ChE curriculum

A COMBINED BACHELORS-MASTERS PROGRAM

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THIS ARTICLE DESCRIBES the undergraduate chemical engineering curriculum at the Speed Scientific School of the University of Louisville. We are motivated to write this short article describing the curriculum to bring out some of its interesting features which lead to a regular supply of research students during their final year. In these days of diminishing supply of graduate students, the foregoing fact has been very helpful in maintaining a reasonable level of research effort in the department.

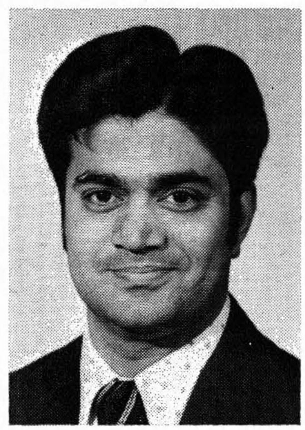
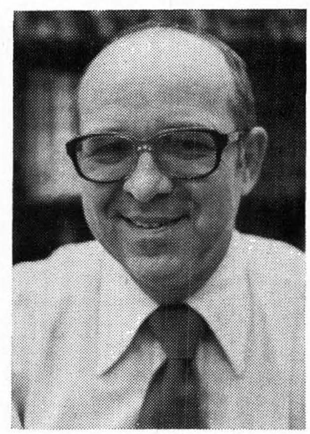
HISTORICAL

THE SPEED SCIENTIFIC School, the college of engineering at the University of Louisville, began operations in 1925 with an endowment from the James Breckenridge Speed Foundation. First degrees in chemical engineering were awarded in 1929. The school offers academic programs in chemical engineering, environmental engineering, civil engineering, electrical engineering, engineering management and industrial engineering, and mechanical engineering.

From its inception in 1925 through 1970 the chemical engineering department offered the B.Ch.E. degree. Graduate work at the Masters level was begun in 1934 and at the Doctorate level in 1955. The concept of cooperative internships with industry was an integral part of the undergraduate program from the beginning. With the exception of several years during World War II all students in the baccalaureate program were required to spend several periods, totaling one calendar year, with industrial organizations.

In 1970 the Speed Scientific School initiated a new five-year program leading to the graduate professional degree, Master of Chemical Engineering, but retaining the required cooperative internship in the first four years. While a student receives a B.S. in Applied Science at the end of four years, it is the Master of Chemical Engineering degree which is accredited by E.C.P.D. All students with a grade point average of 2.5 (on a 4.0 point scale), at the end of their fourth year, are eligible to enter the final year of the chemical engineering program. The M.S. and Ph.D. programs remained unaltered.

The department also offers a separate program leading to the degree of Master of Environmental Engineering. There is, however, considerable interaction between both programs. Many chemical engineering students take some of their

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electives from the environmental engineering offering while some of the environmental engineering students opt to take some of the Unit Operations courses. Although the chemical engineering and environmental engineering programs are separate, their format with regard to cooperative internships, thesis requirements, etc. is the same.

THE CURRICULUM

A listing of the courses in the chemical engineering curriculum is shown in Table I. The curriculum is divided into divisions of pre-engineering, basic studies and a division of higher studies. The first two academic years of the curriculum are, in general, common to all engineering students. The first cooperative internship falls in the summer after the student completes these first two years at Speed School. Thereafter, he/she spends every other semester in industry and so by the end of four years the student completes three cooperative internship periods in industry.

At the end of four years the student receives a B.S. degree in Applied Science and has the option of leaving the program (or going to Graduate School, here or elsewhere) or continuing for one calendar year and earning the Master of Chemical Engineering degree. Those students who choose the latter option (and over 80% of all qualified students do) are provided an elaborate list of thesis topics at the beginning of their fifth year. These topics are provided by the faculty members of the department and represent their research interests. Every year these topics include several projects sponsored by major local and regional industries. Most projects are of the applied research nature.

