PROFESSIONS REQUIRING A KNOWLEDGE OF MATHEMATICS

A Project

Presented to

the Faculty of the School of Education

University of Southern California

In Partial Fulfillment

of the Requirements for the Degree

Master of Science in Education

by

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January 1955

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This project report, written under the direction of the candidate's adviser and approved by him, has been presented to and accepted by the faculty of the School of Education in partial fulfillment of the requirements for the degree of Master of Science in Education.

Date January 12, 1955

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INTRODUCTION

CHAPTER I

THE PROBLEM AND METHOD OF PROCEDURE

During the past few years there has been a great increase in professional opportunities for those with a background of mathematical training. Rapid scientific advancement has brought about this increased demand for trained technological workers. The shortage of scientific personnel will soon result in limiting further advancement unless there is concentrated effort to combat this shortage. A potential source of such trained people is in the high school. The teacher of mathematics can be of great help by presenting information regarding vocational and professional opportunities to these students.

I. THE PROBLEM

Statement of the problem. The purpose of this study was to provide information concerning professions which require a knowledge of mathematics; this information was to be compiled and organized in a form helpful to high school mathematics students and teachers.

Importance of the study. It is impossible to discuss the importance of the problem without first considering the general objectives of education and the importance of

mathematics in our educational program. Objectives of education have been stated in many ways by many committees and individuals. These objectives are usually expressed in terms of specific achievement, in terms of desired social goals, or in terms of individual behavior traits.[1] Consequently, lists of objectives vary to a great extent; yet all are concerned with the importance of the individual both as an individual and as a member of society. A person's capabilities should be developed to the utmost for his own satisfaction and success. In addition, each person should be educated to become a useful member of society if our society is to progress.

The importance of mathematics in an educational program that is concerned with the individual in relation to society was aptly expressed by Rudolph E. Langer, Professor of Mathematics at the University of Wisconsin.

> And in our time and place mathematical instruction is of peculiar significance. We are the children of so-called "Western" culture. Flourishing in modern times, this is the culture of the peoples of America and the lands of Western Europe. This culture differs from that of other present-day peoples, such as those of the Orient, and from the cultures of past

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[1] J. Paul Leonard, Developing the Secondary School Curriculum (New York: Rinehart and Company, Inc., 1946), p. 121.

> peoples, such as those of Greek or Egyptian antiquity. Its characteristic features have in large measure been effective in making us as we are. Wherein, then, do we differ from the peoples of other cultures? The answer to this question is a pointed one. . . . The Western culture is industrial, technological, and scientific; in short, it is far and away the most mathematical. In our culture we calculate and think in dynamic terms. We have found ourselves gifted with excelling mathematical versatility and inventiveness. We have found in ourselves the genius to master the control of things in flux and to invade the realms of the infinite.[2]

Therefore, it is difficult, if not impossible, to deny the importance of mathematics as part of our educational system.

It follows that the schools are obligated to see that each individual has the opportunity to reach his maximum potential, and that those with mathematical ability know the current professional opportunities available if further training is pursued. However, education is not completely successful in this. As Hobbs pointed out:

> We are not yet making use of all of our human resources, as evidenced by the fact that twenty per cent of the people who never finish college are as intelligent as those who complete college with

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[2] Rudolph E. Langer, "Why We Teach Mathematics," The Bulletin of the National Association of Secondary-School Principals, 38:9, May, 1954.

creditable records. A major problem of our society is how to ensure the fullest development of the human talent that comes with each new generation.3

In summary, education is concerned with the individual in relation to society, and mathematics is an important part of our educational system. Education should seek to develop the individual's capabilities; at the present too many individuals are not using their ability to the fullest possible extent. In view of these facts, this study becomes important. The information compiled should contribute toward encouraging those students with mathematical ability to continue their education and use their ability to the maximum.

Objectives of the study. The objectives in using the information compiled in this study as part of mathematics classroom work are expressed in terms of anticipated outcomes. The objectives concerning society are: (1) an increase in the supply of trained technological workers, (2) an appreciation of the part mathematics plays in the functioning of our society, (3) an increased awareness of problems of society in a scientific age. The objectives

3 Nicholas Hobbs, "Some Notes on Science and Guidance," Education, 73:435, March, 1953.

concerning the individual are: (1) a knowledge of the type of work in specific fields and the opportunities in each, (2) a knowledge of personal qualifications and educational requirements necessary for scientific professions, (3) a knowledge of where and how to find additional information, (4) an appreciation of the importance of mathematics taken in high school, and (5) an appreciation of the value of good work habits in high school.

II. METHOD OF PROCEDURE

Acquisition of information. Literature regarding the type of work, personal qualifications, and educational requirements of various professions requiring advanced mathematical knowledge was reviewed. The facilities of the library of the University of Southern California, the Los Angeles Public Library, and high school libraries of the Los Angeles City School System were used for this purpose. In addition, pamphlets published by private industries were obtained.

Most of the information presented was summarized from a series of career monographs[4] published by the

[4] Careers (Chicago: The Institute for Research).

Institute for Research in Chicago. A general statement of the type of work and personal and educational requirements was made concerning each field. No attempt was made to include specific college requirements; a statement of the length of the course and the minimum amount of mathematics required was considered sufficient for the purposes of this study.

A bibliography was selected from the literature; a list of references for obtaining further information was included in the discussion of each field.

Limitations. The professional fields considered were those for the mathematically able student; only those fields requiring at least two years of college mathematics training were included. No attempt was made to study the problem of identifying the mathematically able or the problem of enriching subject matter as a means of creating interest in mathematics. Both of these are important problems in themselves, but were outside the scope of this particular study.

Certain assumptions were made concerning facilities in a school; these facilities may or may not exist in any one high school. It was assumed that the school had a counseling service, and that at least some of the standard

tests as to ability, aptitude, and interest were given by the counselor. It was assumed that such information was available to the classroom teacher and the student.

Organization of the remainder of the study. The literature in the field of vocational and professional opportunities in mathematics is reviewed in Chapter II. The literature reviewed is that concerned with opportunities that have arisen due to the scientific personnel shortage. This is divided into three areas: (1) literature on the shortage of scientific personnel, (2) literature on the recruitment of scientific personnel by industry, and (3) literature on vocational guidance in the classroom with respect to scientific personnel.

