivity. ***Work Skills* (3d, 3g)**
11. Our graduates will appreciate the need for and engage in life-long learning to maintain and enhance the professional practice of chemical engineering. ***Work Skills* (3i)**

B.3.4. Program Educational Objectives and Program Educational Outcomes

The relationship between program educational objectives and program educational outcomes is illustrated in Table 3-4.

Table 3-4 Relationship Between Program Educational Objectives and Program Educational Outcomes

	Program Objective				
Program Educational Outcome	1. Develop within our graduates the technical proficiency needed for the professional practice of chemical engineering.	2. Develop within our graduates the ability to communicate their ideas effectively.	3. Provide our graduates with the basis for, and instill within them an appreciation of and a commitment towards lifelong scientific inquiry, learning and creativity.	4. Foster within our graduates the development of an appreciation and understanding for the need to maintain the highest ethical and professional standards.	5. Foster within our graduates a commitment to protect the public interest, health, and safety in their practice of the chemical engineering profession.
1. Our graduates will be able to apply mathematics, science, and engineering principles to solve chemical engineering problems. Although there will be an emphasis on chemical engineering principles, proficiency is also required in various general engineering and science areas as well.	☑				
2. Our graduates will be able to identify, formulate, and solve a range of chemical engineering problems systematically employing the skills of critical thinking and creative problem solving.	☑				
3. Our graduates will be able to design and conduct experiments, as well as analyze data, interpret and apply results to chemical systems and processes.	☑				
4. Our graduates will be able to utilize the techniques, skills, and modern computational tools necessary for contemporary chemical engineering practice. This includes a proficiency in the use of computer hardware and software packages.	☑				☑
5. Our graduates will be able to design a system, component, or process to meet desired technical, economic, safety, and environmental criteria. They will be able to perform design calculations from the conceptual stage to full-scale plant design, and to conduct an economic evaluation of the process.				☑	
6. Our graduates will understand and appreciate the need for professional integrity and ethical decision making in the professional practice of chemical engineering.				☑	☑
7. Our graduates will demonstrate an understanding of contemporary issues encountered in the professional practice of chemical engineering including business practices, environmental, health, and safety issues and other public interests. Our graduates will be aware of the wide reaching effects that engineering decisions have on society, our global community and our natural					☑

environment.					
8. Our graduates will demonstrate proficiency in written communications.		☑			
9. Our graduates will demonstrate proficiency in oral communications.		☑			
10. Our graduates will be able to function successfully as a member of a multi-disciplinary team. They will be aware of leadership and group dynamics issues and exhibit a level of cooperation that allows for team productivity.		☑			
11. Our graduates will appreciate the need for and engage in life-long learning to maintain and enhance the professional practice of chemical engineering.			☑	☑	

B.3.5. Relationship Of Program Educational Outcomes To EC2000 Criterion 3

The relationship between program educational objectives and program educational outcomes is illustrated in Table 3-5. This table illustrates that all ABET-mandated issues are accounted for in the department's program educational outcomes. In several instances, groups (such as combining contemporary issues, business practices, environment, health and safety issues) and rearrangements (such as breaking apart oral and written communications) were made to facilitate the collection and interpretation of assessment data.

Table 3-5 Relationship Between Program Educational Outcomes And ABET Criteria 3

	AUCHEN Program Outcome (short version)	ABET Criteria 3										
		3a	**3b**	**3c**	**3d**	**3e**	**3f**	**3g**	**3h**	**3i**	**3j**	**3k**
1	Apply mathematics, chemistry, physics, and engineering	✓	✓									
2	Identify, formulate, and solve chemical engineering.					✓						
3	Design and conduct experiments, analyze and interpret		✓									
4	Utilize the techniques, skills, and modern computational		✓			✓						✓
5	Design a system, component, or process			✓								✓
6	Professional integrity and ethical decision						✓		✓		✓	
7	Contemporary issues, business practices, environmental, health, safety issues						✓		✓		✓	
8	Proficiency in written communications							✓				
9	Proficiency in oral communications							✓				
10	Function successfully as a member of a multi-disciplinary team				✓			✓				
11	Engage in life-long learning									✓		

B.3.6. Process Used To Assess Program Outcomes

Methods Used to Collect Assessment Data

The department employs a variety of both direct and indirect assessment methods.

Direct Assessment Methods

Direct assessment methods require students to demonstrate knowledge and skills and provide data that directly measure achievement of expected outcomes. These currently include:

- Capstone design course experience
- Laboratory course experience
- Progress assessment exams (proficiency)

Each of these methods is discussed in detail below.

Rubrics Developed For Assessment

In order to standardize the measurement of performance, the following assessment rubrics are used:

1. Design project assessment rubric (Figure 3-1)
2. Written communication assessment rubric (Figure 3-2)
3. Oral communications assessment rubric (Figure 3-3)
4. Ethics, safety, society, environment assessment rubric (Figure 3-4)
5. Other work skills assessment rubric (Figure 3-5)
6. Data analysis / experimental design assessment rubric (Figure 3-6)

Capstone Design Course Experience

During CHEN 6470 Process Design Practice students are assigned to prepare a variety of reports, papers and presentations that are evaluated by faculty and external review teams. The following rubrics are employed during this evaluation: design project assessment rubric (Figure 3-1), written communication assessment rubric (Figure 3-2), oral communications assessment rubric (Figure 3-3), ethics, safety, society, environment assessment rubric (Figure 3-4), and other work skills assessment rubric (Figure 3-5).

Laboratory Course Experience

During CHEN 3820 Chemical Engineering Laboratory I and CHEN 4860 Chemical Engineering Laboratory II students participate in a variety of laboratory experiments and prepare reports, papers and presentations that are evaluated by faculty and external review teams. The following rubrics are employed during this evaluation: written communication assessment rubric (Figure 3-2), oral communications assessment rubric (Figure 3-3), and data analysis / experimental design assessment rubric (Figure 3-6).

Figure 3-1 Design Project Assessment Rubric

Department of Chemical Engineering
Auburn University

Design Project Assessment Rubric

Course No.: _____ Date: _____

Team/Student: _____ Reviewer: _____

Topic (Weight)	Unacceptable (0)	Marginal (1)	Acceptable (2)	Exceptional (3)	Points
Design Problem and Boundaries (1)	☐ Little or no grasp of problem. Incapable of producing a successful solution.	☐ Some understanding of problem. Major deficiencies that will impact the quality of solution.	☐ Overall sound understanding of the problem and constraints. Does not significantly impair solution.	☐ Clear and complete understanding of design goal and constraints.	
Alternative Designs (2)	☐ Only one design presented or clearly infeasible alternative given.	☐ Serious deficiencies in exploring and identifying alternative designs.	☐ Alternative approaches identified to some degree.	☐ Final design achieved after review of reasonable alternatives.	
Use of Computer–Aided Tools (2)	☐ Serious deficiencies in understanding the correct selection and/or use of tools.	☐ Minimal application and use of appropriate tools.	☐ Computer–aided tools used with moderate effectiveness to develop designs.	☐ Computer–aided tools are used effectively to develop and analyze designs.	
Application of Engineering Principles (2)	☐ No or erroneous application of engineering principles yielding unreasonable solution.	☐ Serious deficiencies in proper selection and use of engineering principles.	☐ Effective application of engineering principles resulting in reasonable solution.	☐ Critical selection and application of engineering principles ensuring reasonable results.	
Final Design (3)	☐ Not capable of achieving desired objectives. No implementation of resource conservation and recycle strategies.	☐ Barely capable of achieving desired objectives. Minimal utilization of resource conservation and recycle potentials.	☐ Design meets desired objectives. Moderately effective utilization of resource conservation and recycle potentials.	☐ Design meets or exceeds desired objectives. Effective implementation of resource conservation and recycle strategies.	
Process Economics (1)	☐ No or totally erroneous cost estimates presented.	☐ Reasonable cost estimates presented, but no profitability analysis included.	☐ Reasonable profitability analysis presented, but no interpretation of the results.	☐ Effective use of profitability analysis leading to improvement recommendations.	
Interpretation of Results (2)	☐ No or erroneous conclusions based on achieved results.	☐ Serious deficiencies in support for stated conclusions.	☐ Sound conclusions reached based on achieved results.	☐ Insightful, supported conclusions and recommendations.	
OVERALL PERFORMANCE	☐ **Unacceptable**	☐ **Marginal**	☐ **Acceptable**	☐ **Exceptional**	**TOTAL**
POINTS					

Figure 3-2 Written Communication Assessment Rubric

Department of Chemical Engineering
Auburn University

Written Communication Assessment Rubric

Course No.: _____ Date: _____

Team/Student: _____ Reviewer: _____

Topic (Weight)	Unacceptable (0)	Marginal (1)	Acceptable (2)	Exceptional (3)	Points
Organization & Style (2)	☐ Sequence of information is difficult to follow. No apparent structure or continuity. Purpose of work is not clearly stated.	☐ Work is hard to follow as there is very little continuity. Purpose of work is stated, but does not assist in following work.	☐ Information is presented in a logical manner, which is easily followed. Purpose of work is clearly stated assists the structure of work.	☐ Information is presented in a logical, interesting way, which is easy to follow. Purpose is clearly stated and explains the structure of work.	
Content & Knowledge (3)	☐ No grasp of information. Clearly no knowledge of subject matter. No questions are answered. No interpretation made.	☐ Uncomfortable with content. Only basic concepts are demonstrated and interpreted.	☐ At ease with content and able to elaborate and explain to some degree.	☐ Demonstration of full knowledge of the subject with explanations and elaboration.	
Format & Aesthetics (1)	☐ Work is illegible, format changes throughout, e.g. font type, size etc. Figures and tables are sloppy and fail to provide intended information.	☐ Mostly consistent format. Figures and tables are legible, but not convincing.	☐ Format is generally consistent including heading styles and captions. Figures and tables are neatly done and provide intended information.	☐ Format is consistent throughout including heading styles and captions. Figures and tables are presented logically and reinforce the text.	
Spelling & Grammar (1)	☐ Numerous spelling and grammatical errors.	☐ Several spelling and grammatical errors.	☐ Minor misspellings and/or grammatical errors.	☐ Negligible misspellings and/or grammatical errors.	
References (2)	☐ No referencing system used.	☐ Inadequate list of references or references in text. Inconsistent or illogical referencing system.	☐ Minor inadequacies in references. Consistent referencing system.	☐ Reference section complete and comprehensive. Consistent and logical referencing system.	
OVERALL PERFORMANCE	☐ **Unacceptable**	☐ **Marginal**	☐ **Acceptable**	☐ **Exceptional**	**TOTAL**
POINTS REQUIRED	0–6	7–13	14–20	21–27	

Figure 3-3 Oral Communications Assessment Rubric

Department of Chemical Engineering
Auburn University

Oral Communications Assessment Rubric

Course No.: _____ Date: _____

Team/Student: _____ Reviewer: _____

Topic (Weight)	Unacceptable (0)	Marginal (1)	Acceptable (2)	Exceptional (3)	Points
Organization & Structure (1)	☐ Not possible to understand presentation due to absence of structure.	☐ Difficult to follow presentation due to erratic topical shifts and jumps.	☐ Most information is presented in logical order which is easy to follow.	☐ All information is presented in a logical, interesting and novel sequence, which is easily followed.	
Content & Knowledge (3)	☐ No grasp of information. Unable to answer questions about subject.	☐ Uncomfortable with information. Capable only of answering rudimentary questions.	☐ At ease with content and able to elaborate and explain to some degree.	☐ Demonstration of full knowledge of the subject with explanations and elaboration.	
Visual Aids & Neatness (2)	☐ No visual aids.	☐ Occasional use of visual aids, however they barely support text or presentation. Several misspellings and/or grammatical errors on slides.	☐ Visual aids are related to text and presentation. Minor misspellings and/or grammatical errors.	☐ Text and presentation are reinforced by the use of visual aids. Negligible misspellings and/or grammatical errors.	
Delivery & Speaking Skills (2)	☐ Significant mumbling and incorrect pronunciation of terms. Voice level too low or too high. Monotonous, no eye contact, rate of speech too fast or too slow	☐ Occasional mispronunciation of terms. Little eye contact, uneven rate, only little expression	☐ Voice is clear and at a proper level. Most words pronounced correctly. Some eye contact, steady rate, excessively rehearsed	☐ Clear voice and correct, precise pronunciation of terms. Good eye contact, steady rate, enthusiasm, confidence	
Presentation Length (1)	☐ Too long or too short. +/– 10 minutes	☐ +/– 6 minutes	☐ +/– 4 minutes	☐ +/– 2 minutes	
OVERALL PERFORMANCE	☐ Unacceptable	☐ Marginal	☐ Acceptable	☐ Exceptional	TOTAL
POINTS REQUIRED	0–6	7–13	14–20	21–27	

Figure 3-4 Ethics, Safety, Society Envr Assessment Rubric

Department of Chemical Engineering
Auburn University

Ethics, Safety, Society, Environment Assessment Rubric

Course No.: _____ Date: _____

Team/Student: _____ Reviewer: _____

Topic (Weight)	Unacceptable (0)	Marginal (1)	Acceptable (2)	Exceptional (3)	Points
Professional Integrity & Ethical Decision Making (1)	☐ No evidence of any appreciation and/or understanding of professional integrity and/or ethics. Incapable of answering any questions on the subject.	☐ Serious deficiencies in appreciation and/or understanding of professional integrity and/or ethics. Only rudimentary questions are answered. Not able to elaborate or explain.	☐ Sound understanding of and mostly effective in addressing issues related to integrity and ethics. Most decisions and recommendations are supported and can be justified. Some elaboration and explanations given.	☐ Clear and complete understanding of and effective in addressing issues related to integrity and ethics. Decisions and recommendations are supported and discussed along with elaboration and explanation.	
Safety & Health Issues (1)	☐ No understanding or appreciation of safety and health related issues.	☐ Serious deficiencies in addressing health and safety issues leading to a unsupported and/or infeasible result.	☐ Sound understanding of health and safety issues. Mostly effective in achieving supported results.	☐ Complete understanding of health and safety issues leading to sound and supported results.	
Environmental Aspects (1)	☐ No understanding or appreciation of the importance of environmental concerns.	☐ Environmental aspects are addressed ineffectively with little or no effect on end results.	☐ Sound understanding of environmental aspects. Mostly effective in addressing environmental issues.	☐ Complete understanding of environmental aspects. Effective in addressing of environmental issues leading to a better result.	
Public Interest & Societal Impact (1)	☐ No consideration of public interest or societal impact. None or erroneous evaluation of global effects of engineering project/product.	☐ Serious deficiencies in understanding public interest and/or societal impact. Ineffective evaluation of impact of engineering project/product adversely affects result.	☐ Sound understanding of public interest and societal impact. Mostly effective evaluation of engineering project/product impact leads to improved results.	☐ Complete understanding of public interest and societal impact. Effective assessment of engineering project/product impact support and explain results.	
OVERALL PERFORMANCE	☐ Unacceptable	☐ Marginal	☐ Acceptable	☐ Exceptional	TOTAL
POINTS REQUIRED	0–3	4–6	7–9	10–12	

