Strategic Plan for Improving Undergraduate Engineering Education at the University of Arizona:
A Progress Report

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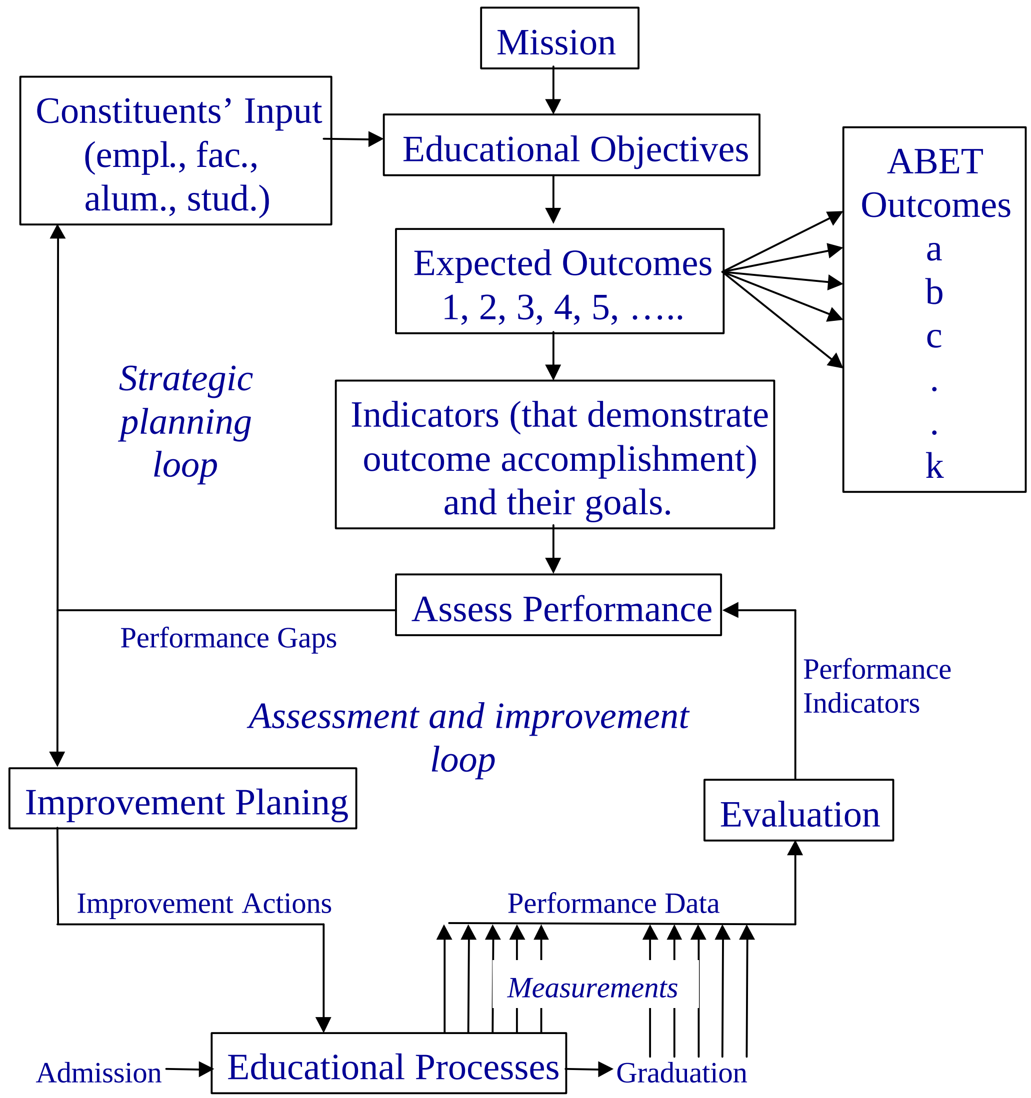
**AIChE Meeting
Dallas, TX 1999**

