Updating the Chemical Engineering Curriculum for the 21st Century

Dana E. Knox & Robert B. Barat

Otto H. York Department of Chemical Engineering
New Jersey Institute of Technology
Newark, NJ 07102

Abstract

The field of chemical engineering is evolving, and curricula must evolve to match the new world in which graduates of our programs will find themselves. There is a general consensus that there should be ever-greater emphasis on biological-based processes and on batch processes. But does this force a decreased emphasis on chemical processes and continuous processes? Feedback from alumni and from industry continues to indicate the need for an even greater emphasis on written and oral communication skills, as well as the ability to function well in teams and in multidisciplinary environments. But does this require less emphasis on engineering fundamentals? Students often have difficulty synthesizing material from various courses. Can design content be introduced throughout the curriculum to help resolve this without adverse effects? These are the types of issues that must be addressed by all departments when they undergo their periodic program reviews.

The chemical engineering department at New Jersey Institute of Technology has just completed an extensive top-to-bottom review and revision of the curriculum for its Bachelor of Science in Chemical Engineering degree. This paper will review the input that was received from our various constituencies, and will discuss how the above (and other) issues were resolved in the re-development of our program.

Introduction

The need for periodic review of your core processes is needed in all fields of endeavor. Higher education is no different. Curricula must change and evolve as the world changes and evolves.

The field of chemical engineering has undergone substantial change in recent years and continues to do so in the present. Most departments of chemical engineering across the country are renaming themselves to include some aspect of biology in their names. These changes reflect a fundamental shift in where most chemical engineering graduates find jobs in the modern world.

In years past, most jobs were to be found in the petroleum, petrochemical and commodity chemical fields. Now, the jobs are shifting to areas such as the pharmaceuticals, specialty chemical and food industries. Newer fields include biomedical engineering, genetic engineering and biotechnology in general. These changes must be reflected in the curriculum.

Engineers also work differently than in the past. At one time, designs were done with drawings and graph paper and slide rules; now much of the design process is accomplished by computer. The tools used by engineers in practice have changed, and university curricula must change to reflect this.

Constituency Input

Before any substantive change is made, the impact on, and advice of, the program's principal constituencies must be considered. Input from each of our principal constituencies was obtained by surveys.

Employers/Industry. A survey of the employers of our graduates showed general satisfaction with their quality and education. However, a number of areas were consistently cited as needing improvement. These included 1) awareness of business needs, 2) written communication skills, 3) economic skills, 4) oral communication skills and 5) use of computers. The following attributes were consistently listed as being the most important 1) problem solving, 2) professional and ethical responsibility, 3) computer skills, and 4) teamwork skills. Several members of the department advisory board have also indicated the need to include some coverage of biology and more effective coverage of the use computer simulation software in the curriculum.

Graduating Students. A survey of the graduating students showed general satisfaction with their education. However, a number of areas were consistently cited as needing improvement. These included 1) written communication skills, 2) awareness of current technologies and 3) interpersonal skills.

Alumni. A university survey of alumni showed general satisfaction with their education. However, a number of areas were consistently cited as needing improvement. These included 1) interpersonal skills, 2) written communication skills and 3) oral communication skills. A department survey of alumni also showed general satisfaction with their education but with a number of areas consistently cited as needing improvement. These included 1) computer skills, 2) awareness of current technologies, 3) ethical awareness, 4) physics knowledge and 5) oral communication skills.

Faculty. The main concern of faculty is that the curriculum remains both effective in equipping our graduates with the skills needed for success in their careers and abreast of modern developments in the field of chemical engineering.

There was clear consistency among the responses from the various constituencies. With this consensus of opinion, the department set about redeveloping its curriculum.

