AN INVESTIGATION OF ENGINEERING SCHOOL ADMISSION REQUIREMENTS, WITH SPECIAL EMPHASIS UPON SECONDARY SCHOOL MATHEMATICS AND THE PHYSICAL SCIENCES

A Thesis

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CHAPTER I

THE PROBLEM AND IT'S IMPORTANCE

The great surge of World War II Veterans to institutions of higher learning in this academic year 1946-1947 has been, in many cases, for the preparation of a career in engineering. The problem of the selection of applicant for admission to the engineering schools, and the ever existent high rate of failures, is indicative of the necessity of a study of these problems at this time.

1. STATEMENT OF THE PROBLEM

An investigation of engineering school admission requirements, with special emphasis upon secondary school mathematics and the physical sciences.

11. PURPOSES

1. To determine the general admission requirement for engineering colleges throughout the United States with respect to mathematics and the physical sciences.
2. To determine if the public secondary schools of the United States are fully prepared, with respect to course offerings, to train students to meet these requirements.
3. To determine what per cent of the secondary school

students in the United States prepare themselves to meet the requirements.

4. To determine what proportion of the college students of the United State are enrolled in engineering.
5. To determine what proportion of the college students in engineering were admitted with "conditions", in those subjects.
6. To determine the effect of those conditions upon the student progress and academic success in engineering school.
7. To determine if a correlation does exist between lack of secondary school preparation in those subjects and failure in engineering schools; if so, then what remedial measures can be recommended.

III. IMPORTANCE OF THE STUDY

Socrates, writing on the problem of the division of labor in his ideal state said, "I am myself reminded that we are not all alike; there are diversities of nature among us which are adapted to different occupations".[1]

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1 Jewett, B., "The Dialogues of Plato" (Translation) Vol II The Republic National Library Co., New York, N. Y. Quoted from "Ability Patterns of Engineers and Success in Engineering School", by Charles H. Goodman: Doctorate Dissertation, Pennsylvania State University 1941.

The philosophy of that statement can well be exemplified by the fact that schools of engineering in the United States fail to graduate an average of sixty per cent of all freshmen enrolling for a course in engineering.[1] As early as 1909 the seriousness of the situation was realized by V. F. Dearborn of the University of Wisconsin at which time he found that forty per cent of the candidates in engineering school were dropping out during the freshman year.[2]

To quote the report of the committee investigating engineering education from the Society for the Promotion of Engineering Education, Pittsburgh, Pennsylvanie 1930, "The elimination rate in engineering schools has grown steadily higher since 1900 (1900-1924)".[3]

The causes most frequently mentioned were lack of interest and lack of ability.

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1 Dearborn, V. F., "The Relative Standing of Pupils in High School and the University". The University of Wisconsin Press 1909.

2 Ibid., P. 143

3 Report of the Committee for the Promotion of Engineering, Journal of Engineering Education, Dec. 1941 P. 202.

As chairman for the "Committee on Admissions and Selections for Engineering Schools", W. E. Timbie felt that if high school seniors really understood the intellectual demands of an engineering education and the knowledge of what kind of a preparation is necessary to insure success in engineering school, then the sixty per cent mortality could be greatly reduced. The committee expressed the humanitarian point of view by saying: "It seems there is a much more serious condition than economic reasons, and that is the effect on the boys who come to engineering schools without proper preparation and who do not make good ... the loss to them is more serious than the loss to the institution".[1]

A similar plea has been advanced during the last decade by the chairman of an investigating committee in which the secondary school, as well as the college, receives a share of the responsibility for the seemingly eternal high rate of drops and failures in the engineering schools. This chairman, R. L. Sackett pointed to ability

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1 Timbie, W. E., "Selection and Admission of Applicants for Entrance to Engineering Colleges". Journal of Engineering Education, Feb. 1932, 448-61, 482-84.

in mathematics as the basic consideration for success in an engineering education. The further expression of the committee was the fact that if the profession believed in raising it's standards the selection and counseling should be made in the high school, and only those students who are interested and prepared should apply for admission to an engineering college.

A portion of the report:

> "Schools, colleges, and the engineering profession should be concerned with reducing the chance of failure and contributing to the certainty of success. Boys are taking a chance by choosing an engineering college course without knowing all of the facts necessary for sound judgment."[1]

With respect to high school preparation as a contributing factor in the success or failure of a student embarking on an engineering education, a study was made in 1933 by J. J. Higgins. They study, made at Cornell University revealed that the scholastic averages of 153 engineering students decreased with a decrease in average grades secured in mathematics classes. The correlation between grades secured in mathematics classes and engineering studies was +.84.

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1 R. L. Sackett., "Selecting Future Engineers in High School", Chairman: Committee on Student Selection and Guidance, Mining and Metallurgy, August 1938 19 353.

Higgins, at that time, suggested that a future study should be made to discover the relationship between secondary school success in mathematics and those grades secured in college mathematics. He pointed out that when a definite positive relationship could be found between those two then a possible way could be found for picking applicants that would have the best chance of success in engineering college.[1]

IV. PREVIEW OF THESIS

It was the aim of this study, in keeping with the recommendation of Higgins study and the present pressure on the engineering schools by the great influx of veterans into the engineering colleges in this post-war period, to attempt to define some remedial measures with respect to the continuing high rate of failures in the engineering colleges. The study will place emphasis on high school preparation in mathematics and natural sciences, and attempt to determine whether or not it is a primary factor for success in engineering school.

Research in the past pertaining to this problem had

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1 J. J. Higgins, "Study of Mathematics Ability in Relation to Success in Engineering School," Journal of Engineering Education, June 1923 23 743-46.

been objective and statistical, and due to the variables of time (1900-1945), geographic location, number of students involved in the studies, difference in institutional requirements, factors involved in the analysis, and the personal elements of the authors, a review of the literature and publications pertaining to the studies produced considerable incongruity when any attempt at integration was made.

The approach in t is instance did not concern the situation in any definite institution or locality, any particular group of students, nor any series of achievement or aptitude tests, but endeavors to survey the field of engineering education on a national basis. Initially, the secondary school curriculums of various states throughout the country were studied, and a representative sampling from each main division of the United States was discussed to establish, if possible, about what percentage of the high school students of the country are offered the opportunity to prepare for an engineering education as it exists in it's present form. Next, the admission requirements of a sampling of engineering schools, nation wide and both private and public, were compiled and compared as to the capacity of the secondary schools to produce students to meet them. The thesis will tabulate and analyze the results of a questionnaire form received from the deans of the same

engineering schools relative to the causes of failures and drops during the freshman year, and suggestions as to means to alleviate the situation.

By the very nature of the survay the result were in some ways subjective, rather than one hundred per cent objective. The personalities and opinions of the engineering school deans inadvertently were injected into the final analysis. Their position, however, as the leading educators in the field, and the fact that their reports when considered as a whole, represented the situation and the trends throughout the country for engineering education, produced a conclusion worthy of consideration.

It would be well to clearly understand, at this point, that this study pertains only to the engineering and pre-engineering divisions of educational endeavor, and all research, conclusions and suggestions, are relative exclusively to that field. It is not the intention to include the numerous areas of study of modern secondary and higher education in this analysis.

CHAPTER II.

A PRESENTATION OF THE HISTORY AND PRESENT STATUS OF THE PROBLEM

Educators, as well as the engineering profession, have been greatly concerned over the extremely high rate of failures among engineering students, and as a result, numberous committees and individuals made surveys and studies of the problem.

A survey of the research up to the present time will be more comprehensive if discussed in chronological order. Generally, the conclusions of each study will be given in a short summary, however, in a few instances, when a study happens to parallel this one, a detailed abstract will be given. Several of the reports, of course, involved research utilizing an entirely different group of factors for analysis, and in such cases only the portion of the treatise that was pertinent to high school preparation as a basic consideration for success in engineering education will be examined.

1920

Chairman L. L. Thurstone of a Wisconsin Committee on Intelligence Tests procured and detailed from six

different type of tests a score from eight institutions of higher learning. The results displayed a correlation between high school mathematics and first term engineering scholarship as follows:

1.	Algebra Test	.41
	Algebra H.S. Grade	.39
2.	Geometry Test	.41
	Geometry H.S. Grade	.23
3.	Physics Test	.40
	Physics H.S. Grade	.24

This study showed evidence of the superiority of test scores over the criterion of high school work as a basis for predicting success in engineering.[1]

1924

The report of an engineering education investigation committee over a previous two year period was submitted at great length, and the aspects pertaining to this thesis are of sufficient importance to be quoted directly. It was noted that during that period thirty

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1 Report of the Society for the Promotion of Engineering 1920. Quoted from B. J. Ullsvik "A Factor Analysis and Prognosis of the Scholastic Success of Freshman Engineers During Their First Semester at the University of Wisconsin". Doctorate Dissertation, The University of Wisconsin, 1941.

eight out of one hundred engineering students were graduating, and only twenty eight students completed the work in the specified period.

> "This ratio of graduations to admissions is the lowest of any division of collegiate work for which figures could be obtained ... a first and obvious step in the ri ht direction would seem to be a reduction in the numbers admitted with conditions. In 1924 elimination among students admitted with conditions was 60 per cent greater than those admitted with clear records.
>
> It has been shown only too plainly from the results of the investigation that either our present program is not adapted to the needs of a large portion of those students whom we admit, or that students are not adapted to the requirements of the program.
>
> Admission to engineering colleges from secondary schools on the basis of graduation is sound in principle, necessary in the use of tax supported institutions, but attended by much loss of time, money, and human heartache on the part of students coming improperly prepared to pursue an engineering curriculum. A large portion of our lost students go out with needlessly unsatisfactory scholastic records against them".[1]

1925

An investigating committee during that year published the fact that 94 per cent of the engineering schools of the

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1 Dickendon, W. E., "Investigation of Engineering Education", Engineering Education, January 1924 14 218-252.

United States admitted students on credentials from accredited high schools, and 65 per cent of the specified the actual required units. For example, the average specification for math was 2.8 units, or one or two units of science, and 60 per cent specified 1/2 unit of Solid Geometry.

Of 8,728 students admitted to 52 institutions in 1924, 19 per cent were classified as "conditioned" students. Of these 67 per cent were classified thus for deficiency in mathematics and 21 per cent for science. Only 20 per cent of the institutions refused admittance of conditioned students to the engineering department.

From these statistics it will appear obvious in a later chapter of this thesis that entrance credits presented from the modern high school vary little from the ones presented twenty years ago.

It was further disclosed, that in nine institutions where engineering students were admitted with conditions in mathematics, only in one institution did the conditioned men survive as well as the non-conditioned men.

The fundamental problem of the committee did not appear to be one of shifting entrance requirements, but rather one of demanding correct grounding in the high

school subjects required for entrance to the engineering college. The committee raised the unanswered question:

> "how can the engineering colleges exert a direct and effective influence upon the preparatory schools in the way of securing greater emphasis and better instruction in the subjects of the high school curriculum which are fundamental to collegiate study.
>
> The average rate of elimination in schools of engineering throughout the country is 72 per cent for the four year period!
>
> The statistics for elimination are as follows:
> (Based on 38 institutions)
> 1. 53.8 per cent failure
> 2. 15.5 per cent voluntary change of course
> 3. 9.1 per cent financial reasons
> 4. 5.5 per cent health
> 5. 2.7 per cent improper conduct
> 6. 1.5 per cent family reasons
> 7. 12.3 per cent unknown
>
> The reasons for scholastic failure of those above were found to be as follows:
>
> 1. 69.4 per cent lack of preparation and ability
> 2. 7.? per cent health
> 3. 5.3 per cent financial (self-support)
> 4. 2.7 per cent social activities
> 5. 15.4 per cent miscellaneous."[1]

Concerning the matter of eliminations the committee offered the following comment;

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1 Report of the Committee on Admissions and Eliminations of Engineering Students. Journal of Engineering Education. Sept. 1925 16 47-73

> "The rate of elimination will continue to increase in direct proportion to the failure of high schools to give training in essentially preparatory work, in proportion to the increase of distracting influences in both high school and college life outside the classroom, and in direct proportion to lack of balance and stimulus in our engineering curricula."[1]

To illustrate with a few related statistics for later comparisons ... in 1925 it was discovered that one out of every five entering engineering school was a conditioned student. The effect upon rate of eliminations of those admitted with mathematics deficiencies is shown in the following list. (The list is a summation of the material from the original table, which in turn, summarized the reports from nine institutions.)

1.	Total freshman 1924	1,534
2.	Percentage having entrance conditions in mathematics	31.2
3.	Freshmen not conditioned in mathematics	1,055
4.	Freshmen conditioned in mathematics	479
5.	Percentage surviving the freshman year a. Conditioned	41.1

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1 Report of the Committee on Admissions and Eliminations of Engineering Students. Journal of Engineering Education, Sept. 1925 16 47-73

b. Non-conditioned 57.2

It was reported that 39.8 per cent of all high school males went to college in 1921, and 14.1 per cent of those enrolled in engineering colleges. Although 87 per cent graduated from public high schools the quality of preparation had aparently decreased during the ten years prior to 1921.

> "the work of many of the colleges has been seriously hampered, and to an increasing degree, during the first two years of engineering courses by the necessity of segregating poorly prepared students in special sections in which the elementary mathematics is reviewed."[1]

An illustration was furnished by a table from which the following facts were summarized.

Of eleven institutions there were 676 failures in engineering in one year; the reasons for failure were classified:

1. Entrance conditions 9
2. Poor preparation and lack of ability 469
3. Extra curricular activities 12
4. Social activities 18

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1 Report of the Committee on Admissions and Eliminations of Engineering Students. Journal of Engineering Education, Sept. 1925 16 47-73.

5. Health 49

6. Self Support 36

7. Unknown 83

In conclusion the committee defines causes for eliminations to fall in three main categories. In order of decreasing significance they are:

1. Poor preparation in high school in subject that form the necessary foundations for engineering training.

2. Lack of effective guidance in selecting a college course.

3. Failure on the part of the college to deal with the student after admission.[1]

1927

Statistics compiled at the university of Minnesota disclosed that 18.6 per cent of the engineering freshmen claim to have been honor students in high school, and an additional 42.6 per cent claim to have been in the upper third of the graduating class. Only 2.6 per cent admit to have been in the lower third of their class. The statistics were later confirmed by high school records.

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1 "Report of the Committee on Admissions and Eliminations of Engineering Students." Journal of Engineering Education, Sept. 1925 16 47-73

Thus, it appeared that engineering colleges were receiving a considerably better than average selection of students from the standpoint of mental ability.