Two faculty teams led our ABET preparation activities

- **ABET Implementation Team**: ***One person from each department to coordinate departmental activities.***

- **Assessment Team**: ***Individuals with specific interest and/or assessment skills***

An overall flow chart for the improvement process used



Educational objectives were created to support the college's mission

Educational objectives:

- ***Strive to provide high quality broad based education that will prepare students for productive careers in an increasingly diverse and technological society***
- ***Provide a foundation for lifelong learning to nurture personal and professional growth***
- ***Base student's education on a knowledge of engineering and science tools appropriate to their disciplines***
- ***Continuously improve the undergraduate academic programs in partnership with industry, alumni, and government***

Expected outcomes were identified

Student attributes and operational strategies were identified to demonstrate achievement of the educational objectives.

Example

Strive to provide high quality broad based education that will prepare students for productive careers in an increasingly diverse and technological society by insuring that graduates have:

- ***An ability to function on multi-disciplinary teams.***
- ***An understanding of professional and ethical responsibility.***
- ***An ability to communicate effectively.***
- ***The broad education necessary to understand the impact of engineering solutions in a global/societal context.***
- ***A knowledge of contemporary issues.***

Course syllabi - Fluid Flow & Heat Transfer

» 1997 - 1998 Catalog Data: Chemical Engineering Heat Transfer and Fluid Flow (3) Theory and calculations in the unit operations of fluid flow, heat transfer, and evaporation. 1.5ES, 1.5ED. P, 201.

» Textbook: C. J. Geankoplis, *Transport Processes and Unit Operations, 3rd Edition*, Prentice Hall PTR, 1993

» References:

- McCabe, Smith and Harriott, Unit Operations of Chemical Engineering, McGraw-Hill 1993
- Bird, Stewart and Lightfoot, Transport Phenomena, 1963
- Perry and Green, Perry's Chemical Engineers' Handbook, 6th Ed., McGraw-Hill 1984

Syllabus Cont.

» Instructor: J. S. Riley, Assistant Research Scientist

» Prerequisites by Topic: Material and Energy Balances

» Method for Assessing Knowledge of Prerequisite Topics:

- 1. First homework assignment to cover review material from prerequisite courses.
- 2. In class examination on fourth day of class (exam & exam topics announced second day of class). Results evaluated and remedial instruction offered to students as needed.

» Overall Educational Goal:The course gives students in CHEE the concepts of macroscopic heat transfer and fluid flow in the context of chemical engineering processes.

Syllabus cont.

» Specific Instructional Goals:

- 1. Demonstrate an ability to derive overall material, energy and momentum balances to describe physical processes.
- 2. Demonstrate an ability to analyze the flow of fluids in common chemical engineering processes.
- 3. Develop an understanding of the mechanisms of heat transfer.
- 4. Develop an ability to analyze and design chemical engineering unit operations required for heat transfer.
- 5. Acquire a working knowledge of a computerized process simulator to analyze and design unit operations pertaining to heat transfer and fluid flow.

Syllabus cont.

» Course Outline

» Class Requirements:

- 1. Two lecture sessions per week.
- 2. Approximately two to three homework problems per week.
- 3. Approximately three group projects utilizing a process simulation package to analyze and design chemical engineering unit operations based on the principles of heat and fluid flow.
- 4. Approximately two to three in-class quizzes designed to ensure students' comprehension of fundamental concepts.
- 5. Two in-class examinations and a final examination.

Syllabus cont.