Curricular Reform

Charged with overseeing the effort was the department curriculum committee. The committee, however, did not work on the task in a vacuum. Throughout the process, various other people/departments/groups were involved. However, to make substantive progress, responsibility had to ultimately reside in the curriculum committee. Several steps were taken in the process:

- Gather feedback from constituent groups (discussed above)
- Survey other chemical engineering programs around the country
- Develop a priority list of topics / activities that should be in curriculum
- Put together a possible new curriculum
- Finalize the new curriculum

After each stage, additional feedback was gathered from each of the department's principal constituencies. This was necessary to ensure that the various proposals were as much in line with their expectations as possible.

Survey of Other Chemical Engineering Programs

An important source of information that helped to guide our curriculum reorganization was an examination of other chemical engineering programs. This task, done near the beginning of our effort, was intended to provide us with a representative "snapshot" of existing chemical engineering programs. We included highly rated undergraduate programs in departments without doctoral degrees as judged by U.S. News & World Report: *Cooper-Union, Manhattan, Minnesota (Duluth),* and *Rose-Hulman.* We also included several programs in departments to whom we have historically compared ourselves.

Some of the programs we included, like ours, we termed "traditional": *Cooper-Union, Georgia Tech, Manhattan,* and *Minnesota (Duluth).* We also included what we termed "non-traditional" programs: *Drexel, Lehigh, Penn State, Rose-Hulman, Rowan,* and *Rutgers.* Finally, we noted that several of the departments are in our geographic region and can be considered our direct competitors: *Cooper-Union, Drexel, Lehigh, Manhattan, Rowan,* and *Rutgers.*

Information on these programs was gathered from their respective web sites. The information obtained is summarized in Table I according to the number of credits in the following courses: humanities and social sciences (required courses and restricted electives), chemistry and physics, mathematics, other science or engineering (required courses), material and energy balances, transport phenomena, thermodynamics, kinetics and reactor engineering, plant design, unit operations laboratory, process dynamics and control, concentration (minor), chemical engineering electives, free electives, and physical education.

We made several important observations in comparing our program with the others:

- 19% more credits in humanities and social sciences
- 15% more credits in chemistry and physics
- 50% more credits in thermodynamics

Table I: Breakdown Of Credits (As Of February 2002) For Various Chemical Engineering Programs (Part 1)

	Mat/Eng Balances	Transport	Thermo	Kinetics/ Rxn Engg	Plant Design	Unit Ops Lab	Proc.Dyn & Control	ChE Electives	Conc (Minor)
Cooper Union	3	10	6	3	6	3	3	0	0
Drexel *	6 4	15 10	3 2	4 3	9 6	9 6	3 2	0 0	14 10
Georgia Tech	3	9	6	3	3	3	4	3	0
Lehigh	3	10	4	3	6	4	3	---	---
Manhattan	3	12	3	3	9	5	3	0	0
Minnesota Duluth	3	9	3	3	8	6	3	3	0
NJIT	4	12	6	3	4	8	4	3	0
Penn State	3	8	5	3	3	3	3	0	18
Rose-Hulman*	8 5	16 11	8 5	4 3	8 5	5 3	4 3	--- ---	--- ---
Rowan	4	15	3	4	7	3	3	6	0
Rutgers	6	12	3	3	4	8	3	3	0
Average**	3.7	10.6	4	3.1	5.7	4.4	3		

* On quarter system (upper number) - scaled by multiplying by 2/3 (2 semesters = 3 quarters) (lower number)

** Average excludes NJIT

Table I: Breakdown Of Credits (As Of February 2002) For Various Chemical Engineering Programs (Part 2)

	Hum/SS	Chem/Phys	Math	Sci/Eng(req)	Free Electives	Physical Education	Total Credits
Cooper Union	24	37	20	11	9	0	135
Drexel *	30 20	36 24	17 11	40 27	6 4	0 0	192 129
Georgia Tech	27	31	19	4	15	2	132
Lehigh	22	36	15	12	15	0	133
Manhattan	24	33	12	12	12	0	131
Minnesota Duluth	21	34	18	16	3	0	130
NJIT	27	36	16	7	3	2	135
Penn State	26	34	16	12	0	0	134
Rose-Hulman*	40 27	36 24	27 18	16 11	24 16	0 0	196 131
Rowan	18	22	16	30	0	0	131
Rutgers	18	36.5	16	9.5	15	0	137
Average**	22.7	31.2	16.1	14.5			132.3