Figure 3-5 Other Work Skills Assessment Rubric

Department of Chemical Engineering
Auburn University

Other Work Skills Assessment Rubric

Course No.: _____ Date: _____

Team/Student: _____ Reviewer: _____

Topic (Weight)	Unacceptable (0)	Marginal (1)	Acceptable (2)	Exceptional (3)	Points
Need for Life-Long Learning (1)	☐ Little or no awareness and/or use of external sources of information. Little or no initiative to explore new learning opportunities. Unwilling to take risks by undertaking challenging or unfamiliar assignments, e.g. no initiative to learn new software.	☐ Some evidence of efforts to locate and use external resources. Some willingness to participate in learning activities and take risks. Some ability to use library/internet sources and e.g. new software packages.	☐ Reasonable awareness and use of external resources. Reasonable willingness to participate in learning activities and take risks. Adequate ability to locate and use library and Internet resources. Shows reasonable attempt to, e.g. learn new software packages.	☐ Fully aware of external sources of material. Effective use of supplementary resources. Actively seeks learning opportunities (reading, self-study, extra-curricular activities). Excellent ability to locate and use library and Internet resources. Seeks opportunities to learn new material, e.g. software packages.	
Teamwork (1)	☐ Little or no distribution of work efforts and responsibilities. Little or no ability to work together in a professional and productive manner adversely affecting end result.	☐ Minimal organization and planning with limited contributions of most team members. Significant deficiencies in leadership, cooperation and/or interaction. End result may suffer to some degree.	☐ Adequate organization and planning with contributions from all members of the team. Some leadership, planning and interaction is evident.	☐ Great organization and planning with full participation and technical contributions from all members. Utilizes technical strengths of each team member to full advantage leading to productive interaction.	
OVERALL PERFORMANCE	☐ **Unacceptable**	☐ **Marginal**	☐ **Acceptable**	☐ **Exceptional**	**TOTAL**
POINTS REQUIRED	0–1	2–3	4-5	6	

Figure 3-6 Data Analysis / Experimental Design Assessment Rubric

Department of Chemical Engineering
Auburn University

Data Analysis / Experimental Design Assessment Rubric

Course No.: _____ Date: _____

Team/Student: _____ Reviewer: _____

Topic (Weight)	Unacceptable (0)	Marginal (1)	Acceptable (2)	Exceptional (3)	Points
Effectiveness of Experimental Design and/or Procedures (2)	☐ Very ineffective. Would not allow experimenters to achieve any goals.	☐ Somewhat ineffective. Would allow experimenter(s) to achieve some goals.	☐ Somewhat effective. Would allow experimenter(s) to achieve most goals.	☐ Effective. Would allow experimenter(s) to achieve all goals.	
Execution of Procedures (1)	☐ Demonstrated little or no ability to conduct experiments. Did not collect meaningful data.	☐ Demonstrated some ability to conduct experiments. Collected some meaningful data.	☐ Demonstrated adequate ability to conduct experiments. Collected most of the needed data.	☐ Demonstrated superior ability to conduct experiments. Collected all the appropriate data.	
Statistical Methods: Error Analysis, Regression, ANOVA (2)	☐ Statistical methods were completely misapplied or absent.	☐ Statistical methods were attempted. Some methods were applied but with significant errors or omissions.	☐ Statistical methods were attempted. Most methods were correctly applied but more could have been done with the data.	☐ Statistical methods were fully and correctly applied.	
Focus of Results and Discussion (1)	☐ No insight. Entirely missed the point of the experiment.	☐ Little insight. Analyzed only the most basic points.	☐ Adequate insight. Missed some important points.	☐ Excellent insight. Results and discussion well focused.	
Interpretation of Data (2)	☐ Little or no attempt to interpret data or over-interpreted data.	☐ Interpreted some data correctly. Significant errors, omissions, or over-interpreted data.	☐ Interpreted most data correctly. Some conclusions may be suspect or over-interpreted.	☐ Data completely and appropriately interpreted. Not over-interpreted.	
OVERALL PERFORMANCE	☐ **Unacceptable**	☐ **Marginal**	☐ **Acceptable**	☐ **Exceptional**	**TOTAL**

Progress Assessment Exams (Proficiency)

Progress assessment exams are employed to broadly test the student's retention and ability to use prerequisite material. The subject matter includes math, chemistry, physics, chemical engineering. Some questions pertain to matters such as understanding professional/ethical responsibilities, impact of engineering on the global community and society, and contemporary issues.

- CHEN 2@@0 Chemical Engineering Progress Assessment I (sophomore-level)
- CHEN 3@@0 Chemical Engineering Progress Assessment II (junior-level)

The assessment exams are used as prerequisites for student enrollment in the capstone design course. Students must have passed both CHEN 2@@0 and CHEN 3@@0 by achieving a score of 70% or greater on both assessment exams.

Due to the sensitive nature of the assessment exams, copies of typical exams are not available in this document. They will be available for viewing at the time of the accreditation visit. Problems employed on the exams are taken from standard sources (such as study guides and textbook homework and example problems). The students are apprised of the specific sources used.

The courses in which these exams are given have only recently been approved by the university (Spring 2004), therefore assessment data from these exams are not available in this document. Data from the Spring 2004 and Summer 2004 offerings of CHEN 2@@0 will be available during the ABET visitation.

Indirect Assessment Methods

Indirect assessment methods such as surveys and interviews ask students to reflect on their learning, faculty to reflect on their teaching experiences and alumni to reflect on their experiences and preparedness for their career.

The department currently employs seven different types of surveys. Table 3-5 shows the audience that participates in each survey as well as what figure in the self-study report contains the survey questions. These figures are presented consecutively in this section. They are also available on-line at the following web links:

http://www.eng.auburn.edu/department/che/surveyforms/abetlinks.html

Table 3-5 Survey Instruments Employed

Survey Instrument	Audience	Figure
Senior Faculty and Course Survey	Graduating Seniors	Figure 3-7
Senior Exit Survey	Graduating Seniors	Figure 3-8
Senior Information Survey	Graduating Seniors	Figure 3-9
End of Course Student Survey	Students	Figure 3-10
Sophomore Survey	Entering Students	Figure 3-11
End of Course Faculty Survey	Faculty	Figure 3-12
Alumni Survey	Alumni	Figure 3-13

We employ software available from Survey Solutions software from Perseus Development Systems. This software allows the department to quickly prepare new web-based surveys which can be accessed from anywhere in the world. When the student, faculty or alumni complete the surveys, the results are instantly processed and sent by email to our survey account to be later retrieved and analyzed. The submissions are currently treated as anonymous so that the survey takers respond honestly and openly to the questions posed. To date, the rate of return on surveys varies between 50-90% depending on the specific survey. The software allows for preliminary statistical tabulation as well as report generation. This is our third year using this product. More information about the software can be found at the following web link:

http://www.perseus.com/

Exit Interviews (Senior Surveys)

Exit interviews (senior surveys) contain sections that specifically focus on student learning (knowledge, skills, abilities) in addition to the traditional questions of student satisfaction. The questions relate back directly to program outcomes that have been made familiar to the students throughout the curriculum. The interview/survey process is conducted at the end of each spring term by the departmental chair. Both oral comments and written evaluations are collected at this time.

- Senior Faculty and Course Survey – comments about course, faculty and curriculum issues
- Senior Exit Survey – includes questions directly reflecting the program outcomes
- Senior Information Survey – provides for personal and contact information
- Senior Interview –oral interview allows for students to express their thoughts about their total education experience

Student Course Surveys

Student surveys are conducted at the end of each course to gain information about the course and instructor but also to allow students to see the role between course outcomes and program

outcomes. It also serves to familiarize the students with survey-based assessment. Additional special purpose surveys are conducted to gauge student preparedness and perceptions.

- End of Course Student Survey – A custom designed survey is available for each core chemical engineering course reflecting the unique course outcomes associated with this course. Students are requested to do two evaluations for each course, one for the instructor (administered on behalf of the university) and one focusing on course and program outcomes. In addition to assigning numerical scores for various criteria, space is provided on the forms for students to make any additional comments. The results of the course evaluations are tabulated and statistically analyzed for each course. Numerical statistics are compiled for each question. The results of the student evaluation of the course outcomes and faculty comments are made available to faculty during the faculty retreats. Faculty are also required to provide brief written comments of their views on the extent to which the course outcomes were met in their courses. (See End of Course Faculty Survey).
- Sophomore Student Survey – Used to introduce the students to the survey software as well as establishing data about student attitudes and perceptions of the program.

Faculty Surveys

Faculty surveys are aimed at getting feedback about perceptions of student knowledge and skills as well as documenting changes made to the course to improve the mastery of course material. Faculty also reflect on the relationship between courses in the curriculum and how they can strengthen this subject matter dependence.

- Faculty End of Course Survey – A custom designed survey is available for each core chemical engineering course reflecting the unique course outcomes associated with this course as well as a generic version for elective courses in the curriculum.

Alumni Surveys

Alumni surveys are aimed at evaluating perceptions of knowledge, skills, and abilities gained while studying in the program.

- Alumni Survey – This survey targets alumni that have recently graduated (within the last 1-5 years). It includes program-specific survey questions. Our initial use of this survey was broadened as it was sent to all department alumni.
- COE Alumni Survey – This survey is conducted by the College of Engineering and targets alumni of the college. Although not specific to the chemical engineering program, a significant number of those polled graduated from the department. It is also felt the broad issues covered by the survey are appropriate for judging the important and validity of our program objectives and program educational outcomes. The current survey form can be found at the following web link:

  http://www.eng.auburn.edu/department/che/SGCOE 2003 Surveys/COE Alumni Survey Form.pdf

Employer (Industry) Survey

Employer surveys are aimed at evaluating an employer's perception of knowledge, skills, and abilities that recent graduates of the program have demonstrated on-the-job. The college of engineering currently conducts an Industry Survey and makes the results available to each engineering department. The last set of survey data available is from the survey of July 2003.

- Industrial Survey – This survey is conducted by the College of Engineering and targets employers who have hired and observed the work performance of recent graduates. The current survey form can be found at the following web link:

http://www.eng.auburn.edu/department/che/SGCOE 2003 Surveys/COE Industry Survey Form.pdf

Nationally Normed Surveys

The College of Engineering employs the EBI (Engineering Benchmark Industry) survey as a nationally normed survey. The EBI survey is completed during the spring semester and broadly addresses and overlaps many ABET EC2000 concerns. More information about the EBI survey is available at the following web link: http://www.webebi.com/AboutEBI/history.htm

Figure 3-7 Senior Faculty and Course Survey

Senior Faculty and Course Survey (Version April 2003)
Department of Chemical Engineering
Auburn University

Dear graduating seniors,

We have prepared this senior faculty/course survey to allow you to comment about our faculty and the courses you took from us. The information you provide in this survey is confidential and anonymous, therefore we ask you to make candid and constructive comments.

We thank you for your time and your participation in helping us continuously improve our program.

What CHEN courses or labs did you get the most benefit from? Which faculty members or graduate teaching assistants taught those courses?

What aspects of our CHEN courses or labs provided the greatest learning experiences? (e.g., design problems, experimental labs, computer labs, examples given in class, lots of homework, faculty going over homework in class, posting homework solutions, informal interactions with faculty, working in groups, etc.)

What aspects of our CHEN courses or labs provided the poorest learning experiences? Give constructive suggestions.

From what CHEN faculty member(s) did you learn the most (difference between initial knowledge and final knowledge of subject)?

From what CHEN faculty member(s) did you learn how to think (how to employ critical thinking skills, the most (difference between initial knowledge and final knowledge of subject)?

From what CHEN faculty member(s) did you learn the least? Why? How can that faculty member improve?

Do you have other constructive suggestions for improving the Chemical Engineering program?

Figure 3-8 Senior Exit Survey

Senior Exit Survey (Version April 2003)
Department of Chemical Engineering
Auburn University

Dear graduating seniors,

The ABET accreditation process requires our department to define program objectives and program outcomes and to establish an assessment procedure to determine whether these outcomes are being achieved. We recognize that our graduating seniors have a unique perspective on our program and its success in achieving these outcomes.

We have prepared this senior exit survey to allow you the opportunity to rate the department in each of the areas that have been identified as program educational outcomes. In addition, you will be able to provide valuable feedback to us by responding to a series of questions about your experiences while a student.

The results of the survey and personal interview are used by the department for allow us to improve the program. Your participation in this process is crucial and very much appreciated.

This information is being collected anonymously, therefore, we ask you to make candid and constructive comments. We thank you for your time and your participation in helping us continuously improve our program.

Part 1 - Why You Selected CHEN at Auburn

Where did you graduate from high school?
High School _____
City _____
State _____

High school graduation year

Do you think your high school preparation was adequate to successfully start your college experience?
❍ Yes ❍ No

If you answered "No" to the last question, please explain what skills or subject matter would have been helpful to successfully start your college experience.

What advice would you give high school students on preparation for CHEN?

What was the single most important factor that influenced you in choosing chemical engineering as a degree/professional career?