- Computer Usage: Pro/II process simulation package
- Laboratory Projects: None
- Assessment of Course Goals:
  - 1. Through homeworks, examinations and group projects.
  - 2. By instructors in CHEE 303, CHEE 304, CHEE 370 and CHEE 442 who rely on this course to provide students with prerequisites.
- ABET Category Content:
  - A,E
  - C,D,G,K

Course Classification Form to relate its activities to the expected outcomes

ABET 2000 Criteria Course Classification Form

Course Number ______________ Course Name ____
Required? Circle: YES / NO Semester/Instructor ____________________________________
Homework Frequency?______________ Exam Frequency?______________________
Course Project? Circle: YES / NO Labs or Case Studies? Circle: YES / NO

For each of the following ABET outcome criteria, please list the level (**H**igh, **M**edium, **L**ow, or blank if not applicable) contained in this course. The criteria descriptions that will be used by the College in the ABET evaluation are attached. Please describe the relevant course activities that you can use to justify why you think your course meets the criteria. **No course is expected to address all of these criteria and it would be rare to have more than 2 or 3 criteria at a high level (except a capstone course)** Be conservative in your judgment. For the ABET evaluation, we will assess student performance for criteria that are judged High. If you judge your course as High in a criteria, then the course should include a large percentage of effort (class time, homework, projects) devoted to the criteria. Note that 2 extra table entries are available for departments to specify their own criteria.

Outcome criteria	Level H M L	Relevant Activities
A. Apply mathematics, science and engineering principles		
B. Ability to design and conduct experiments and interpret data		
C. Ability to design a system, component, or process to meet desired needs		
D. Ability to function on multidisciplinary teams		
E. Ability to identify, formulate, and solve engineering problems		
F. Understanding of professional and ethical responsibility		
G. Ability to communicate effectively		
H. The broad education necessary to understand the impact of engineering solutions in a global context		
I. Recognition of the need for and an ability to engage in life-long learning		
J. Knowledge of contemporary issues		
K. Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice		

Optional: Comment on the overall strengths and shortcomings of the courses that are prerequisites to this course:

Courses and other activities were mapped into the expected outcomes by using QFD

Importance of Required Activities

Standard 9-3-1		
Strong	●	9.0
Moderate	○	3.0
Weak	▽	1.0

Courses and other activities

Expected outcomes

		1 basic science courses	2 math / calculus / diff. eq.	3 English composition (Engl. 101 & 102)	4 writing proficiency exam	5 humanities / social science electives	6 Engr 102 Intro. to Engr.	7 Engr. 170 Prob. Solving Using Compt.	8 MSE 110 Solid State Chemistry	9 MSE 222 Intro. Mat. Sci.	10 MSE 240 Thermo. Mat.	11 MSE 260 Struc. & Prop. Mat. I	12 MSE 360R Struc. & Prop. Mat. II	13 MSE 360L Mat. Lab.	14 MSE 380 Kinetics Proc. in Mat.	15 MSE 409 Transport Phenom.	16 MSE 480 Exp. Methods Microstructural Anal.	17 MSE 442A Mat. Engr. Design	18 MSE 442B Mat. Engr. Design	19 MSE 444 Design Competition	20 ECE 207 Elements of Elec. Engr.	1 Importance of the WHATs	2 Weighted Importance (sum (rating X credit hrs.))	3 Percent Weighted Importance	Percent Weighted Importance (Max = 23.3, Min = 2.1)
Credit Hours	1	18	16	6	1	16	3	3	4	3	4	4	3	1	3	3	3	2	2	3	3				
A. Apply mathematics, science & engr. principles	1	●	●				○	▽	●	●	●	●	●	○	●	●	○	▽	▽	▽	●	103	580	23.3	1
B. Ability to design & conduct experiments & interpret data	2	○					○		○			○		●			○			●		33	132	5.3	2
C. Ability to design sys., component, or process to meet desired needs	3						●	○	▽			○	○	○			▽	●	●	●	▽	51	133	5.3	3
D. Ability to function on multidisciplinary teams	4						●		○			○		●			●	▽	▽	●		44	118	4.7	4
E. Ability to identify, formulate, and solve engr. problems	5						●	●	○	●	○	▽	○	○	○	●	▽	○	○	○	▽	63	184	7.4	5
F. Understanding of professional & ethical responsibility	6	▽	▽	▽		▽	○		▽		▽	▽	▽	▽	▽	▽	○	●	●	○	▽	39	144	5.8	6
G. Ability to communicate effectively	7	○		●	●	●	○	▽	○	○	▽	○	○	●	▽		●	●	●	○		67	403	16.2	7
H. Broad educ. to understand impact of engr. solutions in global context	8					○			▽			▽	▽	▽			▽	○	○			14	75	3.0	8
I. Recognition of need & ability to engage in lifelong learning	9						○		○			○				○		▽	▽	▽	▽	16	52	2.1	9
J. Knowledge of contemporary issues	10					●			▽			▽					○	○	○	○	▽	24	185	7.4	10
K. Ability use techniques, skills & modern engr. tools for engr. practice	11	○	●	●	●		○	●	○		●	○	●	○	○	○	●	○	○	○	●	102	480	19.3	11
Importance of the HOWs	1	19	19	19	18	22	45	23	31	21	23	31	29	41	17	25	42	42	42	44	23				
Weighted Importance (credit hrs. X Importance)	2	342	304	114	18	352	135	69	124	63	92	124	87	41	51	75	126	84	84	132	69				
Percent Weighted Importance of the HOWs	3	13.8	12.2	4.6	0.7	14.2	5.4	2.8	5.0	2.5	3.7	5.0	3.5	1.6	2.1	3.0	5.1	3.4	3.4	5.3	2.8				
Max = 14.2 Percent Weighted Importance of the HOWs Min = 0.7																									
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20				

