WHERE ARE THE ENGINEERS?*

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In spite of our usual confident reliance upon the balance between supply and demand, the relationship between the output of our engineering colleges and the need for practicing engineers does not seem to be following the rule. All of the factors which we would expect to contribute to a great demand for engineers seem to be present. Engineering employment has reached new highs and graduating students of engineering colleges are offered a half dozen or more jobs upon graduation. There are complaints from many potential employers that they are unable to fill their quotas. Indeed, the meteoric rise in the employment of technicians in the engineering field, while largely due to a heretofore unfilled need for this kind of service, is also greatly influenced by the unavailability of young engineers.

Incentives are certainly present in the current situation. The satisfaction to the individual of making a contribution to technical advancement has never been greater and recognition on the part of the general public of the contribution of engineers is well established. Salaries and other remuneration for engineers are at new peaks, higher than those for most other career professionals, at least in the years immediately following graduation. Engineering starting salaries are increasing and at a rate higher than the rate of increase for other professionals.

Thus, the high and unsatisfied demand seems to have created the expected result of increased incentives for the study of engineering. Why then, should there be any shortage of engineers? Many contend that there is no shortage, or rather, they cite statistics to show that there is a consistent increase in the number who choose to study engineering. They conclude that we should not fear a shortage as long as the trends continue.

A comprehensive study published in the January, 1966 *Journal of the American Society for Engineering Education*, by the ECAC (committee for analysis of engineering enrollment) presented data in total engineering enrollments between 1949 and 1962. They note the large contribution of veterans under the government educational programs who swelled the enrollment in the years immediately following World War II and also during 1954-56 subsequent to the Korean military involvement. This analysis illustrated that if the enrollment of veterans was not included in the totals, the fluctuations in enrollment of engineering students are much reduced and a definite and consistent trend was evident. It was concluded that the apparent appreciation in engineering enrollments of about 13,500 each year (during the entire thirteen-year period covered) might be confidently extrapolated for another few years.

It becomes the responsibility of engineering educators to perceive the changes in trends, and to exert the necessary influence to reverse undesirable ones. Two conditions which contribute markedly to the rate of output of engineers are (1) the number of entering college students choosing engineering as a career and (2) the retention of those students through graduation from engineering college. The desirability of, and the incentive to, study engineering must be communicated to the high school and junior high school public (student, parent, and counselor). Depending upon the success of this contact, more (or fewer) students may choose the profession of engineering. The statistics upon which Figure 1 is based illustrate that in the years 1949 to 1952 there was indeed a marked decrease in the total enrollment in universities in our country. This was undoubtedly due both to the then declining number of World War II veterans enrolling and the decrease in the enrollment of younger men

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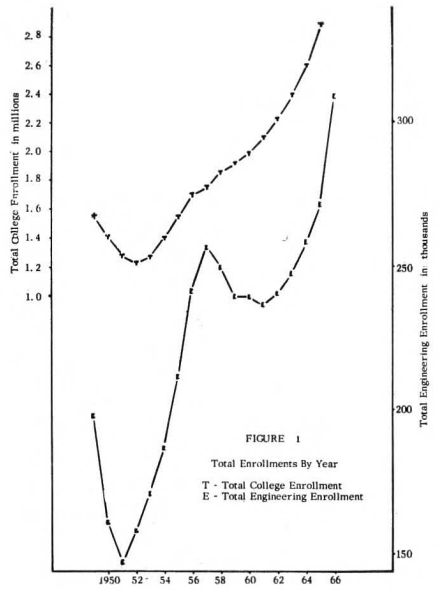