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As shown in Table I, the department offers the required General Chemistry and Physical Chemistry courses and laboratories. Organic Chemistry and an Advanced Chemistry elective

TABLE I. CHEMICAL ENGINEERING CURRICULUM

SEMESTER / YEAR	PRE-ENGINEERING-1 FIRST YEAR		PRE-ENGINEERING-2 SECOND YEAR		BASIC STUDIES-1 THIRD YEAR		BASIC STUDIES-2 FOURTH YEAR		HIGHER STUDIES	
	COURSE TITLE	CREDIT HOURS	COURSE TITLE	CREDIT HOURS	COURSE TITLE	CREDIT HOURS	COURSE TITLE	CREDIT HOURS	COURSE TITLE	CREDIT HOURS
SUMMER			Mechanics 2	3	Cooperative Internship	2	Engineering Economics	3	Process Control	3
			Electromagnetic Phenomena	3			Thermodynamics	3	Process Control Laboratory	2
			Mathematics 3	4			Heat Transfer	3	Design of Experiments	3
							Heat Transfer Laboratory	1	M. Eng. Seminar	1
									M. Eng. Thesis	1
FALL	Computer Programing	1	Differential Equations	3	Physical Chemistry 2	3	Cooperative Internship	2	Process Design	3
	Engineering Drawing	1	Active & Passive Networks	3	Physical Chemistry Laboratory	1			Chemical Engineering Elective	3
	General Chemistry 1	3	Organic Chemistry 1	3	Fluid Dynamics	3			Chemical Engineering Elective	3
	General Chemistry 1 Laboratory	1	Organic Laboratory 1	1	Fluids Laboratory	1			Chemistry Elective	3
	Mathematics 1	4	Physical Chemistry 1	3	Probability & Statistics	3			M. Eng. Thesis	2
	English 1	3	Humanities / Social Science Elective	3	Free Elective	3				
	Humanities / Social Science Elective	3			Humanities / Social Science Elective	3				
SPRING	Computer Programing	1	Numerical Calculus	3	Cooperative Internship	2	Separation Operations	3	Chemical Engineering Elective	3
	The Profession	1	Material Science	3			Mass Transfer Principles	3	Chemical Engineering Elective	3
	General Chemistry 2	3	Organic Chemistry 2	3			Reaction Kinetics	3	M. Eng. Thesis	5
	General Chemistry 2 Laboratory	1	Material & Energy Balances	4			Mass Transfer Laboratory	1	Humanities / Social Science Elective	3
	Mathematics 2	4	Humanities / Social Science Elective	3			Free Elective	3		
	English 2	3					Humanities / Social Science Elective	3		
	Mechanics 1	3								
CUMULATIVE TOTAL CREDIT HOURS		32		74		95		123		161

are taught by the chemistry department of the Arts and Sciences College. A faculty member of the chemical engineering department whose academic training is in both chemistry and chemical engineering is mainly responsible for our courses. This arrangement offers the obvious advantage of control of course content for these basic courses as well as allowing us to provide financial assistance to more of the graduate or M.Eng. students in the form of additional teaching assistantships. This in turn strengthens the M.Eng., M.S. and Ph.D. programs.

Student enrollment, of course, fluctuates depending on the strength of the job market and the department has graduated, one year, as few as six students. Leaving this phenomena (which affects all departments) aside, the fifth year progra mhas provided a large number of research students (for a department of our size). All of these students have one year of industrial experience in the form of cooperative internships. Many of the better students do graduate-level research with no difficulty. In these days of diminishing supply of graduate students this feature of the curriculum has been most helpful in maintaining a reasonable level of research effort in the department.

At the end of four years the student receives a B.S. degree in Applied Science and has the option of leaving the program (or going to Graduate School here or elsewhere) or continuing for one calendar year and earning the Master of Chemical Engineering degree.

During the fifth year, the student takes, among other things, courses in process control and process design. For the past several years, process design has been offered jointly by a full-time faculty member of the department and an experienced chemical engineer at DuPont, Louisville Works. In addition to these courses the student usually takes one or more advanced or graduate level courses which are offered in the department every semester.

STRENGTHS AND WEAKNESS

THE SUCCESS OF AN academic program can be gauged by several factors; What kind of companies offer employment to the graduates?, How do the salary levels compare with the national average?, How have the graduates performed in their jobs? An indication of the answers to these questions may come from the fact that a large number of industrial and government organizations recruit at Speed every year. Included among these are numerous major employers of chemical engineers who are known to have a preference for the "best from the lot." A comparison of the salary data of Speed graduates (Table II) with the data representing national average shows that Speed graduates have fared better. In fact, Speed graduates have done progressively better over the past 3 years. Since the same employers, generally, recruit on campus each year, it is tempting to conclude that Speed graduates have done better in their jobs also. The fact that Speed graduates have one year of cooperative internship experience, have completed a comprehensive thesis, and have taken several graduate level courses has separated them, we believe, from the graduates of a traditional cooperative department.