* On quarter system (upper number) - scaled by multiplying by 2/3 (2 semesters = 3 quarters) (lower number)

** Average excludes NJIT

- 30% fewer credits in plant design
- 82% more credits in unit operations laboratory
- 33% more credits in process dynamics and control
- No minor or concentration based on elective courses

As a result of these observations, as well as the comments collected from our various constituencies, the curriculum committee considered numerous recommendations:

+ Reduce the total number of credits
+ Modernize the curriculum while maintaining the fundamentals
+ Reduce humanities and social science credits
+ Reduce chemistry/physics credits
+ Include non-chemical engineering requirements, especially biology
+ Decrease credits in thermodynamics
+ Increase plant design credits (need 2 terms)
+ Decrease unit operations laboratory credits
+ Increase credits in electives and/or adopt a minor/concentration system
+ Make freshman/sophomore design component "real"

The apparent need to reduce our total credits in chemistry and physics led to a contentious issue – how many credits are needed in organic chemistry. Table II shows that we required 19% more credits in organic chemistry than the average. While most of the programs had two distinct organic chemistry courses, most did not have a distinct organic chemistry laboratory course, as we required.

The information that was gathered from the other programs was, as indicated above, considered to be a "snapshot" of what other programs were doing. They were evaluated mainly to see if they had incorporated any ideas that we should consider, and how many credits they devote to the different areas within the curriculum. None of the changes that we made were motivated by what we found. However, in some cases, the fact that another department had implemented a similar change to one that we considered was encouraging.

Revised Chemical Engineering Curriculum at NJIT

The revised chemical engineering curriculum at NJIT is described below. We have reduced total credits from 135 to 132 according to the following breakdown:

- Math / Science 52 → 46
- ChE / Engg. Sci. 48 → 51
- General Education 29 → 26
- Electives 6 → 9

Table II: Breakdown Of Required Credits in Organic Chemistry (As Of February 2002) For Various Chemical Engineering Programs					
	Organic Chemistry (1st course)	Organic Chemistry (2nd course)	Organic Chemistry (lab course)	Total Organic Chemistry	Total Credits
Cooper Union	3	2	2	7	135
Drexel *	4 2.5	4 2.5	none ***	8 5	192 129
Georgia Tech	?	?	?	?	132
Lehigh	4	3	none ***	7	133
Manhattan	3	3	2	8	131
Minnesota Duluth	4	0	none ***	4	130
NJIT	3	3	2	8	135
Penn State	3	3	2	8	134
Rose-Hulman*	4 2.5	4 2.5	none ***	8 5	196 131
Rowan	4	0	none ***	4	131
Rutgers	4	4	2	10	137
Average**				6.4	132.3

* On quarter system (upper number) - scaled by multiplying by 2/3 (2 semesters = 3 quarters) (lower number)

** Average excludes NJIT

*** Either no lab course or lab incorporated into lecture course(s)

Table III. NJIT Chemical Engineering Undergraduate Curriculum
(Part 1 - Freshman Year)
(Changes in RED (*italics*); * indicates a new or substantially revised course)
(GUR indicates course or elective required by General University Requirements)
(#-#-# indicates class hours - lab/workshop hours - credit hours)