What was the single most important factor that influenced you in choosing Auburn to pursue your degree in chemical engineering?

Part 2 - Academic Profile

Did you follow a program specialization?
- ❍ Regular CHEN program
- ❍ Biochemical
- ❍ Computer Control
- ❍ Environmental
- ❍ Pre-Medical /Bio-Medical
- ❍ Pulp and Paper
- ❍ Technical Service
- ❍ Switched around between several of the above
- ❍ Started but did not finish a program specializations

Do you think program specializations are a good feature of the program?

How did you enter the chemical engineering program at Auburn?
- ❍ Entered as "new freshman"
- ❍ Switched into chemical engineering from another engineering program at Auburn
- ❍ Switched into chemical engineering from non-engineering program at Auburn
- ❍ Transferred from a junior college (what college?)
- ❍ Other (describe)

Did you participate in the co-op program?
❍ Yes ❍ No

If you did participate in co-op, how valuable to your career do you feel this experience was?

Did you participate in the Honors College program?
❍ Yes ❍ No

Extra Semesters: If a student enters the program as a "new freshman" and follows the published curriculum, it takes nine semesters to complete the program. For other situations (such as junior college transfers) the minimum number of semesters at Auburn to complete the program varies. Many students take "extra semesters" of courses for a variety of reasons.

How many extra semesters will you have enrolled in before finishing your degree requirements?
- ❍ finished ahead of schedule
- ❍ 0 (finished on schedule)
- ❍ 1 extra
- ❍ 2 extra
- ❍ 3 extra
- ❍ 4 extra
- ❍ 5 or more extra

Check all the applicable items if you took any extra semesters
- ❑ Took extra semester at Auburn to retake courses to get higher grade
- ❑ Took extra academic session (not at Auburn) to retake courses to get higher grade
- ❑ Took extra semester at Auburn to lighten semester load or get ahead
- ❑ Took extra academic session (not at Auburn) to lighten semester load or get ahead
- ❑ Transferring into Auburn required taking extra semesters
- ❑ Changing my major at Auburn required taking extra semesters
- ❑ Changing my specialization in Chemical Engineering required taking extra semesters
- ❑ Other reasons (specify)

Did you work at least part-time while completing your degree? This question concerns work during school terms (not summers, internships, or coop).
❍ Yes ❍ No

If you answered "Yes" to the last question, please indicate the type of work you did, the number of semesters you had a job, and the number of hours per week you typically worked during the school term.

What clubs, societies and organizations did you participate in?

How active were you in student professional organizations?
- ❍ Very Active
- ❍ Somewhat Active
- ❍ Not Very Active
- ❍ Did not belong to any professional organization

Part 3. Curriculum and Program Questions

How would you rate the advising you received from the Student Academic Advisor
- ❍ Excellent
- ❍ Very Good
- ❍ Good
- ❍ Fair
- ❍ Poor

How would you rate the advising you received by the department faculty (both formal and informal)?

- ❍ Excellent
- ❍ Very Good
- ❍ Good
- ❍ Fair
- ❍ Poor
- ❍ Never received any faculty advising

How satisfied were you with "out of class" faculty assistance in your courses?

- ❍ Very Satisfied
- ❍ Somewhat Satisfied
- ❍ Not Very Satisfied
- ❍ Not At All Satisfied

Please make any comments or suggestions about faculty availability or helpfulness?

Do you feel there is unnecessary "material overlap" (duplication of subject matter) in the curriculum?

Is there "missing material" (absent or incomplete coverage of subject matter) that you believe to be essential in the curriculum?

Do you have any comments regarding chemical engineering core courses?

Do you have any comments regarding chemical engineering technical electives?

Do you have any comments regarding the service courses you took? These courses would include chemistry, math, physics, electrical engineering, etc.

Do you have any comments regarding chemical engineering lab facilities, equipment, and courses? These courses would include Unit Ops I & 2, Process Control, Pulp and Paper Lab courses, etc.)

Do you have any comments regarding "on-campus" computer facilities?

Do you have any comments regarding the university core courses you took? These courses would include english, history, philosophy, fine arts, etc.

How would you characterize the department's integration and use of computer technology in the curriculum?

- ❍ Excellent
- ❍ Satisfactory
- ❍ Unsatisfactory
- ❍ Very poor

Do you have any suggestions how to better integrate computer technology in the curriculum?

Do you think the CHEN program prepared you adequately for your career?

- ❍ Strongly Agree
- ❍ Agree
- ❍ Neutral
- ❍ Disagree
- ❍ Strongly Disagree

What most hindered your academic success?

What most helped your academic success?

The next four questions asks you to comment about academic honesty issues. Two separate issues are addressed. (1) dishonest actions (copying someone else's material and claiming it to be theirs, "crib notes", passing calculators during exam with answers, etc.) and (2) unfairness issues (some people having access to old exams and professors who “reuse” the same problems on exam).

To what extent do you think "cheating" or other "dishonesty issues" are a problem in CHEN courses?

- ❍ Very serious (it is widespread and frequently)
- ❍ Quite serious (it happens far too often)
- ❍ Not very serious (it is only an occasional problem)
- ❍ Not a problem (have not been aware of any honesty problems)

Please provide any comments you have about "cheating" and "dishonesty issues" in CHEN courses.

To what extent do you think "unfairnesses" or other related issues are a problem in CHEN courses?

- ❍ Very serious (it is widespread and frequently)
- ❍ Quite serious (it happens far too often)
- ❍ Not very serious (it is only an occasional problem)
- ❍ Not a problem (have not been aware of any honesty problems)

Please provide any comments you have about "unfairnesses" in CHEN courses.

What other changes do you feel should be implemented to improve the curriculum?

Did you ever think about quitting the CHEN program?

- ❍ No
- ❍ Yes (please explain) _____

Part 4. Program Outcomes (Educational Goals)

Please tell us how well we have met the educational goals and program outcomes of our department by answering the following questions:

1. I am able to apply mathematics, science, and engineering principles to solve chemical engineering problems. Although the major emphasis was on chemical engineering principles, I am also proficient in general engineering and science areas as well.
❍Strongly Agree ❍Agree ❍Neutral ❍Disagree ❍Strongly Disagree

2. I can identify, formulate, and solve a range of chemical engineering problems systematically employing the skills of critical thinking and creative problem solving.
❍Strongly Agree ❍Agree ❍Neutral ❍Disagree ❍Strongly Disagree

3. I can design and conduct experiments, as well as analyze data, interpret and apply results to chemical systems and processes.
❍Strongly Agree ❍Agree ❍Neutral ❍Disagree ❍Strongly Disagree

4. I can utilize the techniques, skills, and modern computational tools necessary for contemporary chemical engineering practice. I am proficient in the use of computer hardware and software packages.
❍Strongly Agree ❍Agree ❍Neutral ❍Disagree ❍Strongly Disagree

5. I am able to design a system, component, or process to meet desired technical, economic, safety, and environmental criteria. I can perform design calculations from the conceptual stage to full-scale plant design, and to conduct an economic evaluation of the process.
❍Strongly Agree ❍Agree ❍Neutral ❍Disagree ❍Strongly Disagree

6. I understand and appreciate the need for professional integrity and ethical decision making in the professional practice of chemical engineering.
❍Strongly Agree ❍Agree ❍Neutral ❍Disagree ❍Strongly Disagree

7. I understand contemporary issues encountered in the professional practice of chemical engineering including business practices, environmental, health, and safety issues and other public interests. I am aware of the wide reaching effects that engineering decisions have on society, our global community and our natural environment.
❍Strongly Agree ❍Agree ❍Neutral ❍Disagree ❍Strongly Disagree

8. I am proficient in written technical communications.
❍Strongly Agree ❍Agree ❍Neutral ❍Disagree ❍Strongly Disagree

9. I am proficient in oral technical communications.
❍Strongly Agree ❍Agree ❍Neutral ❍Disagree ❍Strongly Disagree

10. I can function successfully as a member of a multi-disciplinary team. I am aware of leadership and group dynamics issues and exhibit a level of cooperation that allows for team productivity.
❍Strongly Agree ❍Agree ❍Neutral ❍Disagree ❍Strongly Disagree

11. I appreciate the need for, and I will engage in, life-long learning to maintain and enhance the professional practice of chemical engineering.
❍Strongly Agree ❍Agree ❍Neutral ❍Disagree ❍Strongly Disagree

Please provide any other comments you wish.

Figure 3-9 Senior Information Survey

Senior Information Survey (Version April 2003)
Department of Chemical Engineering
Auburn University

Dear graduating seniors,

We have prepared this senior information survey to allow us to collect information that will allow us to stay in touch with you and allow us to learn more about your employment situation. Some of this information also is used in our accreditation activities.

Your participation is very much appreciated. We thank you for your time and wish you success in your career objectives.

Part 1 - Personal Information

Name _____
Permanent Email _____
Permanent Address _____
Apt (etc) _____
City, State, ZIP _____

What semester do you anticipate meeting all graduation requirements?
Spring 2003
Summer 2003
Fall 2003
Spring 2004

Part 2 - Industrial (Military) Position Survey

What Type of Work will you seek (check all that apply):
Graduate or Professional School
Military Service
Research
Design
Management
Programming/Modeling
Maintanance
Owner/Operator
Teaching/Training
Manufacturing/Production
Sales/Marketing
Technical Service/Support
Environmental/Pollution Control
Safety Other _____

How many on-campus interviews at Placement Services did you have?

How many plant trips have you been on?

How many employment positions have you been offered?

Have you accepted an engineering position?

If you answered "yes", please provide the following information:
Employer _____
Location _____
Title or position _____

What is your approximate annual salary (optional)? LEAVE BLANK if you haven't accepted a position.
less than $45,000
$45,000-47,500
$47,500-50,000
$50,000-52,500
$52,500-55,000
$55,000-60,000
$60,000-70,000
more than $70,000

Would you like us to contact you about job opportunities we may learn about? We will use the permanent email address you provided above.
No
Yes

Part 3 - Graduate (Professional) School Survey

How many campus trips (interviews) have you been on?

How many graduate/professional school positions have you been offered?

Have you accepted a graduate/professional school offer?

If you answered "yes", please provide the following information:
University _____
Location _____
Program/Discipline _____
Degree sought _____

Please provide any other comments you wish.

Figure 3-10 Student End of Course Survey (typical)

Student End of Course Survey (CHEN 2610 used as example)
Department of Chemical Engineering
Auburn University

This survey is provided to collect student feedback for improving this course and the Auburn University Chemical Engineering program. Information collected will also be used for program accreditation purposes.

Important information about this survey:

(1) This survey is independent of information gathered in the standard university course evaluation.
(2) This is an evaluation of the course, not of the instructor. Comments and concerns about the instructor are collected during the standard university course evaluation.
(3) Your comments are anonymous. Answers provided will not affect your course grade. Please answer each item as candidly and fully as possible.

Part 1. Background

Please select the course number:

Please select the appropriate semester:

Please select the course instructor:

Part 2. Learning Issues

What most helped your learning the course materials and skills?

What most hindered your learning the course materials and skills?

In what areas do you need to improve to become an effective learner?

In what ways can the department facilitate your learning and become a more effective learner?

Part 3. Course Outcomes Evaluation

Important information about this section:

In this section you are asked to rate your capability in each of the course's outcomes on a 1 to 5 numerical scale. Use the following criteria to determine your response. Please take a few moments to acquaint yourself with these criteria.

1 = Weak <u>I am unfamiliar with the concept.</u> I cannot explain or employ the concept successfully. I cannot cite the underlying principles. I cannot answer questions about the concept.

2 = Developing <u>I can solve problems involving this concept only occasionally and with difficulty.</u> There are large gaps my knowledge. I rely on the book to be guided how to solve problems involving this concept. I answer questions about the concept with vagueness and ambiguity. My ability to explain or justify conclusions is weak and sporadic.

3 = Acceptable <u>I can apply the concept to straight-forward problems but not to problems where the principle isn't clearly identified.</u> My explanation of the concept is with difficulty and with some significant errors.

4 = Strong <u>I can almost always apply the concept successfully.</u> I have a sufficient but not complete understanding of the concepts involved. I can discuss the concepts with others but with some uncertainty. Problems I work involving this concept may contain minor errors.

5 = Exceptional <u>I can always apply the concept successfully.</u> I completely understand the concepts involved. I can explain the concept clearly to others. I can apply this concept correctly in situations having novel circumstances.

Course Outcomes Evaluation

1. Use the hydrostatic and barometric equations to determine pressure, density, or elevation for fluids at rest.
2. Explain and properly employ the concepts of absolute pressure, gauge pressure, buoyancy, and manometry.
3. Explain the concepts of streamline, stream tube, fluid acceleration, mass flow rate, volumetric flow rate, velocity profile, average velocity.
4. Use appropriate tables to find actual pipe and tubing dimensions given the nominal pipe size and schedule number.
5. Use the continuity equation for steady flow to calculate flow rates in closed conduits of constant and varying cross section, with and without multiple branches.
6. Determine volumetric flow rate, average velocity, momentum correction factor, kinetic energy correction fact for a given velocity profile.
7. Explain the concepts of Newtonian and non-Newtonian fluid, viscosity, laminar and turbulent flow, Reynolds number, pipe roughness, and friction factor.
8. Employ the equations for velocity profile, pressure drop, and friction factor for developed laminar flow of a Newtonian fluid in a circular pipe.
9. Calculate the friction factor for turbulent flow in a circular pipe and other simple geometries, given the Reynolds number and pipe roughness, using the friction factor plot and appropriate equations.
10. Calculate the mechanical energy loss due to friction in a piping system containing various kinds of valves and fittings.

