

A PROPOSED HANDBOOK FOR HIGH SCHOOL STUDENTS AND THEIR
ADVISORS DEALING WITH ENGINEERING EDUCATION
IN THE STATE OF KANSAS

by

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INTRODUCTION

The decision as to what one should do for his life's work is one of the most important which the high school student must make. While it is true that he need not rigidly adopt some vocational objective, he must make at least a tentative decision. This is particularly true for those who may be considering vocations which require education at the college level or beyond. Professional engineering requires this advanced education. Because of the expense and time involved in obtaining an engineering degree, it is desirable that the student make an early decision. In order to make this decision the student needs information concerning the work of an engineer and the training required.

The decision for the prospective engineer is perhaps even more difficult than that for a lower ability student. The difficulty is increased for the prospective engineer because he has many more vocational opportunities open to him due to his greater talent.

Statement of The Problem

The purpose of this report was to furnish a description of the engineering profession and a description of the educational opportunities for engineers in the state of Kansas. So that this information might reach the ones who

most need it--high school students, their teachers, parents, and other advisors--there is included in this report a proposed handbook of engineering for Kansas high school students and their advisors. The objective for the writing of this handbook was to furnish the students and their advisors with (1) a brief description of engineering, (2) a survey of the educational opportunities for engineers available in Kansas, and (3) a bibliography of books, pamphlets, and articles which are available in the libraries at the state universities or are dispatched from the various schools and colleges within the state. Comments are furnished on some of the better references.

Significance of The Problem

There are two primary ways in which one may view the significance of this problem: from the point of view of society or from the point of view of the individual.

Looking at the problem from the point of view of society, one might say that a society of free nations, and particularly the United States of America, needs to utilize her available manpower fully if she is not to be out-classed in the cold and technological war which she is now waging with the Communist countries of the world. References pointing to the extent to which we are failing as a nation to develop the quantity and quality of engineers

needed for a technological race are many. For example, the Bureau of Labor Statistics reports that over the decade up until 1970, we shall have an available supply of only 45,000 engineers a year with a need of about 72,000 per year.¹ More complete data concerning the supply and demand in this decade are furnished in the section concerned with the review of the literature.

Surely the educator, while concerned about the effects on society, is immediately more concerned that each individual develop to his fullest and that he find an occupation for which he is qualified and which is satisfying to him. The significance of this aspect should be evident without further comment.

Limitations and Procedure

The scope of this report was limited by its aim, which was to describe the engineering profession and the opportunities for engineering education in Kansas. According to the Guide to College Majors for the fall of 1966-67, Kansas State University, the University of Kansas, and Wichita State University are the only schools in the state of Kansas where one may obtain a bachelor's degree

¹H. V. Stambler, "Scientists and Engineers 1960-70; Supply and Demand," Monthly Labor Review, 86:1282, November, 1963.

in engineering.¹ Therefore, they were the primary educational institutions considered.

The bibliography presented within the handbook was limited to those books and pamphlets which are available in libraries in the state or may be obtained from the schools and colleges within Kansas.

The procedure for developing this report was that of a library research effort. This was supplemented by conferences with educators and engineers in the state of Kansas.

Definitions

There are many definitions of engineering which may be given. Williams and Farber give this definition which they say includes the great core of engineering:

"Engineering" is the scientific utilization of the forces and materials of nature in the design, construction, production, and operation of works for the benefit of man.²

They go on to point out that according to the origin of the word engineer, it may be said that an engineer is an ingenious designer or planner, and only in a recent and local sense does it signify one who operates an engine, for which vocation "engineman" is more

¹Guide to College Majors (Moravia, New York: Chronicle Guidance Publications, Inc., 1965), pp. 63-65.

²Clement C. Williams and Erick A. Farber, Building an Engineering Career (third edition; New York: McGraw-Hill Book Company, Inc., 1957), p. 16.

accurate and appropriate. This latter use of the word engineer is confined to the United States.¹

In one of its pamphlets, the National Society of Professional Engineers defines engineering as follows:

Engineering is the profession in which a knowledge of the mathematical and natural sciences gained by study, experience and practice is applied with judgement to develop ways to utilize, economically, the materials and forces of nature for the benefit of mankind.²

There are certain words which occur in most of the definitions of engineering. These are words such as "create," "harness" or "control," "mankind," "natural," and "science." This author would put these words together as follows to define engineering: "Engineering is the creative harnessing of natural resources through the use of science for the benefit of mankind."

