ChE survey

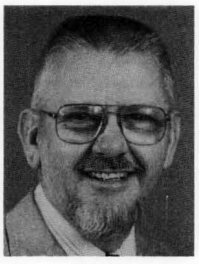
THE CHEMICAL ENGINEERING CURRICULUM — 1989

GEORGE A. COULMAN
Cleveland State University
Cleveland, OH 44115

The Education Projects Committee of the American Institute of Chemical Engineers has conducted surveys of the chemical engineering undergraduate curricula since 1957 [1-7]. The most recent survey was initiated in the summer of 1989. The information provided by the chemical engineering departments in the United States was to be based on the curricula in effect as of the fall term of 1989. The survey results are based on ninety-two departmental responses to a mailing which was made to all departments listed with AIChE in the summer of 1989.

The data received were entered into a LOTUS 1-2-3 worksheet for ease of analysis and review. The questionnaire was revised to closely correspond with the ABET/AIChE categories in order to facilitate completing the form.

The semester hours required for the bachelor's degree appear to be stabilized in the low 130*s*, as shown in Figure 1. It is interesting to observe from the more detailed information on the spreadsheet that the range is from 112 to 146.3 SH. It is difficult to determine if this is an anomaly of the individual school's credit system or a true reflection of the classroom hours of the student. More than eighty percent of the departments require 125 to 140 semester hours, with only seven reporting fewer than 125 and seven reporting more than 140.



George A. Coulman *is the Dean of Fenn College of Engineering and a professor of chemical engineering at Cleveland State University. He received his BS in chemical engineering, his MS from the University of Michigan, and his PhD as a Ford Foundation Fellow at Case Institute of Technology. After seven years in industry, he moved to academia and has taught at the University of Waterloo, Michigan State University, and Cleveland State University. He teaches courses in control, computation, and optimization, as well as introductory chemical engineering.*

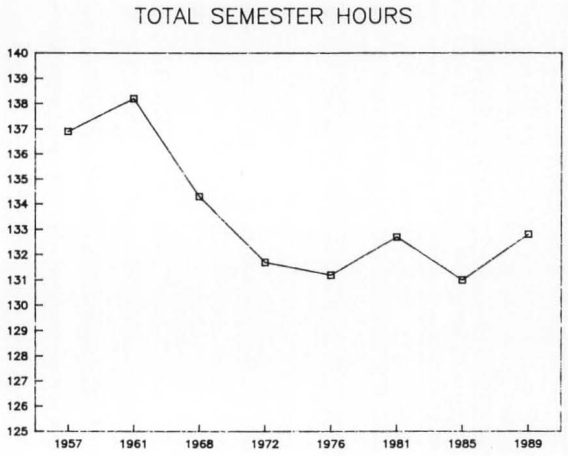


FIGURE 1

The average curricular area distribution continues to be very close to the ABET/EAC requirements, as shown in Table 1. However, it is interesting to notice that the range of the categories is quite wide. The mathematics category ranges from 12.0 to 22.0 hours, with an average of 16.4. The average is

TABLE 1
Distribution of Course Work

	AIChE	*1981*	*1985*	*1989*
Curricular Area	%	Avg	Avg	Avg
Mathematics beyond Trigonometry	12.5	13.6	12.7	12.4
Basic Sciences	25.0	24.3	25.4	24.8
(Incl. Advanced Chemistry)	(12.5)	(11.7)	(12.8)	(12.3)
Engineering Sciences/Design	37.5	37.3	37.2	39.7
Humanities/Social Sciences	12.5	16.1	15.1	13.5
Other	12.5	8.7	9.7	9.6
TOTAL PERCENT	100.0	100.0	100.0	100.0
TOTAL CREDIT HOURS		133.4	131.0	132.8

the specified 12.5%, but the range would result in values from less than ten to more than sixteen percent. Similar attributes exist in the other categories. No significant changes have occurred in the program category averages.

Some changes have occurred within the categories. Although mathematics continues to be predominantly calculus and differential equations, a diversity appears in the residual credits. Twenty-one departments require linear algebra, nineteen require advanced calculus, and thirteen require partial differential equations. Many departments have a mathematics elective.