Part II of the study is the compilation of information on professions requiring mathematical knowledge. Chapter III describes the need for people trained in mathematics, personal and educational qualifications, opportunities in government work and in the armed services, opportunities for women, and sources of information. The succeeding chapters present information concerning careers in engineering, careers in science, careers in miscellaneous fields, and careers in teaching. Chapter VIII presents an annotated list of books and pamphlets to assist students in obtaining further information.

CHAPTER II

REVIEW OF THE LITERATURE

The literature in the field of vocational and professional opportunities in mathematics consists primarily of two types: (1) articles about opportunities that have arisen due to the scientific personnel shortage, and (2) occupational information for student and teacher use. The latter was not included in this review of the literature, but was considered in Part II in the section on suggested references for further reading. The literature of the first type was grouped under three headings: (1) literature on the shortage of scientific personnel, (2) literature on the recruitment of scientific personnel by industry, and (3) literature on vocational guidance in the classroom with respect to scientific personnel.

I. LITERATURE ON THE SHORTAGE OF SCIENTIFIC PERSONNEL

The literature concerning the shortage of scientific personnel was not confined to educational publications; The American Magazine published an extensive article in 1953 concerning the seriousness of the shortage. Some of the opportunities were indicated as well as a discussion

of industry's recruitment program.[1]

Articles in educational publications by Rogers[2] and Astin[3] discussed the shortage in more detail. In 1953 the estimated shortage of engineers was between 80,000 and 100,000. Statistics have shown that an estimated 30,000 new engineers will be needed each year to meet regular expansion. Yet studies of enrollment trends in college have indicated less than 20,000 engineering graduates per year. No immediate hope of reducing this shortage was foreseen. The Office of Defense Mobilization recognized the problem and made three recommendations: (1) a government plan for better utilization of specialists within the field, (2) a plan sponsored by industry offering in-service training for personnel to handle the less highly specialized work, and (3) increased attention to the education of engineers and scientists by employers, governmental agencies, and schools.[4]

Among proposed solutions to the problem listed by Rogers were increased salaries, increased use of women,

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[1] Vance Packard, "Youngsters Wanted for Jobs Unlimited," The American Magazine, 155:27-28, June, 1953.

[2] T. H. Rogers, "Supply and Demand of Technical Personnel in American Industry," School Science and Mathematics, 53:87-96, February, 1953.

[3] A. V. Astin, "Some Facts on the Current Shortage of Technical Personnel," Education, 73:405-408, March, 1953.

[4] Ibid., pp. 405-406.

minimized non-technical military service assignments for technically trained men, and an increased scholarship program.[5] The importance of guidance by the high school teacher was also indicated by the statement, "The persons who are in the most strategic position to stimulate and advise high-school students who have technical aptitudes are the teachers of mathematics and science."[6]

Brune[7] approached the problem through a discussion of opportunities in various fields, e.g., accounting, actuarial work, industry, statistics, research, government, national defense, and teaching. Although not detailed, the discussion of each field gave essential information regarding the type of work, general requirements, and the demand.

II. LITERATURE ON THE RECRUITMENT OF SCIENTIFIC PERSONNEL BY INDUSTRY

Many private industries have been attempting to foster interest in technical work. In fact, much of the

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[5] Rogers, op. cit., p. 92.

[6] Ibid., p. 94.

[7] Irvin H. Brune, "Vocational Opportunities in Mathematics," The Bulletin of the National Association of Secondary School Principals, 38:20-31, May, 1954.

literature published was written by men in industry. D. C. Lee[8] of Westinghouse Corporation discussed the need for guidance toward the electronics field. He made special reference to the Westinghouse National Science Talent Search which offers scholarships to high school students. Westinghouse also sponsors various university programs for its engineers by refunding half tuition on satisfactory completion of each class and refunding the rest upon completion of an entire course.

Questions concerning present and future demands for engineers, as well as rewards and educational requirements of engineers were answered by R. L. McWilliams[9] of General Motors Corporation. In addition to monetary rewards the highly technical worker is rewarded by a feeling of usefulness and satisfaction in that he is a creator and therefore contributes to social progress.

Neil B. Reynolds[10] of the General Electric Company

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[8] D. C. Lee, "Guidance Toward Electronics Research and Development," Education, 73:451-453, March, 1953.

[9] R. L. McWilliams, "Guidance Toward Engineering," Education, 73:409-13, March, 1953.

[10] Neil B. Reynolds, "Mathematics and the Needs of Industry," The Bulletin of the National Association of Secondary School Principals, 38:31-35, May, 1954.

discussed the needs of industry in relation to mathematics with specific reference to the General Electric program. Two pamphlets, Why Study Math and Math At General Electric have been published and offered free to high school teachers for classroom use. The response to these two booklets was tremendous; reports from teachers indicated they were very successful in stimulating interest.

III. LITERATURE ON VOCATIONAL GUIDANCE IN THE CLASSROOM WITH RESPECT TO SCIENTIFIC PERSONNEL

An article written by Kitson[11] in 1927 was one of the first to mention vocational guidance in the mathematics classroom. However, the concern here was more with the approach to subject matter from a vocational standpoint. In 1943 an article by Welch[12] appeared entitled, "What Can the Teacher of Mathematics Do About Vocational Guidance?" This was a result of the impetus given mathematics by war-time activities. The emphasis in this article was on the mathematics needed in various branches

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[11] Harry D. Kitson, "Vocational Guidance Through School Subjects," Teachers College Record, 28:900-15, May, 1927.

[12] Harriet A. Welch, "What Can the Teacher of Mathematics Do About Vocational Guidance?" The Mathematics Teacher, 36:99-101, March, 1943.

of the military service.

The importance of vocational guidance in the mathematics classroom was recognized by the National Council of Teachers of Mathematics; the Guidance Pamphlet in Mathematics for High School Students was published in 1947.[13] This was revised in 1953. A similar booklet, Why Study Mathematics? was published in Canada.[14] Both of these publications are for student and teacher use and give an over-all picture of the importance of mathematics for every individual as well as a discussion of occupational information. Both include a bibliography. Other articles have appeared giving suggested bibliographies on guidance in mathematics for teachers such as those by Schaaf[15] and Bernhard.[16]

In 1953 and 1954 articles containing more specific suggestions concerning guidance in scientific fields began

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[13] Guidance Pamphlet in Mathematics for High School Students (Washington, D. C.: National Council of Teachers of Mathematics, 1953).

