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Where Is the Roller Coaster Headed?

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THE DEMAND FOR engineers has been widely touted recently by such mass media publications as the Wall Street Journal and Time Magazine. This has generally been a result of reports emanating from the Engineering Manpower Commission. Professional journals have also vividly described the apparent disparity between engineering enrollments and projected demands for B.S. engineers. An example of this is the series "Supply, Demand and Utilization of Engineers" in *Chemical Engineering Progress* last year.

It appeared that engineering enrollments were on the decline up to the Fall of 1975. At that time, ChE Departments began to talk about a quantum surge in enrollments and fears of a boom and bust cycle were being mentioned at national AIChE meetings. It became evident that this was a

Will these and other survey results moderate the present enrollment rise and degree projections? Where is the roller coaster headed? Do we want to stop it? What action do you, the Professional Chemical Engineer, feel AIChE and ASEE should take?

TABLE 1

PERCENTAGE INCREASE IN FRESHMAN ENROLLMENTS

Percentage Increase	Number of U.S. Schools	Number of Canadian Schools
<0%	1	1
0- 9%	8	1
10- 19%	10	
20- 29%	10	
30- 39%	11	
40- 49%	10	2
50- 59%	10	1
60- 69%	12	
70- 79%	3	
80- 89%	2	
90- 99%	2	
100-109%	3	
110% +	2	
Median	40	40

nation-wide phenomenon. The National Career Guidance Committee of AIChE sought verification of this as well as other pertinent data to offer a true perspective of the increases. They conducted a survey of all ChE Departments in the United States and Canada which asked for estimates of projected B.S. degrees to 1979, past degree production data, present and future capacity data, trends in enrollments, attitudes toward coping with the increased enrollments and career guidance programs and needs. Were we really on an enrollment roller coaster and did we want to get off?

One hundred nineteen of the one hundred thirty-six U.S. ChE Departments responded to the survey (see Appended copy) conducted in March and April of 1976. Thirteen of the seventeen Canadian departments also responded. Use-

ful data was obtained from U.S. Departments representing almost 90% of the B.S. degrees granted. The Canadian schools reporting represented approximately 82% of the B.S. degree volume for that country. The survey results indicate that in 1978, 5328 Bachelor of Science degrees in ChE will be awarded by schools in the United States and another 523 by Canadian schools. This will be an increase of more than 50% over the average number of B.S. chemical engineers graduated between 1966 and 1975 for the U.S. The predictions also indicate the 1979 graduating classes will be 5656 and 698 for the United States and Canada, respectively. Only twice has the number of United States ChE Bachelors degrees exceeded 3800. In 1949 it was 4506 and in 1950, 4529.

The 119 United States ChE Departments are hoping to add between 98 and 117 new faculty positions in ChE to meet this enrollment surge. This increase in faculty will mean the United States will have the capacity for producing an estimated 6271 B.S. graduates per year. Present estimated United States capacity is 5785. The present estimated Canadian annual capacity is 649 B.S. degrees and a projected increase of four faculty positions will bring this to 680.

The survey first polled the chemical engineering departments on the increases in the freshman and sophomore enrollments. Tables 1 and 2 show the distribution of percentage increases. Generally, the largest increases were reported by small departments. The median reported freshman increase was 40% and the median reported sopho-

TABLE 2
PERCENTAGE INCREASE IN
SOPHOMORE ENROLLMENTS

Percentage Increase	Number of U.S. Schools	Number of Canadian Schools
<0%	3	1
0- 9%	9	2
10- 19%	21	
20- 29%	18	3
30- 39%	11	
40- 49%	9	
50- 59%	12	3
60- 69%	7	1
70- 79%	3	1
80- 89%		
90- 99%		
100-109%	11	1
110% +	7	
Median	30	37.5

TABLE 3
ATTRITION RATE
IN CHEMICAL ENGINEERING

Attrition Rate %	Number of U.S. Schools	Number of Canadian Schools
0- 4	3	
5- 9	1	
10-14	4	1
15-19	7	2
20-24	10	1
25-29	12	1
30-34	21	3
35-39	4	
40-44	10	
45-49	3	
50-54	14	1
55-59		
60-64	4	
80	1	
Median	30	23

more increase was 30%. When the schools were asked if the number of highly qualified students which were likely to graduate in ChE had increased, 75% (62%)* said yes and 17% (31%)* said no. This is a good indication that the expanded student body can survive the rigors of a ChE program.