From the upper third of graduating classes for three years from a city high school in Minneapolis it was found that approximately 30 per cent enter engineering. From that it was apparent that high school rank of seniors play a minor role in differentially selecting them for entrance to the engineering college. The author commented in the summary: "A larger share of mortality can now be assigned to scholastic incompetency on the part of a large number of entering students".[1]

1928

An interesting point relative to this study was brought to light by Hammond and Stoddard.

The results of a physics training test used for an entrance examination for 534 freshmen entering an engineering college, all of whom had previously completed a high

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1 Patterson, D. G., and Thorburg, P. M., "High School Scholarship Standing of Freshmen Engineering Students". Journal of Engineering Education, April 1927 17 807-811.

school physics course, exposed the facts that 50 per cent were unable to answer any one question correctly.

The point observed was that students learn so little in the way of physical theory in high school that the college physics teacher cannot assume any beginning knowledge on the part of most of the class.[1]

1930

The peliminary report of a committee working on the coordination and preparation for an engineering education contained two considerations that are related to this study.

1. A summary on the correlation of preparatory school grades and college grades in engineering courses.

2. The reliability of preparatory school grades in mathematics and physics as an index of success in an engineering curriculum.

The committee's conclusions were as follows:

1. The average high school mathematics grades give very good prediction for success in engineering school.

2. High school physics grades give a fair prediction.

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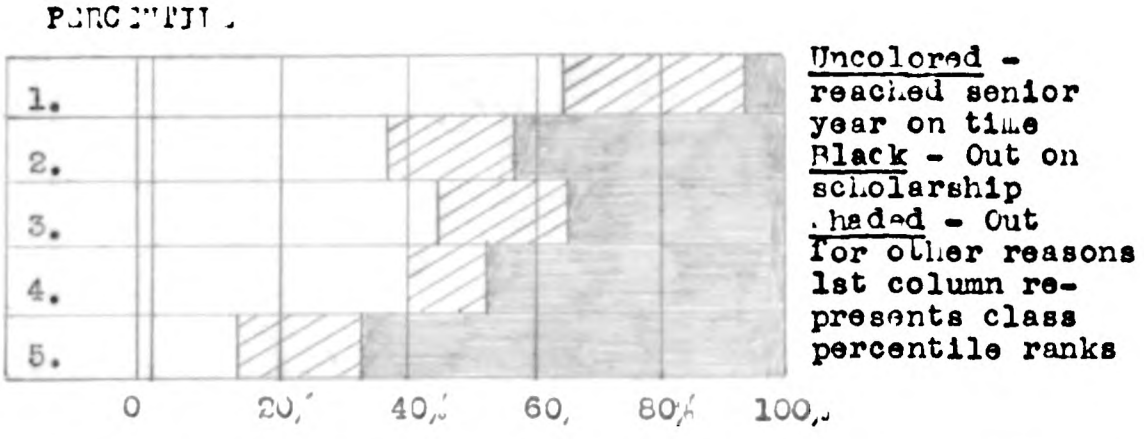
1 Hammond, H. P. and Stoddard, G. P., "A Study of Placement Examinations". Journal of Engineering Education Sept. 1928 19 25-83.

3. Students from the lowest third of the high school classes are very poor risks.

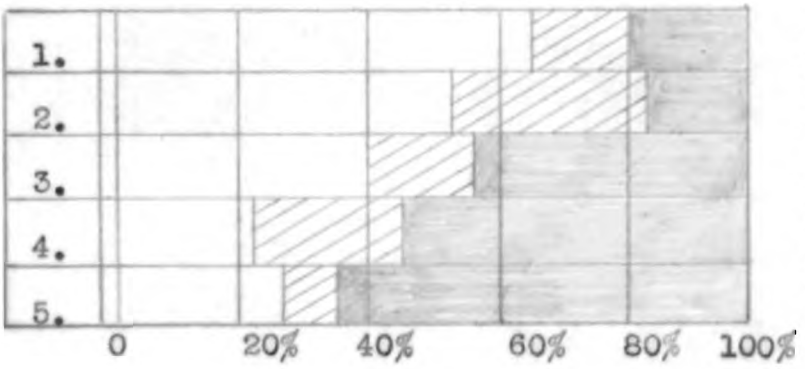
Two graphic representations as transcribed from the report are significant. The graphs show the high school class divided into fifths, then in fifths by percentages of students reaching the senior year on time. The computations were made from the engineering class of 1930 at Case School of Applied Science.

1. Predictive value of high school mathematic grades 100 cases.



2. Predictive value of high school physics grades. 173 cases.

PERCENTILE.



Uncolored - reached senior year on time.
Black - Out on scholarship
Shaded - Out for other reasons
1st column represents class percentile ranks

1932

To quote Ex-President Lowell of Harvard University:

"In the secondary school we study what should have been finished earlier, in college we do what should have been done at high school."

It was in sup ort of that contention that J. W. Young, Professor of Mathematics at Dartmouth University, wrote that mathematics should be taught in higher forms, such as analytical Geometry and Calculus, in the secondary schools, and thus alleviate the present situation wherein so many students enter college unprepared.

Furthermore, Bulletin No. 2 of the Committee on the

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1 "Preliminary Report of the Committee on Coordination of Preparatory and Engineering Education". Journal of Engineering ducation, Jun. 1930 20 473-484.

Investigation of Engineering Education was quoted in which 70 per cent of the failures in engineering school were attributed to lack of ability, interest, and preparation. The indication was that high school graduation standards were too low, or college standards too high, or possibly both.

Young outlined a remedical course.

1. Better methods of college selection
2. Improving quality of high school instructions
3. More effective means of treating the students after they have entered engineering school.

Also it was indicated that the practice of permitting students to enter engineering with conditions be abandoned. A strong plea was put forth that all colleges of engineering make trigonometry a required secondary school achievement among the college admission requirements. At that time 13 per cent required trigonometry.

Young firmly contended that the primary source was the high school, in which, the average at best was mediocre. The quality of high school instruction was a grievious fault, and the entrance examination boards should exert their influences to improve secondary school instructions. Mathematics teachers received par-

ticular emphasis.[1]

1932

A. B. Crawford and P. S. Burham. of Yale University stated that in 1932 the grades on the college entrance board examination predicted average freshman year grades for over 3000 Yale students less well than did secondary school records. The investigators were disappointed in the correlation of grades on specific subject examinations with freshman year averages in the corresponding subject. That such findings may, or may not, hold at other engineering schools was admitted.[2]

1933

Dvorak and Salyer secured eight measures on each of the students in a 1928-1929 freshman engineering class for the means to a factor analysis involving entrance requirements at the University of Washington. Of these,

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1 Young, J. W., "The Adjustment Between Secondary School and College Work in Mathematics". Journal of Engineering Education March 1932 22 586-595

2 Crawford, A. B., & Burham, P. S., "Entrance Examinations and College Achievements". School and Society 1932 36 344-352.

two are important in relation to this article.

1. Average scholarship in high school mathematics
2. Average scholarship in high school natural sciences.

The correlation between those two factors and college freshman ability in engineering was found to be .66. It is interesting to note, at this point, that high school natural sciences records were estimated to be 1b.2 times as significant as the high school social science records.[1]

1934

The purpose of a relatively important study completed during that year was to determine what groups, if any, of high school courses contributed the most to success in engineering in the college of engineering at the University of Minnesota. The study was made using 139 students entering in the Fall of 1934.

Admission requirements at that time were similar to those of the present.

Subject Units

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1 Dvorak, A. & Salyer, R. C., "Significance of the Entrance Requirements for the Engineering College at the University of Washington". Journal of Engineering Education, April 193[illegible], 23 618-623.

English	4
Mathematics	3
Electives & Languages	8
Total	15

Chemistry and physics were excepted.

To measure the achievements in engineering and architecture four criteria were employed. They were:

1. Total amount of credit earned in the college of Engineering from 1924 to 1939.
2. The total honor points.
3. Ratio between total honor points and total credits.
4. Percentage awarded degrees by the college of engineering.

The following coefficients of correlation were the conclusions of the authors.

"1. Total high school credits in science, mathematics, and manual training with total engineering credits. R = .194 ±0.036

2. Total high school credit in science, mathematics, and manual training with honor point ratio in engineering. R= .190 ±.030

3. Total high school credits in science, mathematics, and manual training, with percentile rank on the college aptitude test R = .030 ±.058."[1]

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1 Boardman, Chas. W. & Finch, F. H., "Relation of Secondary School of Preparation to Success in the College of Engineering". Journal of Engineering Education, Mar. 1934 25 466-475.

"From the data it may be tentatively inferred that students who offer more extensive training in high school science, mathematics, and manual training, on the whole are somewhat better prospects for success in the college of engineering than are those students who have had slight contacts in high school in those fields."[1]

1936

A report covering a research problem conducted at the University of Oregon in 1930 was mainly for the purpose of establishing a relationship between the amount and quality of training in high school mathematics and subsequent marks in college academic subjects.

Utilizing Pearson Product-moment Coefficient of Correlation between the number of semester credit in high school mathematics and the average college marks made by these students in various college fields for the first two years are shown as follows:

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1. Boardman, Chas. W. & Finch, F. H., "Relation of Secondary School of Preparation to Success in the College of Engineering". Journal of Engineering Education March 1934 25 466-475

COLLEGE SUBJECT	ZERO ORDER COEFFICIENT	PARTIAL-CORRELATION COEFFICIENT
Mathematics	+.28 ±.06	+.17
Physical Science	+.16 ±.05	+.14

The entire correlation covered a variety of subjects as the study was made at a liberal arts college, however the material transcribed for this study is, to a certain extent, pertinent to the engineering curricula.

The correlation between the number of semester credit in high school mathematics and average college marks in all subjects were found to be no greater than .02, and when the factor of intelligence was held constant the partial correlation proved to be -.13. In fact, the college marks of students with two units of mathematics were found to be almost exactly the same as the marks of students with three and four units respectively.

An analysis of the percentage of students doing unsatisfactory work in the various fields, in which the students with two units of high school mathematics or less were compared to students with two or more units, revealed no significant difference. It was found, however, that the students with more than two units of

mathematics furnished a smaller percentage of the unsatisfactory students.

On the other hand it was proven that the average mark in high school mathematics correlated significantly with the average college mark in every field. For example:

COLLEGE SUBJECT	CORRELATION COEFFICIENT	CORRELATION RATIO
Mathematics	.46 ±.05	.55 ±.05
Physical Science	.25 ±.04	.32 ±.04

Furthermore, the study displayed evidence that in the prediction of success in college mathematics, the high school mark in mathematics and average mark in all other subjects were of equal merit. The correlation being .47 and .46 respectively.

Among the conclusions listed in the summary of the study was one that is closely allied to engineering in that it pertains to success in college mathematics.

> "Prediction of success of students in college mathematics cannot be made with any high degree of accuracy from knowledge of the amount of high school training mathematics, the average high school mark in mathematics, the average mark in all high school subject, rank on the Psychological Examination of the American Council on Education, or any combination of these variables. The best prediction

that can be made is secured from the average high school mark in all subjects."[1]

The committee on student selection and guidance submitted a report to the Engineers Council for Professional development relative to test scores and prediction for success in engineering in mathematics as follows:

> "The committee believes that the results obtained establish the value of the tests in mathematics for entering freshman engineers -- a correlation of +.55 with academic success."[2]

1937

A. V. Bingham devotes a chapter of his book to engineering aptitudes, and concurring with many authorities he mentions that 62 per cent of the engineering students fail to complete the course for various reasons. Notably was the fact that certain subjects in the curriculum place a premium upon special aptitudes; aptitude for mathematics, aptitude for the physical sciences,

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1 Douglas, H. R. & Michaelson, J. H., "The Relation of High School Mathematics to College Marks and Other Factors to College Marks in Mathematics". School Review 1936 44 615-619

2 "Report of E.C.P.D. on Student Selection and Guidance." The Electrical Engineer Nov. 1936 55 1824-1825 Obtained from Ullsvik, B. R. "A Factor Analysis and Prognosis of the Scholastic Success of Freshman Engineers during Their First Semester at the University of Wisconsin." 1941.

and aptitude for manipulating the ideas of spatial relations.

The probability of young man's success in such a course of study was said to be definitely and closely related to his aptitude for higher mathematics. Consequently the high school marks in algebra and geometry should be carefully scrutinized. Another type of information indicative of the candidate's success or failure in the engineering college would be the record of the candidates achievements in high school physics and chemistry. "The candidates previous school achievements and his performance in scholastic aptitude tests furnish evidence regarding his general ability."[1]

1938

A study producing a correlation between ability in physics and mathematics and capacity for engineering training was produced by the Dean of Engineering at the University of Akron, Ohio. F. E. Ayer presented the following table as a result of the study. It represents work done in the freshman year for the classes

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1 Bingham, W. V., "Aptitudes and Aptitude Testing" p. 170-177. Published by Harper Bros., New York, 1937

1926-1936.

"1.	Total freshman in engineering	745
	Graduated in engineering	27.8%
2.	Failed neither mathematics or physics	469
	Graduated in engineering	39.5%
3.	Failed mathematics and passed physics	116
	Graduated in engineering	14.7%
4.	Failed physics and passed mathematics	114
	Graduated in engineering	2.6%"[1]

Concurrently, at the University of Texas, another individual was conducting research relative to freshman engineering. The data involved comparisons of a class according to their rank in the high school graduating class and according to the distribution of the various high school subjects presented for admission to the university. The author initially apologized for using a sample of students too small to produce statistically valid results.

The study was made during the session 1935-1936 using a group of 275 freshman engineers and the remainder of the total of 1042 freshman men enrolled in various

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1 Ayer, Fred E., "Physics, Mathematics and Engineering". Journal of Engineering Education, April 1938 28:582.

other courses.

It is interesting, in view of the purposes of this thesis, to note the proportion of the class which presented certain entrance subjects.

1. The combination of Algebra, plane and solid geometry, and trigonometry was presented by 34.6 per cent of the class.

2. The combination of three units in mathematics was presented by 34.6 per cent of the class.

3. Two units of mathematics plus chemistry and physics were presented by 29.4 per cent of the class.

4. The combination of chemistry and physics was presented by 30.9 per cent.

5. Physics was presented by 50.1 per cent of the class.

The survey further illustrated that the scholastic performance of freshmen has a very definite relation to the previous performance in high school. Nine out of ten who rank in the highest quarter of the class in high school will pass the freshman year in college, but only four of ten of those in the lowest quarter will pass.

Of the group that presented a combination of high school algebra, plane and solid geometry, trigonometry, chemistry and physics (represented one sixth of the class) 85 per cent passed the first semester in engineering; 62

per cent of the others passed. The former group earned "A" and "B" grades in 47 per cent of their work, while the other group earned "A" and "B" grades in but 24 per cent of their work.