[14] Why Study Mathematics? (Montreal: The Canadian Mathematical Congress, n.d.).

[15] William L. Schaaf, "Guidance: The Case for Mathematics," The Mathematics Teacher, 44:130-34, February, 1951.

[16] Ida May Bernhard, "Materials Available for Counseling in Mathematics," The Mathematics Teacher, 47:279-280, April, 1954.

to appear. Johnson[17] gave suggestions to the science teacher for guidance activities within the classroom, the school, and the community. Wilson[18] discussed the need for physicists and the problem of locating and guiding students toward research. Murphy[19] listed qualifications necessary for students entering chemical engineering.

Hobbs[20] pointed out that although it is extremely important that we do guidance work in the scientific field, we must remember that guidance should not be compulsion. Scientists alone cannot fulfill all the needs of society.

IV. SUMMARY

There has been an increased awareness of the problem of a shortage of scientific personnel; this shortage will not be overcome for some time. Industry has been doing a

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[17] Philip G. Johnson, "A High School Teacher's Opportunities for Guidance Toward Science," Education, 73:439-41, April, 1953.

[18] Leland L. Wilson, "Guidance Toward Research and Development in Physics," Education, 73:414-17, March, 1954.

[19] Walter J. Murphy, "Guidance Toward Chemical Engineering and Research," Education, 73:418-21, March, 1953.

[20] Nicholas Hobbs, "Some Notes on Science and Guidance," Education, 73:434-46, March, 1953.

great deal by a publicity program, by offering scholarships, and by publications directed toward the high school student. Possible solutions to the problem included guidance by high school teachers. Recently, a few specific suggestions for teachers have appeared in the literature.

The literature indicated that industry has made more diligent effort to solve the problem than has education. Industry's specific contribution has been of great value. However, more should be done by education so as to provide students with a complete factual background of all vocational and professional opportunities in the field.

PART II

TO THE STUDENT

CHAPTER III

PROFESSIONAL OPPORTUNITIES

I. SHORTAGE OF SCIENTIFIC PERSONNEL

Everyone is aware of products made possible by new scientific discoveries. During the past few years plastics, television, jet planes, "miracle" drugs, and atomic energy have greatly altered our lives, to name but a few. Products such as these are made possible only by increased knowledge of all science including mathematics.

We are indeed living in an age of science. Our way of living is becoming much more complex; it takes more people highly educated in science to cope with life in a scientific age. This scientific advancement has brought about an increased demand for trained workers. In fact, this advancement has been so rapid during the past few years that the supply of people available for technological positions has not kept pace with the demand. There are almost unlimited opportunities for young people in professions that require a knowledge of mathematics; from all indications it seems that this will be the case for some time to come.

Any student in high school who likes mathematics and who makes good grades in it should consider the

possibility of continuing education in one of the fields using mathematical knowledge. The material presented in the following pages is for the purpose of acquainting the high school student proficient in mathematics with professional careers that require a background of college mathematics. The professional fields discussed are those that require at least two years of college mathematics.

The student reading this material should realize that there are lesser positions in each of the fields discussed that would be available to the person who did not complete an entire course. However, the opportunities are so much better with a complete course that a student should train for a top-level position if at all possible. It should also be remembered that the beginner must take a routine position, prove his ability, and work up to the top. For example, no young graduate engineer would be given the responsibility of designing and erecting a dam.

II. PERSONAL AND EDUCATIONAL QUALIFICATIONS

In all scientific professions certain personal qualities are necessary. One such quality is the ability to get along with others. Even the research worker no longer is able to work entirely alone. Much of the research of today is accomplished by team work and consequently the research worker must have a well-rounded

personality. The ability to speak and write clearly using correct English is an absolute necessity. Many otherwise successful technical workers have lost their chance for advancement because of their failure to realize the importance of English when they were in school. Other necessary personal qualities are above average intelligence and an analytic mind.

All the professional careers listed require a college degree; other educational requirements vary. The high school requirements listed are general requirements and should not be construed as definite requirements. The student should consult the graduation requirements of his own school and the entrance requirements of the university of his choice. No attempt was made to indicate a definite college course to follow. Only the length of the course and the minimum amount of mathematics required was indicated. Quite often more mathematics is desirable, and higher degrees must be obtained for advancement to the top.

III. OPPORTUNITIES IN GOVERNMENT WORK AND IN THE ARMED SERVICES

The student good in mathematics may be interested in government work, in which case his job will be a civil

service job, and he will be appointed according to his placement on an examination. There are government jobs available in most of the fields discussed; if interested the student should write to the United States Civil Service Commission, Washington, D.C. for further information. There are also state, county, and city civil service positions available.

Also, there are careers in branches of the armed services in many of the professional fields. Recruiting stations of each service provide information about permanent careers in the service.

IV. OPPORTUNITIES FOR WOMEN

Opportunities for women in fields requiring mathematical knowledge are increasing. Although much of this work is known traditionally as a man's field, the indications are that women are gradually being absorbed in certain jobs in practically every field. Any high school girl good and interested in mathematics should follow the profession of her interest. She should realize that there may be prejudice against her because of her sex and that the obstacles may be great. However, many of the jobs have been known as men's jobs because women have not been interested in technical work, rather than because of

prejudice against them.

V. SOURCES OF INFORMATION

With few exceptions the information presented on the following pages was summarized from the series of career monographs published by The Institute for Research in Chicago. For more detailed information the student should consult the career monograph on the career of his interest. Further information may also be obtained from the list of suggested references at the end of each section. The numbers refer to the list of suggested references in Chapter VIII. For further information regarding opportunities in general for a person with interest and ability in mathematics, the following references should prove helpful: 5, 17, 21, 25, 35, 36, 38.