The departments were then asked to supply their freshman-senior attrition experience. Table 3 illustrates the distribution and again the smaller departments usually experienced the larger rates. The median attrition rate is 30%. Thirty-four percent (0%) of the departments expect the attrition rate to increase, 11% (17%) to decrease and 49% (83%) to remain the same. Here again is an indication that the increased enrollments can be expected to appear as future graduates.

Not only are those selecting ChE initially increasing but those transferring into our field are also increasing. Eighty-eight percent (54%) of the responding schools found an increasing shift of degree major toward ChE at the B.S. level. Sixty-one percent (23%) found an increased shift at the M.S. level.

ESTIMATED GROWTH

EACH RESPONDENT was asked to estimate the number of expected B.S. degrees over the next four years. Table 4 summarizes the estimates that were supplied by U.S. schools. The number

*The numbers not in parenthesis are for the U.S. schools; those in parenthesis are for the Canadian schools.

TABLE 4
UNITED STATES ENROLLMENT PROJECTIONS

Year	Sum of Estimates	Number of Schools	Reported* 10 year average sum	Estimated Yearly Total
1976	3237	119	3190.7	3607
1977	3880	119	3190.7	4320
1978	4718	117	3145.7	5328
1979	4699	107	2951.3	5656
Present Capacity	4936	117	3030.7	5785
Future Capacity	5351	117	3030.7	6272

*Including an estimate by authors for 3 schools.

of schools that provided useful estimates are indicated. Also listed are the estimates of total degrees to be awarded. These are based upon the sum of 10-year averages provided by the schools that estimated future enrollments (for three of these schools, the authors had to estimate their 10-year average). This sum was added to the calculated average for the 17 non-answering schools plus the four who have ceased offering a degree in ChE. This total divided by the sum for the schools estimating future enrollments was multiplied by their estimates to obtain the projected yearly totals for the next four years. For the schools which did not provide 10-year estimates these were obtained from the number of graduates listed in "Chemical Engineering Faculties". Where values were missing these were estimated by the authors. The average number of U.S. Bachelors degrees was calculated to be 3552. The Engineering Manpower Commission estimates the average between 1966 and 1975 to be 3371 B.S. graduates. This is the

TABLE 5
CANADIAN ENROLLMENT PROJECTIONS

Year	Sum of Estimates	Number of Schools	Reported Ten Year Average Sum	Estimated Yearly Total
1976	255	13	320.3	312
1977	351	13	320.3	430
1978	427	13	320.3	523
1979	374	9	210.3	698
Present Capacity	530	13	320.3	650
Future Capacity	555	13	320.3	680

equivalent to an error of 5.37% or an over-estimation of 1.56 graduates per year for each of schools responding. The equivalent figures for Canadian schools are given in Table 5. The projected totals were estimated in a similar way. Table 6 gives the projected number of Bachelor level engineering degrees as estimated by the Engineering Manpower Commission in its publication "Prospects of Engineering and Technology Graduates 1975". To obtain the ChE bachelors degrees this was multiplied by 8-1/2%. This is the figure John Alden (*CEP*, Oct. 1975, pg. 25) estimated as the past and future percentage of total engineering bachelor degrees. The difference in these figures is astonishing. Since the vast majority of these prospective graduates are currently enrolled in ChE and each school estimated its own prospective number of graduates, the authors feel the figures estimated by this survey are reasonably accurate. In fact these figures may be a little low

TABLE 6
COMPARISON OF UNITED STATES
ENROLLMENT PROJECTIONS

Year	Total U.S.* Bachelors Degrees	ChE** Bachelors Degrees	Estimate from Table 4
1976	40,600	3,450	3,607
1977	44,200	3,757	4,320
1978	50,700	4,310	5,328
1979	51,900	4,416	5,656

*Source: "Engineering Manpower Commission"

**8-1/2% of Total Bachelors Degrees

because the number of Master of Science degrees which will be granted to non-B.S. ChE degree holders must also be considered as part of the annual output of ChE's. The schools answering this question indicated 129 (22) of these will be granted in 1976 and 206 (39) in 1977. Currently at least 60 United States (8) schools offer organized programs in this sort and 13 (0) are planning to add such programs in the next few years.