¹Ibid., p. 18.

²Engineering, A Career of Opportunity (Washington, D. C.: National Society of Professional Engineers, [n.d.]), p. 5.

REVIEW OF THE LITERATURE

Need for Information Concerning Professional Engineering

In an article concerning Georgia Tech freshmen for the school year 1958-59, N. Z. Medalia considers the objectives and expectations these freshmen have for their college education. He compares the results of his study with work done by Dr. Lelia Sussman with Massachusetts Institute of Technology freshmen in 1957. Medalia says that:

When these freshmen were asked to narrow down their educational values to the one which they thought would be most important to them personally in their career at Georgia Tech or MIT, 78% at Georgia Tech said "getting a thorough preparation for my future occupation"; 9.3% "getting intellectual enjoyment from my work," and 6.7% "getting good grades." Freshmen at MIT were only slightly less vocationally oriented: for 69%, getting a thorough preparation for their future work was the one value most important to them in their college career, for 15%, intellectual enjoyment from their work, and for 11%, good grades.¹

It should be noted that these students who were so concerned with obtaining a thorough preparation for a future occupation were not so certain that they knew what that occupation should be. Medalia reports:

Considering the salience to these young men of specific vocational preparation as an educational

¹N. Z. Medalia, "Why Technological Education?", Higher Education in Engineering and Science, ed. Herman A. Estrin (New York: McGraw-Hill Book Company, Inc., 1963), p. 405.

value or objective, we are first of all struck by the fact that they have not made very firm decisions about the kind of career they wish to follow. They are much more certain that their college should prepare them for an occupation, than they are about the occupation for which they want to prepare.

Three lines of evidence would seem to support this contention. In the first place, we have the freshmen's answer to the direct question, "Have you made definite plans about the kind of career you want to have?". Only 22% checked the response "I have made definite plans." In contrast, another 22% said "I have not made definite plans," while the majority, 56% answered "I have made plans but they are not too definite." These responses were given by almost exactly the same proportion of MIT freshmen (23%, 19%, 58%).¹

Since it is related to the above, it is interesting to consider the concept of engineering held by these freshmen.

Concerning the conception which these freshmen have of engineering, the occupation 70% said they were planning to enter or leaning toward most heavily, we find that the three points on which freshmen agree most strongly are that it is prestigious, pays well compared to other professions; and in particular, offers good opportunity for future advancement.

Thus 82% of Georgia Tech freshmen said "yes," in answer to the question, "among the public generally would you say engineering is regarded as a profession?"; 13% were not sure, and only 9% said "no." Between 77 and 78 per cent thought that the prestige of engineering was higher in the U. S. than that of a life-science (Biology); a social science (Economics); or than the field of Business Administration. . . .²

This last paragraph refers to the status the engineer holds in the eyes of the engineering student. A psychologist in the Counseling Center at Kansas State University has

¹Ibid., p. 406.

²Ibid., p. 408.

suggested that prestige and financial reward strongly influence students to try engineering.¹ This suggestion seems to be in agreement with the statistics reported above.

While he was an undergraduate student in chemical engineering at the University of Kansas, this author found that many engineering students, particularly beginning engineering students, were in a situation similar to those reported at Georgia Tech. That is, they wanted good occupational training, they wished to have the status and position accompanying that of a professional man, but actually their plans were not too definite. They just chose engineering.

Need for Engineers

Even though status and financial reward are associated with engineering, there are still not enough engineers to fill the jobs available. Looking into the future, the Bureau of Labor Statistics reported two years ago that

A comparison of the projections of supply and demand indicates that fewer than 765,000 newly trained scientists and engineers will become available to fill more than 1 million openings for such personnel between 1960 and 1970. Thus unless concerted actions are taken to increase or more effectively utilize the supply of scientific and technical manpower in the middle and late 1960's, the Nation may face a continuation and intensification of the shortages which have

¹Darrell Jenkins, Psychologist, Counseling Center, Kansas State University, Interview on June 23, 1965.

marked most of the 1950's and early 1960's.