11. Employ the mechanical energy balance to calculate required brake and fluid horsepower for specific piping configurations.
12. Use the mechanical energy balance to calculate flow rate or pipe sizes as appropriate.
13. Describe the characteristics of centrifugal and positive displacement pumps, and select an appropriate pump to deliver a specified flow rate.
14. Explain the concepts of form and skin drag. Explain the concepts of life and drag.
15. Calculate the drag on a submerged object of simple shape in a flowing fluid using drag coefficient correlations.
16. Explain the concepts of porosity, void fraction, specific volume, specific surface area, particle equivalent diameter.
17. Calculate pressure drop for flow through a packed bed in various flow regimes.
18. Explain the advantages and disadvantages of venturi meters, orifice meters, pitot tubes, rotameters to measure velocity or flow rate. Establish flow rate and velocity using these devices and appropriate equations.
19. Successfully solve closed and open-ended chemical engineering probems. Demonstrate critical thinking skills and strategic problem solving methods.
20. Demonstrate an appreciation of the responsibilities and expectations of the profession.
21. Successfully work as effective team members on group assignments.
22. Use appropriate computer software in solving homework problems.
23. Turn in (on time) classwork that is neat and professional in appearance and which is effective in conveying the solution.

Part 5. Student Expectations and Comments

Did the course meet your expectations?
- Exceeded my expectations
- Met my expectations
- Failed to meet my expectations

How did this course not meet your expectations?
What were the strongest features of this course?
What were the weakest features of this course?
How would you like to see this course changed in the future?

Figure 3-11 Sophomore Survey

Sophomore Information Survey
Department of Chemical Engineering
Auburn University

The Department of Chemical Engineering strives to seek input from our students to improve our program and be aware of the concerns of our student body. One way we seek this information is to periodically employ surveys where students submit their thoughts about particular questions.

This survey is specifically designed to be administered to students in CHEN 2100 (Process Principles) to learn about student perceptions about the chemical engineering curriculum, our courses, and those service courses that are taken as preparation for chemical engineering.

We appreciate your taking the time to carefully and thoughtfully fill out this survey. Information submitted via this form will be directed to the Undergraduate Program Committee Chair who will provide the information to the Process Fundamentals Committee and in particular those faculty who teach CHEN 2100.

PLEASE FEEL FREE TO BE ENTIRELY OPEN AND HONEST IN YOUR COMMENTS AND SUGGESTIONS. WE ARE TRULY INTERESTED IN YOUR FEELINGS AND EXPERIENCES.

Q. BasicData
Please provide the following information:
Name _____
Email address _____

Q. Classification
What is your current student classification?
- m 01 PCHEN
- m 02 CHEN
- m 03 CHEN
- m 04 CHEN
- m MS CHEN
- m PhD CHEN
- m Other

Q. ContactAndAssistance
It is important that students feel that they are part of the chemical engineering department and have access to us for advising and other academic assistance.
Do you feel we have done a good job providing this contact and assistance?
Do you have any suggestions how we can do a better job?

Q. MathSkills
During the freshman year, you were introduced to many important mathematics skills which you will use throughout your career.
How well prepared are you to use those skills and concepts?
Do you have specific comments about the math courses you have already taken?

Q. ChemistrySkills
During the freshman year, you took general chemistry and were introduced to many important chemistry concepts which you will use throughout your career.
How well prepared are you to use those skills and concepts?
Do you have specific comments about the chemistry courses you have already taken?

Q. Impressions2100
Students often come to a new course having received impressions from their fellow students who have taken the course in the past.
We would be interested in knowing what students expect of this course (CHEN 2100-1 Lecture and Lab) based on student comments.

Q. ImpressionsDept
Students within a department frequently develop impressions based on what fellow students say or based on their personal experiences.
We would be interested in knowing what are your perceptions of the department based on either your own experiences or those which you have heard from other students.

Q. EffectiveLearning
How familiar are you with effective study techniques, effective exam taking strategies, and effective problem solving skills?

Q. ThreeReasons
What are the three most important reasons you choose chemical engineering?

Q. ComputersComfort
What is your general "comfort level" with using computers?

Q. ComputersSoftware
What software (types or specific programs) are you proficient with?

Q. OwnComputer
Do you own your own computer?
- m No
- m Laptop
- m Desktop
- m More than one computer

Q. FieldOfInterest
Chemical Engineers work in an amazing variety of fields.

What area or areas interest you the most?
Check as many as you wish.
- q Alternative Energy (Solar, Fuel Cells)
- q Biotechnology
- q Chemical Processing
- q Cosmetics/Detergents
- q Environmental
- q Food and Beverage Processing
- q Nanotechnology
- q Pulp and Paper
- q Petroleum and Natural Gas
- q Pharmaceuticals
- q Medicine
- q Plastics and Composite Materials
- q Recycling and Remediation
- q Semiconductors and Materials
- q Technical Sales and Marketing
- q Other (specify) _____

Q. NegativeExp
Have you had any particularly negative experiences while you have been associated with our department?

Q. PositiveExp
Have you had any particularly positive experiences while you have been associated with our department?

<hr>
Q. OtherComments
Please provide any other comments you wish.
<hr>Thank you for your input !

Figure 3-12 Faculty End of Course Survey (typical)

Faculty End of Course Survey (CHEN 2610 used as example)
Department of Chemical Engineering
Auburn University

Dear Chemical Engineering Faculty,

As part of the department's assessment activities, an End of Course Faculty Survey is conducted in all undergraduate chemical engineering courses each term. The survey looks at two main issues: (1) how effective is the course in helping students develop proficiency in our program educational outcomes and (2) how effective is the course in achieving the course outcomes developed for the course.

All our courses can be evaluated on the first issue but only those courses with published course outcomes (limited to our core courses) can be evaluated on the second issue. For courses without "official outcomes" there is a "generic survey".

This survey should be completed at the earliest possible date convenient following final exams but must be submitted no later than one week after the end of final exams. It is suggested you attend to this as soon as possible so that your recollections are fresh and so the survey can be concentrated on before the rush of getting ready for the next term.

It is appreciated that this is a new survey instrument and it will take some time to become familiar with its approach to collecting assessment data. We would appreciate any comments you have about the clarity of these instructions or the wording or purpose of the various survey questions. Please use the area at the end of the survey for that purpose.

Part 1. Basic Course Data

Please select the course number:
Please select the appropriate semester:
Please select the course instructor:

Please indicate the number and percentage of students with each grade.

Number of: A's ____ B's ____ C's ____ D's ____ F's ____
W's ____ IN's ____

Percent of: A's ____ B's ____ C's ____ D's ____ F's ____
W's ____ IN's ____

Part 2. Impact of Course in Achieving Program Educational Outcomes (PEO's).

Please estimate the extent to which this course as taught this term contributed to the students achieving (formally or informally) each AUCHEN program educational outcome. It should be remembered that most courses are not designed to emphasize all these items and some make no contribution to some of these items.

Use the following scale for your evaluation.

1 = None 2 = Limited 3 = Modest 4 = Significant 5 = Very Significant

Program Objectives Contribution

1. Apply mathematics, science and engineering principles
2. Identify, formulate, and solve chemical engineering problems systematically
3. Design and conduct experiments, analyze data and interpret results
4. Utilize modern computational tools including computer software
5. Design a system, component, or process
6. Professional integrity and ethical decision
7. Contemporary issues, business practices, environmental, health, safety
8. Proficiency in written communications
9. Proficiency in oral communications
10. Function successfully as a member of a multi-disciplinary team
11. Engage in life-long learning

Do you have any suggestions for ways your course can better meet these objectives?

Part 3. Student Preparedness (Prerequisite Skills and Knowledge)

The following section asks you to provide information about whether the students taking the course this term were adequately prepared (in terms of prerequisite skills and knowledge). This information is used to improve the preparedness of our students to be successful in their courses.

Estimate the percentage of students who were prepared at each level
Percent Adequately Prepared To Succeed _____
Percent With Moderate Deficiencies That Hindered Success _____
Percent With Severe Deficiencies That Compromised Success _____

Check the topics in which there were deficiencies (check as many as apply)
Math
Chemistry
Physics
Computers
Chemical Engineering

List specific information about deficiencies (topics, extents of problem, etc).

Part 4. Changes Made to Course To Better Meet Course Outcomes and Program Outcomes

Please discuss any changes you have made to the course to better meet this course's outcomes or to meet the department's program educational outcomes. This could include special topics covered, examples taken from "real life" (real world issues), group projects, handouts developed to help overcome deficiencies, handouts developed to enhance learning skills, etc.

Part 5. Other Suggestions, Concerns and Observations

The following section asks you to provide information about issues not previously addressed. Please feel free to discuss any concerns, suggestions or observations concerning this course.

What recommendations do you have for improvements or changes in the course?

What recommendations do you have for improvements or changes in the chemical engineering program and curriculum that would improve this course (e.g., changes to prerequisite courses that would improve student preparation for this course, etc.)?

Do you have any other recommendations or comments not covered above?

Part 6. Attainment of Course Outcomes

Instructions: Please provide your assessment about how effective you feel this course is in meeting each of the published course outcomes. Use the following scale for your evaluation.

1 = Poor Students are in general unfamiliar with the concept. They cannot explain or employ the concept successfully. They cannot cite the underlying principles. They cannot answer questions about the concept.

2 = Weak Students can solve problems involving this concept only occasionally and with difficulty. There are large gaps their knowledge. They rely on the book to be guided how to solve problems involving this concept. They answer questions about the concept with vagueness and ambiguity. THeir ability to explain or justify conclusions is weak and sporadic.

3 = Acceptable Student can apply the concept to straight-forward problems but not to problems where the principle isn't clearly identified. Their explanation of the concept is with difficulty and with some significant errors.

4 = Strong Students can almost always apply the concept successfully. They have a sufficient but not complete understanding of the concepts involved. They can discuss the concepts with others but with some uncertainty. Problems they work involving this concept may contain minor errors.

5 = Exceptional Students can always apply the concept successfully. They completely understand the concepts involved. They can explain the concept clearly to others. They can apply this concept correctly in situations having novel circumstances.

Attainment of Course Outcomes
1. Use the hydrostatic and barometric equations to determine pressure, density, or elevation for fluids at rest.
2. Explain and properly employ the concepts of absolute pressure, gauge pressure, buoyancy, and manometry.
3. Explain the concepts of streamline, stream tube, fluid acceleration, mass flow rate, volumetric flow rate, velocity profile, average velocity.
4. Use appropriate tables to find actual pipe and tubing dimensions given the nominal pipe size and schedule number.
5. Use the continuity equation for steady flow to calculate flow rates in closed conduits of constant and varying cross section, with and without multiple branches.

6. Determine volumetric flow rate, average velocity, momentum correction factor, kinetic energy correction fact for a given velocity profile.
7. Explain the concepts of Newtonian and non-Newtonian fluid, viscosity, laminar and turbulent flow, Reynolds number, pipe roughness, and friction factor.
8. Employ the equations for velocity profile, pressure drop, and friction factor for developed laminar flow of a Newtonian fluid in a circular pipe.
9. Calculate the friction factor for turbulent flow in a circular pipe and other simple geometries, given the Reynolds number and pipe roughness, using thefriction factor plot and appropriate equations.
10. Calculate the mechanical energy loss due to friction in a piping system containing various kinds of valves and fittings.
11. Employ the mechanical energy balance to calculate required brake and fluid horsepower for specific piping configurations.
12. Use the mechanical energy balance to calculate flow rate or pipe sizes as appropriate.
13. Describe the characteristics of centrifugal and positive displacement pumps, and select an appropriate pump to deliver a specified flow rate.
14. Explain the concepts of form and skin drag. Explain the concepts of life and drag.
15. Calculate the drag on a submerged object of simple shape in a flowing fluid using drag coefficient correlations.
16. Explain the concepts of porosity, void fraction, specific volume, specific surface area, particle equivalent diameter.
17. Calculate pressure drop for flow through a packed bed in various flow regimes.
18. Explain the advantages and disadvantages of venturi meters, orifice meters, pitot tubes, rotameters to measure velocity or flow rate. Establish flow rate and velocity using these devices and appropriate equations.
19. Successfully solve closed and open-ended chemical engineering probems. Demonstrate critical thinking skills and strategic problem solving methods.
20. Demonstrate an appreciation of the responsibilities and expectations of the profession.
21. Successfully work as effective team members on group assignments.
22. Use appropriate computer software in solving homework problems.
23. Turn in (on time) classwork that is neat and professional in appearance and which is effective in conveying the solution.

Do you have any suggestions improve the effectiveness of meeting any of the course's outcomes?

Do you feel any of the course's outcomes should be deleted?

Do you feel any of the course's outcomes should be modified? Provide a specific rewording of the outcome and discuss your recommendation.

Do you feel there should be additional course outcomes. Provide a specific wording of the outcome and discuss your recommendation.

Part 7. Any Last Thoughts

Do you have suggestions on how to improve this survey? Please provide any other comments you wish.

Figure 3-13 Alumni Survey

Alumni Survey (Version 2003a)
Department of Chemical Engineering
Auburn University

Dear Chemical Engineering Alumni,

Thank you for taking the time to participate in our Alumni Survey.

The ABET accreditation process requires our department to define program objectives and program outcomes and to establish an assessment procedure to determine whether these outcomes are being achieved.

We recognize that our alumni are a valuable resource for assessing the quality of our program and for developing suggestions to improve it. We have prepared a survey which will give you an opportunity to rate the department in each of the areas that have been identified as desired program objectives and educational outcomes. You will also have a chance to list your own specific suggestions for improving our program, including your interest in participating in curriculum development activities.

We thank you for your time and your participation in helping us continuously improve our program.

Part 1. General Information

Name _____
Address _____
City/State/ZIP _____
Email Address _____
Current Employer _____
Employer Location (City/State/ZIP)
_____
Job Title _____

What Auburn University chemical engineering degree(s) did you obtain?
BS ChE
MS ChE
PhD ChE
M ChE (non-thesis)
Other _____

When did you receive your last chemical engineering degree
Year (as 19xx or 20xx) _____

Job Description or Type of Work (check all that apply):
Education
Research
Design
Management
Programming
Maintanance
Owner/Operator
Teaching/Training
Manufacturing/Production
Sales/Marketing
Technical Service/Support
Environmental/Pollution Control
Safety
Other _____

Part 2. Program Objectives

Program Objectives are the general qualities expected of engineering graduates to meet the needs of "constituents" (typically students, alumni, employers and industry). As alumni, your evaluation of our program objectives is important to our being able to respond to the changing and evolving needs of the profession and society.