CHAPTER IV

CAREERS IN ENGINEERING

Most high school students have a general idea of the work of an engineer, yet if asked to define engineering they run into difficulty. The term is difficult to define since it has grown to include so many activities. A good description of the profession of engineering is that found in Engineering A Creative Profession, "It adapts materials found in nature to a more useful form, and harnesses natural forces to do man's work."[1] To be more specific, it might be helpful to consider the functions of various kinds of engineers. There are five main divisions of engineering: civil, mechanical, electrical, chemical, and mining. A civil engineer is concerned with structures necessary for community living such as bridges, highways, pipelines, sewage and drainage systems. A mechanical engineer is concerned with all kinds of machines and the power to operate them. An electrical engineer is concerned with practical uses of electricity. A chemical engineer is concerned with the practical

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[1] Engineering A Creative Profession (New York: Engineers' Council for Professional Development, 1954), p. 2.

application of new discoveries in chemistry. A mining engineer is concerned with finding and extracting ores and minerals and processing them into useful materials.

Often an engineer's work is concerned with more than one field; however, he usually gets a college degree in one of the five fields and then specializes in a subdivision. The following outline is presented to help clarify the type of work included in each of the fields of engineering.

A. Civil Engineering

1. Architectural
2. Hydraulic
3. Sanitary
4. Structural
5. Transportation (includes highway, airport, railway, pipeline engineering)

B. Mechanical Engineering

1. Aeronautical
2. Air Conditioning
3. Atomic Power
4. Automotive
5. Industrial
6. Marine
7. Refrigerating

C. Electrical Engineering

1. Electronics
2. Radio
3. Television

D. Mining Engineering

1. Metallurgical
2. Petroleum

E. Chemical Engineering

1. Ceramic

Many of these are discussed in the pages that follow.

An engineer in any field may do research work entirely. Other engineering positions are concerned with designing and developing the discoveries of research into products to be manufactured, or finding a practical use for a product. Also, an engineer may do sales work; it takes a person with an engineering degree to be able to sell a highly technical product.

On the pages that follow are brief descriptions of various fields of engineering with the qualifications required for each. The person interested in these fields should realize that an over-all picture of the type of work is being given. Many of the higher jobs take additional years of study and experience, but they are available for those with ability, initiative, and interest.

Suggested references: Chapter VIII-- 7, 14, 15, 34.

I. CIVIL ENGINEERING

Type of work. The work of the civil engineer probably affects our everyday living more than any other engineering position. The civil engineer plans and constructs structures necessary for community living. It is

due to the civil engineer that we have sewage systems, bridges, tunnels, paved highways, dams, reservoirs, and other similar structures.

The field of civil engineering is so broad that a civil engineer usually specializes in just one branch of it. The main divisions of specialization are transportation, structural, hydraulic, and sanitary engineering. There are four types of transportation engineering: (1) highway: construction and maintenance of highways as well as planning of new routes, solving of traffic control problems, (2) airport: planning and construction of airport facilities, (3) railway: maintenance and improvement of tracks and routes and other railway structures; construction of bridges, tunnels used by railways, and (4) pipeline: planning, laying of long pipelines.

A structural engineer designs and builds large buildings, bridges, tunnels, dams, and other structures. The hydraulic engineer is concerned with the storage and transportation of liquids such as gasoline, oil, and water. For example, it is a hydraulic engineer who figures out the amount of pressure created by water in a river flowing into a dam of a certain size and the method of controlling the water. The work of the hydraulic engineer also includes flood control problems, irrigation, and even port

facilities. The sanitary engineer is responsible for a system of sewage and waste disposal which is an absolute necessity if we are to escape disease and even death. He is also responsible for seeing that the public water supply is safe and free from contamination. This involves planning and constructing aqueducts, reservoirs, pipelines, sewage treatment plants.

Often the work of a civil engineer takes him out in the field where life may be simple but inconvenient. Unless a person is willing to do this, he should not undertake a career in this area.

Personal qualifications: Ability to get along with others; ability to speak and write clearly and correctly; analytical mind; ability to apply principles of mathematics and science to engineering problems; strong character; sincere interest, good physical health, especially necessary in construction work.

Educational requirements: High School: 3½ years mathematics, 1 year physics, 3 years English, 2 years history, 2 years foreign language, mechanical drawing. 1 year chemistry recommended. College: a 4-5 year course with a bachelor's degree in civil engineering. Minimum mathematics requirement: 2 years.

Suggested references: Chapter VIII-- 8, 14.

II. HIGHWAY ENGINEERING

Type of work. Highway engineering is a branch of civil engineering. The highway engineer applies his knowledge of civil engineering to constructing highways. This includes surveying the land, determining the best route from a construction standpoint and from an economical standpoint, planning and supervising the actual construction, and keeping roads in good repair after construction. Any construction work involved in road-building becomes the concern of the highway engineer. This may be the construction of bridges, underpasses, etc. The highway engineer must also be familiar with various types of soil, roadbeds, and the composition of highway materials.

Probably the most recent work of the highway engineer familiar to all is the construction of freeways. Just looking at the maze created by several joining freeways such as in Los Angeles makes a person realize the complexity of the work of the advanced highway engineer.

There is a variety of occupations in highway engineering; advancement depends a great deal on experience. Some jobs are available to the graduate engineer with a degree in civil engineering and no experience; others of

the highest level require from seven to eleven years experience.

Personal qualifications: Ability to get along with others, ability to speak and write clearly and correctly, analytic mind, ability to apply principles of mathematics and science to engineering problems, strong character, sincere interest, good health (especially important).

Educational requirements: High School: 2 years algebra, ½ year trigonometry, 1 year physics, 3 years English. Recommended: 1 year chemistry, 2 years foreign language. College: bachelor's degree in civil engineering (4-5 year course). Minimum mathematics requirement: 2 years.

Suggested references: Chapter VIII-- 8, 14.

III. SANITARY ENGINEERING

Type of work. Sanitary engineering is that branch of civil engineering that deals with making our communities safe and healthful places in which to live. With our growing population and congested city life the work of the sanitary engineer has become extremely important. His activities in the field of sanitation include control of the following: water supply, air supply, milk supply,

other food products, all liquid waste disposal, disposal of solid wastes such as garbage and rubbish, animal and insect carriers of disease (eradication of rats, mosquitoes, etc.), cleanliness of the community, sanitary conditions in public buildings. The sanitary engineer works in close cooperation with the bacteriologist, physician, and agriculture research worker.

Sanitary engineers are employed by government agencies, by manufacturers of water and sewer plants, by private firms of consulting engineers, and by private industries with special problems of waste disposal or water supply.