In engineering, the demand for new personnel over the 1960 decade is projected at more than 700,000--550,000 for increases in requirements, and 165,000 for replacement needs. The number of new entrants into engineering--including engineering graduates, other college graduates, and non-degree personnel--is projected at about 450,000 persons, 265,000 less than the projected demand.

The situation will probably be particularly severe during the mid-1960's, when the needs of the U. S. space program and a growing economy may require increasing numbers of engineers, when engineering graduations are expected to be at their lowest point in many years. By the end of the 1960 decade, if expenditures for the Nation's space program level off and if the number of engineering graduates should increase, the situation may be somewhat less critical. Over the decade as a whole, the demand for engineers is expected to average about 72,000 a year, compared with a projected available supply of about 45,000 a year.¹

Present Orientation Programs

Some of the engineering schools and some of the departments within the schools offer orientation courses. These courses may be of a lecture nature, or the student may be more actively involved. Some of the courses are designed for freshmen, others for upperclassmen. Since the number and nature of these courses vary from school to school, from department to department, and from year to year, it is difficult to generalize.

¹H. V. Stambler, "Scientists and Engineers 1960-70; Supply and Demand," Monthly Labor Review, 86:1282, November, 1963.

This author has worked with one of the more extensive orientation programs offered. He was privileged to serve as a teaching assistant to Dr. James O. Maloney, Department of Chemical Engineering, the University of Kansas, in a course which is now entitled "Introduction to the Profession." The objective of this course has been to orient the freshmen to chemical engineering. This has been done by showing them some of the equipment and facilities that engineers use and illustrating problems of an engineering nature with which they will later be dealing. Assistance with calculus and chemistry has also been provided.

Occupational Literature for Vocational Counseling

Need for the literature. There is a definite need and place in vocational guidance for literature describing occupations, for the counselor must rely mainly upon literature for information to guide his students. The student also needs descriptive material. As Baer and Roeber point out:

. . . Today, most of the mysteries of occupational life are hidden behind the walls of great factories, office buildings, and laboratories. Therefore, young people, including a growing number of career-aspiring girls, find it possible to observe at first hand only a few of the thousands of occupations that comprise the modern world of work. They must now

get most of their information from occupational literature.¹

These authors also point out that occupational information is an educational essential regardless of the condition of the labor market. In periods of wide-spread unemployment the need is easily recognized and there is a great demand for occupational literature, but the information can be of greater value during periods of full employment. During this period the newcomer on the labor scene will have little difficulty finding a beginning job. Therefore, he needs the information necessary to properly discriminate between his opportunities.²

The need for information such as occupational literature and its place in vocational guidance is not new, for in 1909 Parsons wrote:

In the wise choice of a vocation there are three broad factors: (1) a clear understanding of yourself, your aptitudes, abilities, interests, ambitions, resources, limitations, and their causes; (2) a knowledge of the requirements and conditions of success, advantages and disadvantages, compensation, opportunities, and prospects in different lines of work; (3) true reasoning on the relations of these two groups of facts.

Every young person needs help on all three of these

¹Max F. Baer and Edward C. Roeber, Occupational Information (second edition; Chicago: Science Research Associates, Inc., 1951), pp. 64-65.

²Ibid., p. 2.

points. He needs all the information and assistance he can get. . . .¹

Hutson points out that counseling concerned with higher education involves two problems: the choice of whether or not to go to college and the choice of a specific college.² Certainly before one can solve these problems he needs to know something about the education required for the vocations in which he is interested and the places where he may obtain this education.

Content of the literature. There are many questions which need to be answered if a person is to make a wise vocational decision. Lovejoy suggests that the student ask these questions before he selects a vocation:

1. What is the nature of the vocation?
2. What is the education necessary for that vocation?
3. What other qualifications are necessary?
4. What earnings can one expect?
5. How does one "break into the field"?
6. What is the future of that vocation?

¹Frank Parsons, Choosing A Vocation (Boston: Houghton Mifflin Company, 1909), p. 5.