Please rate each of our program objectives in terms of how appropriate they are to the department's educational mission. Use the following scale for your responses

Very Appropriate Appropriate Neutral
Inappropriate Very Inappropriate

Program Objectives Appropriateness

1. Develop within our graduates the technical proficiency needed for
the professional practice of chemical engineering.
2. Develop within our graduates the ability to communicate
effectively.
3. Instill within our graduates a commitment towards lifelong scientific
inquiry, learning and creativity.
4. Foster within our graduates a commitment to protect the public
interest, health, safety, and environment in the practice of the
chemical engineering profession.
5. Foster within our graduates an understanding of the need to
maintain the highest ethical and professional standards.

Please rate each of our program objectives in terms of how successful we were in achieving them (while you were a student) in our program. Use the following scale for your responses

Highly Successful Successful Neutral
Unsuccessful Very Unsuccessful

Program Objectives Success

1. Develop within our graduates the technical proficiency needed for
the professional practice of chemical engineering.
2. Develop within our graduates the ability to communicate
effectively.
3. Instill within our graduates a commitment towards lifelong scientific
inquiry, learning and creativity.
4. Foster within our graduates a commitment to protect the public
interest, health, safety, and environment in the practice of the
chemical engineering profession.
5. Foster within our graduates an understanding of the need to
maintain the highest ethical and professional standards.

Do you have any suggestions for ways to better meet these objectives?

Do you have any suggestions to modify, add or delete any of these objectives?

Part 3. Program Educational Outcomes

Program Educational Outcomes are the qualities of graduating engineering students that arise from the educational activities of the program that lead to the achievement of the Program Objectives.

Please rate each of our Program Outcomes in terms of the strength of coverage while you were a student at Auburn University and in terms of its subsequent importance to you on the job.

Strength of coverage while a student...
Very thorough Thorough Adequate
Inadequate Very inadequate

Subsequent importance on the job...
Very important Important Neutral
Unimportant Very unimportant

1. Our graduates will be able to apply mathematics, science, and engineering principles to solve chemical engineering problems. Although there will be an emphasis on chemical engineering principles, proficiency is also required in various general engineering and science areas as well.

2. Our graduates will be able to identify, formulate, and solve a range of chemical engineering problems systematically employing the skills of critical thinking and creative problem solving.

3. Our graduates will be able to design and conduct experiments, as well as analyze data, interpret and apply results to chemical systems and processes.

4. Our graduates will be able to utilize the techniques, skills, and modern computational tools necessary for contemporary chemical engineering practice. This includes a proficiency in the use of computer hardware and software packages.

5. Our graduates will be able to design a system, component, or process to meet desired technical, economic, safety, and environmental criteria. They will be able to perform design calculations from the conceptual stage to full-scale plant design, and to conduct an economic evaluation of the process.

6. Our graduates will understand and appreciate the need for professional integrity and ethical decision making in the professional practice of chemical engineering.

7. Our graduates will demonstrate an understanding of contemporary issues encountered in the professional practice of chemical engineering including business practices, environmental, health, and safety issues and other public interests. Our graduates will be aware of the wide reaching effects that engineering decisions have on society, our global community and our natural environment.

8. Our graduates will demonstrate proficiency in oral communication.

9. Our graduates will demonstrate proficiency in written communications.

10. Our graduates will be able to function successfully as a member of a multi-disciplinary team. They will be aware of leadership and group dynamics issues and exhibit a level of cooperation that allows for team productivity.

11. Our graduates will appreciate the need for and engage in life-long learning to maintain and enhance the professional practice of chemical engineering.

Part 4. Other Questions and Comments
Please take a few minutes to complete this section of the survey. You may add any comments you wish in this section.

Have you engaged in professional development by attending professional seminars/professional society meetings?
Yes No

Have you engaged in professional development by pursuing a graduate degree or professional certification?
Yes No

How do you rate your preparation relative to that of your peers from other institutions?

- Superior to peers
- Somewhat better than peers
- Same as peers
- Worse than peers

Please rate the AUCHEN BS degree program's overall effectiveness in preparing you for your job or graduate study.

- Excellent
- Good
- Fair
- Poor

Based on your post-graduation experience, what software products or computer related techniques should receive coverage in the AUCHEN BS degree program?

Based on your post-graduation experience, what, if any, areas of study should receive more emphasis in the AUCHEN BS degree program?

Please provide any other comments you wish.

Performance Criteria

Each of the assessment methods that yield quantitative data (such as rubrics and numerical responses to survey questions) has a three-tiered performance criteria associated with it. We seek to differentiate between those areas where we have met the program educational outcome target performance and those areas needing minor or significant improvement. These levels are:

- Level A – The assessment data for this program outcome is consistent with departmental performance expectations. Discussions with constituents will be conducted to continue to improve performance for this program outcome. Appropriate adjectives are "on target" and "satisfactory."
- Level B – The assessment data for this program outcome is slightly below the target value. Attention should be paid to this area by the department, and discussions with constituents to improve performance are appropriate. Minor changes to the curriculum should be satisfactory to improve the situation. Appropriate adjectives are "below target" and "needs improvement".
- Level C – The assessment data for this program outcome is much below the target value. Significant attention should be paid to this area, and discussions with constituents are essential. Major and minor changes to the curriculum may be necessary to remedy the situation. Appropriate adjectives are "well below target" and "needs significant improvement".

The CAPAC committee is responsible for reviewing and modifying the specific criteria associated with each level.

Table 3-6 provides information about how each assessment method is employed to establish a performance criterion.

Table 3-6 Performance Criteria for Specific Assessment Methods

Assessment Data Collected from Senior Exit Survey

Level A	Greater than 85% of the students "Strongly Agree" or "Agree" with the survey question and no more than 5% "Disagree" or "Strongly Disagree"
Level B	Between 75% - 85% of the students "Strongly Agree" or "Agree" with the survey question.
Level C	Less than 75% of the students "Strongly Agree" or "Agree" with the survey question.

Assessment Data Collected via Rubric Employed in Capstone Design Course

Level A	Greater than 95% of the students are judged "Exceptional" or "Acceptable" with reference to the maximum rubric score* for this program outcome.
Level B	Between 90% - 95% of the students are judged "Exceptional" or "Acceptable" with reference to the maximum rubric score* for this program outcome.
Level C	Less than 90% of the students are judged "Exceptional" or "Acceptable" with reference to the maximum rubric score* for this program outcome.

* = maximum rubric score is the number of rubric topics (questions) related to a particular program educational outcome (see "Rubric Topic Matrix")

Assessment Data Collected via Rubric Employed in Laboratory Courses

Level A	Greater than 95% of the students are judged "Exceptional" or "Acceptable" with reference to the maximum rubric score* for this program outcome.
Level B	Between 90% - 95% of the students are judged "Exceptional" or "Acceptable" with reference to the maximum rubric score* for this program outcome.
Level C	Less than 90% of the students are judged "Exceptional" or "Acceptable" with reference to the maximum rubric score* for this program outcome.

maximum rubric score is the number of rubric topics (questions) related to a particular program educational outcome (see "Rubric Topic Matrix")

Assessment Data Collected via Progress Assessment Examination Courses (CHEN 2@@0 and CHEN 3@@0)

Level A	At least 50% of the students taking the exam the first time pass (grade 70% or more). At least 80% of students pass the exam by the third time taken (during the first time the course is taken).
Level B	At least 40% of the students taking the exam the first time pass (grade 70% or more). At least 70% of students pass the exam by the third time taken (during the first time the course is taken).
Level C	Fewer than 30% of the students taking the exam the first time pass (grade 70% or more). Fewer than 60% of students pass the exam by the third time taken (during the first time the course is taken).

Assessment Data Collected via EBI Survey Questions

Note (1): The questions utilized for assessment from the EBI survey ask questions in the following sense:
"To what degree did your education enhance your ability to…
Benchmarks are only provided by EBI for ratings of "1", "4" and "7". A middle or average score would thus be interpreted as "moderately". This leave open what "descriptor" the students will associated with 2, 3, 5, and 6. It is suggested that upon distributing the EBI survey, a complete descriptor is provided. The below descriptors are suggested to the students.

1	2	3	4	5	6	7
not at all	slightly	somewhat	moderately	significantly	very significantly	extremely

Note (2): EBI results are not available in a "frequency format" … only as a question average. Hence, the performance criteria must be based either on the average value of all students or by ranking compared to selected groups/institutions.

Two independent desirable items are reflected in the scoring and analysis provided by EBI. Obviously getting a numerically high score (independent of what scores are obtained at other universities) is an important indicator. If the descriptor "significantly" is associated with a response of "5", then it is fair to say one measure of success is if the average student believes he/she has had their abilities enhanced "significantly". On the other hand, there is considerable variation in the scores across schools (and that is reflected in the CC average value). If everyone in the nation tends to sees their education only enhancing their ability to the extent of 4.50 and AUCHEN students respond 4.80 to this same questions, that also seems to indicate "we are doing a satisfactory job." By contrast, if we fall far below the CC average values (regardless of numerical value) we should attempt to improve the situation. Hence a second important factor is the "ranking" of AUCHEN students among CC-schools.

Level A	Rank is in upper 50% of all CC schools and the average survey score for this program outcome is greater than 5.0
Level B	Level B contains all cases not assigned to Level A or Level C.
Level C	Rank is in the lower 20% of all CC schools and/or average survey score for this program outcome is less than 4.5

* = maximum survey score is the number of survey questions related to a particular program educational outcome (see "EBI Survey Matrix")

Assessment Data Collected from Alumni Survey

Level A	Greater than 80% of the alumni respondents find the strength of coverage "Very Thorough" or "Thorough" with no more than 5% responding that the strength of coverage was "Inadequate" or "Very Inadequate".
Level B	Greater than 60% of the alumni respondents find the strength of coverage "Very Thorough" or "Thorough" with no more than 10% responding that the strength of coverage was "Inadequate" or "Very Inadequate".
Level C	Less than 60% of the alumni respondents find the strength of coverage "Very Thorough" or "Thorough" or more than 20% responding that the strength of coverage was "Inadequate" or "Very Inadequate".

Note: This is "post tassel" data and requires interpretation.

Assessment Data Collected from Industry Survey At present the department has not finalized a survey specifically tailored for distribution to employers and representative industry. Data is being collected informally through discussions with recruiters and from alumni who are active in hiring and evaluation.
Assessment Data Collected from COE Alumni Survey The data collected from the COE Alumni Survey is used to indirectly assess the appropriateness and continued use of Departmental Program Objectives and Program Educational Outcomes. Since the survey is distributed to COE alumni from all disciplines, the results are interpreted to broadly represent all engineering disciplines including Chemical Engineering.
Assessment Data Collected from COE Industry Survey The data collected from the COE Industry Survey is used to indirectly assess the appropriateness and continued use of Departmental Program Objectives and Program Educational Outcomes. Since the survey is distributed to COE alumni from all disciplines, the results are interpreted to broadly represent all engineering disciplines including Chemical Engineering.

Timetable for Assessment Methods

Table 3-7 outlines the schedule followed in collecting assessment data via the methods described above:

Table 3-7 Schedule For Assessment Activities

Item	Format	Schedule	Notes	When Available
End Of Course Student Survey	On-line	Each semester	Students take this survey in all core chemical engineering courses during the last week of classes	Spring Faculty Retreat
End of Course Faculty Survey	On-line	Each semester	Faculty take this survey in all chemical engineering courses during after final grades have been submitted.	Spring Faculty Retreat
Senior Exit Survey	On-line and in person	Each spring term	Taken by graduating seniors. Includes assessment information, course/faculty information and general information.	Fall Faculty Retreat
EBI Survey	Machine form	Each spring term	Taken by graduating seniors.	Fall Faculty Retreat
CHEN 2@@0 Progress Assessment I	Multiple choice exam	The exam is offered three times each term	First offering Spring 2004	Spring Faculty Retreat
CHEN 3@@0 Progress Assessment II	Multiple choice exam	The exam is offered three times each term	First offering Fall 2004	Spring Faculty Retreat
Alumni Survey	On-line	Periodic	Available On-line continuously but employed via invitation approximately every three years. Last used during Fall 2004	Fall Faculty Retreat
Industry Survey	Mailed by College of Engineering	Irregular	Used in 1995 and Fall 2003	Irregular
Design Rubrics (4)	Rubric form	Each spring term	Used in capstone design course	Fall Faculty Retreat
Lab Rubrics (1)	Rubric form	Each spring term	Used in senior lab course	Fall Faculty Retreat
Sophomore Survey	On-line	Each term	Taken by entering CHEN students in CHEN 2100	Spring Faculty Retreat
Miscellaneous Surveys	On-line	As needed	The department constructs new on-line surveys according to need (such as academic honesty and student opinion polls).	As available

B.3.7. Relationship Between Assessment Methods and Program Educational Outcomes

Different assessment tools (methods, surveys, and rubrics) are used to assess each program educational outcome. Table 3-8 outlines the relationship between assessment methods (tools) and program educational outcomes. Each tool can provide primary numerical data (suitable for direct use) designated "P", secondary numerical data (requiring additional interpretation before use) designated "S", and textual data (written comments, etc., that can provide very valuable insight into curriculum and program matters) designated "T". In some cases, the method can produce different types of data (P/T, etc.).

Table 3-8 Relationship Between Assessment Methods and Program Educational Outcomes

Outcome	Description (Short)	Senior Exit Survey	Rubrics						Progress Assessment Exam 1	Progress Assessment Exam 2	EBI Survey (Questions Analyzed)	Faculty End of Course Survey	Alumni Survey	Employer Survey**
			Design	Written Communication	Oral Communications	Work Skills	Ethics, Safety, Society, Environment	Data Analysis / Experimental Design						
1	Apply math science engineering	P/T	P						P	P	52,53,54	T	S	S
2	Identify formulate solve problems	P/T	P						P	P	43,55,56	T	S	S
3	Design conduct experiments analyze data	P/T						P		P	38,39,40	T	S	S
4	Utilize computational skills	P/T	P							P	46	T	S	S
5	Design system component process	P/T	P				P			P	41	T	S	S
6	Professional integrity ethical decision making	P/T					P			P	44	T	S	S
7	Environment safety health society public interest	P/T					P			P	45,57	T	S	S
8	Written communications	P/T		P						P	48	T	S	S
9	Oral communications	P/T			P					P	47	T	S	S
10	Multidisciplinary teaming	P/T				P				P	42	T	S	S
11	Lifelong love of learning	P/T				P				P	51	T	S	S

P Primary data w/performance criteria
S Secondary data w/o performance criteria or post-tassel data
T Textual data requiring interpretation

**Numbering as of Spring 2003 EBI Survey **A formal survey is under consideration but not yet in use..*

B.3.8. Processes To Assure That Educational Outcomes Are Achieved

In this section we describe how we analyze the data obtained from our assessment activities, discuss the results with our constituents and develop action plans for improving the curriculum and program.