PREVIOUS				REVISED			
Freshman I		Freshman II		Freshman I		Freshman II	
General Chemistry I	3-0-3	General Chemistry II	3-0-3	General Chemistry I	3-0-3	General Chemistry II	3-0-3
FED (CAD)	0-2.25-1	General Chem Lab	0-2-1	FED (CAD)	0-2.25-1	General Chem Lab	0-2-1
FED (design)	0-2.25-1	Computer Program.	2-1-2	FED (design)	0-2.25-1	*Computer Tools**[1]	2-1-2
HSS 101 (GUR)	3-0-3	HSS 21x (GUR)	3-0-3	HSS 101 (GUR)	3-0-3	HSS 21x (GUR)	3-0-3
Calculus I	4-1-4	Calculus II	4-1-4	Calculus I	4-1-4	Calculus II	4-1-4
Physics I	3-0-3	Physics II	3-0-3	Physics I	3-0-3	Physics II	3-0-3
Physics I Lab	0-2-1	Physics II Lab	0-2-1	Physics I Lab	0-2-1	Physics II Lab	0-2-1
Freshman Seminar	1-0-0	Physical Education	0-1-1	Freshman Seminar	1-0-0	Physical Education	0-1-1
Physical Education	0-1-1			Physical Education	0-1-1		
Introduction to ChE	1-0-0			Introduction to ChE	1-0-0		
TOTAL	17	TOTAL	18	TOTAL	17	TOTAL	18

[1] Computing Tools for Engineers – Matlab, Excel, Visual Basic (or equivalent)

Table III. NJIT Chemical Engineering Undergraduate Curriculum
(Part 2 - Sophomore Year)
(Changes in RED (*italics*); * indicates a new or substantially revised course)
(GUR indicates course or elective required by General University Requirements)
(#-#-# indicates class hours - lab/workshop hours - credit hours)

PREVIOUS				REVISED			
Sophomore I		Sophomore II		Sophomore I		Sophomore II	
Calculus IIIA	3-0-3	Differential Eqns.	4-0-4	Calculus IIIA	3-0-3	Differential Eqns.	4-0-4
Physical Chem. I	3-0-3	ChE Thermo. I	2-2-3	*Thermodynamics I**[2]	3-0-3	Fluid Flow	3-0-3
Analytical Chem.	0-4-2	Organic Chem. II	3-0-3	Statics/Dynamics	3-0-3	*Physical Chem**[3]	4-0-4
Material Balances	4-0-4	Organic Chem. Lab	0-4-2	*ChE Process Calcs I**[4]	2-1-2	*ChE Process Calcs II**[5]	3-1-3
Organic Chem. I	3-0-3	Physical Chem. II	3-0-3	*Organic Chemistry**[6]	3-0-3	Social Science GUR	3-0-3
HSS 21x (GUR)	3-0-3	Social Science GUR	3-0-3	HSS 21x (GUR)	3-0-3		
TOTAL	18	TOTAL	18	TOTAL	17	TOTAL	17

[2] Remove energy balance material from, and put into new Process Calcs II; add thermo from PChem I
[3] Condense P-chem I & II; remove redundant energy balance/thermo material
[4] ChE Process Calcs I – material balances, reduced credits
[5] ChE Process Calcs II – energy balances, design component
[6] Organic Chem for ChE – condense 2 terms into 1; emphasize highlights

Table III. NJIT Chemical Engineering Undergraduate Curriculum
(Part 3 - Junior Year)
(Changes in RED (*italics*); * indicates a new or substantially revised course)
(GUR indicates course or elective required by General University Requirements)
(#-#-# indicates class hours - lab/workshop hours - credit hours)

PREVIOUS				REVISED			
Junior I		Junior II		Junior I		Junior II	
Fluid Flow	3-0-3	Statics/Dynamics	3-0-3	ChE Thermo. II	3-0-3	*Biology for ChE**[7]	3-0-3
ChE Thermo. II	3-0-3	Material Science	3-0-3	*Anal/Phys/Org Lab**[8]	0-7-3	*ChE Material Science**[9]	3-0-3
Physical Chem. Lab	0-4-2	Reaction Engineering	3-0-3	*Heat/Mass Transfer**[10]	4-0-4	Reaction Engineering	3-0-3
Economics (GUR)	3-0-3	Heat Transfer	3-0-3	*ChE Math Methods**[11]	3-0-3	*ChE Laboratory I*[12]	0-6-3
Statistics (GUR)	1-0-1	Diffusional Systems	3-0-3	*Technical Writing*[13]	3-0-3	*Separations**[14]	4-0-4
LHPS 3xx (GUR)	3-0-3						
TOTAL	15	TOTAL	15	TOTAL	16	TOTAL	16