²Percival W. Hutson, The Guidance Function in Education (New York: Appleton-Century-Crofts, Inc., 1958), p. 562.

7. What is it that you like that is required for this work?

8. How do your abilities compare with those demanded by the vocation?

9. What training is available to prepare you for the career?¹

The lists and questions which other writers suggest as check lists of topics to be considered when discussing an occupation with a client² or questions to be used in appraising occupational literature³ are very similar to those of Lovejoy's given above.

The proposed handbook, divided according to the method described below, was written to answer most of the questions listed by Lovejoy. Particular emphasis was given to the educational opportunities in Kansas. Of course, those questions concerned with self-evaluation can be answered only by the individual. However, the counselor

¹Clarence E. Lovejoy, Lovejoy's Vocational School Guide (New York: Simon and Schuster, 1955), p. 6.

²Robert Hoppock, "Check List of Facts About Jobs for Use in Vocational Guidance," The American Psychologist, 3:417-18, September, 1948.

³Max F. Baer and Edward C. Roeber, Occupational Information (second edition; Chicago: Science Research Associates, Inc., 1951), pp. 52-54; and Robert Hoppock, Occupational Information; Where to Get It and How to Use It in Counseling and Teaching (New York: McGraw-Hill Book Company, Inc., 1957), pp. 36-40.

can greatly assist him in answering those questions concerned with individual appraisal.

Form of The Handbook

The structure and format for the handbook included in this report was decided upon after observing the primary divisions which repeatedly occurred in pamphlets and, to a lesser extent, books dealing with engineering. Examples of such pamphlets include:

1. Engineering, A Career of Opportunity is subdivided into the following major divisions: Challenge of Tomorrow, What Is Engineering?, Preparing For A Career in Engineering, Women in Engineering, Junior Engineering Technical Society, Technicians, and Additional Reading.¹

2. Jobs In Engineering is divided into the following chapters: Looking Ahead to Your Career, Some Careers in Engineering, What Does It Take?, How to Qualify, Getting Started, and And What of The Future? In discussing careers in engineering, the authors considered the various areas of engineering such as aeronautical, civil, and chemical. For each area the authors discussed what engineers do, where they work, and the employment outlook for that area.²

¹Engineering, A Career of Opportunity (Washington, D. C.: National Society of Professional Engineers, [n.d.]).

²S. Dolores Branche (ed.), Jobs In Engineering (Chicago: Science Research Associates, Inc., 1959).

3. The Kansas State University pamphlet, Engineering, It's Your Decision, includes the areas of What Is An Engineer?, What Does An Engineer Do?, Engineering at Kansas State University, and Aptitudes and Preparation. This is followed by a discussion of the various departments of engineering at Kansas State University, a section on engineering opportunities for outstanding students, and a conclusion which reasserts that the student must make the decision.¹

Using these pamphlets as a guideline, the author selected the various areas for his handbook which he felt were needed to accomplish the purpose of describing engineering and the educational opportunities for engineers in the state of Kansas.

¹Engineering: It's Your Decision (Manhattan, Kansas: Kansas State University, [n.d.]).

RECOMMENDATIONS

This author recommends that teachers and counselors study this handbook and the primary references so that they may use it for the benefit of their students. Clearly, this handbook is of no value unless it is used. Students should be encouraged to use the handbook and the references provided therein. Use by parents and others who may be counseling prospective engineers is also recommended.

THE EDUCATION AND JOB OF AN ENGINEER;
A HANDBOOK FOR KANSAS HIGH SCHOOL STUDENTS
AND THEIR ADVISORS

GARY WALDO ROSENWALD

1966

HANDBOOK

Introduction and Objectives

The decision that you make concerning what you will do for your life's work is one of the most important that you must make. It is true that while you are still in high school you need not rigidly adopt some vocational objective, but you should make at least a tentative decision. This is particularly true if you are considering a vocation which requires education at the college level or beyond. Professional engineering requires this advanced education. Because of the expense and time involved in obtaining an engineering degree, it is best that you make an early decision. In order to make this decision you need information concerning the work of an engineer and the training required.