Of the group presenting three units of mathematics, 88 per cent passed the first semester in engineering. Corresponding figures for the group not presenting this combination was 54 per cent. The former group earned honor grades in 42 per cent of their work in the first semester and 39 per cent in the second. The latter group made honor points in 20 per cent of their work in the first semester and 25 per cent in the second.

Using the combination of chemistry and physics; 75 per cent of those presenting them passed the first semester, while the group not presenting the natural sciences passed 60 per cent. The former group earned honor grades in 39 per cent of their work during the first semester while the latter totaled 23 per cent honor grades.

In summary, the conclusions were that freshman performance in college has a definite relationship to later college achievements, and that certain related combinations of subjects taken in high school, produce a

better scholastic record the freshman year of college.[1]

1939

An article appearing at that period featured a problem involving the selection of the most promising candidates and eliminating the unfit early in the training period.

This was accomplished by a battery of tests, among which the mathematics aptitude test proved to be the best single measure. Nearly on a par with it was the Iowa High School Content Test, and combined with two others, the four produced a coefficient of correlation between prediction and scholastic success in college for the first semester of ±.74 ±.03.

To quote two rather parodoxical phrases from the concluding statements of the article:

> "Naturally, all the entering students present the required high school credits. Therefore the completion of certain high school subjects becomes an invalid basis for selection.
>
> Although all the reasons for the high mortality cannot be ascertained, a high portion may be

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1 Fichtenbaum, Max, "An Analysis of Freshman Engineers at the University of Texas During the Session of 1935-1936". Journal of Engineering Education, April 1938 28 533-540.

laid to inadequacy of abilities and preparation".[1]

1940

To repeat a statement of R. L. Sackett, Dean of Engineering at Pennsylvania State College:

> "It is clear that intelligent and understanding guidance by the high school is fundamental in any effective attack on the problem of selection."

Chairman Sackett of the Committee on the Selection of Guidance supplied reliable information relative to selection by a study of histories of 3000 engineering students in four colleges.

The committee found three types of tests valuable in a predictive sense.

1. Aptitude Tests
2. Visualization (emphasis on geometry)
3. Cooperative mathematics test

To quote a summarizing statement from Dean Sackett:

> "Tests of scholarship and aptitudes are available, but none of them are infallible. There still remains the question whether past high school records or present examinations are adequate criteria for admissions. There are exceptions and the methods of elimination should be flex-

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1 Feder, D. D. & Adler, D. L., "Predicting the Scholastic Achievements of Engineering Students." Journal of Engineering Education, May 1939 29 380-387

> ible enough to provide for the admission of the applicants who fails to top arbitrary hurdles, but has essential interests, aptitudes, and certain scholastic preparation which is fundamental. The method of exploring the unstandardized is no better than the provision for them to proceed if admitted. Standardization when carried to the point that it ignores personal differences, tends likewise to sumerge the individuality of the institution, it's faculty, and it's curricula."[1]

A. S. Northby of the University of Minnesota showed a correlation of .695 between Iowa Math Placement Tests and first semester engineering grades for 138 freshmen in 1931. The next highest correlation with grades was with high school scholarship.[2]

Another group of investigators found coefficients of correlation well above .30 for a number of measures including:

1. High school principals rating on intellectual performance.

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1 Sackett, R. L., "Selection of Engineering Students", Journal of Engineering Education, March 1940 30 595-600

2 Northby, A. S., "Prediction of Scholastic Success in the College of Engineering and Architecture", From M. E. Haggerty, Chairman on Educational Research Studies in Articulation. P. 42-49

Quoted from: Johnson, A. P., "The Relationship of Test Scores to Scholastic Achievement for 244 Engineering Freshmen Entering Purdue University in Sept. 1939", Purdue University Doctorate Dissertation 1940.

2. Average grades in the high school subjects of English, mathematics, physics, and the biological sciences.[1]

The conclusion of a doctorate dissertation by A. P. Johnson, of Purdue University, was relevant to successful efforts in engineering education.

Four measures were selected by the Wherry-Doolittle Test Selection Method to give a relationship with first semester grade point averages. The measures contributed decreasing increments of relationship in an order placing high school preparation and scholastic standing as number two. The coefficient of correlation between these measures and the first semester grades of 244 freshmen engineers entering Purdue in 1939 was .0.791.[2]

1941

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1 Dywer, P. S., Horner, C., & Yokum, C. S., "A Statistical Summary of the Records of Students Entering the University of Michigan as Freshmen in the Decade of 1927-1936. University of Michigan Administrative Studies Vol. 1, No. 4 1940.

Obtained from: Johnson, A. P., "The Relationship of Test Scores to Scholastic Achievement for 244 Engineering Freshmen Entering Purdue University in Sept. 1939" Purdue University Doctorate Dissertation 1940

2 John, A. P., "The Relationship of Test Scores to Scholastic Achievement for 244 Engineering Freshmen Entering Purdue University in Sept. 1939", Purdue University Doctorate Dissertation 1940.

An author writing on the subject of academic achievements in engineering school made an introductory statement to the effect that no means yet had been devised whereby the prediction of success in engineering school could be dispatched with any degree of reliability.

Beyond that initial frank statement the article would not pertain to this thesis in that it involved the success in upper levels of engineering based on achievements at the Junior College level.[1]

The aims of the committee on Student Selection and Guidance of the Society for the Promotion of Engineering Education were primarily one of guidance and cooperation to be established among high school teachers, engineering teachers, and practicing engineers, for the advancement of engineering education.

The committee's report for 1941 indicated that high school scholarship, when properly used as a basis for admission, reduces the mortality rate materially; a personal interview, in turn, is the most promising supplementary instrument. To quote:

"From the experience of engineering colleges

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1 Siemens, Cornelius H., "Forecasting the Academic Achievement of Engineering Students". Journal of Engineering Education 1941 32 617-621.

> rank in class in high school is the most reliable index of later success after assurances that the individual has taken enough sciences and mathematics to satisfy the admission requirements and to demonstrate his ability along these lines."

The report notes that a high school record is unsatisfactory as a predictive measure for border line students.

The report chiefly concerned various types of achievement tests, psychological tests, etc. of which this thesis is not primarily concerned. It is noteworthy, however, that tests of general achievement in high school subjects, particularly mathematics and science, are useful in selection and guidance.

The final conclusions of the committee included, as a secondary consideration, that the rank in high school as a basis for selection comes first, and is particularly reliable if the high schools are rated.[1]

An additional study, though primarily conducted on a basis of mechanical ability and its relation to engineering school success, does take into consideration the beneficent factor of high school work.

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1 Sackett, R. L., "Report of Committee on Student Selection", Presented at the 49th Annual Meeting of the S.P.E.E., Journal of Engineering Education, 1941 32 224-256

Utilizing a number of tests conducted on students of engineering at the University of Maine the attempt was to find the coefficient of correlation between first year grades in engineering and the prediction of test scores.

Among the conclusions listed, in effect, is that the predictive power of tests of mechanical ability are not very great. The authors suggests that some evidence of engineering aptitude is found in intelligence tests, scholastic aptitude, and grades in certain high school courses.[1]

Robert Millikan of the California Institute of Technology in an address to the Phi Beta Kappa Society stated:

> "For the first time in human history the people of a nation enjoy the advantages of considerable education since compulsory public schooling now assures almost every young person a high school education. The absence of facilities to steer properly qualified youth into trade and industry, has resulted in numerous high school graduates who are seriously deficient in capacities and training requisite for success at institutions of higher learning presenting themselves to the college and universities for entrance."

It was Milliken's plea that high schools and college

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1 Brush, Edward M., "Mechanical Ability as a Factor in Engineering Aptitude", Journal of Applied Psychology June 1941 25 300-311.

cooperate to secure a better selection of material for higher education by a mutual recognition of their distinctive problems. For only by cooperation can the secondary schools discharge their responsibilities and the colleges maintain their scholarly competence in research and engineering.

The author implied that the normal group in American High Schools was a non-college group, and that educators realized the central objectives of high school training were citizenship and vocational adjustment and establishment.

Valuable approaches for reorganization for college needs were shown as follows:

1. Only after counciling has been well done can effective teaching follow.
2. Customary pattern of high school subjects is not the only route to maturity.
3. Wide variations of secondary schooling exist among the high school populations of various states; standardization is needed.
4. Professional training of science teachers is inadequate.
5. Mathematics should be grouped into senior high schools and open to those capable of college work.
6. Mathematics should be integrated with shop and manufacturing plant techniques.

7. The identification of the capable is a joint responsibility of both high school and college.

In conclusion it was maintained that selection of stud nts for engineering college should not be based solely on any one pattern of high school subjects nor single entrance examinations, but demands continued observation and reappraisal as the pupils are successively exposed to differentiated treatment, especially in science and mathematics.[1]

A portion of the findings of B. R. Ullsvik in his doctorate dissertation at the University of Wisconsin are relative to this issue.

One of the purposes of the study was to develop equations to predict the scholastic success of freshmen engineers in their principal subjects, among them being mathematics.

The result substantiated a previous study by determining the relationship between rank in high school graduating class and subsequent scholastic success at the University. The findings presented the fact that the

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1 Lindsay, F. B., "Problems in Secondary Education that Effect Engineering Colleges". Journal of Engineering Education, March 1941 31 479-486.

percentile equations developed.

Included in the thirty three measures considered were:

1. Number of semester hours of high school science.
2. Grade points in high school science.
3. Number of semester hours of high school math.
4. Grade points in high school tests.
5. Characteristics of high school from which student graduated.

Utilizing many factors other than those mentioned above, Ullsvik derived five hundred and twenty eight inter-correlations, all of which were subjected to the factor analysis of Professor L. L. Thurstone.

The final analysis, when considering the prediction of successes in freshmen engineering subjects for the first semester in a college of engineering, produced a coefficient of correlation of ±0.7 between predictions and the grades received. The subject matter involved included English, chemistry and mathematics.

The relationship, however, between the characteristics of the high school from which the student graduated and the factors indentified did not seem clear.

The author commented on the fact that two of his colleagues, C. R. Mannard and E. L. Thorndike used a com-

bination of seven tests for prediction purposes, of which five were tests of mathematics.[1]

1942

To quote an excerpt from a 1942 committee report from the United States Office of Education:

> "In the first place, it is important in advising students to enroll in engineering or not to take into consideration their interest and ability in mathematics, science, drawing and making things".[2]

1944

The curricular revisions of secondary schools over a period of years proved that the trend was toward training students to fit into democratic life and social culture more effectively. A. H. Blaisdell of the Carnegie Institute of Technology contended that the curricula was based upon the sup osition that the majority of high school students will never attend college. The engineering schools

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1 Thurstone, L. I., "A New Rotational Method of Factor Analysis", Psychological Bulletin 1940 37 189-236
Quoted from: Ullsvik, B. R., "A Factor Analysis and Prognosis of Scholastic Success of Freshmen Engineers During Their First Semester at the University of Wisconsin". University of Wisconsin Doctorate Dissertation 1941.

2 U.S. Office of Education, "Report of the Committee on Student Selection and Guidance", School and Society June 27, 1942 55 717.

watched the trends with great misgivings, but nevertheless felt that it was up to them to make the basic and vital changes in their educational programs so as to conform to the ability of the high school product.

For one thing, the applied science courses had to be altered to conform to the German System, wherein labratory work enjoyed more importance than lecture, but secondary schools must too conform in order for the system to be effective.

The concluding remarks concerned more humanistic social studies for engineering students, not only to make them more sensitive to human values, but because they were better prepared for such work.[1]

A study connected with the war and its effect on engineering education emphasizes the point that the war will bring about some necessary and justified adjustments in the engineering curricula.

To counteract the influences of advanced scientific inventions upon engineering, it was considered good judgment on the part of engineering educators that increased atten-

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1 Blaisdell, Allen H., "Comments on the Future of Engineering Education". Journal of Engineering Education November 1944 35 205-211.

tion should be given to the basic sciences, humanistic, and social studies. Some of the advanced technical matter now in the undergraduate curricula should be transferred to the graduate level where the students would be more prepared to rigorously pursue the study.[1]

Such a trend, considered relative to this thesis, would obviously conform more readily to the present high school preparation of the average student.

1945

A quotation from an article by L.O. Stewart, of the Engineering Department of Iowa State College refers to the question of just who should study engineering and lists the following as an indispensable individual attribute:

> "Ability to do mathematics is a prime requisite. A better than average ability to learn this subject as shown by high school grades or test scores is essential."[2]

1946

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1 Crothers, H. M., "War Pressures on the Curricula", Journal of Engineering Education, Oct. 1944 35 P. 81.

2 Stewart, L. O., "Advice to Young Men Who Seek Careers in Engineering", Journal of Engineering Education November 1946 36 211-214.

A post war approach to engineering educators was advanced by Oscar S. Bray. It was mentioned in his study that engineering education in the past had largely been based upon high school scholastic background, but the fact that sucha basis for selection was not the entire answer is demonstrated frequently by the careers of men who graduate below the magic upper quarter of the class. Such qualities as imagination, moral courage, leadership, native intelligence, and capacity for work, are of equal or greater importance than mere ability to learn and should be given full weight in a decision to accept or reject an applicant.[1]

SUMMARY

Previous research rather definitely produced evidence that a high degree of correlation existed between academic accomplishments in high school and later success in engineering college. The implication, however, was very clear that no really effective measure had been found for predicting success in engineering college.

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1 Bray, Oscar S., "Postwar Graduate Engineer Training", Journal of Engineering Education, November 1946 36 211-214.

The two most successful measures appear to have been (1) high school record (2) achievement tests prior to college admission.

An expression for greater cooperation, between the levels of education, also received emphasis throughout the previous studies.

CHAPTER III.

SECONDARY SCHOOL OFFERINGS AND ENROLLMENTS

In 1938 the Office of Education of the United States Department of Interior published Bulletin No. 6 entitled "Offerings and Registrations in High School Subjects 1933-34". Unfortunately that publication was the most recent information compiled on a nation wide scale that tabulated the numbers of students enrolled in the secondary school curriculum. The Office presented, specifically, the numbers taking each subject, by state, throughout the nation, and indicated by discussion the trends toward the various types of subject matter.

1933-34 was more than a decade removed from 1946, however, and a questionnaire form (See appendix A) was mailed to the Office of the State Superintendent of Schools for each and every state within the continental limits of the country for the purpose of obtaining more recent statistics as to secondary school curriculums in mathematics and the natural sciences.