The basic science category shows an initial move to diversity. Introductory physics and chemistry have traditionally satisfied this requirement and continue to dominate the credit hours. However, twelve departments report modern physics, six list biology, and seven indicate other basic sciences.

The advanced chemistry requirement continues to average 12.5% (16.28 hours) of the program. However, the range of 10.0 to 22.0 was surprising. The total chemistry content is shown in Figure 2. This value has stabilized, as might be expected.

The engineering science and design category has increased slightly to 39.6%. Statics is taken by nearly seventy percent of the departments, while approximately one-quarter of the departments report dynamics and/or mechanics of materials. Sixty-seven departments indicate introduction to electrical engineering and/or electronics, with an average of approximately 3.0 hours. Material science is required by half of the departments. One-third of the departments require engineering graphics.

TABLE 2
Elective Offerings

Elective	*# Depts.*	*Elective*	*# Depts.*
1. Biochemical	47	12. Petroleum	12
2. Polymers	38	13. Catalysts	11
3. Environmental	28	14. Paper	9
4. Transport Phenomena	27	15. Nuclear	7
5. Applied Math	25	16. Coal	5
6. Control	19	17. Energy	4
7. Biomedical	15	18. Equipment	3
8. Design	15	19. Food	3
9. Mass Transfer	15	20. Fuel	2
10. Reactors	13	21. Natural Gas	2
11. Electrochemistry	12	22. Other	45

Some changes have occurred within the categories. Although mathematics continues to be predominantly calculus and differential equations, a diversity appears in the residual credits.

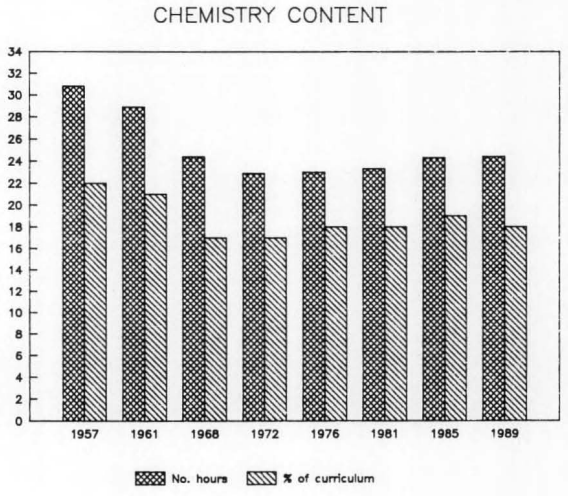


FIGURE 2

The chemical engineering component is seventy percent of the engineering category. Several observations in this area suggest that some significant differences may exist. Three course identifiers overlap but suggest a difference in focus. Seventy-five percent of the departments report transport phenomena, eight-two percent report mass transfer, and fifty-four percent report unit operation theory. The process dynamics and process control courses appear to offer little distinct information and will be consolidated in the next survey. This appears to be true of kinetics and reactor design as well. Also, it is surprising that four departments do not report a capstone design course.

The most significant differentiation between departments was in the elective available. Twenty-one specific electives were included in the category questionnaire along with a broad "other." The results are presented in Table 2. The leading elective is biochemical, with approximately half the departments offering it. Forty percent offered polymers and environmental electives. At the lower end of the offerings were the energy-related areas (coal, fuel, natural gas, *etc.*).

The cultural category (humanities and social science) continued a modest decline, as shown in

Figure 3. The average program contains 13.5 percent (17.95 hours), which is near the ABET minimum. At the low end is a department with 6.0 hours, while the high end is 55.3 hours. This extreme range is startling. The high extreme is 42 percent of the program.

The collection of subjects in the ABET "Other" category is expectedly diverse. However, the area of communication (Figure 4) appears to have stabilized at 90% of the departments requiring either written or oral communication courses. Prior to the 1970*s*, it was near 95%. The 1970*s* saw a drop to approximately 78%, followed by a rise to the present level. The only other course with a significant number of departments (70%) requiring it is computer programming. Still expanding is the availability of "free-electives," with forty percent of the departments reporting them.