Personal qualifications: Ability to get along with others, ability to speak and write clearly and correctly, analytic mind, knowledge of political and economic activities in his community, possess a broad background of general culture, willingness to continue study, conscientious.

Educational requirements: High School: 2 years algebra, 1 year plane geometry, ½ year solid geometry, ½ year trigonometry, 1 year physics, 3 years chemistry. College: bachelor's degree in sanitary engineering (4 year course) or a bachelor's degree in civil engineering

plus graduate work in sanitary engineering (5 year course). Minimum mathematics requirement: 2 years.

Suggested references: Chapter VIII-- 8, 14.

IV. MECHANICAL ENGINEERING

Type of work. The mechanical engineer is concerned with all kinds of machines and the power to operate them. The field is quite broad; usually a mechanical engineer specializes in one area. The mechanical engineer may work on research, design, construction, operation or maintenance of machines. The field also includes the organization and operation of industrial plants according to scientific principles of management. This is known as industrial engineering.

Mechanical engineers may work exclusively in generating power to drive machines; this includes working out problems in the handling and storage of various types of fuels. Manufacturing industries employ mechanical engineers to design their products; even more prevalent is their work in designing and operating the machinery which makes the product of the manufacturer. Our modern system of mass production of items calls upon the ingenuity of the mechanical engineer.

Aeronautical engineers are mechanical engineers specializing in design and production of aircraft and aircraft parts. This is a dynamic field; as air transportation becomes more and more rapid, changes in design and structure of aircraft become necessary. Some of the other well known fields in mechanical engineering are refrigerating, marine, atomic power, and automotive engineering.

Personal qualifications: Ability to get along with others, ability to speak and write clearly and correctly, analytic mind, patience and perseverance in solving problems, genuine interest in machines and mechanical problems, good health, liking for mathematics, ability to participate in community life.

Educational requirements: High School: beginning and advanced algebra, trigonometry, plane and solid geometry, 1 year physics, 4 years English. Recommended: 1 year chemistry, modern foreign language, history, civics, mechanical drawing. College: bachelor's degree in mechanical engineering (4 year course). Minimum mathematics requirement: 2 years.

Suggested references: Chapter VIII-- 8, 14.

V. AERONAUTICAL ENGINEERING

Type of work. The aeronautical engineer solves mechanical and mathematical problems regarding air travel. He is always striving toward practical results, not just theory. The term aeronautical engineer (a specialized mechanical engineer) is itself a broad term and includes several major subdivisions, such as aerodynamical engineer, flight test engineer, laboratory and wind tunnel researcher, aircraft designer, aircraft engine designer, aircraft propeller designer, and airline engineer.

The work of the aeronautical engineer may be in analyzing and designing new parts or instruments, it may involve testing instruments or whole aircraft, or a study of factors affecting air travel such as forces, pressures, speed, lift, range. Often a complicated and detailed mathematical analysis is necessary, especially in research, design, or testing of parts or instruments.

There has been a great deal of publicity regarding recent developments in this field. We are aware of jet planes, of the planes that rise vertically, of the problems created by extreme high altitude flying, etc. All of these are the concern of the aeronautical engineer.

Personal qualifications: The qualifications vary

according to the field of specialization. Ability to get along with others, ability to speak and write clearly and correctly, and an analytic mind are needed by all. In designing and research excellent mathematical ability, precise work, imagination, and ability to do meticulous work are necessary. In instrument work extraordinary manual dexterity is necessary. In flight test work, a person should be fond of adventure.

Educational requirements: High School: 2 years algebra, plane geometry, solid geometry, trigonometry, physics, chemistry, mechanical drawing, metal shop. College: bachelor's degree in aeronautical engineering or mechanical engineering (4 year course). Minimum mathematics requirement: 2 years (usually more is taken).

Suggested references: Chapter VIII-- 1, 8, 14.

VI. ATOMIC POWER ENGINEERING

Type of work. At present atomic power is in the stage of early development; it is difficult to predict the future of a mechanical engineer in this field. All reports seem to indicate that there will be opportunities in the field of peace time industrial use of atomic power. This depends upon the establishment of atomic power plants for

peace time use. Mechanical engineers with a background of nuclear physics and trained in atomic power engineering would undoubtedly be in demand.

Those now working in this field are from various fields of engineering and science. As industry begins to use atomic power, there should be opportunities for those trained in the various phases of atomic power engineering: managing, operating, maintenance, safety, consultant, and sales engineers.

Personal qualifications: Ability to get along with others, ability to speak and write clearly and correctly, analytic mind, willingness to continue study, imatination, creative mind, perserverance, resourcefulness, interest in building things.

Educational requirements: High School: 3-4 years mathematics, physics, chemistry, 3-4 years English, 2 years foreign language, 2-3 years history. Good training in mathematics and English is especially important in this field. College: bachelor's degree in engineering (4-5 year course). Minimum mathematics requirement: 2-3 years.

Suggested references: Chapter VIII-- 3, 8, 14.

VII. AUTOMOTIVE ENGINEERING

Type of work. This field became a specialized branch of mechanical engineering with the great expansion of the manufacture and use of automobiles, busses, trucks, tractors, etc. The automotive engineer's work may be the designing of new automobiles, busses, etc., the designing of new parts, testing and developing to improve existing models, or developing additional uses for machines. An automotive engineer may work with any machine that is self-propelled.

An automotive engineer may find employment in the automobile industry, the automobile parts industry, the farm machinery industry, petroleum industry (working with fuels and lubricants necessary for the machines), or the diesel industry.

Personal qualifications: Ability to get along with others, ability to speak and write clearly and correctly, analytic mind, imagination, possess geometric visualization.

Educational requirements: High School: 2 years algebra, plane geometry, solid geometry, trigonometry, physics, chemistry, 3 years English, 1 year mechanical

drawing, freehand sketching. College: bachelor's degree in mechanical engineering (4 year course). Minimum mathematics requirement: 2 years.

Suggested references: Chapter VIII-- 8, 14.

VIII. INDUSTRIAL ENGINEERING

Type of work. Industrial engineer is the name given to the specialist in scientific management. It is the industrial engineer's job to study and develop the best, most efficient way of operating an industrial plant and at the same time reduce cost of operation if possible. Some industrial engineers specialize in one field of plant operation such as production of equipment, production scheduling, inspection procedures, packing and shipping, or safety.