Figure 3-13 shows schematically the flow of data, interpreted results, action plans and curriculum changes amongst various departmental committees and constituents. At the heart of the process is the CAPAC committee that is responsible for coordinating various assessment activities and the flow of the resulting data.

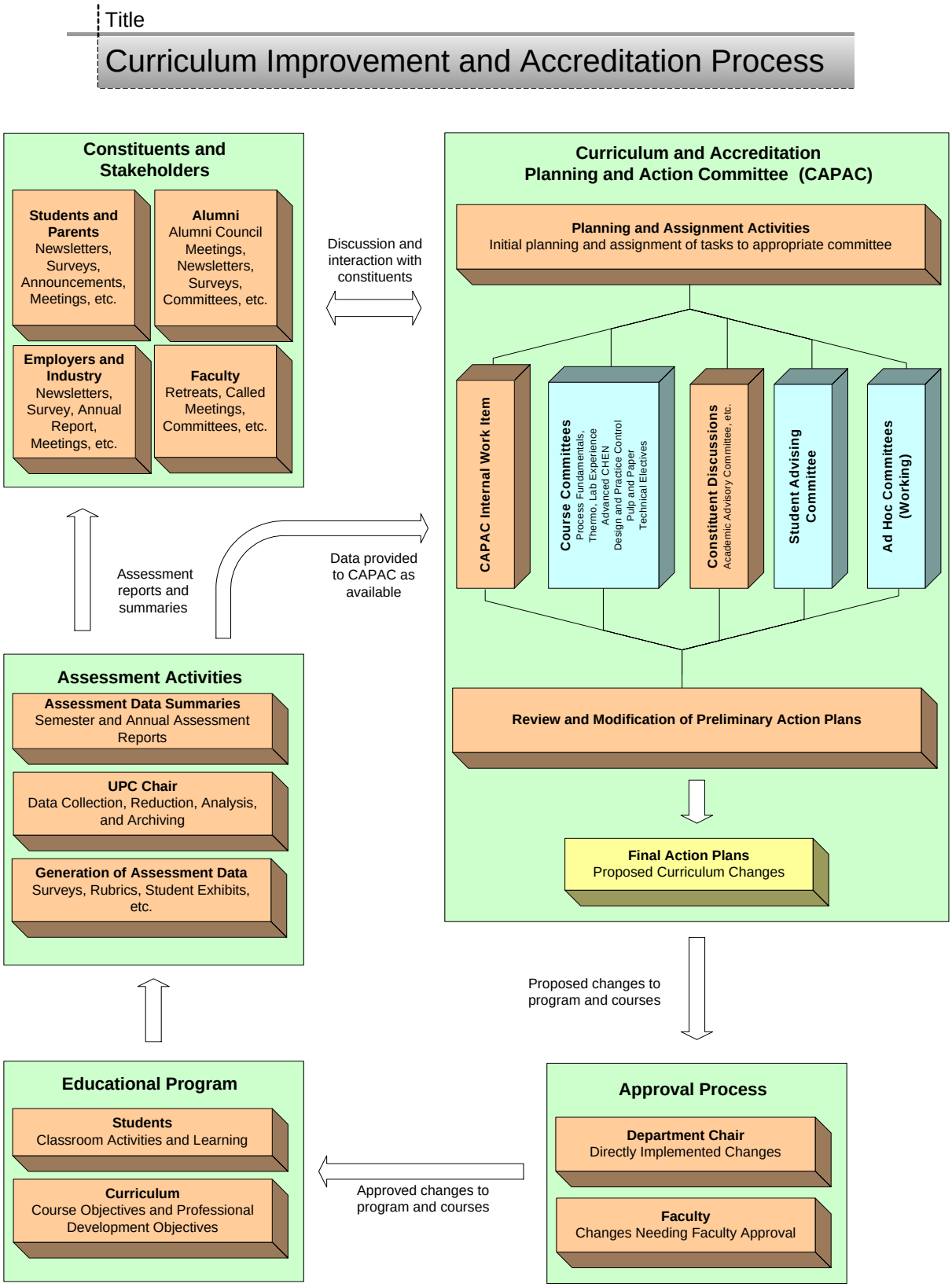
Beginning with the *Educational Program* (lower left of Figure 3-13), classroom activities result in the acquisition of knowledge and abilities by our students. The UPC chair is responsible for the administration of the various survey instruments and the collection of data by faculty (rubrics, student exhibits, etc.) as well as the subsequent reduction, analysis and archiving of results. These results are used to develop reports and data summaries that are available for use with the program's various constituencies.

As the diagram illustrates, there are many different activities whereby the department discusses the results of our assessment activities and seeks the insight of our constituencies. Of particular importance are our twice-yearly faculty retreats and our twice yearly alumni advisory council meetings. At both of these events, significant attention is devoted to curriculum and program changes in light of assessment results. (During the ABET site visit, the retreat and alumni council notebooks will be available for viewing.) The department also seeks to widely distribute information about the department via various newsletters and web announcements as well as during informal discussions with parents, students, and industrial recruiters.

Based on these activities and internal discussions with the faculty, the CAPAC committee provides planning and assignment activities by considering the nature of the particular issue being considered and identifying the best group of individuals to give the matter proper attention. These groups include the CAPAC committee itself, the standing course committees of the department, called discussions with constituents, the student advising committee and various ad-hoc (working) committees formed to look at specific issues.

After these individuals complete their work on an issue, it is sent back to the CAPAC committee for final consideration and possible implementation. In the case of minor matters, the CAPAC committee can initiate changes in the courses or curriculum, but in the case of major matters, carefully developed action plans are delivered to the Department Chair and faculty for consideration and approval. Once approved these changes are reflected in the curriculum and program and are monitored to see if the anticipate improvement or change is reflected in the assessment data.

Figure 3-13 Curriculum Improvement and Accreditation Process



Another important function provided by the CAPAC committee is the continual checking of the appropriateness of the program educational outcomes (as well as the program objectives). Data for this is collected during the survey processed already described. Recent results for this activity are presented in Tables 3-9 and 3-10 which show a strong correlation between the existing program objectives and program educational outcomes and the relevancy as seen in the COE Industry Survey and the COE Alumni Survey.

COE Industry Survey (Program Objectives and Program Educational Outcomes)

The Industry Survey is an important source of input from industry and employer of Auburn University chemical engineers. This survey was conducted in 1995 and 2003 and polled about 170 employers who recruit or employ engineers from Auburn University. The objective of the study was to identify the attributes considered to be essential for success as an engineering professional. This type of input is essential to keep both program objectives and program educational outcomes in line with the needs of state and regional employers. It is anticipated that the College of Engineering will conduct this survey every 6 years in keeping with the needs of regular ABET accreditation visits.

Table 3-9 Validation of Department's Program Objectives and Program Educational Outcomes with COE Industry Survey

College of Engineering Industrial Survey	Percent Rating Essential or Highly Desirable			
Characteristic	1995 Survey	2003 Survey	Departmental Program Objective	Departmental Program Educational Outcome
Ability to learn on their own.	94.0	87.1	3. Instill within our graduates a commitment towards lifelong scientific inquiry, learning and creativity.	11. Engage in life-long learning
Experience in communicating technical information through written documents.	87.3	82.5	2. Develop within our graduates the ability to communicate effectively.	8. Proficiency in written communications
In-depth technical knowledge of the student's major engineering discipline.	81.9	76.0	1. Develop within our graduates the technical proficiency needed for the professional practice of chemical engineering.	1. Apply mathematics, chemistry, physics, and engineering
Experience in working with people of different genders, races, and cultural backgrounds.	74.9	74.9		10. Function successfully as a member of a multi-disciplinary team
Experience using or ability to quickly learn existing software to solve practical problems.	74.5	70.2	1. Develop within our graduates the technical proficiency needed for the professional practice of chemical engineering.	4. Utilize the techniques, skills, and modern computational tools.
Experience in communicating technical information through oral presentations.	80.8	69.6	2. Develop within our graduates the ability to communicate effectively.	9. Proficiency in oral communications
Experience in working on practical design projects.	61.8	61.4	1. Develop within our graduates the technical proficiency needed for the professional practice of chemical engineering.	5. Design a system, component, or process
Co-op experience with industry.	63.1	57.9		
A summer internship with industry.	56.0	55.9		
Importance of other job experience in working on practical projects.	43.0	45.0		
Experience in working with students from other engineering disciplines in solving large-scale practical problems.	37.9	36.1		10. Function successfully as a member of a multi-

				disciplinary team
Well-rounded background demonstrated from choice of elective course work outside of engineering.	40.6	33.9		7. Contemporary issues, business practices, environmental, health, safety issues
Experience in working in teams with students from outside the engineering college to solve large-scale practical problems.	42.3	33.9	4. Foster within our graduates a commitment to protect the public interest, health, safety, and environment in the practice of the chemical engineering profession.	10. Function successfully as a member of a multi-disciplinary team
Knowledge of several areas of engineering outside of the student's major discipline.	30.2	22.8	4. Foster within our graduates a commitment to protect the public interest, health, safety, and environment in the practice of the chemical engineering profession.	7. Contemporary issues, business practices, environmental, health, safety issues
Ability to develop custom computer software using C, Matlab, Fortran, or other high-level languages for specific applications.	25.5	22.2		4. Utilize the techniques, skills, and modern computational tools.
Ability to develop computer software using an assembly language.	14.1	9.4		2. Identify, formulate, and solve chemical engineering.
Knowledge of a foreign language.	3.0	2.9		

With the exception of job experience (summer internships and co-operative education opportunities, etc.) and the knowledge of a foreign language (ranked as least important), the department's program objectives and program educational outcomes are consistent with the needs of our major employers and regional industries. It should be pointed out that the department has a very strong commitment to and encourages both summer internships and co-operative education.

COE Alumni Survey (Program Objectives and Program Educational Outcomes)

The College of Engineering Alumni Survey (which is independent of the department's Alumni Survey) is an important source of input from Auburn engineering alumni. This survey was conducted in 1995 and 2003 and polled about 400 alumni to assess issues of alumni satisfaction and to identify areas of perceived strengths and weaknesses. This type of input is essential to keep both program objectives and program educational outcomes in line with properly preparing our graduates for employment in the diverse industries employing chemical engineers. It is anticipated that the college of engineering will conduct this survey every 6 years in keeping with the needs of regular ABET accreditation visits.

Table 3-10 Validation of Department's Program Objectives and Program Educational Outcomes with Alumni Survey

College of Engineering Industrial Survey	Percent Rating Essential or Highly Desirable			
Characteristic	1995 Survey	2003 Survey	Departmental Program Objective	Departmental Program Educational Outcome
Ability to learn on their own	89.4	88.5	3. Instill within our graduates a commitment towards lifelong scientific inquiry, learning and creativity.	11. Engage in life-long learning
Experience in communicating technical information through written documents	84.4	81.9	2. Develop within our graduates the ability to communicate effectively.	8. Proficiency in written communications
Experience in communicating technical information through oral presentations	80.8	76.8	2. Develop within our graduates the ability to communicate effectively.	9. Proficiency in oral communications
Experience in working on practical design projects	69.1	71.4	1. Develop within our graduates the technical proficiency needed for the professional practice of chemical engineering.	5. Design a system, component, or process
In-depth technical knowledge of the student's major engineering discipline	74.2	67.8	1. Develop within our graduates the technical proficiency needed for the professional practice of chemical engineering.	1. Apply mathematics, chemistry, physics, and engineering
Experience using or ability to quickly learn existing software packages to solve practical problems	75.5	63.0	1. Develop within our graduates the technical proficiency needed for the professional practice of chemical engineering.	4. Utilize the techniques, skills, and modern computational tools.
Experience in working with people of different gender, race, and cultural backgrounds	61.4	62.2		10. Function successfully as a member of a multi-disciplinary team
Experience in working with students from other engineering disciplines in solving large-scale practical problems	46.4	46.9		10. Function successfully as a member of a multi-disciplinary team
Other job experience in working on practical projects	45.1	43.8		
Co-op experience with	42.5	42.0		

industry				
A summer internship with industry	37.9	38.4		
Knowledge of several areas of engineering outside of the student's major discipline	47.8	38.3	4. Foster within our graduates a commitment to protect the public interest, health, safety, and environment in the practice of the chemical engineering profession.	7. Contemporary issues, business practices, environmental, health, safety issues
Well-rounded background demonstrated from choice of elective coursework outside of engineering	42.3	33.9		7. Contemporary issues, business practices, environmental, health, safety issues
Experience in working in teams with students from outside the engineering college to solve large-scale practical problems	30.2	22.8	4. Foster within our graduates a commitment to protect the public interest, health, safety, and environment in the practice of the chemical engineering profession.	10. Function successfully as a member of a multi-disciplinary team
Ability to develop custom computer software using C, Matlab, Fortran, or other high-level languages for specific applications	25.5	22.2		4. Utilize the techniques, skills, and modern computational tools.

With the exception of job experience (summer internships and co-operative education opportunities, etc.), the department's program objectives and program educational outcomes are consistent with the needs of our major employers and regional industries. It should be pointed out that the department has a very strong commitment to and encourages both summer internships and co-operative education.