TABLE II
Comparison: Salary Data of Speed Graduates in ChE with the National Average

	SPEED M.ENG. GRADUATES* — $/year			U.S. DATA**
Year	High	Low	Average	—$/year—
1973-74	14,700	12,000	13,848	12,828
1974-75	16,800	12,600	14,940	14,616
1975-76	17,400	15,600	16,120	15,516
1976-77	18,900	15,840	18,343	16,884
1977-78	21,000	16,800	19,434	19,548***

*Compiled by Mr. Joseph Pierce, Office of Cooperative Education and Placement, Speed Scientific School, University of Louisville.

**These data are for 5-year Cooperative Program Graduates. The information is available from "CPC Salary Surveys" published every year by the College Placement Council, P.O. Box 2263, Bethlehem, PA 18001.

***This figure represents M.S. salary levels. CPC has now discontinued gathering salary data for 5-year Co-operative Program Graduates.

It would be an untruth if we claimed that the program had no weaknesses. The curriculum does have some weaknesses but we believe that strengths far outweigh the weaknesses. For example, the B.S. graduate of the department who does not qualify to enter the M.Eng. program because of low grade point average, leaves the program without having taken courses in process design and process control. But note that a vast majority of the students do qualify for entrance to the M.Eng. program. Since the B.S. degree is

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. . . this experiment is a good learning experience. This is . . . demonstrated by the fact that (it) is always chosen by one group for an oral presentation at the end of the semester.

$$N_w = \frac{D}{A} = \frac{5.2\ g/hr}{433\ cm^2} = 0.012 \frac{g}{cm^2 - hr.}$$

ΔH_s = 2838 J/g (reference 2)

$$q = \Delta H_s N_w = (2838\ J/g)(0.012 \frac{g}{cm^2 - hr}) = 34.1 \frac{J}{cm^2 - hr}$$

$$U = \frac{q}{(T_w - T_i)} = \frac{34.1\ J/cm^2 - hr}{[21°C - (-30°C)]}$$

Saturated vapor pressure above ice @ −30°C: P_s = 0.2859 torr (reference 4)

$$K = \frac{N_w}{(P_s - P_a)} = \frac{0.012\ g/cm^2 - hr}{(0.2859\ torr - 0.168\ torr)} = 0.102 \frac{g}{cm^2 - hr - torr}$$

DISCUSSION

THE LABORATORY IS scheduled for two 3-hour periods per week and the students are given 2 semester hours credit. The reason for the additional hours per week and credit is that emphasis is placed on communication skills, both written and oral, as well as technical competence in the laboratory procedure and data analysis.

For this particular experiment, the students are given four 3-hour laboratory periods to complete the experiment and the written report. The first laboratory period is spent in instructing the students in the use of the equipment and choosing a material to be freeze-dried. The following morning the students start the experiment and take hourly data for the next 24 hours. The remaining periods are used by the students to study the reference material and write a group report which effectively communicates the desired information.

The students indicate that this experiment is a good learning experience even though the time required for taking data is relatively long. This is further demonstrated by the fact that this experiment is always chosen by one group for an oral presentation at the end of the semester. One reason for good student response is the fact that the experiment "works". The data they obtain gives reasonable results and they can visually observe the success of the experiment. This eliminates the frustration associated with poor data.

One improvement in the experiment would be to place a thermocouple in a larger frozen slab with the vacuum chamber to obtain the core temperature. This would eliminate any assumption of this value. This will be done in future experiments.

In conclusion, a laboratory experiment for freeze-drying fruits and vegetables has been described. It utilizes a small amount of space, is relatively inexpensive, and gives reasonable results. The experiment is very useful for presenting the concepts associated with drying and combined heat and mass transfer. □

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COMBINED PROGRAM

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not accredited by ECPD, persons obtaining only this degree find it impossible to become licensed professional engineers in a few states.

The starting salaries of M.Eng. graduates are not significantly lower than those of the M.S. graduates and it generally takes longer to complete the M.S. thesis. As a result, most students prefer the M.Eng. route. This, we believe, may have adversely affected the size of our M.S. and Ph.D. programs. We hasten to add that this effect must necessarily be a modest one since the number of American students enrolling in Ph.D. programs in most universities these days is small.

In summary, we believe that the M.Eng. concept is a beneficial one, in the current situation. It is not without problems but the severity of the problems can be dealt with to preserve the strengths of the program. □