An industrial engineer may be a regular employee of a private industry; often he is a member of a firm of consulting engineers. A consulting engineer is hired by an industry that wants a special problem handled. For example, a producer of nuts and bolts may want a study made of his company's method of packing and shipping to see if it can be done more efficiently and at less cost. He would hire an industrial engineer specializing in this field.

Personal qualifications: Ability to get along with others; ability to speak and write clearly and correctly; analytic mind; the combined aptitudes of a mechanical engineer, an accountant, and business executive; liking for methodical work; liking for mathematics; ability to develop new methods and procedures; persistence; pleasant disposition; integrity; good health.

Educational requirements: High School: algebra, plane and solid geometry, trigonometry, physics, chemistry, mechanical drawing. College: bachelor's degree in industrial engineering or mechanical engineering (4-5 year course). Minimum mathematics requirement: 2 years.

Suggested references: Chapter VIII--8, 14.

IX. REFRIGERATING ENGINEERING

Type of work. Refrigerating engineering is concerned with the removal of heat from rooms, buildings, or other spaces, and from materials. A great deal of research and testing is necessary to develop equipment such as compressors, and to develop a complete unit such as a cold storage plant. Also much of the work in this field involves solving the problems of the customer. It takes a technically trained person to take a cooling problem

and select and apply the product to the needs of the customer. Other more familiar fields of work of the refrigerating engineer are in air conditioning buildings, household refrigeration and deep freezing units, the use of refrigeration in the food-handling industries as well as many other industries, and the entire realm of the frozen food industry.

Personal qualifications: Ability to get along with others, ability to speak and write clearly and correctly, analytic mind, interest in science and technical work, willingness to study, integrity, loyalty.

Educational requirements: High School: algebra, plane and solid geometry, trigonometry. Recommended: physics, chemistry. College: bachelor's degree in mechanical engineering (4 year course). Minimum mathematics requirement: 2 years.

Suggested references: Chapter VIII--8, 14.

X. ELECTRICAL ENGINEERING

Type of work. The electrical engineer's job is to find practical, beneficial ways of using electricity. He may work in any one of several industries as well as in

university laboratories or for government agencies. Some of the fields in which electrical engineer's find employment are: home appliances such as vacuum cleaners, washing machines; communication by telephone; the radio and television, radar, factory lighting problems, electric motors, generation of electricity, transmission of electricity. The field of electronics itself offers tremendous opportunities for the future. The modern high speed computers, the many industrial uses of the electron tube are indications of the possibilities in the field, especially in research.

It would be almost impossible to name all things dependent upon electricity for their operation; it takes but a moment's reflection to realize how much we rely on electricity. These many uses were made possible by the work of electrical engineers.

The electrical engineer needs the most extensive mathematical background of all engineers and makes more constant use of his mathematics than other engineers.

Personal qualifications: Ability to get along with others, ability to speak and write clearly and correctly, analytic mind, scientific curiosity, imagination, persistence.

Educational requirements: High School: 2 years algebra, plane and solid geometry, trigonometry, physics, chemistry, mechanical drawing, shop courses. The student must excel in physics and mathematics. Recommended: English, history, foreign language, speech. College: bachelor's degree in electrical engineering. Minimum mathematics requirement: $2\frac{1}{2}$ years (very often more is required).

Suggested references: Chapter VIII-- 6, 8, 13, 14, 25, 33.

XI. ELECTRONICS ENGINEERING

Type of work. Electronics refers to electronic tubes (including X-ray tubes) and to devices using these tubes, as well as to related equipment such as the photo-electric cell. Work in electronics offers many possibilities. Examples indicating the possibilities are electronic tube design and the operation, design, and maintenance of complete units such as automatic welding devices or long distance telephone repeater stations. Electronics is being applied in industrial power equipment, in communication, and in the manufacturing and use of various kinds of instruments.

A person interested in electronics usually does not specialize in this field until he has received a degree in electrical engineering. He then takes graduate work in electronics.

Personal qualifications: Ability to get along with others, ability to speak and write clearly and correctly, analytic mind, ability to understand scientific writing, ability to visualize ideas, initiative, ingenuity, manual dexterity, good appearance.

Educational requirements: High School: mathematics, physics, English, history. Recommended: mechanical drawing, shop work. College: bachelor's degree in electrical engineering plus graduate work. Minimum mathematics requirement: $2\frac{1}{2}$ years plus some courses in graduate work.

Suggested references: Chapter VIII--1, 6, 8, 13, 14, 25.

XII. RADIO AND TELEVISION ENGINEERING

Type of work. Various divisions of the radio industry offer employment for specialized engineers. These engineers design, install, operate, and maintain all types of equipment for broadcasting, communications, and navigation. In the manufacturing industry a radio engineer

designs and develops new models or improves existing equipment. Other industries such as the aircraft industry often employ radio engineers for specialized work.

There are two major divisions in the television industry: manufacturing and programming. Manufacturing refers to the production, sales and servicing of television sets, while programming refers to the creation of programs, selling them to a sponsor and telecasting them. There are opportunities for highly trained technical workers in each of these divisions. There are many jobs in both divisions which require little training beyond high school. However, the information here refers just to the top positions for which a college degree is required.

In the manufacturing division the design engineer (a graduate electrical engineer) is employed to do research, to develop new models, or to improve television apparatus and receiving sets. The most recently publicized work along this line is that on color television. A production engineer is concerned with the operation and maintenance of television equipment.

In the programming division many of the jobs can be handled by other than graduate engineers, but advancement is unlikely. There is a growing tendency to hire engineers for these positions. Video and audio engineers,

the technical directors in charge of the actual telecasting, fall in this classification.

Personal qualifications: Ability to get along with others, ability to speak and write clearly and correctly, analytic mind, ability to make practical application of knowledge, initiative, persistence, determination, willingness to meet competition.

Educational requirements: High School: thorough background in mathematics, physics, chemistry, general science. Recommended: mechnical drawing, photography, music appreciation, accounting, commercial law. College: bachelor's degree in electrical engineering with major in communications or radio engineering. Minimum mathematics requirement: 2½ years.