B.3.9. Evidence To Verify Program Improvement Through Assessment

To illustrate the fashion in which assessment data is analyzed and interpreted to develop a performance rating to monitor the success in attaining our program educational outcomes, the data recently presented at the Fall 2003 and Spring 2004 faculty retreats will be presented in abbreviated form. The full analysis of the data is available in the faculty retreat notebooks available for viewing during the site visit.

Data from EBI Survey Analysis (Spring 2003)

The EBI survey questions are grouped according to the program educational outcome they best measure. This information is presented in Table 3-11. For example, in establishing the success of attaining PEO number 1 *(Our graduates will be able to apply mathematics, science, and engineering principles to solve chemical engineering problems. Although there will be an*

emphasis on chemical engineering principles, proficiency is also required in various general engineering and science areas as well) we view the responses from three different EBI questions (namely, No. 50, 51, and 52). The response to two of the three questions was a level C performance while the third question merited a level B. Data such as this leads to a concern that our students are not retaining and being able to successfully apply some of the technical material necessary for their profession.

This concern was the most troublesome of all the responses and the department is working hard on a number of fronts to correct this (described below). Most other areas were associated with a level A performance.

Table 3-11 Overview of Data Available From EBI Survey (Spring 2003)

Outcome	Description	EBI Survey (Questions Analyzed)	Auburn Average Score (AAS)	CC Average (Ccavg)	CC Factor (AAS – CCavg)	CC Rank (out of 29)	Lower 20%	Level
1	Apply math science engineering	50	5.45	5.69	-0.24	25	✓	**C**
		51	5.62	5.77	-0.15	23	✓	**C**
		52	5.76	5.67	-0.09	13		**B**
2	Identify formulate solve problems	41	5.86	5.83	0.03 0.45	15		**A**
		53	6.10	5.65	0.34	2		**A**
		54	5.69	5.35		6		**A**
3	Design conduct experiments analyze data	36	5.17	5.17	0.0	18		**B**
		37	5.52	5.46	0.06	15		**A**
		38	5.79	5.81	-0.02	15		**A**
4	Utilize computational skills	44	5.52	5.01	0.51	5		**A**
5	Design system component process	39	5.45	5.44	0.01	15		**A**
6	Professional integrity ethical decision making	42	5.52	4.83	0.69	7		**A**
7	Environment safety health society public interest	43	5.45	4.73	0.72	5		**A**
		55	5.55	4.91	0.64	3		**A**
8	Written communications	46	5.97	5.55	0.42	4		**A**
9	Oral communications	45	5.72	5.28	0.44	6		**A**
10	Multidisciplinary teaming	40	5.75	5.24	0.52	5		**A**
11	Lifelong love of learning	49	5.93	5.31	0.62	4		**A**

Data Summary Presented at Fall 2003 Faculty Retreat

In the following section we display (in an outcome by outcome format) the measures of success (performance criteria) provided at the Fall 2003 faculty retreat. The response to these data (modifications to courses, curriculum and program elements) will be discussed in the next section.

1. Our graduates will be able to apply mathematics, science, and engineering principles to solve chemical engineering problems.

Senior Exit Survey Results Sp2003

Program Outcome	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Strongly Agree or Agree	Strongly Disagree or Disagree	Level
1	**17.9**	**74.4**	**5.1**	**2.6**	**0.0**	**92.3**	**2.6**	**A**

Rubric Data Sp2003 (from CHEN6470)

Program Outcome	Number Exceptional	Number Acceptable	Number Marginal	Number Unacceptable	Total Number	Percent Exceptional or Acceptable	Level
1	**21**	**26**	**2**	**0**	**49**	**95.9**	**A**

EBI Survey Sp2003

Outcome	EBI Survey (Questions Analyzed)	Auburn Average Score (AAS)	CC Average (CCavg)	CC Factor (AAS-CCavg)	CC Rank (out of 27)	Lower 20%	Level
	50	**5.45**	**5.69**	**-0.24**	**25**	✓	**C**
1	**51**	**5.62**	**5.77**	**-0.15**	**23**	✓	**C**
	52	**5.76**	**5.67**	**-0.09**	**13**		**B**

2. Our graduates will be able to identify, formulate, and solve a range of chemical engineering problems systematically employing the skills of critical thinking and creative problem solving.

Senior Exit Survey Results Sp2003

Program Outcome	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Strongly Agree or Agree	Strongly Disagree or Disagree	Level
2	**20.5**	**69.2**	**7.7**	**2.6**	**0.0**	**89.7**	**2.6**	**A**

Rubric Data Sp2003 (from CHEN6470)

Program Outcome	Number Exceptional	Number Acceptable	Number Marginal	Number Unacceptable	Total Number	Percent Exceptional or Acceptable	Level
2	**26**	**21**	**2**	**0**	**49**	**95.9**	**A**

EBI Survey Sp2003

Outcome	EBI Survey (Questions Analyzed)	Auburn Average Score (AAS)	CC Average (CCavg)	CC Factor (AAS-CCavg)	CC Rank (out of 27)	Lower 20%	Level
	41	**5.86**	**5.83**	**0.03**	**15**		**A**
2	**53**	**6.10**	**5.65**	**0.45**	**2**		**A**
	54	**5.69**	**5.35**	**0.34**	**6**		**A**

3. Our graduates will be able to design and conduct experiments, as well as analyze data, interpret and apply results to chemical systems and processes.

Senior Exit Survey Results Sp2003

Program Outcome	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Strongly Agree or Agree	Strongly Disagree or Disagree	Level
3	**25.6**	**56.4**	**15.4**	**2.6**	**0.0**	**82.0**	**2.6**	**B**

Rubric Data Sp2003 (from CHEN4860)

Program Outcome	Number Exceptional	Number Acceptable	Number Marginal	Number Unacceptable	Total Number	Percent Exceptional or Acceptable	Level
3							

EBI Survey Sp2003

Outcome	EBI Survey (Questions Analyzed)	Auburn Average Score (AAS)	CC Average (CCavg)	CC Factor (AAS-CCavg)	CC Rank (out of 27)	Lower 20%	Level
	36	**5.17**	**5.17**	**0.0**	**18**		**B**
3	**37**	**5.52**	**5.46**	**0.06**	**15**		**A**
	38	**5.79**	**5.81**	**-0.02**	**15**		**A**

4. Our graduates will be able to utilize the techniques, skills, and modern computational tools necessary for contemporary chemical engineering practice (includes computer/software proficiency).

Senior Exit Survey Results Sp2003

Program Outcome	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Strongly Agree or Agree	Strongly Disagree or Disagree	Level
4	**20.5**	**46.2**	**28.2**	**5.1**	**0.0**	**66.7**	**5.1**	**C**

Rubric Data Sp2003 (from CHEN6470)

Program Outcome	Number Exceptional	Number Acceptable	Number Marginal	Number Unacceptable	Total Number	Percent Exceptional or Acceptable	Level
4	**28**	**20**	**1**	**0**	**49**	**98.0**	**A**

EBI Survey Sp2003

Outcome	EBI Survey (Questions Analyzed)	Auburn Average Score (AAS)	CC Average (CCavg)	CC Factor (AAS-CCavg)	CC Rank (out of 27)	Lower 20%	Level
4	**44**	**5.52**	**5.01**	**0.51**	**5**		**A**

5. Our graduates will be able to design a system, component, or process to meet desired technical, economic, safety, and environmental criteria. They will be able to perform design calculations from the conceptual stage to full-scale plant design, and to conduct an economic evaluation of the process.

Senior Exit Survey Results Sp2003

Program Outcome	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Strongly Agree or Agree	Strongly Disagree or Disagree	Level
5	**12.8**	**71.8**	**12.8**	**2.6**	**0.0**	**84.6**	**2.6**	**B**

Rubric Data Sp2003 (from CHEN6470)

Program Outcome	Number Exceptional	Number Acceptable	Number Marginal	Number Unacceptable	Total Number	Percent Exceptional or Acceptable	Level
5	**118**	**64**	**12**	**2**	**196**	**92.9**	**B**

EBI Survey Sp2003

Outcome	EBI Survey (Questions Analyzed)	Auburn Average Score (AAS)	CC Average (CCavg)	CC Factor (AAS-CCavg)	CC Rank (out of 27)	Lower 20%	Level
5	**39**	**5.45**	**5.44**	**0.01**	**15**		**A**

6. Our graduates will understand and appreciate the need for professional integrity and ethical decision making in the professional practice of chemical engineering.

Senior Exit Survey Results Sp2003

Program Outcome	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Strongly Agree or Agree	Strongly Disagree or Disagree	Level
6	**59.0**	**41.0**	**0.0**	**0.0**	**0.0**	**100.0**	**0.0**	**A**

Rubric Data Sp2003 (from CHEN6470)

Program Outcome	Number Exceptional	Number Acceptable	Number Marginal	Number Unacceptable	Total Number	Percent Exceptional or Acceptable	Level
6	**21**	**27**	**1**	**0**	**49**	**98.0**	**A**

EBI Survey Sp2003

Outcome	EBI Survey (Questions Analyzed)	Auburn Average Score (AAS)	CC Average (CCavg)	CC Factor (AAS-CCavg)	CC Rank (out of 27)	Lower 20%	Level
6	**42**	**5.52**	**4.83**	**0.69**	**7**		**A**

7. Our graduates will demonstrate an understanding of contemporary issues encountered in the professional practice of chemical engineering including business practices, environmental, health, and safety issues and other public interests. Our graduates will be aware of the wide reaching effects that engineering decisions have on society, our global community and our natural environment.

Senior Exit Survey Results Sp2003

Program Outcome	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Strongly Agree or Agree	Strongly Disagree or Disagree	Level
7	**35.9**	**53.8**	**5.1**	**5.1**	**0.0**	**89.7**	**5.1**	**A**

Rubric Data Sp2003 (from CHEN6470)

Program Outcome	Number Exceptional	Number Acceptable	Number Marginal	Number Unacceptable	Total Number	Percent Exceptional or Acceptable	Level
7	**67**	**77**	**3**	**0**	**147**	**98.0**	**A**

EBI Survey Sp2003

Outcome	EBI Survey (Questions Analyzed)	Auburn Average Score (AAS)	CC Average (CCavg)	CC Factor (AAS-CCavg)	CC Rank (out of 27)	Lower 20%	Level
7	**43**	**5.45**	**4.73**	**0.72**	**5**		**A**
	53	**5.55**	**4.91**	**0.64**	**3**		**A**

8. Our graduates will demonstrate proficiency in written communications.

Senior Exit Survey Results Sp2003

Program Outcome	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Strongly Agree or Agree	Strongly Disagree or Disagree	Level
8	**43.6**	**51.3**	**2.6**	**2.6**	**0.0**	**94.9**	**2.6**	**A**

Rubric Data Sp2003 (from CHEN6470)

Program Outcome	Number Exceptional	Number Acceptable	Number Marginal	Number Unacceptable	Total Number	Percent Exceptional or Acceptable	Level
8	**99**	**39**	**2**	**0**	**140**	**98.6**	**A**

EBI Survey Sp2003

Outcome	EBI Survey (Questions Analyzed)	Auburn Average Score (AAS)	CC Average (CCavg)	CC Factor (AAS-CCavg)	CC Rank (out of 27)	Lower 20%	Level
8	**46**	**5.97**	**5.55**	**0.42**	**4**		**A**

9. Our graduates will demonstrate proficiency in oral communications.

Senior Exit Survey Results Sp2003

Program Outcome	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Strongly Agree or Agree	Strongly Disagree or Disagree	Level
9	**28.9**	**60.5**	**10.5**	**0.0**	**0.0**	**89.4**	**0.0**	**A**

Rubric Data Sp2003 (from CHEN6470)

Program Outcome	Number Exceptional	Number Acceptable	Number Marginal	Number Unacceptable	Total Number	Percent Exceptional or Acceptable	Level
9	**151**	**68**	**10**	**11**	**240**	**91.3**	**B**

EBI Survey Sp2003

Outcome	EBI Survey (Questions Analyzed)	Auburn Average Score (AAS)	CC Average (CCavg)	CC Factor (AAS-CCavg)	CC Rank (out of 27)	Lower 20%	Level
9	**45**	**5.72**	**5.28**	**0.44**	**6**		**A**

10. Our graduates will be able to function successfully as a member of a multi-disciplinary team. They will be aware of leadership and group dynamics issues and exhibit a level of cooperation that allows for team productivity.

Senior Exit Survey Results Sp2003

Program Outcome	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Strongly Agree or Agree	Strongly Disagree or Disagree	Level
10	**61.5**	**38.5**	**0.0**	**0.0**	**0.0**	**100.0**	**0.0**	**A**

Rubric Data Sp2003 (from CHEN6470)

Program Outcome	Number Exceptional	Number Acceptable	Number Marginal	Number Unacceptable	Total Number	Percent Exceptional or Acceptable	Level
10	**36**	**11**	**1**	**1**	**49**	**95.9**	**A**

EBI Survey Sp2003

Outcome	EBI Survey (Questions Analyzed)	Auburn Average Score (AAS)	CC Average (CCavg)	CC Factor (AAS-CCavg)	CC Rank (out of 27)	Lower 20%	Level
10	**40**	**5.75**	**5.24**	**0.52**	**5**		**A**

11. Our graduates will appreciate the need for and engage in life-long learning to maintain and enhance the professional practice of chemical engineering.

Senior Exit Survey Results Sp2003

Program Outcome	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Strongly Agree or Agree	Strongly Disagree or Disagree	Level
11	**46.2**	**51.3**	**2.6**	**0.0**	**0.0**	**97.5**	**0.0**	**A**

Rubric Data Sp2003 (from CHEN6470)

Program Outcome	Number Exceptional	Number Acceptable	Number Marginal	Number Unacceptable	Total Number	Percent Exceptional or Acceptable	Level
11	**32**	**16**	**1**	**0**	**49**	**98.0**	**A**

EBI Survey Sp2002

Outcome	EBI Survey (Questions Analyzed)	Auburn Average Score (AAS)	CC Average (CCavg)	CC Factor (AAS-CCavg)	CC Rank (out of 27)	Lower 20%	Level
11	**49**	**5.93**	**5.31**	**0.62**	**4**		**A**

Note: At the current time, data is not available from the progress assessment exam courses (CHEN 2@@0 and CHEN 3@@0). since they will be first offered during the Spring 2004 term (CHEN 2@@)) and the Fall 2004 term (in the case of CHEN 3@@0). This data will be used in future assessment activities.