The objective of this handbook is to help you to decide whether or not you wish to become an engineer. It contains a definition of engineering, a description of the work of an engineer, a summary of engineering education in Kansas, a discussion of how to make your decision, and a bibliography. The bibliography is subdivided into an annotated primary bibliography, which includes a few of the better sources to which you might wish to refer, and a more complete secondary bibliography.

Definitions

There are many definitions of engineering. Williams and Farber give this definition which they say includes the great core of engineering:

"Engineering" is the scientific utilization of the forces and materials of nature in the design, construction, production, and operation of works for the benefit of man.¹

They go on to point out that according to the origin of the word engineering, it may be said that an engineer is an

ingenious designer or planner and only in a recent and local sense does it signify one who operates an engine, for which vocation "engineman" is more accurate and appropriate. This latter use of the word engineer is confined to the United States.²

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There are certain words which occur in most of the definitions of engineering. These are words such as

¹Clement C. Williams and Erick A. Farber, Building An Engineering Career (third edition; New York: McGraw-Hill Book Company, Inc., 1957), p. 16.

²Ibid., p. 18.

³Engineering, A Career of Opportunity (Washington, D. C.: National Society of Professional Engineers, [n.d.]), p. 5.

"create," "harness" or "control," "mankind," "natural," and "science." These words could be put together to define engineering as the creative harnessing of natural resources through the use of science for the benefit of mankind.

The Work of An Engineer

The work done by one who is called an engineer may be in almost any area. The creation, the industrialization, the production, and the use of almost all commercial products in the United States, as well as many services and much of the so-called scientific exploration, is done by engineers. Engineers work with minute electrical components of medical instruments, modern rocketry, food production, the refinement of petroleum, and problems in many other areas. Because of the diversity of the work an engineer does, it is common to subdivide the general topic of engineering by subject matter (area) and by work done (function).

Areas of engineering. The division by subject matter is the division generally used in colleges. In this system, professional engineering is divided into the areas of aeronautical (and aerospace), civil, chemical, electrical, industrial, mechanical, and nuclear engineering. Although these are some of the more common divisions used, a school may not have all of these divisions or it may have others.

It is intended that you use this handbook in conjunction with the college catalogs for Kansas State University, the University of Kansas, and/or Wichita State University. You will find that the catalogs for Kansas State University and the University of Kansas include in their engineering sections a brief description of each of the areas of engineering in which they offer majors. At this time, Wichita State University lists only a description of individual courses and the program of study required for each of the various majors. The book by Morton Sherman which is listed in the annotated bibliography gives a more complete description of the various areas of engineering. If your library does not have a copy of this book, you will find a copy in the Kansas State University library.

Functions of engineering. One of the several ways in which one may divide the functions of the engineer is the following: research and development, design, manufacturing or production, consulting, administration or management, and teaching.

Engineering research and development is concerned with the discovery and development of the principles and new apparatus to be used in production. Research furnishes much of the scientific information needed to design or improve engineering products.

Design is the core of engineering. The area of design starts with the formulation and analysis of a problem, carries through the solution of a problem, and terminates when the problem is solved. Since many engineering problems are concerned with producing a commodity, the designer's job terminates with the successful establishment of a productive method.

For many commodities, the area of production engineering involves keeping the plant running. This includes the scheduling, maintenance, and adjustment of the plant equipment. Minor refinements in the product or the plant would also be included in the job of a production engineer.

These first three functions overlap. In places where there are only a few engineers employed, one may be involved in all three functions, but in the larger industrial concerns he very often specializes in only one phase of a company's total engineering effort. For example, he may be concerned with low temperature research involving hydrocarbons or the solving of distillation problems through the use of a computer.

The last three functions of engineering are not of immediate concern to the beginning engineer. A consulting engineer is employed by clients who need his advice on particular engineering problems. To become an engineering

consultant, one needs many years of experience and an established reputation.

To become an engineering teacher, one must usually first obtain advanced degrees. Industrial experience is usually preferred if not required. Engineering teachers are also often engaged in research or in consultant activities.

Many engineers obtain supervisory or management positions as they advance in a company. Management is the ultimate goal of many engineering students who prepare for it by taking elective courses in business or obtaining a degree in business in addition to their engineering work.