[7] Biology for ChE – in lieu of general biology likely to be school requirement
[8] Combine elements of all three previous lab courses
[9] Material Science for ChE
[10] Heat & Mass Transfer – combined course (including materials from current diffusional systems course)
[11] ChE Math Methods – combine current statistics course, linear algebra, math component from current process control course (statistics component must satisfy GUR)
[12] Reduced credits by 1 to make more realistic
[13] Existing technical writing course to be required (will satisfy current Hum/SS 3xx GUR)
[14] Separations – distillation, extraction, membranes, etc.

Table III. NJIT Chemical Engineering Undergraduate Curriculum
(Part 4 - Senior Year)
(Changes in RED (*italics*); * indicates a new or substantially revised course)
(GUR indicates course or elective required by General University Requirements)
(#-#-# indicates class hours - lab/workshop hours - credit hours)

PREVIOUS				REVISED			
Senior I		Senior II		Senior I		Senior II	
Equilibrium Stages	3-0-3	Plant Design	4-0-4	LHPS 3xx (GUR)	3-0-3	Plant Design	4-0-4
Process Control	4-0-4	ChE elective	3-0-3	*Process Control*[15]	3-0-3	*Elective (conc)*[16]	3-0-3
ChE Laboratory I	1-6-4	ChE Laboratory II	0-8-4	*ChE Laboratory II*[17]	0-6-3	*Elective (conc)*	3-0-3
Management GUR	3-0-3	Technical elective	3-0-3	*Elective (conc)*	3-0-3	*Eng. Economics*[18]	3-0-3
Hum/SS 3xx (GUR)	3-0-3	HSS 4xx (GUR)	3-0-3	Economics (GUR)	3-0-3	HSS 4xx (GUR)	3-0-3
TOTAL	17	TOTAL	17	TOTAL	15	TOTAL	16

[15] Reduced credits by one to reflect move of math component to new math course
[16] One of three electives to form a concentration area
[17] Reduced credits by one to be more realistic
[18] Engineering economics course will be required (currently satisfies Management GUR)

Table III. NJIT Chemical Engineering Undergraduate Curriculum
(Part 5 - Summary)

Overall Total Credits	Previous: 135	Revised: 132
Math/Science total credits: 46	(18 in Math, 8 in Physics, 17 in Chemistry, 3 in Biology) [ABET minimum is 32]	
Engineering total credits: 51	(includes 2 for Computer Tools for Engineers (CIS GUR); 3 for Eng Economics (Mgmt GUR); 2 for FED 101C & FED 101D; 3 for Statics/Dynamics and 41 for ChE courses) [ABET minimum is 48]	
General Education total credits: 26	(24 credits in HSS + 2 in PE)	
Elective total credits: 9	(9 for “concentration” courses)	
Total credits: 132		

Planned Concentration Areas (Need 3 Related Electives):
- Pre-Medical (Organic Chem II, Biology II, BioTransport)
- Polymers (Polymer Sci, Polymer Engg, Polymer Processing)
- Pharmaceuticals (Biochem, Biotransport, Pharmaceutical Engg)

Freshman Year. Table III shows the previous and revised chemical engineering curriculum at NJIT. There is only one change in the freshman year, and it does not affect total credits. The current second term course in computer programming will be substantially revised. Comments and surveys from our chemical engineering students have indicated that the current course emphasizing a programming language (e.g. C++) is of little use to them. The new course will emphasize applications that the students will use in later courses: Matlab®, Excel®, and perhaps Visual Basic®.