Alumni Survey Data to Evaluate Strength of Coverage in Program

During Spring 2003, the Department sought to contact as many alumni as possible via the departmental newsletter. Through this effort we asked them to participate in our first alumni survey. Although many of the survey questions pertain to program objectives two questions directly relate to program educational outcomes. The one reported below is *What was the strength of coverage of this outcome while you were a student?* These results are presented separately from the other data for program educational outcome assessment since these data are derived from graduates who left the program at a time before EC2000 was envisioned. We do not feel that these data necessary should be construed as being "negative" since the curriculum at the time these students graduated was far different than the curriculum of today. We will continue to collect alumni data and use that data to track changes and improvement. The criteria used to establish the "performance level" in Table 3-11 was provided in Table 3-7. Future surveys will more specifically target alumni who have recently graduated so that this bias will not be present.

Table 3-11 Overview of Data Available From Alumni Survey (Spring 2003)

	Alumni Survey Results Sp2003 Strength of Coverage of Outcome While A Student		
Outcomes	Very Thorough or Thorough	Inadequate or Very Inadequate	Performance Level
1	83.8	1.4	A
2	78.6	2.1	B
3	68.3	6.9	B
4	39.7	24.1	C
5	62.8	4.2	B
6	41.4	22.1	C
7	29.1	25	C
8	38.6	27.6	C
9	49.7	13.8	C
10	53.1	13.1	C
11	43.5	9.7	C

B.3.9. Improvements To Program Through Assessment Process

Overview

Since the last ABET visit, the department's curriculum has been reformed in order to accommodate a university-wide change from a quarter-format to a semester-format. A number of other curriculum changes to fully implement EC2000 were recently approved and will be effective beginning Fall 2004. The following material shows specific curriculum changes that resulted from our departmental assessment process.

Changes Resulting From Implementation of Departmental Assessment Process

- Established a permanent Undergraduate Program Committee (UPC) and Curriculum and Accreditation Planning and Action Committee (CAPAC) chaired by a dedicated faculty member who is responsible for coordinating all matters related to undergraduate program administration, student advising and course administration including accreditation and

assessment.

- Involved a significant number of faculty directly in curriculum improvement and assessment activities.
- Encouraged faculty to work to continuously improve all courses by considering ways to better meet program educational outcomes.
- Developed materials especially for students to explain the department's accreditation and assessment activities.
- Revised materials available to students for advising purposes to better illustrate the course selection in the program's various specializations (options) as well as provided appropriate forms to college of engineering Student Services.
- Prepared outcome-based course outlines for all core chemical engineering courses
- Developed suitable rubrics and other assessment tools to be used throughout the curriculum as appropriate.
- Prepared suitable faculty, student, senior, alumni and other special purpose surveys to be administered according to a fixed schedule.
- Conducted three years of end of course, senior and alumni surveys and analyzed and prepared assessment reports detailing the results of these surveys.
- Establishment of two annual faculty retreats to promote and discuss a broad range of assessment and curriculum matters at suitable off-campus locations.
- Established regular meetings with Alumni Advisory Council including Education Committee meetings to discuss accreditation and program educational items.

Phase I Program Changes (Approved August 2003)

Implementation of Progress Assessment courses: The first round of changes made to the curriculum involved the establishment of two non-credit courses to serve to measure proficiency and retention of science, math and engineering subject matter. Based on faculty concerns about subject matter deficiencies in the Faculty End of Course Surveys and also reflected in Senior Exit and Alumni Surveys, the department voted to employ "proficiency exams" similar in form to those already in use by the Auburn mechanical engineering program. In August 2003, the Auburn University curriculum committee approved a proposal by the department to modify the chemical engineering program to implement two progress assessment courses (CHEN 2@@0 Progress Assessment I and CHEN 3@@0 Progress Assessment II). These courses are prerequisite to students enrolling in the senior capstone design course CHEN 6470 Process Design Practice. In addition to serving as a gate to complete the program (assuring quality) the exams serve as a source of assessment data and help understand the perceived deficiencies cited by faculty. Specifically, the test questions are selected to verify the student's capabilities in important prerequisite topics. For example: use of the chain rule in differentiation, balancing redox equations, determination of limiting reactant, determination of reaction yields, etc. The data from the exams can then be used to assess learning, retention, and ability to apply these topics. If deficiencies are noted, the CAPAC committee can investigate the matter and propose necessary changes. Since these courses are just now first being offered, no data is available at this time to judge how helpful the courses are in improving graduate quality. The data from the Spring 2004 offering and Summer 2004 offering of CHEN 2@@0 will be available on site during the visit.

Phase II Program Changes (Approved April 2004)

The second round of changes made to the curriculum involved a number of issues related to accreditation and EC2000 as well as to correct minor issues brought about by the quarter to semester conversion. The most significant of these were:

Addition of CHEN 3600 Computer-Aided Chemical Engineering: Assessment data collected during 2002 and 2003 pointed to a deficiency in the area of computer-applications and software proficiency in solving chemical engineering problems. This partly came about because two courses previously offered under the quarter format (CHE 213 Digital Computers in ChE and CHE 515 Intermediate Computer Applications) were eliminated to decrease the number of hours in the program. The currently taken course COMP1200 Introduction to Programming does not provide sufficient exposure to the required computer language skills, important numerical methods and to software applications in the area of chemical engineering. During the last several senior exit interviews as well as in comments made during the Senior Exit Survey and Alumni Survey it was strongly felt that additional computer-related material was essential. To this end, the department is adding a new course entitled CHEN 3600 Computer-Aided Chemical Engineering to provide necessary instruction in programming specifically applied to the area of chemical engineering. This course will be taken in addition to the COMP 1200 Computer Science course. This course will first be offered Fall 2004.

Standardization of Technical Electives: During the "quarter to semester" conversion, the department converted most of its existing technical elective openings to a two-credit hour format and similarly offered many of its technical elective courses as two-credit hour courses. This has proved to be unsatisfactory for a number of reasons including difficulties in arranging for the department's program specialization plans as well as it being difficult to clearly demonstrate (for accreditation purposes) how these program specializations relate to the chemical engineering program. To remedy this problem, the department has converted all technical elective openings in the program plan to a three-hour format and changing all technical elective courses to a three-hour format as well. This uniformity will make course choices for the student much easier as well as allowing the department to clearly demonstrate that our program specializations are simply formed by appropriate selection of technical electives.

Rearrangements and Consolidations: Our departmental assessment process has revealed that several of the courses in the current curriculum would be more effectively taught if combined. The CHEN 2100 Principles of Chemical Engineering and CHEN 2101 Principles of Chemical Engineering Lab are being combined into a single course CHEN 2100 Principles of Chemical Engineering to provide more uniform instruction. Similarly, the currently offered CHEN 4651 (previously CHEN 6651) Process Safety Lab is being combined with CHEN 4450 Process Economics to form a more valuable CHEN 4450 Process Economics & Safety course. This corrects an accreditation issue that our seniors were involved in their senior process design practice project without having completed their safety course. The two-course process design sequence (CHEN 4460 and CHEN 4470) is being modified to shift an hour from the CHEN 4460 Process Simulation and Optimization course to the CHEN 4470 Process Design Practice course. This is consistent with the workload and time expectations in the CHEN 4470 course. Coverage in CHEN 4460 is reduced to accomplish this.

Improvements to Courses and Course Content Stemming from Accreditation Process

The following set of action plans and improvements were developed from assessment data collected during the 2002-03 academic year and presented and documented in the Fall 2003 and Spring 2004 faculty retreat notebooks.

Employment of Rubrics in Senior Design and Senior Laboratory Courses: Assessment data collected using the Senior Exit Surveys indicated that students perceived grading to be inconsistent and without clear standards. The faculty decided to employ the available assessment rubrics in the capstone design and senior lab classes as one component of the course grade. It was also suggested that faculty broadly employ rubrics in any applicable classroom situation to allow students to become more familiar with our assessment tools and to improve their performance in these program educational outcomes.

Additional Coverage of "Student Success" Materials in CHEN 2100 Principles of Chemical Engineering: Based on low performance on several assessment methods regarding Program Outcome No.1 the faculty has decided to revise the first course in the Chemical Engineering curriculum to contain more material helping students understand how to succeed in learning including materials discussing study habits, classroom activities, preparation of personal notes, exam taking skills, etc. Many of these materials are already being used informally in the program but implementing them at this point formally should help with problems identified by our assessment methods in acquisition and retention of general science, mathematics, and engineering subject matter.

Introduction to Process Simulation Software (ASPEN) in CHEN 2100 Principles of Chemical Engineering for familiarization and as a visualization tool: Our assessment data indicated students did not feel they received sufficient exposure to state-of-the-art software. This deficiency was detected in Senior Exit Surveys, Alumni Surveys and the EBI Survey. To remedy this situation we will undertake the introduction of the ASPEN simulation software into our Principles of Chemical Engineering course. Due to limitations on available computer facilities, this change will not be made until the completion of the departmental Ross Hall renovation when a modern computer laboratory will be available for this purpose. This matter will be discussed further at the Fall 2004 Faculty Retreat.

More Emphasis on Computer Tools (e.g., graphing, data analysis, equation solving) in the Chemical Engineering Fundamentals Courses: As in the above paragraph, the deficiency in computer skills should be broadly addressed in the program. To the end, the department is putting increased emphasis on the use of computers in "routine" assignments as well as special projects in the Chemical Engineering Fundamentals series (CHEN 2100, CHEN 2610, CHEN 3620, and CHEN 3660). Particular attention will be paid in the development of the new CHEN 3600 Computer-Aided Chemical Engineering course to assure that students are well prepared to successfully employ computers and software products.

Additional Content in CHEN 2610 to Teach Critical Thinking and Problem Solving Skills: Based on concerns about critical thinking skills of our undergraduates from Faculty End of Course Surveys as well as Senior Exit Surveys, the department will be revising the curriculum in CHEN 2610 Transport I to formally include teaching "systematic problem solving." It was felt that our second course in chemical engineering is the best place to center this material. Much of

the material to be used has been informally developed during the last two offerings of this course and it is felt that the particular subject matter is well suited to demonstrating critical thinking skills to students.

Consolidation of Decision Making in All Courses in Matters Pertaining to Computers and Software to the Computer Course Committee: Traditionally the department has let each faculty member decide how to best employ computer software in their courses. This has lead to a number of complaints by students seen in the Senior Exit Interview results that too many different software are employed without depth and mastery. To this end, the department has put the course CHEN 3600 Computer-Aided Chemical Engineering into the curriculum. To best coordinate this course and the utilization of the computer skills being taught in the course the faculty has decided to consolidate the coordination of these matters in the hands of the course committee that manages the sequence CHEN 3600 and CHEN 3650. That committee will make recommendation as to how to best employ software and computers throughout the curriculum.

Modify the Survey Questions Asked in the Sophomore Survey to Specifically Evaluate Ability to Perform Elementary Math and Chemisty Skills: During the Spring 2004 faculty retreat, it was felt that better data could be learned from our Sophomore Survey about attitudes and capabilities of students newly in the curriculum if the questioned employed were of a more “specific” nature rather than simply reflecting student opinion. For example, rather than ask the student to rate their capabilities and comfort with the area of calculus, the survey should ask several math questions to establish the student’s knowledge. This action comes about after observing that our sophomore students feel very well equipped to employ chemistry and math but that faculty teaching subsequent courses rank their knowledge and capabilities as needing much improvement.

Consideration of Replacement or Elimination of ELEC 3810 Electrical Engineering: Senior Exit Surveys have consistently indicated student dissatisfaction with the teaching and content of the electrical engineering course. The department is undergoing a review of this matter to establish whether it is due to “teaching” or “content” and to reexamine the extent to which electrical engineering subject matter is necessary in our program. An ad-hoc committee has been formed to deal with this matter and will be making a report back to the CAPAC committee once its investigation is complete.

Arranging for Tutoring and Study Sessions (Junior and Senior Level): It has been frequently commented on by our students in Student End of Course Surveys as well as Senior Exit Surveys that the department could help students more by providing tutoring and/or study session for upper-level departmental courses. Much improved study facilities will be available to students once the Ross Hall renovation is complete, however, in the interim period the department is considering using other facilities and employing GTA’s as tutors.

Assessing and Remedying Math, Chemistry and Physics Background and Preparedness:

A subcommittee is being formed to gather information on current math courses (books, syllabus, etc.) from the math, chemistry and physics departments to learn more about how these courses are taught and evaluated. The subcommittee will meet with individuals in the respective departments to express our "desired outcomes" for these courses.

B.3.12. Materials Available For Review To Verify Program Improvement Through Assessment

The following materials will be available for review during the site visit:

Student Exhibits: Examples of student work and related course outlines, textbooks and other materials will be available for inspection.

Chemical Engineering Undergraduate Student Manual: This student/faculty resource summarizes the current curriculum and advisement process and provides information on a number of topics important to students.

Chemical Engineering Faculty Retreat Notebooks: These notebooks contain substantial amounts of assessment data for discussion and action by the faculty. They include the results of student, alumni, and other surveys as well as progress assessment exam results and performance in capstone design and lab courses. They also provide much information about the development of our program objectives and program outcomes review process and ongoing assessment activities. At the time of the ABET visit there will be four retreat notebooks available for review.

Other Files Available in the Office of the Undergraduate Program Committee Chair: The files of the UPC Chair will be available during the visit for inspection. These files include:

- Minutes of UPC and CAPAC meetings
- Detailed information about the curriculum and program including the new curriculum to become effective Fall 2004
- Course notebooks for individual classes including a listing of course outcomes
- Copies of all faculty retreat notebooks as well as Alumni/Industry Advisory Council meeting notebooks
- 2003 Alumni Survey data and analysis
- 2003 COE Industry Survey and 2003 COE Alumni Survey data and analysis
- Raw data from all assessment activities (see Table 3-7)