Though the results obtained were of a different nature than the material in the bulletin, the information

when combined with enrollment statistics from the bulletin produced the required information for later comparisons. Therefore, the 1938 Bulletin of the Office of Education can be considered to be significant relative to this thesis. The pertinent material in the bulletin will be discussed prior to a report of the very recent findings from the various State Public School Superintendents.

Algebra, geometry, trigonometry, and astronomy were one of the essentials in the 1895 public school curriculums. The enrollment in algebra and geometry, including advanced courses showed a rise in percentages up until 1910, but since that time, until 1934 at least, there was a persistent decline. In fact, the enrollments in mathematics alone showed a marked decline in percentages from 1928-1934.

Physics and chemistry, though appearing in the curriculum at a much later date than either the classics or mathematics, proved to be in great contract as to popularity. The percentage trend to physics pointed generally downward; chemistry displayed a tendency to rise in enrollments for thirty years prior to the 1934 survey.

To quote the 1934 statistics for enrollments in mathematics and physical sciences.

A. Algebra
   1. 90% or the schools offer elementary algebra
      a. 22% of the pupils take it.
      b. 7% take more than one unit

B. Geometry
   1. 84% of the school offer geometry
      a. 15% of the pupils take plane geometry
      b. Slightly over 2% take solid geometry

C. Trigonometry
   1. 1.33% of the students take trigonometry

D. Physics
   1. 6.27% of the students take physics

E. Chemistry
   1. 7.56% of the pupils take chemistry.[1]

Finally, the Office of Education placed science as fourth (inclusive of both social and natural sciences) and mathematics as sixth on a list of subjects tabulated in decreasing order as to curriculum emphasis.

The questionnaire form sent to forty eight state capitals were returned in 31 instances, a total of 64 per cent. Some were answered in full, others rather vaguely, and a few admitted that their respective office did not have the required information available.

Table No. I tabulates the questionnaire findings.

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1. "Offerings and Registrations in High School Subjects 1933-34", Bulletin No. 6 of the Office of Education of the United States Department of Interior, 1938.

TABLE NO. I

THE RESULTS OF QUESTIONNAIRE FORMS RETURNED BY STATE SUPERINTENDENTS OF PUBLIC SCHOOL 1947

	States Reporting	Total Secondary Schools In State	Total Enrollment in all Secondary Schools	Per Cent Schools not Offering over 2 units Math	Per Cent Enrollment in Schools. (See Col. to Math left	Per Cent Sec. Schools Not Offering Physics	Per Cent Sec. Schools not Offering Both Chem. & Physics
1.	Arizona	67	20,684	---	---	---	---
2.	Arkansas	838	65,000	50	25	80	90
3.	Colorado	197?	52,139	43	51	46	48
4.	Connecticut	169	78,000	0	0	0	0
5.	Delaware	3?	10,770	0	0	50	25
6.	Florida	768	151,169	3?	---	3?	27
7.	Idaho	175	28,712	80	75	20	85
8.	Illinois	1,065	368,820	---	---	---	---
9.	Iowa	1,000	23,046	60	50	15	75
10.	Kansas	693	88,602	10	---	0	---
11.	Kentucky	654	130,000	5	10	50	50
12.	Louisiana	594	84,358	0	0	9	3
13.	Massachusetts	436	270,000	50	---	20	---
14.	Missouri	815	149,619	65	85	20	15
15.	Nebraska	517	70,000	80	70	50	85
16.	New Hampshire	130	3,000	10	5	2	2

TABLE I. CONTINUED

States Reporting	Total Secondary Schools In State	Total Enrollment in all Secondary Schools	Per Cent Schools not Offering Over Two Units Math.	Per Cent Enrollment in Schools. (See Col. to Left	Per Cent Sec. Schools Not Offering Physics	Per Cent Sec. Schools not Offering Both Chem. & Physics
17. New Jersey	385	202,600	5	2	5	10
18. New Mexico	140	24,410	70	50	70	75
19. New York	13,000	750,000	5	1	15	15
20. North Carolina	1,010	140,000	0	0	60	75
21. Ohio	1,386	431,046	---	---	---	---
22. Oklahoma	849	131,689	67	38	92	90
23. Pennsylvania	1,210	663,117	0	0	0	2
24. South Dakota	206	31,682	75	50	40	60
25. Tennessee	386	125,000	0	0	70	25
26. Texas	1,252	---	---	---	---	---
27. Utah	83	50,000	80	---	60	40
28. Vermont	106	18,848	38	20	18	17
29. Virginia	369	118,29.	---	---	80	---
30. West Virginia	277	93,939	5.6	67.3	54	63
31. Wyoming	87	15,876	40	---	15	15

Consulting the table, it is obvious, that there are varying degrees of efficiency, with respect to records, throughout the many state departments of public instruction. Those spaces where part of the statistical information is omitted are examples of State Department that returned the questionnaire with the admission that the subject information was unavailable.

Although 64 per cent of the total number of the forms were returned, only 50 per cent of the total were filled out sufficiently to be of use. The final total, was however, a fair representative sampling in that it represented states from every section of the country.

The validity of the results were definitely questionable by two measures (1) at least 50 per cent of the officials detailing the required information on the questionnaire form indicated, by a footnote, that the percentages were "approximate". (2) A discrepancy was noticed in one instance, the state of Massachussetts, in which the individual returning the form stated that all of the schools offered more than two units of mathematics and all offered physics. A publication concerning high school offerings published by the "Commonwealth" of Massachussetts", however, gave concrete statistics to the

effect that only 50 per cent of the schools offered over two units of mathematics, and 20 per cent did not offer physics. It is possible that similar errors were made on others of the questionnaire forms.

An existent anomaly, notably the one of curriculum offerings, can readily be seen in the table. For example, the state of New York with 1300 schools and 750,000 pupils, has organized and centralized its schools so that the vast majority of the pupils have an opportunity to prepare for an engineering education. By comparison note New Mexico with but 144 schools and 244,000 pupils. In that agrarian western state over half the pupils had no opportunity to take courses necessary for entrance into an engineering school. A similar comparison could be found between the heavily populated eastern state of Pennsylvania, and the western states of South Dakota, Idaho and Oklahoma. In fact a careful study of the table clearly showed the superiority in courses (leading to engineering) of organization in the public school curriculum throughout the eastern and New England States over the western and southern states. Fortunately the larger enrollments were in the eastern states.

The results and the averages compiled from the

questionnaire form for the nation as a whole are as follows: (Using only those states wherein the information is complete).

50 Per cent of the States Represented

1.	Total secondary schools	10,943
2.	Total enrollment in the secondary schools	2,789,877
3.	Average per cent not offering over two units of mathematics	34.4%
4.	Average per cent enrolled in schools not offering over two units of mathematics	28.5%
5.	Average per cent not offering physics	37.3%
6.	Average per cent not offering both chemistry and physics	42.9%

SUMMARY

As a summary it was significant to note that over one-third of the secondary schools of the United States did not offer over two units of mathematics, nor physics and chemistry, and what is more, less than 10 per cent of the high school students in the United States enrolled in those courses. Such a fact is not particularly noteworthy by itself, but when correlated with engineering school academic admission requirements the implications appear self evident. The following chapter will compare these facts in relation to the requirements for admission of a representative sampling of engineering schools.

CHAPTER IV.

THE ENGINEERING COLLEGE'S REQUIREMENTS FOR ADMISSION

In the two previous chapters the comparative subject matter was compiled and averaged, and the summarization of this chapter will compare those results in graphic form to the statistics concerning engineering school admission requirements.

In order to determine the admission requirements for the average college of engineering in the United States, a total sampling of seventy five engineering schools were selected as a criteria. These institutions were located in practically every state, and one in Alaska; they include state colleges and universities, private institutions, denominational institutions, schools of technology, and military schools. Both technical schools and liberal arts schools were considered, the essential requirement being an engineering degree course included in the curriculum, in order to integrate their somewhat antithetical philosophies.

The purpose of determining an average set of existing admission requirements for an engineering school is to compare those requirement with the average academic accomplishments of the secondary school product, and to further

compare them with the general offerings of the secondary school curriculum.

The actual requirements for admission to the seventy-five institutions selected as representative were abstracted from the bulletins published and distributed by the individual schools. These bulletins were consulted at the Public Library of Houston, Texas, where they remain on permanent file, and the majority of them were recent editions. A few, in fact, were devoted to a future school year.

In view of the purposes of this study the specific admission requirements abstracted were those involving secondary school credits in mathematics and the natural sciences. In addition, whenever given, the information regarding entrance examinations, admissions with conditions, and whether or not the conditions can be made up, was obtained. Many of the bulletins, however, were either incomplete or generalized to a considerable extent concerning various requirements, which resulted in incomplete information for a number of the institutions. The material concerning entrance examination was supplemented by letters from the Deans of the Engineering Schools in a number of cases.

In Table No. II, the admission requirements for the

TABLE NO. II
TABLE OF ENGINEERING COLLEGE ADMISSION REQUIREMENTS
IN MATHEMATICS AND THE PHYSICAL SCIENCES
75 SCHOOLS REPRESENTED

Name of Institution	No. of Engr. Degrees Offered	Units of Math Required	Units of Physics Required	Units of Chem. Required	Admit With Condition	Require Condition Made up	Required Entrance Exam. or Screening Exam.
1. Alabama Polytechnic Institute Auburn, Alabama	5	3	0	0	Yes	Yes	Yes
2. California Institute of Tech. Pasadena, California	5	4	1	1	No	No	Yes
3. Antioch College Yellow Springs, Ohio	3	2	0	0	Yes	No	No
4. Case School of Applied Scien. Cleveland, Ohio	5	3	1	1	No	Yes	Yes
5. Columbia University New York, New York	7	4	1	1	Yes	Yes	Yes
6. Dartmough College Hanover, N. H.	ALL ARBITRARY						
7. Duke University Durham, North Carolina	3	3	0	0	Yes	No	Yes
8. Emory University Emory, Georgia	1	0	0	0	Yes	No	Yes
9. Emory & Henry University Emory, Virginia	1	2	0	0	Yes	No	Yes
10. Geo. Washington University Washington, D. C.	4	4	1	0	Yes	No	No

TABLE NO. II CONTINUED

Name of Institution	No. of Engr. Degrees Offered	Units of Math Required	Units of Physics Required	Units of Chem. Required	Admit With Condition	Require Condition Made up	Required Entrance Exam. or Screening Exam.
11. Georgia School of Tech. Atlanta, Georgia	10	3	1	0	Yes	No	Yes
12. Haverford College Haverford, Pennsylvania	1	2½	0	0	Yes	Yes	No
13. Iowa State College Ames, Iowa	6	2¹	0	0	Yes	No	Yes
14. Kansas State College Manhattan, Kansas	4	3	0	0	Yes	Yes	Yes
15. Lafayette College Easton, Pennsylvania	7	4	1	1	No	Yes	No
16. Lawrence Institute of Tech. Detroit, Michigan	4	2½	1	0	Yes	Yes	No
17. Lehigh University Bethlehem, Pennsylvania	6	3½	0	0	Yes	No	Yes
18. Massachusetts Inst. of Tech. Boston, Mass.	7	4	1	0	No	---	Yes
19. Michigan College of Min. & Technology Houghton, Michigan	4	3	1	0	Yes	No	Yes
20. Mo. School of Mines & Meta. Rolla, Missouri	6	3	1	0	Yes	No	Yes

TABLE NO. II CONTINUED

Name of Institution	No. of Engr. Degrees Offered	Units of Math Required	Units of Physics Required	Units of Chem. Required	Admit With Condition	Require Condition Made Up	Required Entrance Exam. or Screening Exam.
21. New York University New York, New York	7	3	1	0			
22. Ohio State University Columbus, Ohio	1	3	1	0	No	Yes	Yes
23. Oklahoma A & M College Stillwater, Oklahoma	10	3	0	0	Yes	Yes	No
24. Oregon State College Corvallis, Oregon	7	2½	0	0	Yes	No	Yes
25. Polytechnic Inst. of Brook. Brooklyn, New York	6	3	1	0	Yes		
26. Pratt Institute Brooklyn, New York	3	3	0	0	Yes	No	Yes
27. Princeton University Princeton, N. J.	6	3½	1	0	Yes	Yes	No
28. Purdue University Lafayette, Indiana	7	3	0	0	Yes	Yes	Yes
29. Renesselaer Polytechnic Ins. Troy, New York	4	3½	0	0	No	Yes	Yes
30. Rutgers University New Brunswick, New Jersey	4	4	1	0	Yes	Yes	Yes

TABLE NO. II CONTINUED

Name of Institution	No. of Engr. Degrees Offered	Unit of Math Required	Unit of Physics Required	Units of Chem. Required	Admit With Condition	Require Conditions Made up	Required Entrance Exam. or Screening Exam.
31. Southern Methodist University Dallas, Texas	3	3	0	0	Yes	No	Yes
32. Southwestern Louisiana Ins. Lafayette, Louisiana	4	2	0	0	Yes	Yes	---
33. Stanford University Palo Alto, California	4	3½	1	1	No	Yes	---
34. Texas A & M College College Station, Texas	8	3	1	0	Yes	Yes	Yes
35. Texas Tech. College Lubbock, Texas	5	3	1	0	Yes	Yes	--
36. The Catholic Uni. of Amer. Washington, D. C.	6	3	0	0	Yes	No	Yes
37. The Carnegie Inst. of Tech. Pittsburgh, Pennsylvania	7	3	1	1	Yes	No	Yes
38. The Rice Institute Houston, Texas	4	4	1	1	No	No	No
39. Tri-State College Angola, Indiana	6	2½	1	1	Yes	Yes	No
40. Tufts College Medford, Mass.	5	3	1	0	Yes	No	Yes

TABLE NO. II CONTINUED

Name of Institution	No. of Engr. Degrees Offered	Unit of Math Required	Unit of Physics Required	Unit of Chem. Required	Admit With Condition	Requires Condition Made up	Required Entrance Exam. or Screening Exam.
41. Tulane University New Orleans, Louisiana	4	3	0	0	Yes	No	Yes
42. University of Alabama University, Alabama	7	3	0	0	Yes	Yes	--
43. University of Alaska Fairbanks, Alaska	5	2½	1	0	Yes	Yes	No
44. University of Arizona Tuscon, Arizona	3	3	1	0	No	Yes	Yes
45. University of Arkansas Fayetteville, Arkansas	4	2½	0	0	Yes	No	Yes
46. University of Cincinnati Cincinnati, Ohio	6	2½	0	0	No	Yes	--
47. University of Colorado Boulder, Colorado	6	3	1	0	Yes	No	Yes
48. University of Connecticut Storrs, Connecticut	3	3	1	0	No		
49. University of Delaware Newark, Delaware	4	3	1	0	No		
50. University of Denver Denver, Colorado	4	3	1	1	No		
51. University of Florida Gainesville, Florida	5				Yes	No	Yes