Expected outcomes were expressed in terms of measurable activities

Example

An ability to function on multi-disciplinary teams.

Graduates will be able to function effectively on teams using their knowledge of team dynamics, team communication, social norms, and conflict management.

As demonstrated by:

- *successfully completing Engineering 102 team projects*
- *performing at a professional level on a capstone design course*
- *completing undergraduate team lab exercises*
- *being involved in undergraduate research experiences*
- *working as a co-op or student intern*
- *effectively completing team-based reports in the above activities*
- *performing evaluations of team accomplishments*

Primary assessment tools used

Constituent surveys:

- *Students (I,S)*
- *Exiting seniors (I,S)*
- *Alumni (I,S)*
- *Faculty (I)*
- *Industrial Advisory Council (anecdotal)*

Other tools used by various departments:

- *Longitudinal student portfolios by year*
- *Course portfolios*
- *Design, safety, and computer portfolios*
- *Pre-requisite examinations in follow-on courses*
- *Senior design exam*
- *Student assessment of team participation*
- *Senior design project presentation review by industry*

Senior Portfolio

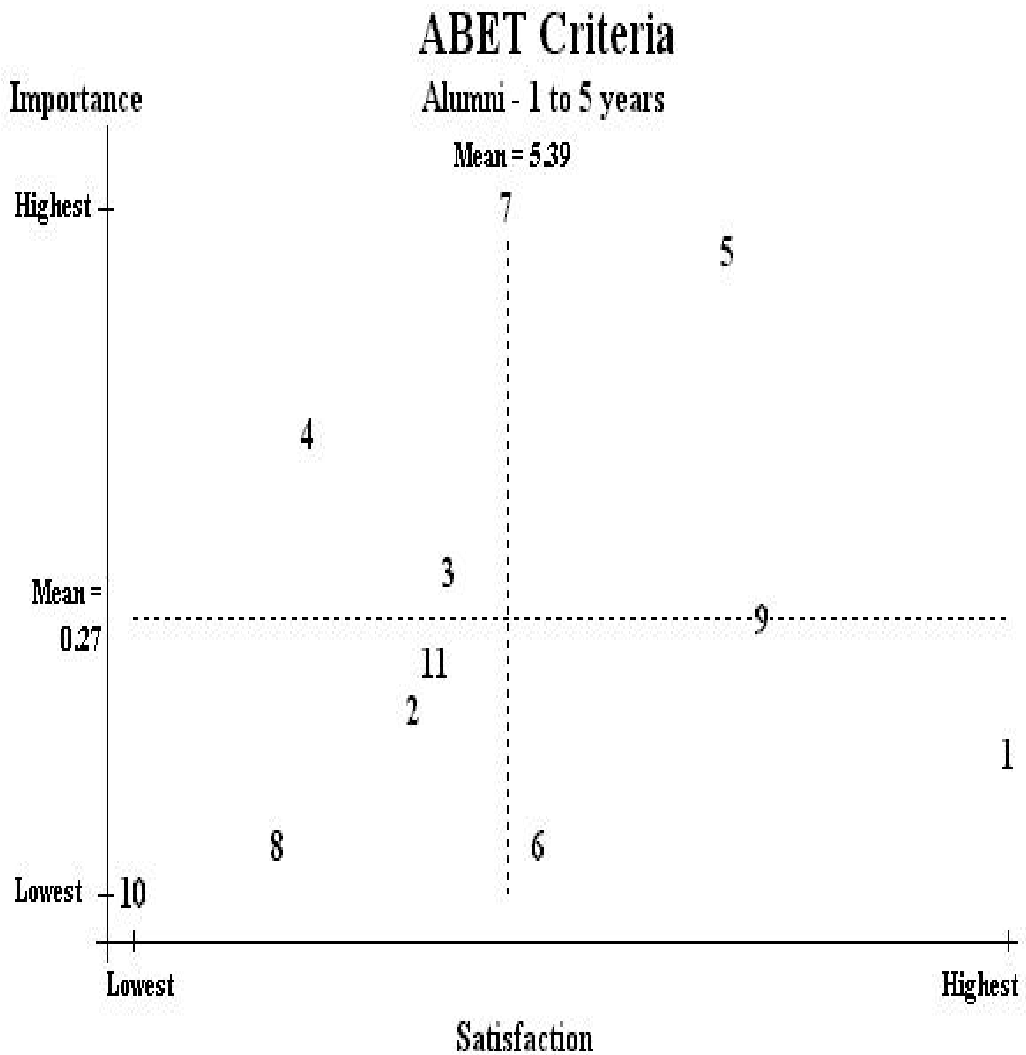
- resume
- SAPR
- senior project report
- pre-requisite tests or assignments
- sample homework assignments from 1 course with engineering science
- sample exams from 2 courses in the department
- lab report that includes the design, operation, analysis, and presentation of an experiment
- video presentation
- sample design projects
- sample computer projects

Rubics for Assessment