FIGURE 1

Total Enrollments By Year

T - Total College Enrollment
E - Total Engineering Enrollment

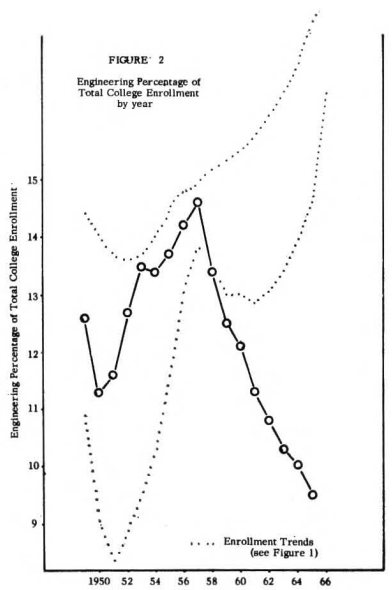


FIGURE 2

Engineering Perceptage of Total College Enrollment by year

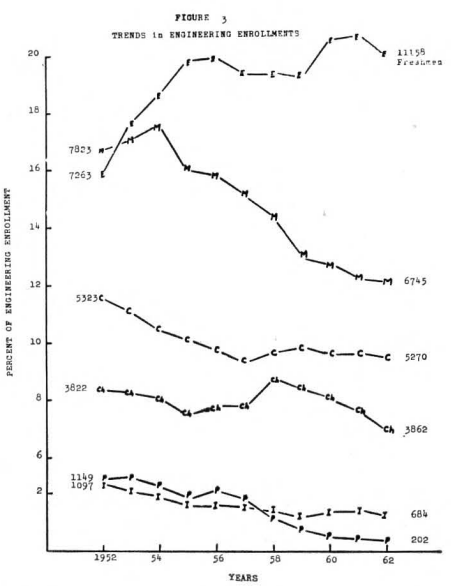


FIGURE 3

TRENDS in ENGINEERING ENROLLMENTS

students due to the Korean involvement. Subsequent to that period, however, from 1952 to the present no disregard of veterans or any other group is necessary to allow the recognition of a consistent, rapidly upward trend in the total enrollment of college men students in our colleges and universities. Comparison of trends in the total college enrollment and in engineering enrollments show the same fluctuations, with variations in the trend for the most part occurring at the same times. However, the variations are greater in the case of the engineering enrollment and the ECAC prediction of an appreciation of 13,500 each year has been exceeded considerably each of the last 4 years, with an ever increasing rate. A significant difference in total enrollment and engineering enrollment is the occurrence of a peak in engineering enrollment in 1957 and a subsequent four-year decline in that enrollment, during which four years, the rise in total college enrollment slowed only slightly.

In 1961, while total college enrollments continued to climb (due, no doubt, to the coming of college age of the unusually large number of post-war babies), engineering enrollments began again to rise. Each year since, the rise has been at a larger rate.

Since our analysis of incentives has been discussed earlier in terms of comparison to other professions and careers, it is logical to evaluate the trends in engineering enrollments in terms of comparison to the overall enrollment. The significance of the 1957 reversal in the upward trend of engineering enrollments is clarified by the curve of Figure 2 which represents the fraction of total enrollment represented by engineers. The percentage of engineers in the total college population rached a peak in 1957 after having risen consistently during the post-Korean period. Subsequent to 1957, this percentage has persistently dropped, until at the present time, it is little more than half of the 1957 value of nearly 15 per cent.

This is taken to be a clear indication of a serious and dangerous lack of rapport with the potential college student on the part of engineering educators. There is small comfort in the existence of an upward trend in engineering enrollments in view of the fact that the shortage of engineers is not being relieved and the increase in engineering enrollments falls so far short of the increase in total college enrollment.

To be most meaningful the statistics must be expressed in terms of the various disciplines. The classical disciplines of Chemical, Civil, Electrical, and Mechanical Engineering account for about half of all engineering students. Industrial and Petroleum Engineering are the only other disciplines with appreciable fractions of total engineering enrollments. In 1952, there were in ECPD accredited departments 3,822 entering freshmen students who wished to study Chemical Engineering, and in 1962, at the end of the reporting by ASEE, there were 3,862, an only slightly larger number (see Figure 3). Reflecting the difference in total engineering enrollments at the start and at the end of this period, the nearly equal numbers of students in Chemical Engineering represented 8 per cent (of total engineering enrollment) in 1952 and hardly more than 7 per cent in 1962. Thus, while maintaining the num-