TABLE NO. II CONTINUED

Name of Institution	No. of Engr. Degrees Offered	Unit of Math Required	Unit of Physics Required	Unit of Chem. Required	Admit With Condition	Require Condition Made Up	Required Entrance Exam. or Screening Exam.
52. University of Houston Houston, Texas	6	3	0	0	Yes	Yes	No
53. University of Idaho Moscow, Idaho	5	3	1	0	Yes	Yes	--
54. University of Iowa Iowa City, Iowa	4	2½	0	0	No	--	--
55. University of Kansas Lawrence, Kansas	9	3	1	0	Yes	Yes	
56. University of Maryland College Park, Maryland	4	3½	0	0	Yes	Yes	--
57. University of Mississippi University, Mississippi	3	3	0	1	Yes	Yes	
58. University of Missouri Columbia, Missouri	5	3	1	0	Yes	Yes	
59. University of Nebraska Lincoln, Nebraska	4	3	1	1	Yes	Yes	
60. University of Notre Dame South Bend, Indiana	3	3	1	1	Yes	Yes	Yes
61. University of Ohio Athens, Ohio	1	2	0	0	Yes	Yes	

TABLE NO. II

Name of Institution	No. of Engr. Degrees Offered	Unit of Math Required	Unit of Physics Required	Unit of Chem. Required	Admit With Condition	Require Condition Made Up	Required Entrance Exam. or Screening Exam.
62. University of Oklahoma Norman, Oklahoma	10	3	1	0	Yes	Yes	
63. University of Penn. Philadelphia, Penn.	5	2	0	0	No		Yes
64. University of South. Calif. Los Angeles, Calif.	6	3½	1	1	Yes	Yes	
65. University of Texas Austin, Texas	7	3	1	1	Yes	Yes	
66. University of Tulsa Tulsa, Oklahoma	1	2½	0	0	Yes	Yes	
67. University of Utah Salt Lake City, Utah	7	3	1	0	No		
68. University of Vermont Burlington, Vermont	3	3	0	0	No		
69. University of Virginia Charlottesville, Va.	4	4	1	0	Yes	Yes	
70. University of Washington Seattle, Washington	6	3	1	1	Yes	Yes	
71. University of Wyoming Laramie, Wyoming	6	2½	1	0	Yes	No	Yes
72. Vanderbilt University Nashville, Tennessee	4	2½	0	0	Yes	No	Yes

TABLE NO. II CONTINUED

Name of Institution	No. of Engr. Degrees Offered	Units of Math Required	Units of Physics Required	Unit of Chem. Required	Admit With Condition	Require Condition Made up	Required Entrance Exam. or Screening Exam.
73. Virginia Military Inst. Lexington, Virginia	2	3	0	0	No	No	No
74. Wayne University Detroit, Michigan	8	3½	1	0	Yes	Yes	
75. Yale University New Haven, Conn.	5	3	1	0	No	Yes	No

various engineering schools are listed, and the following tabulation details the totals and averages derived thereof.

TOTALS (Units refer to secondary schools units of study presented for college admission)

1.	Total requiring	
	a. More than two units of mathematics	66
	b. Total requiring only two units of mathematics	9
2.	a. Total requiring physics	39
	b. Total not requiring physics	36
3.	a. Total requiring both chemistry and physics	13
	b. Total not requiring both chemistry and physics	62
4.	a. Total will admit with conditions	58
	b. Total that will not admit with conditions	17
5.	a. Total requiring make-up	33
	b. Total not requiring make-up	42
6.	a. Total offering entrance examinations	32
	b. Total not offering entrance examinations	43

PERCENTAGES

1.	Per cent of engineering schools requiring over two units of mathematics	88
2.	Per cent of engineering schools requiring one unit of physics	52
3.	Per cent of engineering schools requiring one unit of each physics and chemistry	17
4.	Per cent of engineering schools that refuse admittance with "conditions"	22.5
5.	Per cent of engineering schools requiring "conditions" made-up	57

6. Per cent of engineering schools offering entrance examination 42.6

The significance of the percentages can best be illustrated graphically in a comparison with the information regarding secondary school enrollments and curriculum offerings as compiled in the two previous chapters.

The graphs (Figs. 1, 2 & 3) indicate several noteworthy considerations:

1. That although 88 per cent of the engineering colleges required over two units of high school mathematics for admission only 65 per cent of the high schools offered over two units, and only 7 per cent of the students enrolled for more than two units.

2. That 52 per cent of the engineering colleges required one unit of high school physics for admission, however, 63 per cent of the secondary schools offered physics in the curriculum, yet only 6.27 per cent of the students enrolled in the course.

3. That 57 per cent of the secondary schools offer both chemistry and physics, but only 17 per cent of the engineering schools require both.

FIGURE NO. I

This figure shows the per cent of the nation's engineering colleges requiring more than two units of secondary school mathematics for admission as compared to the per cent of the nation's secondary schools offering over two units of mathematics and the per cent of the nation's secondary school pupils taking over two units of mathematics.

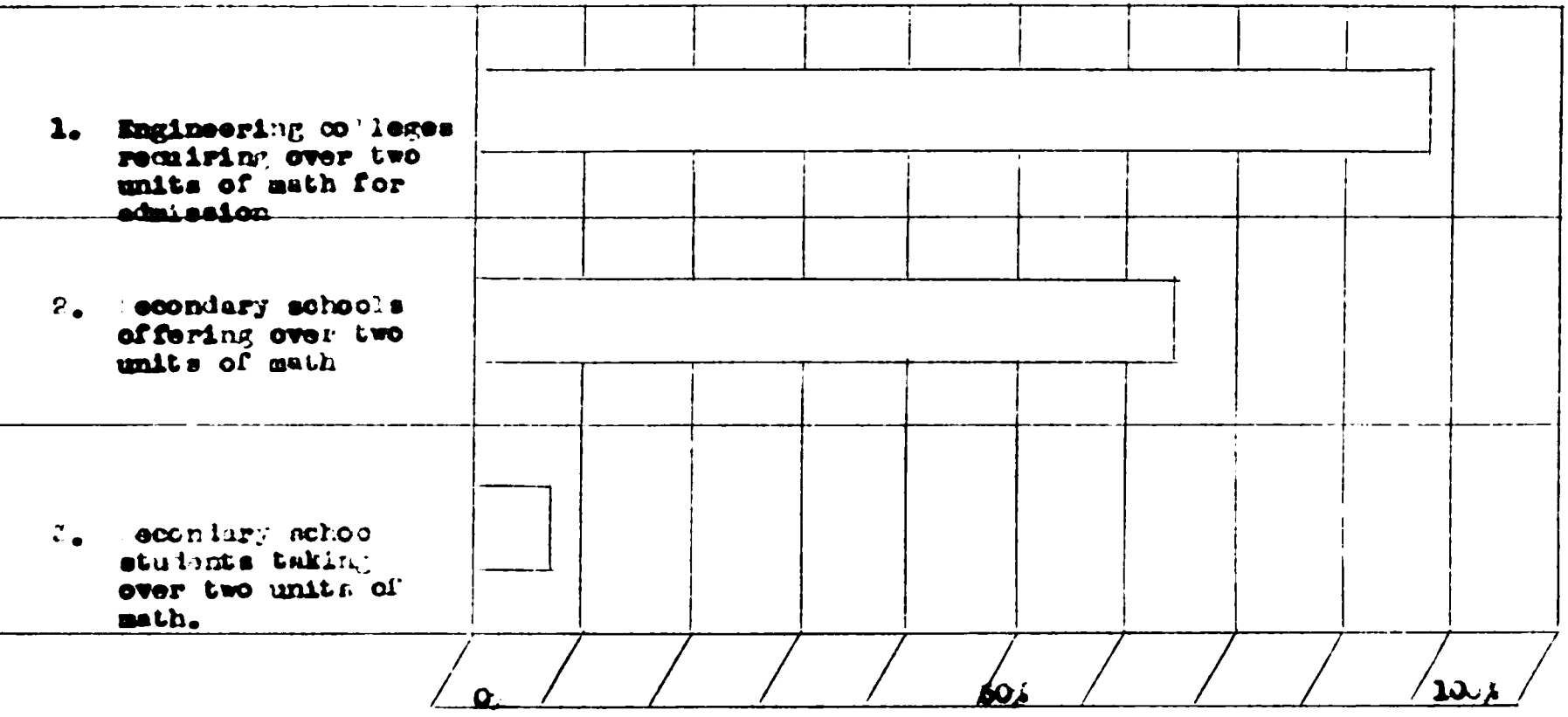


FIGURE NO. II

This figure show the per cent of the nation's engineering colleges requiring one unit of secondary school physics for admission as compared to the per cent of the nation's secondary schools offering one unit of physics and the per cent of the nation's secondary school pupils taking physics.

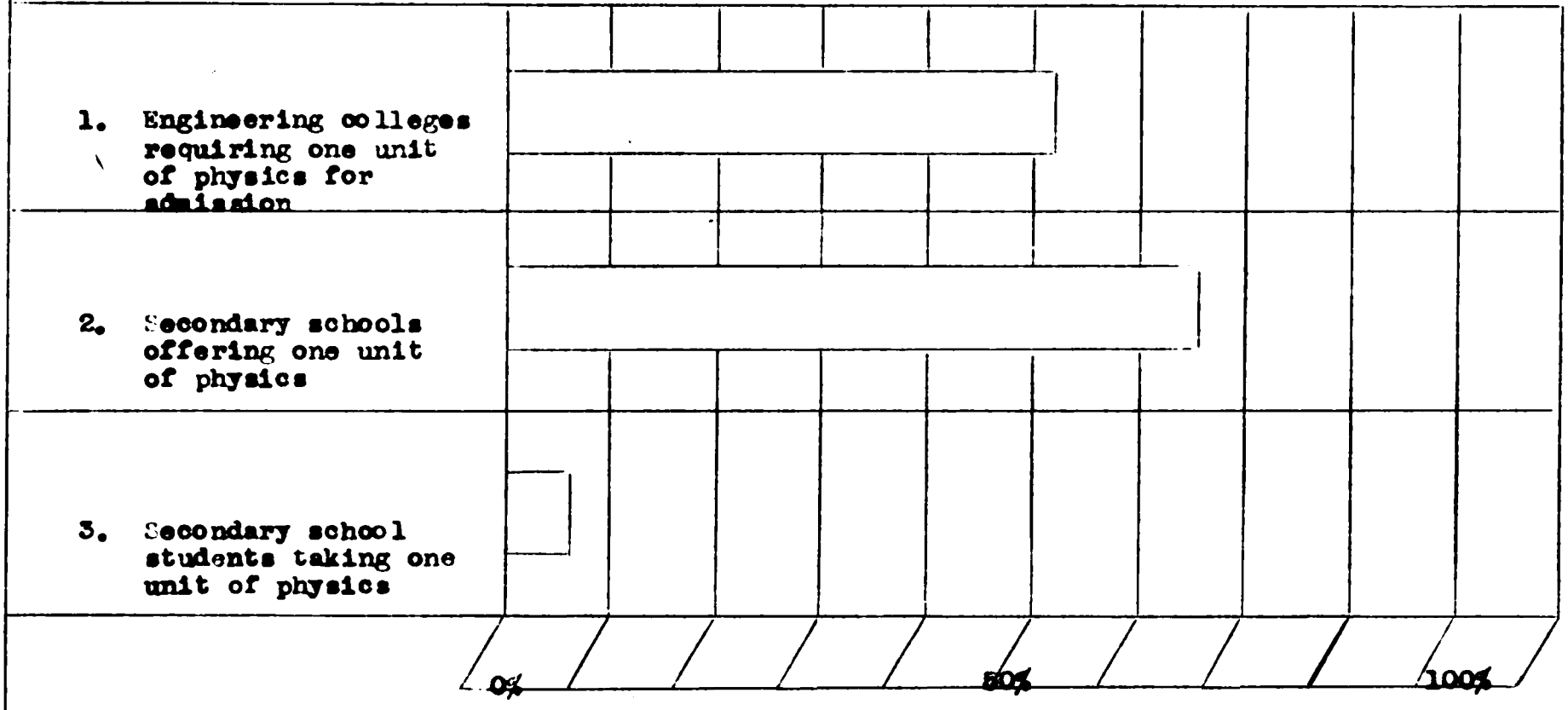
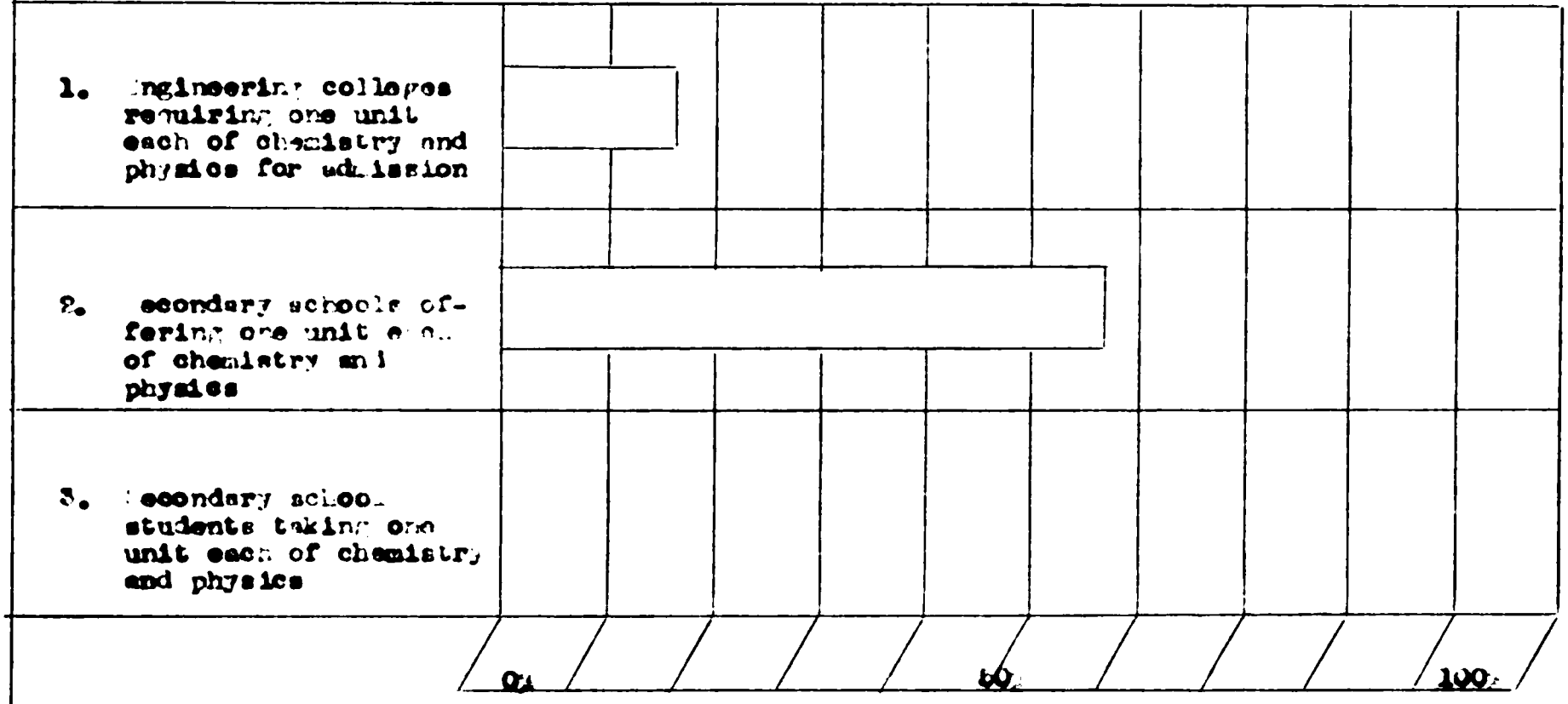


FIGURE NO. III

This figure shows the per cent of the nation's engineering colleges requiring one unit of secondary school chemistry and one unit of physics for admission as compared to the per cent of the nation's secondary schools offering one unit of chemistry and one unit of physics and the per cent of the nation's secondary school pupils taking chemistry and physics.