Example rubric: ***Student monitoring***

1. ***Program is not in place to track student progress through curriculum***
2. ***Informal program is in place but results are not used to assist students or improve outcome assessment***
3. ***Formal program is operational and feedback is supplied to students through advising. Also used to identify deficient progress.***
4. ***Formal program is used for student feedback and program evaluation***
5. ***Formal program as in 4 but periodically reviewed and modified to improve program***

Satisfaction vs, Importance Plots



Process improvement planing

Depending on the evaluation of achievement, an action plan was created:

- ***Prioritization based on perceived importance expressed by faculty, alumni, and students.***
- ***The QFD curriculum map indicates which courses or other activities to modify to achieve needed improvements.***

Example - Curriculum improvement

- Ordinary Differential Equations
  - Taught by Math Department - no applications
  - Taught in ChE - too fast, less computers
  - Taught by Math
- Laboratory
  - Little connection between lab and theory
  - Incorporate labs in classes

Progress Report

Highlights

- Changes were made to improve the curricula
- System in place
- Faculty buy-in
- Contact with evaluators

Lowlights

- Some departments didn't completely close their loops
- Web catalog
- ABET evaluation was good but not perfect

Issues

- Faculty attitude
- 6 year cycle of ABET
- Substantial effort is required (~0.5 FTE/dept)

Plans

- Continuous improvement team is now in place
- Annual assessment is underway
- Curricular improvements are continuing