Engineering Education in The State of Kansas

Kansas State University, the University of Kansas, and Wichita State University are the only schools in the state of Kansas where one may obtain a bachelor's degree in engineering. There are institutions in the state where two-year courses in engineering technology are available, but this is beyond the scope of this handbook. All of the universities in Kansas which offer bachelor's degrees in engineering offer master's degrees in some areas. Kansas State University and the University of Kansas offer the doctorate in a few of the areas of engineering. This is, however, most likely beyond your present concern as a high school student.

By looking at a college catalog you can see that most of the course of study is prescribed or very restricted, being centered around science, math, and engineering. For details about the requirements for a degree in engineering, you should refer to the college bulletin or catalog for the school or schools in which you are interested. (As we have already pointed out, this handbook should be used in conjunction with the engineering college catalogs.) However, we may briefly state the general requirements which will be found at all three universities regardless of the area (civil, electrical, etc.) in which you are seeking a degree.

Most of the curricula are set up on a four-year, eight semester basis with very few unrestricted electives available for the student. Although the programs are set up to be four-year programs, they are commonly spread out over more time by the inclusion of summer school or an extra semester or two. All of the curricula require at least 136 semester hours, with some majors requiring more than 145 hours. This means that if you expect to complete the prescribed program within four years, you must take a load which is approximately 15 per cent heavier than that required to obtain a degree in the college of liberal arts and sciences from the same university.

The course work can be divided into the areas of physical science, mathematics, general engineering,

engineering major, humanities and social sciences, and communication skills. Depending somewhat upon your major and the school selected, you will be required to take eight to eleven hours in the area of language communications which includes English and speech. For most of the majors you will be required to take fifteen to twenty-one hours of mathematics starting with calculus and continuing at least through differential equations. You will need to take five to ten hours each of basic chemistry and physics and perhaps more, depending upon your major. You will have to take between 45 and 75 semester hours of engineering courses. Many of the courses will be in the engineering department in which you are majoring, the rest will be taken in other engineering departments in order that you may become more rounded in the various aspects of engineering. You do have some free electives and some restricted electives. The restricted electives may be required to be technical but some must be in the areas of the humanities and social sciences. Usually a total of twelve to twenty-four hours are taken in these last two areas.

Kansas State University has a formalized cooperative program. In this work-study program you alternate between work assignments and study. If you enter this program, you would obtain industrial experience along with your course work. It takes a longer period of time to earn

the engineering degree in this program, but it may help you to finance your education.

Thus far we have pointed out the general program of studies which you would follow in the engineering school at Kansas State University, the University of Kansas, or Wichita State University if you were to begin your education as a freshman at one of these schools. There are other ways in which you may obtain this degree. You may attend a junior college for two years and then transfer to one of these schools which offer an engineering degree, or you may attend a four-year college for two or three years and then transfer to one of these engineering schools.

There are several four-year colleges and universities in the state which list in their catalogs a 3-2 plan for pre-engineering students.¹ These plans are an informal agreement between the schools whereby the student attends the college for three years and then the university with the engineering school for two years. At the completion of the five years (which is the normal length of time for this program) the student will have earned a bachelor's

¹Some of these colleges and universities which have 3-2 programs with Kansas State University at this time are: Baker University, Bethel College, Bethany College, College of Emporia, Kansas Wesleyan University, McPherson College, Ottawa University, Sterling College, and Washburn University.

degree from the college and a bachelor of science degree in engineering from the university.

There are both advantages and disadvantages to these programs; you must weigh them for yourself. For some of you, attending a smaller college or junior college first may be quite helpful. This is particularly true if you have attended a small high school, for the jump from a high school with 100 or so students to a university with thousands of students may involve problems of adjustment. However, because of problems with such things as transferring credits, you might be required to spend an extra semester or two in school in order to receive the engineering degree.

At some of these smaller colleges and universities there are better opportunities for part-time employment, and the intensity of the school load may even be geared to the working student. An additional advantage in the smaller college is that it may be in your hometown or one which is close. This will allow you to go home more often if need be or to live at home. If you are able to live at home, it will undoubtedly be less expensive to attend college.