SUMMARY

The comparisons of this chapter between engineering school requirements, secondary school curriculums, and student enrollments in relation to secondary school mathematics and natural sciences, were evidence pointing to a lack of coordination between high schools and engineering colleges.

Where student enrollment was concerned the fact that engineering attracts a relatively small number of the total high school students is a factor that possibly accounted for the small enrollments in mathematics and the physical sciences. Whether any of the majority, that did not take chemistry, physics, or over two units of high school mathematics, later applied for admission to engineering schools will be discussed in the following chapter.

CHAPTER V.

THE ENGINEERING EDUCATORS STATEMENTS AND SUGGESTIONS

In order to ascertain, as nearly as possible, (1) the approximate relationship of total college enrollments to engineering college enrollments (2) the relationship as to academic success between students entering with conditions in mathematics and the physical sciences, and those that met the existing requirements and (3) to obtain some concensus of opinion regarding means to decrease the high percentage of failures in engineering schools, a questionnaire form (See appendix B) was mailed to the deans of the school of engineering of each of the seventy-five colleges used as a representative sampling in the previous chapter.

Absolute, concrete, information and statistics was neither the purpose nor the result by the utilization of such a questionnaire but rather the accumulation of a sampling of trends, opinions, and suggestions relative to engineering education. Such information was received from various types of institutions of higher learning all over the United States, and not only represented the prevailing policies and conditions at each institution, but set forth remedial suggestions by leading professional

educators in the engineering field.

The reactions to the questionnaire form were surprising indeed, for 61 per cent of the deans replied almost immediately, and with some degree of enthusiasm. Many, in fact, enclosed personal letters on the subject; of which about one third were constructive, and the other two thirds somewhat vehemenent and critical in regard to the high school standards of efficiency. In view of the infinite variety of requirements, standards, and policies, among the many different institutions at least fifty per cent of the questionnaire forms were not filled out in full, in fact a number substituted a letter for the form. Sufficient information was obtained, however, to form the desired overall picture.

For the findings of the questionnaire forms refer to Table No. III.

The totals of the information received on the questionnaire forms were as follows. (Received from 46 institutions).

1. Total student enrollment 329,146
2. Total student enrollment in engineering 73,100
3. Of the 29 per cent answering as to what per cent of the engineering students were

TABLE NO. III
QUESTIONNAIRE REPLIES FROM THE ENGINEERING COLLEGES
(Consult Appendix B for questionnaire information pertaining to numbers in columns)

Institution	1	2	3	4	5	6	7	8	9
California Institute of Technology	800	800	0	0	--	--	Increase	1 - f 2 - a 3 - b	Col.
Case School of Applied Science	1287	1287	0	0	--	--	Increase	1 - b 2 - a	Both
Columbia University	--	--	--	--	--	--	Remain Same	--	H.S.
Dartmouth College	2,800	120	0	--	Slightly Handi-Capped	--	Remain Same	1 - e 2 - a 3 - f	Both
Emory and Henry University	479	125	10	10	Slightly Handi-Capped	Below Average	Remain Same	1 - a 2 - b 3 - f	Both
Georgia School of Technology	4,555	4,555	0	34	--	--	Increase	1 - a 2 - d 3 - f	Both
Haverford College	--	70	--	--	---	--	--	--	--
Iowa State College	9,200	4,000	35%	--	Slightly Handi-Capped	Below Average	Increase	1 - e	Col.
Lehigh University	2,723	1,817	.5%	--	Normally	Average	--	1 - f 2 - b 3 - a	H.S.

TABLE NO. III CONTINUED

	1	2	3	4	5	6	7	8	9
Mass. Institute of Tech.	5,172	4,042	0	0	--	--	Increase	1 - a	Both
Ohio State College	24,876	4,396	20	0	Slightly Handi-Capped	Below Average	Increase	1 - b 2 - a 3 - d	Both
Oklahoma A & M	10,000	2,634	90	25	Greatly Retarded	Below Average	Increase	1 - a 2 - d 3 - b	Both
New York University	45,000	3,000	0	5	--	--	Increase	1 - b 2 - a 3 - f	Both
Oregon State College	7,165	1,661	0	8	--	--	Remain Same	1 - f 2 - d 3 - e	Both
Pratt Institute of Technology	2,200	700	0	10	Normally	Below Average	Increase	1 - b 2 - a 3 - f	Both
Princeton University	3,500	600	0	0	--	--	Remain Same	1 - b 2 - a 3 - f	Both
Purdue University	11,320	6,801	0	0	--	--	Increase	1 - a 2 - b	Both
Rensselaer Polytechnic Institute	--	--	0	--	--	--	--	1 - f	--
Southern Methodist University	6,736	782	27	35	--	--	Increase	1 -f 2 - a	Both

TABLE NO. III CONTINUED

	1	2	3	4	5	6	7	8	9
Stanford University	7,000	1,075	15	5	Slightly Handicapped	Below Average	Remain Same	1 - a 2 - d 3 - f	Both
Texas A & M College	8,523	4,700	5	30	Greatly Retarded	Below Average	Remain Same	1 - a 2 - b 3 - d	H.S.
Texas Technological College	5,366	1,766	30	--	Slightly Handicapped	Below Average	Remain Same	1 - b 2 - d 3 - f	H.S.
The Catholic University of America	3,700	824	0	0	--	--	Increase	1 - a 2 - b 3 - f	H.S.
The Carnegie Institute of Technology	3.427	2,133	0	0	Normally	Average	--	1 - b 2 - a 3 - f	Both
University of Alabama	8,624	1,573	30	20	Slightly Handicapped	Average	Remain Same	1 - a 2 - f 3 - b	Both
University of Alaska	364	131	90	15	Greatly Retarded	Below Average	Increase	1 - a 2 - f 3 - b	Both
University of Arizona	4,500	740	0	0	--	--	--	1 - b 2 - e 3 - a	--
University of Arkansas	4,400	933	10	50	Greatly Retarded	Below Average	Increase	1 - b 2 - d	Both

TABLE NO. III CONTINUED

	1	2	3	4	5	6	7	8	9
University of Connecticut	6,697	1,400	5	--	Greatly Retarded	Below Average	Increase	1 - a 2 - f	Both
University of Idaho	3,460	669	35	8	--	Average	Remain Same	1 - a 2 - b 3 - f	Both
University of Iowa	10,300	630	--	--	--	--	Increase	1 - d 2 - e 3 - f	Col.
University of Kansas	9,004	2,190	33-1/3	-	Normally	Average	Remain Same	1 - a 2 - f 3 - b	H.S.
University of Mississippi	2,800	200	2	25	Greatly Retarded	Below Average	Increase	--	Both
University of Missouri	10,378	1,546	10	50	Slightly Handi-capped	Average	Remain Same	1 - f 2 - a 3 - e	Both
University of Nebraska	9,500	1,580	--	--	--	--	--	1 - b 2 - a	Both
University of Notre Dame	4,500	1,084	5	--	Slightly Handi-capped	Average	Increase	1 - a 2 - f 3 - b	Both
University of Oklahoma	RECEIVED LETTER BUT NO INFORMATION								
University of Pennsylvania	6,900	595	0	--	--	--	Remain Same	1 - b	Both

TABLE NO. 1a (CONTINUED)

	1	2	3	4	5	6	7	8	9
University of Colorado	7,600	2,271	40	10	Lightly Handicapped	Below Average	Remain same	—	Both
University of Texas	17,200	3,66[illegible]	1	—	Greatly Retarded	Below Average	Increase	1 - b	Both
University of Oklahoma	4,000	870	10	7.5	Lightly Handicapped	Average	Increase	1 - a 2 - e 3 - f	Both
University of Utah	8,638	1,164	0	—	—	—	Remain same	1 - a 3 - f	Both
University of Washington	16,900	2,10[illegible]	0	—	Greatly Retarded	—	—	1 - a 2 - b	Both
University of Wyoming	3,000	770	30	10	Lightly Handicapped	Average	Increase	1 - a 2 - b 3 - f	Both
Virginia Military Institute	788	431	0	—	—	—	—	1 - a 2 - f 3 - b	—
Yale University	6,433	1,062	—	—	Greatly Retarded	Below Average	Increase	1 - a 2 - b 3 - f	Both

admitted with "conditions" the extremes were from .5% to 90%. The average percentage taking engineering with high school deficiencies was 25.5

4. Of the 23 per cent answering as to what per cent of the failures in engineering school can be attributed to deficiencies in secondary schools the extremes were from 5% to 50%. The average percentage of failures due to high school deficiencies was 20.6

(Note on Table III Column 3 and 4 the lack of uniformity among the institutions as to the number of failures due to lack of high school preparation)

5. As to the effects of high school deficiencies in mathematics and the physical sciences upon progress in engineering school, of the 33-1/3 per cent of the deans reporting the results were as follows:

A.	Normally	16%
B.	Slightly handicapped	48%
C.	Greatly retarded	36%

6. As to the relationship between academic success in engineering school and high school deficiencies in mathematics and science, 32 per cent reporting; the students admitted with "conditions" receive grades that are:

A.	Above average	0%
B.	Average	37%
C.	Below Average	63%

7. As to the future for academic admission requirements for engineering schools, of the 49 per cent that expressed an opinion the percentages were as follows:

Requirements will	A.	Increase	62%
	B.	Remain Same	38%
	C.	Decrease	0%

8. The suggestions represented in the questionnaire form as being the most beneficial to the problem were as follows:

   A. Improved guidance in high schools.

   B. Increasing the mathematic requirement for a high school diploma

   C. Lowering admission requirements for engineering schools.

   D. Establishment of a pre-engineering high school program.

   E. Utilization of the five year college engineering program modified to absorb the secondary school admissions.

   F. A screening process, based on aptitude tests, prior to admission to the school of engineering.

   G. The results based upon the opinions of the engineering school deans appear below.

(42 replies to the question)

Per cent favored for 1st place	a.	Improved guidance	52
	b.	Increasing math req.	28
	c.	Lowering admission req.	0
	d.	Pre-engr. program	02
	e.	Five year program	5
	f.	Screening process	13

(36 replies)

Per cent favored for 2nd place	a.	Improved guidance	29
	b.	Increasing math req.	25
	c.	Lowering admission req.	0
	d.	Pre-engr. program	17.
	e.	Five year program	8
	f.	Screening process	21

(28 replies)

Per cent favored for 3rd place	a.	Improved guidance	08
	b.	Increasing math req.	19

c.	Lowering admission req.	0
d.	Pre-engr. program	08
e.	Five year program	10
f.	Screening process	55

From the tabulation of the results it was obvious that (a) was overwhelmingly favored, with (b) as second-best and (f) as third. Thus remedial measures endorsed by engineering school educators in decreasing order of their importance were:

(1) Improved guidance in high schools

(2) Increasing of the mathematics requirements for a high school diploma

(3) A screening process, based upon aptitude tests, prior to admission to the school of engineering.

9. As to determining the responsibility for this problem, the opinion of the engineering college deans were as follows: (41 replies)

a.	College	07
b.	Secondary schools	14
c.	Both	79

10. As to departmental sectionalization of classes on a basis of placement tests, that information was obtained at the request of the Director of the School of Engineering at the University of Houston 1946-47, for his personal file in connection with the responsibilities of his office. It had no particular connection with this study, however, it was found that 38 per cent of the engineering schools sectionalize classes.

11. In regard to suggestions for obtaining a higher percentage of successful candidates in engineering school without lowering the standards for admission, the opinions, suggestions, criticisms and accusations, were plentiful. The letters and quotations, however, were in a measure the personal opinions of the various educators, and to preserve the integrity of the institution which they represented both the name of the writer and the institution must be withheld.

The following quotations are excerpts from the letters and notes received from the various engineering school deans as supplements to the questionnaire form. Only a few of the most pointed and interesting portions of some of the letters are represented and they will be referred to by a "case number".

Case No. 1. "We have increased our entrance mathematics requirements to include trigonometry, so the student must present 1½ years of algebra - 1 year plane geometry - ½ year each of solid geometry and trigonometry. One year each of physics and chemistry is also required. We find that if no exceptions are made in these mathematics and science requirements, and with the selection we have to make because of the number of applicants, that the men as a whole do exceptionally well. There are failures, of course, but as a group the sections make a very excellent showing."

Case No. 2 "Use five year program which has operated very satisfactorily at ___ for 75 years."

Case No. 3 "Some method must be devised whereby students who wish to enter engineering may be brought to a common acceptable level of achievement. I think that some kind of a pre-engineering year, plus, possibly, some kind of an aptitude and interest test would be very helpful."