Sophomore Year. The sophomore year sees the first significant changes in the curriculum. The first major issue is the reorganization of material balances, physical chemistry, and thermodynamics. Students have complained of material duplication, inconsistent nomenclature and formalisms, and an apparent lack of subject relevance. The new ChE Process Calculations I, at a savings of 2 credits, will cover material balances. A required workshop, proven successful in other programs at NJIT, will run in parallel for weaker students. The energy balance material that had been in Thermodynamics I will be shifted over to a new energy balance course called ChE Process Calculations II. This course will be given a significant design component to enhance relevance of material and to help students develop the ability to synthesize material from diverse courses. It will also feature the students' first exposure to the use of process simulation software. Thermodynamics content will be removed from physical chemistry to avoid duplication. The remainder of physical chemistry will be collapsed into a single 4-credit course. The net impact of these changes is a savings of 1 credit.

The second major change in sophomore year involves Organic Chemistry. The 2-course sequence is collapsed into 1 course at a credit savings of 3 credits. While the importance of organic chemistry, especially in view of biology and jobs in the pharmaceutical industry in New Jersey, was universally accepted, there was disagreement on our committee over how many credits to devote to it. Finally, after much discussion, the belief that a more engineering approach stressing classes of reactions in lieu of "cookbook" syntheses prevailed.

Other changes include shifting the engineering school-required Statics & Dynamics course from the junior year to the sophomore year, this was true as well for the first transport phenomena course, Fluid Flow.

Junior Year. Major changes continue into the junior year. Students have expressed dissatisfaction with the current science laboratory courses, especially for organic chemistry. In response, we are condensing the analytical, physical, and organic chemistry laboratory courses into a single advanced chemistry laboratory course for a net savings of 3 credits. Experiments will be selected that integrate lessons from the earlier courses; e.g., an organic synthesis followed by a chromatographic separation / analysis. Emphasis on professional communication skills will be expanded with written and oral reporting.

Concurrent with this new laboratory course will be a required technical writing course. This course has been one of the courses that could be chosen to satisfy one of the general university requirements. Offered by the Humanities Department, this course focuses on technical communication skills for engineers. Feedback from alumni and from our industrial advisory board supports the inclusion of this course.

Recognizing the inherent similarities between aspects of heat and mass transfer, the current separate courses in heat transfer and in diffusional systems will be combined into a single 4-credit course called Heat & Mass Transfer. The material on packed towers from the previous diffusional systems course will be covered in a new 4-credit separations course. This new course will replace the previous course on equilibrium-staged separations from senior year. To satisfy our industrial advisors, the separations course will include methods such as chromatography and membranes, as well as more traditional methods (e.g. distillation). The net impact of these particular changes is a savings of 1 credit.

Biology has been introduced as a required course in the new curriculum. This action reflects feedback from students, alumni, and industrial advisors; the proximity of NJIT to the pharmaceutical industry in New Jersey; and the importance placed on biology as one of the new pillars of chemical engineering[1]. This course will emphasize biology for chemical engineers, as opposed to a traditional general biology course. It will include microbiology and bioprocesses such as fermentation.

Other courses with a chemical engineering orientation will be added or changed in the junior year. The current material science course out of the chemistry department will be changed to a chemical engineering course. Greater emphasis will be placed on issues important to engineers, such as material selection. A new course on mathematical methods for chemical engineers will be added. Feedback from our alumni who pursue graduate studies elsewhere indicate a need for more math, especially linear algebra. This new 3-credit course will combine the current 1-credit statistics course with linear algebra and the math component (Laplace transforms) from the senior-year course on process dynamics and control.

Finally, the first unit operations laboratory course will be moved from the senior to he junior year with reduction of 1 credit. This move will fulfill a student request for a greater sense of relevance by moving the laboratory experience somewhat closer to the prerequisite courses. The credit reduction reflects a more realistic assessment of in-lab time.