The chief disadvantage of the 3-2 programs or in attending a junior college the first couple of years is the time factor: This usually requires you to spend one

or two extra semesters in school. This may or may not be more expensive than spending the normal length of time at one of the engineering schools, depending upon your circumstances. That is, if you were to live at home the first three years, it may be cheaper to go to school five years than four.

You must decide whether the extra time is worth more to you in broadening yourself more at the undergraduate level than it is if it were used in graduate training in your area or out on the job.

The variety of activities and learning experiences available to you is greater at the larger universities. This should be considered a point in favor of spending all of your undergraduate years at the larger university.

Making The Decision

The decision will not be easy for all of you. It is hoped that this handbook and the references listed in the bibliography will help you to better understand what engineering is and to see more clearly some of the alternatives available to you if you wish to become a professional engineer. We may state a few rules for making the decision which may be of some help:

1. Keep an open mind.
2. Try first to determine the criteria you should use to make your decision.

3. Gather as much information about engineering as possible. Use many sources. Critically evaluate your own abilities and interests.

4. Through discussion with advisors, use the criteria and information to reach a conclusion.

There are many personal characteristics and aptitudes which are related to engineering ability. Williams and Farber suggest that a person's character, his understanding of man, his judgement, industry, initiative, curiosity, and health are all qualities which promote professional success. Discussing the topic of who should enter the engineering profession, these authors point out that it depends on the individual's taste and his ability.¹ These authors and many others state that success and taste for mathematics, physics, and chemistry are perhaps the best criteria upon which to make the judgement. Of these they say "mathematics is the most reliable single index of engineering ability."²

While ability and interest in math and science is essential for engineering, engineering is not the same as science. As Edward V. Krick points out, science is a body of knowledge and scientists engaged in a process of research

¹Williams and Farber, *op. cit.*, pp. 9 *et seqq.*

²*Ibid.*, p. 14.

to increase this knowledge.¹ On the other hand, he says that the engineer creates and that his primary work is the creative process referred to as design. In Krick's own words:

An engineer is a problem solver. Ordinarily starting with a broadly expressed function-to-be-fulfilled, the engineer must translate this general statement of what is wanted into the specifications for a device (or structure or process) which will economically fulfill that objective. To arrive at this solution the engineer must apply his knowledge and his inventiveness to uncover a reasonable proportion of the many alternative solutions to the typical problem. He must evaluate these alternative solutions in the face of numerous intangible and conflicting criteria. The limited time available for proposing a solution precludes an exhaustive exploration of all possible solutions. In lieu of complete information the engineer makes extensive use of judgment. The engineering problem that is not complicated by economic considerations is rare indeed. A private enterprise ordinarily accepts an engineer's solution to a problem only if it shows commercial promise and a public enterprise insists on an attractive benefit-to-cost ratio.²

If you feel that you are interested in engineering but you are not certain, you could postpone your decision and start your college education majoring in science or mathematics in the college of liberal arts and sciences at one of the universities in the state. Then, if you decide to become an engineer you could transfer to the school of engineering. However, there seems to be a

¹Edward V. Krick, An Introduction to Engineering and Engineering Design (New York: John Wiley and Sons, Inc., 1965), pp. 36 et seq.

²Ibid., p. 30.

reluctance on the part of the student to transfer into engineering if he does not start his college education there. One reason for this may be the loss of time and credit which is often involved when such a transfer is made. Unless you have some reason in particular for doing otherwise, you might first enroll in engineering, transferring out if you find you do not like it. This is commonly done. An advantage in doing this is that you do get started on your engineering subjects. Even if you should later decide not to become a practicing engineer, the engineering education may be valuable to you in such areas as technical sales or administration. The engineering education could also be put to good use if you were to become a scientist.

Thus, an engineering education is valuable background for many types of careers, technical and nontechnical. This is understandable. A sharp and well-disciplined mind is a major asset to a person in almost any field of endeavor. And, too, ours is a technological culture. A person can no longer be considered broadly educated and intellectually prepared for contemporary civilization if his education does not extend into technology.¹

We might say that there are many attractive features about engineering and there are many challenging problems facing the engineers of tomorrow. The decision is yours. If you have the interest and ability in science and math and if you like to create solutions to problems--problems

¹Ibid., p. 181.

in communications, in medicine, in transportation, in power sources--if you are interested in these problems, you should try engineering.