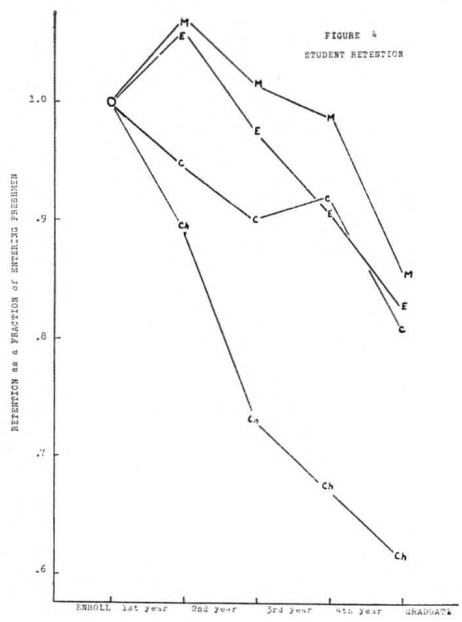
ber of its students, Chemical Engineering has declined slightly in public acceptance as an engineering discipline.

By comparison, and considering the absolute numbers for the beginning and end of the ten-year span as well as the trends, it is evident from the curves (Figure 3) that enrollments in Civil Engineering have dropped slightly, while their percentage has dropped from 11½ to 9½ per cent. There has been a more marked drop in the number of Mechanical Engineers and their percentage is down from 17 to 12 per cent of the total. Both Industrial and Petroleum Engineering disciplines have shown large decreases in the number of students and in their fraction of the total engineering enrollment during this period. Only Electrical Engineering has shown a marked increase in number of students. This has resulted in an increase in its fraction of the total from 16 to 20 per cent.

It becomes evident that the classical disciplines are not generally increasing in spite of the marked increase in total engineering enrollments. The increase is distributed among the newer disciplines, each representing smaller numbers of engineering students. These newer disciplines, while offshoots of the classical disciplines, have completely divorced themselves from the parent departments except in the case of Electrical Engineering. The growth of the Electrical Engineering discipline can be attributed to their absorption of a number of new interests such as Electronics and Communications.

This action on the part of Electrical Engineers to retain within a single discipline the widely varied interests which represent different applications of the same engineering principles is considered a wise one and one which should be emulated by other disciplines. New branches of engineering often are created because of the recognition on the part of their practitioners that their interests stem from more than one of the classical disciplines, and therefore, they consider themselves separate from both. Preferable to this proliferation of engineering disciplines would be an interdisciplinary interest on the part of the parent disciplines. This would tend to unify and strengthen engineering instead of weakening it as does the current practice of splintering.

Having determined the total enrollments as the potential with which we have to work, it is now interesting to observe the retention of this group of students. Over a ten-year period, the average retention for Chemical Engineering



(Figure 4) shows that after the first year the number of students enrolled for their second year is only 90 per cent, and those persisting to the third year only 73 per cent of the entering freshmen. Sixty-seven per cent persisted to their fourth year, and finally 61 per cent were graduated with the B.S. degree after four years. In Civil Engineering, 5 per cent were lost in the first year, with 95 per cent remaining; 90 per cent remained for their third year and a slight appreciation then resulted in the fourth year class of 92 per cent of their entering freshmen. At the end of four years, 80 per cent of the entering Civil Engineering classes were graduated. Mechanical and Electrical Engineering appreciated 6 and 7 per cent, respectively, in the second year after which their number declined so than Mechanical Engineering Departments graduated 85 per cent of their entering freshmen and Electrical Engineering, 83 per cent. Thus, among these disciplines only Chemical Engineering shows no increase at any level during the college career. Rather, the number dropping out of Chemical Engineering during each year is significant.

We can conclude that engineering educators must face up to the fact of a declining acceptance of engineering as a course of study by college students. Instead of fatalistic acceptance, we must strive to reverse this trend and provide greater numbers of graduated professionals by stronger recruitment of high school and junior college graduates and by greater retention of entering students who choose an engineering course of study.