Case No. 4 "Now that 80% of our high school students are not interested in college, the remaining 20% who want to go to college have become very much "the forgotten pupils". Our high schools are no longer providing an education for their talented students who are able and anxious to subject themselves to the severe discipline of honest to goodness intellectual effort. High school courses have been diluted to satisfy the parents of the median high school pupil. Accordingly a very heavy burden rests on our high schools to introduce real college preparatory work in the high school. Many preparatory schools in order to survive are taking individuals

who are not able to do even the work of a mediocre high school. A few preparatory schools are providing a thorough education for truly able college preparatory pupils. If the public high schools are no longer going to be willing, at tax payers' expense, to provide adequate preparation for college work, then parents are going to have to provide that training elsewhere. The college is not the place for this training. Perhaps parents who wish to send their sons and daughters to college will again have to resort to the private academy. It is not the responsibility of the college to give preparatory school work.

I suggest that even though you may not be able to impose an adequate screening process at the point of admission at this time, at least you could require certain examinations and tests to be taken by freshmen immediately after their arrival in the university and in a few years' time you would develop correlations between the results of such tests and success in the first year in the college of engineering. Having demonstrated that you had an adequate "testing" program for discovering who would succeed, it might be possible to start selection students for admission on the basis of such a tests. The raising of entrance requirements in quality would need to be done gradually, if a political situation exists. If for example 50% of the students of the college of engineering are showing themselves to be unsuccessful in their first year, then the lower 20% of the 50% could be screeded out so that 60% would be successful and 40% only would be failures. A few years later the percentage could be reduced to 30% and so on to the point where the precentage of failures was considered to be a reasonable figure within the realms of human ability to select and predict in advance."

Case No. 5 "Strict adherence to admissions requirements in English, mathematics and physics and per-

sonal interview of every applicant with representative of admissions office."

Case No. 6 "Get better cooperation from high schools in meeting their obligations towards pre-engineering students."

Case No. 7 "This is a tough problem. Tendencies of modern education are more and more away from the old fundamentals of "reading, writing, and arithmetic". We must appreciate however that the percentage of high school graduates taking up engineering is rather small. Personally, I feel that one year of high school algebra and one year of plane geometry should be the minimum mathematics requirements for all high school graduates. We get some (and from large city schools, too) without even the algebra, let alone the plane geometry."

Case No. 8 "Procedure at this institution reasonably satisfactory. 1. Students must meet entrance requirements of 1½ years algebra and one year geometry, otherwise they must earn such credit before admission to engineering school. 2. Regardless of high school record a placement examination in math is required. Low ranking students are required to take review or refresher math during which time they are in the lower division of the College and not in the School of Engr. As soon as math deficiencies are completed and if a satisfactory G.P.A. has been earned, the students may transfer into engr. Our efforts to influence secondary schools and provide guidance have been unsuccessful."

Case No. 9 "___ has made it a policy for many years <u>not</u> to admit people with conditions. This practice was made more rigid during the past two years. In checking with our Director of Admissions I find that out of more than 2,000 freshmen, not one was admitted with a condition. Furthermore, a out 7/8 of those admitted are in the upper third of their secondary school graduating class. Thus, the problem you have mentioned does not effect us very seriously."

Case No. 10 "In addition to the usual criteria, especially class standing, we use tests to determine the aptitude and achievement of applicants. Refresher courses providing for a review of mathematics and the sciences have been extremely useful. The fact that we have practically no attrition is due, in considerable part, to the background which students obtain in these courses."

Case No. 11 "Proper vocational and educational guidance in high schools. Many students entering engineering schools do not understand that success requires high aptitude in mathematics."

Case No. 12 "The answer to 8 is based on my idea of the ideal situation. However, I doubt whether the high schools can be influenced to any extent as less than half their graduates go on to college. I think the practical solution is a screening process prior to admission to the school of engineering. The difficulty with this solution, as I see it, lies in the development of a reliable screen, I have known enough highly successful engineers who are not particulary good in mathematics to feel that that is not the sole criterion, although it is becoming increasingly important."

Case No. 13 "Exclude lower half of high school graduating class."

Case No. 14 "At ___, we have an acute admission problem as do all other engineering colleges throughout the country at this time. For the 200 places available in the 1946 fall semester in the college of engineering and science under the limited enrollment system, we made selections among more than 7,000 applicant. In so doing, we used the results of placement tests, letters of recommendation, and preparatory school records as the basis for selection."

Case No. 15 "In my opinion 8 (a) (Improved guidance in high school) is the most needed of all the

improvements suggested. In 32 years of teaching experience, dealing with students entering colleges of engineering from the various secondary schools, I am convinced that there is practically no effective guidance functioning in the secondary schools, since any effort on the part of colleges of engineering either to advise or to suggest plans would be interpreted by secondary school principals and superintendents as unwarranted interference by the institutions of higher education. It is a crying shame that the graduates of high schools are turned loose with neither training nor advice to qualify them either for their life work or for entrance to colleges for technical and professional training.

Under item 11, (request for suggestions) all high school students who signify their intention to enter pre-professional or technical schools should be required to include in their fourth year work one unit of English composition, one unit of review mathematics, principally arithmetic and algebra, and one unit of physics. Such a requirement cannot prove a handicap to those who do not enter college, and would materially decrease the wastage among those who do."

Case No. 16 "We are faced with the same situation you are. We have 474 freshmen and we have a very high percentage of failures in mathematics as well as other freshman work. Many of these freshmen should not be in college at all. We give three tests, and students who are in the fourth or fifth quintiles seldom remain in college. They either withdraw or are dropped. I doubt if we graduate more than 15% of those entering as freshmen.

Our requirement for entrance should be increased; better, we should have a different standard than one and one-half units of algebra. That means nothing because the high schools today do not require real study.

It would be much better to keep students

out of engineering than fail them out. There seems to be no other way to convince them that they should not take engineering except to fail them and drop them out. All air corps men want Mechanical Engineering or Aeronautical Engineering. Not 50% of either have any business in engineering.

I recommend to mathematics teachers that they make mathematics courses stiff for engineers and fail them early in the course. There is less disappointment if they are failed early."

Case No. 17 "We need better guidance, to be sure, but is there any hope to getting it? As long as we let professional educators lay down the law that mathematics has no value in education, there is only one thing we can do: Take the students where we find them and do the best we can for them."

Case No. 18 "In my opinion the student's progress or lack of it is not because of the fact he entered with insufficient high school mathematics, but rather because he does not have the aptitude for engineering. Many of those who come with insufficient entrance preparation in mathematics become some of the best students.

I, therefore, feel that you cannot say categorically that lack of training in mathematics in high school is or is not the reason for failure."

Case No. 19 "The ___ has had eight years experience with the use of placement or preregistration tests in the general academic field in mathematics, English, physics and chemitry. As a result of this experience it has been possible to segregate students with defective preparation and start their educational program at different levels. For example, there are three levels at which a student may start the study of mathematics in the engineering college. If a student starts at the lowest

level he receives no academic credit toward a degree. If he starts at the second level he receives partial credit. If he starts at the high level he receives full credit. The experience at the University of ___ indicates that these placement test in mathematics are more valid evidence of preparation than the number of points earned in high school. Some very excellent students in mathematics are obliged to start at the low level because of not having had the opportunity of studying mathematics at that level during their high school career. A student who has the maximum high school points and then scores low in the preregistration tests is a very poor risk."

Case No. 20 "careful screening of candidates appears to be the most practical solution. Formation of special pre-engineering groups in high school appears to be a promising solution, also."

Case No. 21 "At this University the vast majority of our engineering students had better than average high school records because of stiffened entrance requirements. Maintaining stiff entrance requirements will be a great help to you, I'm sure. Information of this kind gets around and is soon reflected in the attitude of the high schools."

Case No. 22 "The college courses in math, chemistry, and physics, are used at the present time to screen the beginning engineering students. While this is an efficient screening process, it adds to the load in the service courses for the engineering college, and it would be better if much of this screening could be done as suggested in paragraph 8 (f)." (Screening based on aptitude tests.)

Case No. 23 "It is an old question - Not improved by fads

and fancies of "professional" educationists which tend to place more emphasis upon the techniques of pedagogy than upon sound mastery of the subject matter being taught."

Case No. 24 "I believe that higher institutions should forsee that swing to applied courses in high school, and should encourage it; that they should find out just what items of mathematics and science are essential in the pursuit of college courses and find ways of supplying the needed training in those items to promising students whose schooling has not included it. I believe that six or eight hours of college algebra and analytical geometry, and a similar amount of college physics, following the applied courses of the high school, would take care of it."

Case No. 25 "To obtain a higher percentage of successful candidates in colleges of engineering, take only those who can meet adequate requirements for success in college. This means temporarily at least, a reduction in the number of engineering students in any given college of engineering where it has been easy to get in but hard to stay. Whether such a stiffening of of requirements is politically feasible or not in state and municipal colleges and universities, I do not know. The University of Wisconsin undertook to meet the political situation by creating a "General College" to which they admit those high school graduates whom they feel to be below the necessary requirements for success in one of the regular high standard divisions of the institutions. Their constituents have not yet, I believe, taken to writing to state legislators protesting admission to the General College as over against admission to a regular high standard division of the University."

SUMMARY

The consequential features of the questionnaire findings concerned the fact that nearly a quarter of college enrollments were in engineering, and that of those enrolled in engineering exactly one quarter of them were admitted with "conditions" in mathematics and the physical sciences. It was further found that approximately 20 per cent of the failures in engineering schools were listed as due to lack of high school preparation in the same subjects.

Students admitted with conditions progressed "slightly handicapped" and received grades below the average.

It was the opinion of 62 per cent of the engineering college deans that admission requirements for engineering schools would increase in the future, and 79 per cent of the deans expressed the opinion that it was the joint responsibility of the secondary school and college to make adjustments to meet the situation.

Furthermore, it was the professional decision of the engineering educators that the three most effective means for obtaining a higher percentage of successful candidates in engineering school, without lowering the standards for admission, were (1) Improved guidance for high school students; (2) Raising the mathematics

requirements for a high school diploma; and (3) a screening process, based upon aptitude tests, prior to admission to a school of engineering.

Letters and subscripts received in connection with the questionnaire form from the various engineering professors, though somewhat subjective and heterogeneous, generally expressed several sentiments in common. They berated secondary school standards of instruction, they complained of the lack of effective counseling and guidance in the high schools, they expressed the desire for coordination between high schools and colleges, and they felt that examinations as a screen process, coupled with inflexible admission requirements relative to high school achievements, would be the ideal arrangement.

CHAPTER VI.

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

A. SUMMARY

Since 1900 engineering educators have been concerned over the appalling per cent of failures in engineering schools, and studies of the situation since that time produced evidence that approximately 60 per cent of entering freshmen in engineering fail to graduate. The researchers came to further conclusions as to causations and basis for measures to decrease the rate of failure by displaying records that established a definite correlation between success in engineering school and previous secondary school academic achievements.

Although they professed to no medium, through which a prognosis of success in engineering school could be made, had been empirically determined, the general opinions, as well as statistical proof, displayed several measures as fairly successful. Such as:

1. Academic secondary school achievement.
2. Achievement tests prior to college admission.
3. High school preparation in such subjects as mathematics, physics, chemistry, and manual training.
4. Personal interviews.

There was some discrepancy in the results of the studies; in fact, the coefficient of correlation between success in engineering school and high school preparation ranged everywhere from 0 to ±0.84. The educators were in conformity in a general plea for greater cooperation between secondary schools and colleges.

The humanitarian philosophy of education, with the emphasis on a more general program, was studied by several in relation to the problem; and particularly the post war authors (World War II) stressed individual characteristics as a preferable measure over both aptitude test scores and secondary school records as a basis for admission to engineering college.

This study, employing the United States Department of Interior Bulletin No. 6 and a questionnaire form (See Appendix A) sent to the directors of public instruction of each of the forty-eight states, disclosed that over one third of the secondary schools in the United States do not offer over two units of mathematics in the curricula. The same was true with respect to chemistry and physics, and the truly unfortunate aspect of the situation involved statistics proving that less than 10 per cent of the high school students were enrolling in such

courses.

It was found that 88 per cent of the colleges require a student to have over two units of high school mathematics, 52 per cent require one unit of secondary school physics, and 17 per cent require a unit each of secondary school physics and chemistry, for admission. In addition, 22.5 per cent of the engineering schools refuse to admit students with "conditions" (less than three units of mathematics and usually one unit of physics), and 42.6 per cent require a student to pass an entrance examination in those subjects prior to admission. Also, 57 per cent require that conditions be made up before a student can receive full standing in the school of engineering. The facts concerning admission requirements when compared to the statistics covering high school curricula offerings and student enrollment directed attention to an anomaly between student preparation and engineering college requirements for admission.

Whereas 88 per cent of the colleges required over two units of secondary school education, only 7 per cent of the high school students were so prepared; and, but 54 per cent of the secondary schools of the United States offer facilities for such preparation. Although 62 per cent

of the nations engineering schools require one unit of high school physics for admission only 6.27 per cent of the students took the course, 63 per cent of the secondary schools, however, did offer the course. In the case of both physics and chemistry, only 17 per cent of the engineering colleges required a unit of each from secondary schools and 17 per cent of the high schools included both in the curricula. Data proving what percentage of the high school students take both courses were unavailable, however, on a basis of enrollment in physics and mathematics it would be safe to estimate that less than 5 per cent enroll in both of the physical science courses.

Considering that the primary purpose of the high school is not to train young people specifically for college entrance such facts and figures would not be significant, except that further investigation brought additional relevant information to light.

The questionnaire form sent to the deans of seventy-five engineering colleges revealed components related to the previous research in that it produced evidence to the effect that the previously discussed discrepancy between high school preparation and engineering school requirements was of considerable importance.

For one thing, of 329,146 college students distributed all over the nation in the fall of 1946, exactly 22 per cent were enrolled in an engineering course. What is even more significant involves the percentage which were admitted with "conditions" in mathematics and the physical sciences - 25.2 per cent as an overall nationwide average. In one institution 90 per cent of the students had been admitted with such "conditions". The engineering deans, again as an average, estimated that over 20 per cent of the failures in engineering school could be attributed to the lack of high school training in those same subjects, and, due to the large number of veterans taking up engineering, many applicants were being turned away because of their inability to pass stiffened entrance examinations. At Carnegie Institute of Technology, for example, as previously reported, of 7,000 applicants, only 200 were accepted for matriculation. Strict adherence to admission requirement received much emphasis as a result.

The concensus of opinion of the engineering educators, in relation to the problem, was that students admitted with conditions progressed under a slight handicap, and as a whole, received grades that were below the

average.

They felt that the problem was the responsibility of both the high school and college administrations, but their condemnation of the quality of secondary school instruction was almost unanimous as well as derisive.