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Branche, S. Dolores (ed.). Jobs In Engineering. Chicago: Science Research Associates, Inc., 1959.

This is a brief but good explanation of engineering work which considers the various areas of engineering. This pamphlet includes eleven questions of a general nature which should help the student to self-evaluate his ability by pointing out to him the areas in which he will need ability if he is to become an engineer. A description of the engineering technician is also included.

Chronicle Occupational Briefs. Moravia, New York: Chronicle Guidance Publications, Inc., 1964.

This is a series of short descriptions of the various engineering occupations. All of the briefs discuss such things as the type of work, the working requirements, the training requirements, and the opportunities in the area. Sources for further information are given.

Engineering: It's Your Decision. Manhattan, Kansas: Kansas State University, [n.d.] .

This pamphlet does a good job of describing the engineering opportunities available at Kansas State University. It discusses what an engineer is, what he does, and what the various branches of engineering are.

Glennan, T. Keith. Should You Be An Engineer? New York: New York Life Insurance Company, 1960.

This is one of a series of pamphlets. Though not very comprehensive, these pamphlets provide a brief description of engineering work and the training required for the profession.

Krick, Edward V. An Introduction to Engineering and Engineering Design. New York: John Wiley and Sons, Inc., 1965.

This is among the best of the books written to provide an introductory description of engineering; the basic engineering skills of representation, optimization and design are discussed. The author uses examples of current engineering problems to illustrate that the creative solution of problems is the core of engineering.

Sherman, Morton. Professional Careers in Science and Technology. New York: The Scarecrow Press, Inc., 1963.

This book should be helpful to anyone who wants to read a good brief discussion of an area of science, engineering, or technology. The book discusses 52 different career areas.

Smith, Ralph J. Engineering As A Career. Second edition. New York: McGraw-Hill Book Company, Inc., 1962.

This book was written to help the beginning engineering student. Of particular interest to the student trying to decide if he wishes to become an engineer is the part discussing the engineering profession, its history, branches, and function. A chapter on who should study engineering is pertinent. A discussion of the role of engineers versus technicians and scientists is also included.

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A PROPOSED HANDBOOK FOR HIGH SCHOOL STUDENTS AND THEIR
ADVISORS DEALING WITH ENGINEERING EDUCATION
IN THE STATE OF KANSAS

by

GARY WALDO ROSENWALD

B. S., University of Kansas, 1964

AN ABSTRACT OF A MASTER'S REPORT

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

College of Education

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1966

ABSTRACT

The decision as to what one should do for his life's work is one of the most important which the high school student must make. Because of the expense and time involved in obtaining the advanced education required for a degree in professional engineering, it is desirable that a student make an early decision if he is to choose this vocation. In order to make this decision, the student needs information concerning the work of an engineer and the training required. The purpose of this report was to help furnish that needed information.

A handbook describing the job of an engineer and the opportunities for engineering education available in the state of Kansas has been compiled. This handbook was developed through a method of library research using the books, pamphlets, and articles available within the state of Kansas. This was supplemented by conversations with engineers and educators.

The handbook includes a section on the work of the engineer. The section is divided by area and function. The emphasis of the handbook is upon the educational opportunities available within the state of Kansas for the prospective engineer. The course of study required for an engineering degree from Kansas State University, the University of Kansas, or Wichita State University is

described in general terms. Other educational possibilities whereby the student would begin in one school and would finish at an engineering school are also described. The possibilities considered are junior college or small college attendance prior to transferring to an engineering school. A discussion of how the student might effectively make the decision as to whether or not he wishes to become an engineer is included. A two part bibliography is furnished: a short annotated bibliography followed by a more complete secondary one.

It was recommended that vocational counselors use the handbook and the primary references to expand their understanding of engineering and that they refer their students to these sources. It is hoped that with greater understanding of the engineering profession, the student might more easily and more correctly make the decision as to whether or not he wishes to become an engineer.