Senior Year. The biggest change in the senior year is the introduction of concentration areas. A student will choose an area of interest to consist of 3 related elective courses (3 credits each), thus replacing the current approach of 1 technical elective and 1 chemical engineering elective. Our students have expressed a desire for a concentration (minor) as a means of improving their employment prospects. Current faculty interests suggest that our initial concentration offerings will be in polymers, pre-medical, and biology / pharmaceutical. It is anticipated that most of the course requirements of these areas can be met by courses already available at NJIT.

Lesser changes in senior year include the shifting of the second unit operations laboratory course to the first term with a reduction in 1 credit, again to better reflect in-lab time. Also, the course on process dynamics and control is reduced by 1 credit to reflect the shift of its math component to the new mathematics course in the junior year. Finally, an existing 3-credit course on engineering economics will be required concurrent with the plant design course. Our experience shows that the students need more work in plant and investment economics, such as discounted cash flow and depreciation.

Discussion and Observations

Some of the changes discussed impacted the university's General University Requirements (GUR), those curricular requirements that all NJIT students must fulfill. The freshman computer course, the junior mathematics course, and the senior engineering economics course are all examples of courses that also satisfy parts of the GUR. Implementation of several of these courses required the consent and cooperation of other departments, which was not always easily obtained.

The curricular reform was not solely concerned with rearranging topics, courses and credits. Attention has also been paid to how the courses are to be taught, and how the students can best learn the material. Several courses will have an increased emphasis on design. Many of the courses will make increased use of demonstrations and other forms of interactive, experiential learning. All instructors will be encouraged to make use of modern teaching techniques such as collaborative learning; workshops are being formally introduced into several courses.

The process of implementing the new curriculum is, of course, still ongoing. Curricular reform is a process that never ends. As the new courses are developed and given for the first time, there will doubtless be mid-course corrections. The success of the new curriculum, or lack thereof, will be determined not by how many of these corrections are required, but rather by the feedback we obtain from our constituencies as time goes on. Are the number of concerns noted, especially in the areas discussed previously, becoming fewer? Are they shifting to other, hopefully less significant, areas? Are our constituencies happy with the changes that have been made? The answers to these questions will of course shape any further modifications to the curriculum. These considerations can also be quantitatively assessed using many of the assessment tools that the department has formally identified[2] in the past.

Conclusions

The new chemical engineering undergraduate curriculum at NJIT answers feedback from our various constituencies. Concentration areas have been introduced to enhance the attractiveness of our graduates in the job market. Several existing courses have been rationalized and reorganized to enhance students' understanding and sense of relevance within the program. Biology will become a required course, and will doubtless be a prerequisite for several courses used for concentration areas. Heat and mass transfer will be combined, with a new separations course covering a broader spectrum of techniques.

While the total credits have only been reduced by 3 credits, our students will be stronger and better prepared for both industry and graduate school.

References

1. Proceedings of the New Frontiers in Chemical Engineering Education Workshop, Orlando, Florida, January 27-29, 2003, web.mit.edu/che-curriculum/2003/orlando/ proceedings_1_group_reports.pdf
2. Knox, D.E., "Assessment Methods for Engineering Programs – Too Many Choices or Not Enough?", paper 2002-1918, session 2613, Proceedings of the 2002 ASEE Annual Conference & Exposition, Montreal, Canada, June 2002.

Biographical Information

DANA E. KNOX earned his B.S., M.E. and Ph.D. degrees in chemical engineering from Rensselaer Polytechnic Institute. He joined the chemical engineering faculty at New Jersey Institute of Technology in 1982, and is currently the associate chair of that department. He and his wife Petra make their residence in Edison, NJ.

ROBERT B. BARAT earned his B.S. and M.S degrees in chemical engineering from New Jersey Institute Of Technology and his Ph.D. in chemical engineering from Massachusetts Institute of Technology. He joined the chemical engineering faculty at New Jersey Institute of Technology in 1990. He and his wife Katherine and children Alexander and Kendra live in Franklin Park, NJ.