Is this increase in students merely a perturbation about the mean or does it portend a substantial long term growth in B.S. ChE's? Most U.S. schools seem to feel that it may be permanent since 62 (3) of them are planning or hoping to add over 98 (4) new faculty positions. When asked whether there were any constraints upon the departments which would prevent them from increasing their faculty size, only 25% (15%)

TABLE 7

**CONSTRAINTS WHICH MAY PREVENT THE
ChE DEPARTMENTS FROM INCREASING
THEIR NUMBER OF FACULTY MEMBERS**

	U.S. Schools Number of Replies	Canadian Number of Replies
Money	60	11
Administration Policy	18	
Space (Laboratory or Classroom)	17	
Enrollment	10	2
Faculty	2	
Job Opportunities	2	
Resources	1	
Graduate Students	1	
Research	1	

said no. Those that answered yes listed the constraints given in Table 7. The overwhelming majority cited budgetary restraints of one form or another. It appears from the comments received that quite a few university administrations are putting a lid on the total number of faculty and any increase in engineering faculty would have to come at the expense of other departments.

The Survey indicates that 36 (3) schools feel they will exceed their estimated capacity by 1979. The authors anticipated this and asked the question, "If the number of freshman or sophomore ChE majors exceeded the largest number of ChE's which you felt you could reasonably graduate would you (a) increase the size of the faculty, (b) set a maximum number of students admitted to junior courses, (c) hire graduate students to teach undergraduate courses, (d) increase standards so more students flunk out of the program, (e) do

TABLE 8

**UNITED STATES DEPARTMENTAL RESPONSES TO
"If the number of freshman or sophomore chemical
engineering majors exceeded the largest number of
chemical engineers which you felt you could reason-
ably graduate, what course of action would you
take?"**

	Yes	No	Unknown
Increase the size of the faculty	56	22	14
Set a maximum number of stu- dents admitted to junior course	35	37	10
Hire graduate students to teach undergraduate courses	22	49	6
Increase standards so more stu- dents flunk out of the pro- gram	38	31	9
Nothing	5	31	5

nothing, (f) other. The responses varied and are given in Table 8 and 9. The favorite U.S. method of coping was to increase faculty. Increasing standards and regulating junior class size met with split decisions while using graduate students to teach met with disfavor. The most frequently noted alternative was controlling admissions at the outset. It is noteworthy that this appears to be the method favored in Canada since 6 of 13 schools indicated this as a course of action, and some stated they were presently employing it. The use of adjunct faculty was the second most mentioned alternative as a short-term means of helping a department through the present surge.

This survey has quantified the present enrollment surge and projected an unusual situation in ChE education. Undoubtedly, many factors are

TABLE 9

**CANADIAN DEPARTMENTAL RESPONSES TO
"If the number of freshman or sophomore chemical
engineering majors exceeded the largest number of
chemical engineers which you felt you could reason-
ably graduate, what course of action would you
take?"**

	Yes	No	Unknown
Increase the size of the faculty	2	4	1
Set a maximum number of stu- dents admitted to junior course	3	2	1
Hire graduate students to teach undergraduate courses	0	5	0
Increase standards so more stu- dents flunk out of the pro- gram	0	5	0
Nothing	0	0	0

responsible for the present situation and many others will affect the outcome over the next few years. Many questions come to mind as a consequence of this survey. Are the ChE departments on an enrollment roller coaster? Are the future plans of these departments for faculty additions realistic? Is this surge in enrollments due to publicity in the mass media, lack of jobs in other scientific fields, and/or lack of jobs for high school and college graduates due to the recession? Should ChE departments regulate their admissions or just bend with the breeze? Will there be enough job openings offering meaningful employment for the anticipated surge of engineers? Will these and other survey results moderate the present enrollment rise and degree projections? Where is the roller coaster headed? Do we want to stop it? What action do you, the Professional Chemical Engineer, feel AIChE and ASCE should take? □