The recommendations for obtaining a higher percentage of successful candidates for engineering schools are listed in order of their decreasing popularity.

1. Improved guidance in high schools
2. Increasing the mathematics requirements for a high school diploma.
3. A screening process, based on aptitude tests, prior to admission to an engineering school.

They agreed the problem was of immediate importance, and expressed the opinion that, in the future, admission requirements for engineering schools would become even more rigid and exacting.

B. CONCLUSIONS

The national economy, such as it is, indirectly dictates the educational policies of the nation to the extent that secondary schools function as an entity, and though many offer what is known as a college preparatory course, their primary responsibility is to educate the

average pupil to go out into society endowed with democratic principles and to become an economic and cultural asset to his, or her, community. Under such conditions it would be highly illogical to even attempt to advise that the high school curriculum be modified to correspond to the future on an occasional engineering student.

The conclusions based upon the study are as follows:

1. The fact that 88 per cent of the schools of engineering in the United States required over two units of secondary school mathematics for admission in comparison to the fact that only 7 per cent of the high school students take the advanced mathematics courses, coupled with a similar situation with regard to the physical sciences, was indicative of the existence of a serious discrepany between the general admission requirements in engineering schools and the enrollment in mathematics and natural sciences in high school. This is particularly noteworthy in the light of the fact that 22 per cent of college students at present are enrolling in engineering.

2. The fact that 25 per cent of those enrolled

in engineering schools are "conditioned" in mathematics and the physical science points to a lack of any effective counseling in the public schools. Considering the very small percentage of high school students that enter engineering, and with 7 per cent of the high school students taking advanced mathematics and 6 per cent taking physics, such percentages would amply furnish engineering schools with qualified applicants if cooperation existed between the two educational levels. Cooperation to assure that those individuals enrolled in such courses were the same individuals to later enter engineering college.

In this connection it was the opinion of many of the engineering educators that the public school administrators welcomed neither advice or suggestion from the colleges.

3. The reports indicating that only 64 per cent of the Nation's secondary schools offer sufficient mathematics to meet the demand of engineering show that many students never have an opportunity to prepare for an engineering education. All of which was further implication of the failure of the public schools in their obligation to the student that may desire an engineering

college education. Therefore the secondary school must inevitably face the issue that college preparation is becoming an ever increasing responsibility, and take the necessary steps to provide both guidance and facilities to prepare students for later specialized training.

4. Information received from 64 engineering schools approximated that over 20 per cent of the failures in engineering schools are due to a lack of high school preparation in the aforementioned subjects, that students with conditions both progress and receive grades that are below average, and yet admission requirements for engineering schools would progress in the future. Such a condition formulates the conclusion that engineering schools put their admission standards on a more inflexible and selective basis which will subsequently exclude the large percentage of unqualified applicants. Possibly seeming unjust, but obviously a step in the direction that would materially decrease the present percentage of failures.

C. RECOMMENDATIONS

The conclusions of this study open the way to a

number of remedial suggestions pertinent to the reduction of excessive failures among students in engineering college. It is conceded that part of the recommendations have been recognized as almost a necessity for some time by many educators, and consequently are gradually becoming a reality. Two of them, however, raise a controversial issue between engineering educators and professional public school administrators; the former supporting specialized training, and the latter generally adopting the broad fields philosophy. The facts brought forth by this study justify the following recommendations irregardless of whether or not they are in accordance with the views and opinions of all educators or laymen before whom they may appear.

1. The engineering colleges put their admission requirements on a standardized and strictly rigid basis, admitting only those applicants that have prepared themselves in secondary school to meet the requirements.

2. The high schools implement a more operative guidance program enabling students to better prepare themselves in the event they wish to attend college. The cumulative records of students being forwarded to the college to assist the college counseling organiza-

tion in it's responsibility to the student.

3. The high schools provide for courses and facilities allowing students to specialize for preparation toward a definite college course.

4. The engineering colleges organize a committee to make a study of the various aptitude and achievement tests, and select and adapt the best possible series of tests that the engineering colleges could use for selective entrance examinations.

5. The engineering school administrators might well pause, though amidst a period of rapid technical and scientific development, and begin to accept the fact that they are training humans for life in a modern democratic society, as well as professional engineers, and thus attempt to understand and cooperate with the humanistic philosophers and public school administrators.

D. SUGGESTED PROBLEMS FOR FUTURE RESEARCH

1. A study should be made to determine if the engineering schools are justified relative to their standards for admission, particularly with respect to mathematics and the physical sciences.

2. A study should be made to define an effective program for liason between secondary school guidance facilities and engineering school counseling services.

3. A study should be made of specialization in the secondary school curriculum in order to determine it's effect upon the general knowledge and ability of the average high school graduate.

BIBLIOGRAPHY

A BOOKS

1. Bingham, W. V., Aptitudes and Aptitude Testing. New York: Harper Brothers, 1937. 390 pp.

2. Jewett, B., The Dialogues of Plato. New York: The Republic National Library Company, 1921. 184 pp.

B PERIODICALS

1. Ayer, Fred E., "Physics, Mathematics, and Engineering." Journal of Engineering Education, April 1938. 28: 582 p.

2. Blaisdell, Allen H., "Comments on the Future of Engineering Education", Journal of Engineering Education, Nov. 1944 35, 205-211 pp.

3. Boardman, Charles W. & Finch, F. H., "Relation of Secondary School of Preparation to Success in the College of Engineering", Journal of Engineering Education, March 1934 25, 466-475 pp.

4. Bray, Oscar S., "Postwar Graduate Engineer Training," Journal of Engineering Education, Nov. 1946 36 211-214 pp.

5. Brush, Edward N., "Mechanical Ability as a Factor in Engineering Aptitude", Journal of Applied Psychology, June 1941 25 300-311 pp.

6. Crawford, A. B., and Burhan, P. S., "Entrance Examinations and College Achievements", School and Society, 1932 36 344-352 pp.

7. Crothers, H. M., "War Pressure on the Curricula", Journal of Engineering Education, Oct. 1944 35 p. 81

8. Dearborn, V. F., "The Relative Standing of Pupils in High School and the University", The University of Wisconsin Press, 1909.

9. Douglas, H. R. and Michaelson, J. H., "The Relation of High School Mathematics to College Marks and Other Factors to College Marks in Mathematics", School Review, 1936 44 615-619 pp.

10. Dvorak, A., and Sulyer, R. C., "Significance of the Entrance Requirements for the Engineering College at the University of Washington", April 1933, 23 618-623 pp.

11. Dywer, P. S., Horner, C., and Yokum, C. S., "A Statistical Summary of the Records of Students Entering the University of Michigan as Freshman in the decade of 1927-1936", University of Michigan Administrative Studies, Vol. 1, No. 4, 1940

12. Feder, D. D., and Adler, D. L., "Predicting the Scholastic Achievements of Engineering Students", Journal of Engineering Education, May 1939 29 383-387

13. Fitchenbaum, Max., "An Analysis of Freshman Engineers at the University of Texas During the Session of 1935-1936", Journal of Engineering Education, April 1938 28 533-540 pp.

14. Hammond, H. P. and Stoddard, G. P., "A Study of Placement Examinations", Journal of Engineering Education Sept. 1928 19 25-83 pp.

15. Higgins, J. J., "Study of Mathematics Ability in Relation to Success in Engineering School", Journal of Engineering Education, June 1923 23 743-746 pp.

16. Lindsay, F. B., "Problems in Secondary Education that Effect Engineering Colleges", Journal of Engineering Education, March 1941 31 479-486 pp.

17. Northby, A. S., "Prediction of Scholastic Success in the College of Engineering and Architecture", From M. E. Haggerty, Chairman on Education Research Studies in Articulation, 42-49 pp.

18. "Offerings and Registration in High School Subjects", Bulletin No. 6 from the United States Office of Education.

19. Patterson, D. G. and Thornburg, P. M., "High School Scholarship Standing of Freshman Engineering Students", Journal of Engineering Education, April 1927 17 807-811 pp.

20. "Preliminary Report of the Committee on Coordination of Preparation and Engineering Education", Journal of Engineering Education, Jan. 1930 20 473-484 pp.

21. "Report of the Committee for the Promotion of Engineering", Journal of Engineering Education, Dec. 1941.

22. "Report of the Committee of Admissions and Eliminations of Engineering Students", Journal of Engineering Education, Sept. 1925 16 47-73 pp.

23. "Report of E. C. P. D. on Student Selection and Guidance", The Electrical Engineer, Nov. 1936 55 182 -1825 pp.

24. Sachett, R. L., "Selecting Future Engineers in High School", Chairman: Committee on Student Selection and Guidance", Mining and Metallurgy, Aug. 1938 319-353 pp.

25. Sackett, R. L., "Selection of Engineering Students", Journal of Engineering Education, Mar. 1940 30 595-600 pp.

26. Sackett, R. L., "Report of Committee on Student Selection", Presented at the 49th Annual Meeting of the S.P.E.E. Journal of Engineering Education, 1941 32 224-256 pp.

27. Siemens, Cornelius H., "Forecasting the Academic Achievements of Engineering Students", Journal of Engineering Education, 1941 32 617-621 pp.

28. Stewart, L. G., "Advice to Young Men who Seek Careers in Engineering", Journal of Engineering Education, Sept. 1945

29. Thurstone, L. L., "A New Rotational Method of Factor Analysis", Psychological Bulletin, 1940 37 189-236 pp.

30. Timbie, W. H., "Selection and Admission of Applicants for Entrance to Engineering Colleges", Journal of Engineering Education, Feb. 1932 448-61, 482-84 pp.

31. United States Office of Education, "Report of the Committee on Student Selection and Guidance", School and Society, June 27, 1942 55 717 p.

32. Wickendon, W. E., "Investigation of Engineering Education", Journal of Engineering Education. Oct. 1924

33. Young, J. W., "The Adjustment Between Secondary School and College Work in Mathematics", Journal of Engineering Education, March 1932 22 586-595 pp.

C MANUSCRIPTS

1. Goodman, Charles H., "Ability Patterns of Engineers and Success in Engineering School" Doctorate Dissertation, Pennsylvania State University, 1941

2. Johnson, A. P., "The Relationship of Test Scores to Scholarship Achievement for the 244 Engineering Freshman Entering Purdue University in September 1939", Doctorate Dissertation, Purdue University 1940

3. Ullsvik, B. J., "A Factor Analysis and Prognosis of the Scholastic Success of Freshman Engineers During Their First Semester at the University of Wisconsin", Doctorate Dissertation, The University of Wisconsin, 1941.

APPENDIX A

Engineering Department
The University of Houston
Houston, Texas
November 25, 1946

State Superintendent of Schools

Dear Sir:

With the present influx of students into engineering schools, and with the liklihood of an increase in the future, this department is faced with a probelm that directly involves secondary school education.

We have a great many aspirants in the Schools of Engineering who are unqualified, on a basis of secondary school preparation in Mathematics and Physics, to Pursue a course in Engineering.

In this connection we are attempting to establish a criterion to test the justification of the present admission requirements of School of Engineering.

Part of the necessary information involves the answers which your office can supply on the enclosed questionnaire. Your cooperation in this matter will be appreciated and it is hoped that this inquiry will not be too great an inconvenience.

Thank you.

Yours Very truly

E. W. McMillin
Engineering Department

Approved by:

M. L. Ray, Director
School of Engineering

QUESTIONNAIRE

Date_____

STATE

Name

1. What is the total number of secondary schools in your state system (inclusive of public, private, accredited and non-accredited)? _____

2. What is the total enrollment at present in these schools? _____

3. What per cent of these schools do not offer more than two units of mathematics (1 unit geometry and 1 unit algebra)? _____

4. What per cent of the total enrollment is represented by these schools? _____%

5. What per cent of the total number of secondary schools do not offer both chemistry and physics?

In the event this information is not available in the files of your office, any suggestions as to its source will be welcomed.

Engineering Department
The University of Houston
Houston, Texas
November 29, 1946

Dear Sir:

With the pesent influx of students into the field of engineering, and with the likelihood of an increase in the future, this department is faced with a problem that requires serious consideration.

We have a great many aspirants in the University of Houston School of Engineering who are unqualified, on a basis of secondary school preparation in mathematics and physics, to pursue a course in engineering. The academic requirements of the Engineering Curriculum, therefore, are forcing many candidates to drop during the freshman year.

Presumably, your office is presented with a similar situation, and we wish to rely upon your integrity and help relative to this problem.

A copy of the enclosed questionnaire has been mailed to the deans of numerous engineering schools throughout the country in an effort to obtain an authoritative concensus regarding this existent anomaly between engineering school standards and the mathematical background of so many secondary school graduates.

The discretion and cooperation of your office will be greatly appreciated in this matter, and it is hoped this inquiry will not prove an inconvenience. In the event this survey yields a significant result, a copy of the conclusions will be forwarded to you.

Yours very truly

E. V. McMillin
Engineering Department

Approved by:
M. L. Ray, Director
School of Engineering

QUESTIONNAIRE

Date _____

Name

Institution

1. What is the total enrollment in your institution? _____

2. What is the enrollment in your School of Engineering? _____

3. What per cent of the enrollment in your School of Engineering has been admitted with less than three units of secondary school mathematics? _____%

4. What per cent (approximately) fail or drop out of your Engineering School as a result of inadequate high school mathematics preparation? _____%

5. Do the individuals admitted with math deficiencies generally progress: Check One

Normally	_____
Slightly Handicapped	_____
Greatly Retarded	_____

6. As a whole do these individuals maintain a Grade Point Average that is: Check One

Below Average	_____
Average	_____
Above Average	_____

7. Do you feel that, in the future, academic entrance requirements for Engineering Schools will: Check One

Increase	_____
Remain Same	_____
Decrease	_____

8. Which of the following suggestions would you advocate as the most beneficial in regard to this problem? (Indicate by numbers 1, 2, etc.)

___ (a) Improved guidance in high schools
___ (b) Increasing of the math requirement for a high school diploma.
___ (c) Lowering admission requirement for engineering schools.
___ (d) Establishment of a pre-engineering, post graduate high school program.
___ (e) Utilization of the 5 year College Engineering program modified to absorb the secondary school deficiencies.

___ (f) A screening process, based on aptitude tests, prior to admission to the school of Engineering.

9. Do you consider this problem a responsibility of: Check One

College	_____
Secondary Schools	_____
Both	_____

10. Does your department sectionalize classes on the basis of placement examinations?

Yes	_____
No	_____

11. Do you have any suggestions to offer with regard to obtaining a higher percentage of successful candidates in Engineering Schools without lowering the present academic standards and requirements for admission?

_____

_____

_____

_____