An illustration of the average program is shown

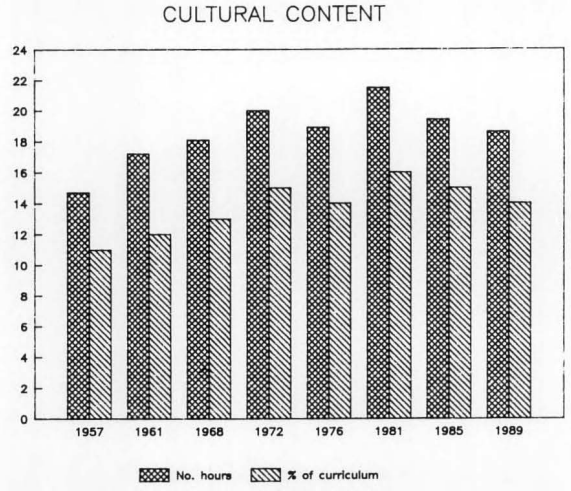


FIGURE 3

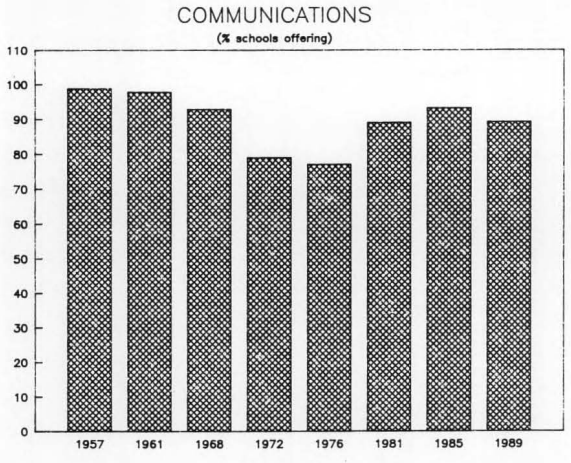


FIGURE 4

TABLE 3
Average Program Abstract

Course	*Hours*	*Course*	*Hours*
Analytical Geometry	2.81	Thermodynamics	4.00
Calculus	8.66	Reaction Engineering	3.00
Differential Equations	3.09	Transport Phenomena	4.28
General Physics	8.07	Mass Transfer	3.24
General Chemistry	7.81	Unit Operations	4.02
Physical Chemistry	6.43	Laboratory	3.31
Organic Chemistry	7.25	Process Control	3.00
Other Chemistry	3.68	Design	5.04
Statics	2.54	ChE Electives	5.94
Electrical Engineering	3.13	Humanities	8.40
Material Science	3.01	Social Science	7.44
Fluid Mechanics	2.83	Communications	5.19
Heat Transfer	2.33	Computer Programming	2.50
Material and		Electives	6.20
Energy Balance	3.38	Other	2.58
		TOTAL	**132.78**

in Table 3. This composite is useful for comparison. However, for detailed understanding of the program variation among departments, a review of the spreadsheet is necessary. I have distributed this to all departments that participated in the survey. If others are interested, the author would be pleased to send copies while they last.

The staffing questionnaire had no surprises. The ninety-two reporting departments indicated 69.5 openings. Total current staffing includes five hundred twenty-two professors, two hundred forty-five associate professors, and one hundred ninety-one assistant professors.

REFERENCES

1. Thatcher, C.M., "The Chemical Engineering Curriculum, *Chem. Eng. Ed.,* September (1962)
2. Schmidt, A.X., "What is the Current ChE Curriculum?" *J. of Eng. Ed.,* October (1958)
3. Balch, C.W., "Undergraduate Curricula in Chemical Engineering, 1969-1970, *Chem. Eng. Ed.,* **6**[1] (1972)
4. Barker, D.H., "Undergraduate Curricula in Chemical Engineering, 1970-71," *Chem. Eng. Ed.,* **6**[1] (1972)
5. Barker, D.H., "Undergraduate Curricula 1976," *Chem. Eng. Ed.,* **11**[2] (1977)
6. Barker, D.H., "1981 AIChE-EPC Survey," *Chem. Eng. Ed.,* **15**[4] (1982)
7. Coulman, G.A., "Chemical Engineering Curriculum - 1985," *Chem. Eng. Ed.,* **20**[3] (1986) ❐