Suggested references: Chapter VIII--6, 8, 13, 14, 33.

XIII. CHEMICAL ENGINEERING

Type of work. The chemical engineer applies principles of engineering to all phases of the chemical industry. He transforms the developments of the research laboratory into products that can be commercially produced and used. He is responsible for getting the new

discoveries in chemistry on the market for public use. This includes the designing, construction, and supervision of equipment and of entire plants to manufacture the new products.

Opportunities for chemical engineers are primarily in private industry. A few fields employing chemical engineers are: plastics, ceramics, cosmetics, perfumes, paints, petroleum products, synthetic material (nylon, orlon, etc.), rubber products, soaps and detergents, sprays for insects. This list could be extended almost indefinitely, but is enough to indicate the great variety of industries open to the chemical engineer. Opportunities for chemical engineers are excellent and will continue to be so for some time due to continuing research.

Personal qualifications: Ability to get along with others, ability to speak and write clearly and correctly, analytic mind, ability to combine scientific and engineering principles, interest in application of knowledge to practical problems, intellectual curiosity, desire to create, initiative.

Educational requirements: High School: 3 or 4 years of mathematics, chemistry, physics, 3 years English, 2-3 years foreign language. College: bachelor's degree

in chemical engineering (4 year course). Minimum mathematics requirement: 2 years.

Suggested references: Chapter VIII--2, 8, 9, 12, 14, 21, 31.

XIV. CERAMIC ENGINEERING

Type of work. The ceramics industry has recently developed to the point where it is not just an artistic outlet; it is now a large industry producing such items as structural materials, material for insulation, enameled metals, acoustic units, pottery and tableware, as well as art objects. With this expansion came the need for new equipment and new production methods. This required the services of a highly trained person, and so the ceramic engineer came into being.

The ceramic engineer is a chemical engineer specializing in ceramics who may work in any phase of the industry. This includes designing, constructing, operating equipment for ceramic processes, testing and developing new materials (such as glazes) and processes, demonstrating and selling equipment.

Personal qualifications: Ability to get along with others; ability to speak and write clearly and correctly;

analytic mind; aptitude for mathematics, chemistry, and physics; mechanically inclined; liking for mineralogy and geology; imagination; ingenuity; good health; strong physique.

Educational requirements: High School: mathematics, physics, chemistry. College: bachelor's degree in chemical engineering (4 year course). Minimum mathematics requirement: 2 years.

Suggested references: Chapter VIII--2, 8, 10, 11.

XV. MINING ENGINEERING

Type of work. A mining engineer is concerned with the actual removal of minerals from the earth. He decides the best method of mining the particular mineral and plans and supervises the entire mining operation. This involves selection of equipment, construction and location of equipment at mine site, obtaining power, operating the mine, and frequently providing for housing, recreation, and medical facilities for workers.

Mining engineers often specialize in one type of mining. Probably the most well known specialist is the petroleum engineer who specializes in removal of oil from the earth. The work of the mining engineer involves

aspects of civil, mechanical, chemical, and electrical engineers. Also, his work is often in remote areas. For a person who likes to travel there are opportunities abroad for mining engineers, especially petroleum engineers.

Personal qualifications: Ability to get along with others, ability to speak and write clearly and correctly, analytic mind, self assurance, good disposition, fair, favorable appearance, fond of adventure, good health.

Educational requirements: High School: 1½ years algebra, 1 year plane geometry, trigonometry, 3 years English, foreign language, chemistry, physics. Recommended: solid geometry. College: bachelor's degree in mining engineering (4 year course). Minimum mathematics requirement: 2 years.

Suggested references: Chapter VIII--4, 8, 10, 14.

XVI. METALLURGICAL ENGINEERING

Type of work. A metallurgical engineer applies the principles of chemistry and physics to the preparation of metals from alloys. There are three fields of metallurgy: (1) refining ore to produce a metal, (2) preparing this metal for use in industry, and (3) selecting and developing

metals or combinations of metals suitable for specific industrial uses. These divisions of work indicate that the metallurgical engineer may work in the mines, in laboratories, or in industries using metals.

There are many opportunities for metallurgical engineers. The use of stainless steel for kitchen sinks is a relatively recent development made possible by metallurgical engineers. Most of the manufacturing industries using metals in their products are constantly searching for new combination of materials and for economic materials. This in combination with many new discoveries creates positions for metallurgical engineers.

Personal qualifications: Ability to get along with others; ability to speak and write clearly and correctly; analytic mind; interest in science; aptitude for chemistry, physics, and mathematics; questioning mind, patience to perfect plans, courage to stay with a task to completion, good health.

Educational requirements: High School: physics, chemistry, mathematics. College: bachelor's degree in engineering or science (4 year course). Many industries will hire only those applicants with a master's degree (5 year course). Minimum mathematics requirement:

2-3 years.

Suggested references: Chapter VIII--8, 10, 14, 32.

XVII. ACOUSTICAL ENGINEERING

Type of work. As the name indicates acoustical engineers deal with the problem of sound in enclosed spaces. There are three types of problems that face the acoustical engineer: (1) insulating a room or building against sound; reducing the amount of sound passing through walls, ceilings, etc. by means of certain materials, (2) noise quieting; reducing the loudness of undesirable sound in a room such as reducing noise made by typewriters or by machinery, and (3) control of sound within a building, especially in auditoriums, theaters, churches so that speaker or music can be heard to best advantage in all parts of the room.

There are opportunities for an acoustical engineer in new building construction to provide for a maximum amount of good listening space; sound insulation in buildings; noise quieting in offices, factories, theaters, schools, radio and television studios, hospitals; city noise abatement projects; and in research. The acoustical engineer usually has a background of mechanical and

electrical engineering with a working knowledge of architecture, decoration, and building materials.

Personal qualifications: Ability to get along with others, ability to speak and write clearly and correctly, analytic mind, acute powers of perception and analysis, good eyesight, good hearing.

Educational requirements: High School: special emphasis on physics and mathematics. College: Very few if any institutions offer a course in acoustical engineering. The best training can be obtained by selecting subjects from a general course in engineering physics. A bachelor's degree is required. Minimum mathematics requirement: 2 years.

Suggested references: Chapter VIII--8, 14.

XVIII. AGRICULTURAL ENGINEERING

Type of work. The agricultural engineer applies his knowledge of engineering (civil, mechanical, chemical, mining, or electrical) to problems of agriculture. A mechanical engineer working on the design, development, or use of farm machinery would be known as an agricultural engineer. Similarly, the design and construction of

buildings on a farm (modern dairy buildings, silos, grain elevators, etc.) would require civil engineering training. An electrical engineer might be working in the field of rural electrification, i.e., the practical use of electricity for doing work on a farm. Soil and water conservation would be the concern of a civil engineer. Since all of these areas are concerned with agriculture the term agricultural engineer is used to designate any engineer working in the field of agriculture.

In addition to the usual distinction of work in the fields of research, design, application and sales work, the agricultural engineer may do extension work. He may go into agricultural areas and do educational work or he may demonstrate his product on farms. An engineer doing this type of work might be an employee of federal, state, or county government; a power company; or a private manufacturing industry.

Personal qualifications: Ability to get along with others, ability to speak and write clearly and correctly, analytic mind, interest in farm life, ability to apply principles of mathematics to practical problems.

Educational requirements: High School: algebra, plane and solid geometry, physics or chemistry, 4 years

English, 2 years foreign language, history. Recommended: trigonometry, mechanical drawing, typing, bookkeeping.

College: bachelor's degree in engineering (4-5 year course). Minimum mathematics requirement: 2 years.

Suggested references: Chapter VIII--8.

CHAPTER V

CAREERS IN SCIENCE

I. ASTRONOMY

Type of work. A person seeking a career in astronomy must be proficient in higher mathematics. In fact there is a very close relationship between mathematics and astronomy. A person aspiring to be an astronomer would obtain a Ph.D. degree; he would probably begin his work teaching in a university.

An astronomer studies the moon, stars, and planets; makes observations of their movements; predicts eclipses, comets, and other unusual phenomena; and is constantly searching for new facts and relationships. Employment in observatory work is usually obtained from university grants, private foundations for research, or government agencies.

Personal qualifications: Ability to get along with others, ability to speak and write clearly and correctly, analytic mind, patience, intellectual curiosity, willingness to continue study, persistence, good eyesight.

Educational requirements: High School: emphasis on mathematics, physics, chemistry. College: A doctor's

degree in science (6-7 year course). Minimum mathematics requirement: 4-5 years.

Suggested references: Chapter VIII--36.

II. BACTERIOLOGY

Type of work. Bacteria are microscopic living organisms which are around us constantly and outnumber any other living thing on the earth. It is the purpose of the bacteriologist to study these organisms, learn all possible facts about their life, and to determine whether or not they are harmful. If harmful, the bacteriologist studies ways of controlling them. If harmless, studies to determine their usefulness are made. It is the bacteriologist who is responsible for doing away with epidemics of disease, for controlling spoilage of food, and for discovering and developing some of the new drugs.

A bacteriologist may find employment in various fields. In government public health work there are opportunities in the fields of water supply, sewage disposal, and in control of food producing industries. In private industries opportunities are found with any branch of the food industry and with any industries using a fermentation process such as alcoholic beverage industries. Pharmaceutical organizations maintain their own laboratories

and offer opportunities for bacteriological research.

Personal qualifications: Ability to get along with others, ability to speak and write clearly and correctly, analytic mind, ability to learn and remember a great number of technical details and formulas, intellectual curiosity, possess the attributes of orderliness and cleanliness.

Educational requirements: High School: mathematics, chemistry, biology, physics, botany, hygiene. College: bachelor's degree in bacteriology (4 year course). Graduate work is recommended. Minimum mathematics requirement: 2 years.

Suggested references: Chapter VIII--5, 8, 38.

III. CHEMISTRY

Type of work. Chemistry as such offers a multitude of opportunities. There are many fields of specialization for a person with a degree in chemistry. A chemist ordinarily works in a laboratory making certain tests, analyzing factors, or doing some type of research. However, he may be called upon to do sales work or purchasing. A research chemist spends practically all his time in a

laboratory studying, analyzing, performing experiments. Discoveries of the research chemist may be discoveries in pure science which add to scientific knowledge but which are without practical application, or they may be discoveries in an industrial laboratory that lead to a better or cheaper product. It is the chemist who is the "miracle man" in making new discoveries; a chemical engineer takes these discoveries and develops them into a product that can be sold to the public.

There are opportunities for chemists and research chemists in many industries; some of these areas are so extensive they have been given special names such as a food chemist. Food chemistry deals with the chemical nature of foods and the chemical changes that take place in various foods during handling, canning or freezing which cause spoilage. This in turn leads to the development of appropriate and safe ways of handling foods as well as a determination of beneficial and detrimental substances in foods. Other industries offering opportunities for chemists are petroleum, explosives, paints and varnishes, leather, match, meat packing, glass, photography, rubber, soap and detergents, cosmetic, etc. Chemists working in industry are often called industrial chemists.

Personal qualifications: Ability to speak and write clearly and correctly, analytic mind, enjoy solving problems, orderly mind, scientific curiosity, keen powers of observation, ability to undergo sustained hard work, patience, intellectual honesty, accuracy, manual dexterity, good eyesight.

Educational requirements: High School: algebra, geometry, trigonometry, chemistry, physics, biology, English, history, foreign language, social studies (agriculture for a food chemist). College: bachelor's degree in chemistry (4 year course). Graduate work and a higher degree almost a necessity for research work. Minimum mathematics requirement: 2 years.

Suggested references: Chapter VIII--2, 4, 5, 8, 9, 31, 38.

VI. GEOLOGY

Type of work. Geology is a study of the structure of the earth. A geologist with his knowledge of various types of soil, rock and ground configurations is in demand when construction projects are undertaken. The civil engineer consults with the geologist in planning construction of dams, bridges, large buildings, etc. Also, the

geologist is called into consultation concerning materials for houses and other structures, strength of structural materials, and ground conditions for certain structures. A geologist may also find work in mining, conservation of natural resources (finding minerals that can be used in place of scarce minerals), locating oil, iron, etc., and sewage disposal. The most recent discovery and work in the geological field is the determination of heat of the earth and making practical use of this heat.

Geophysics, a combination of physics and geology, is a study of the physics of the earth. It includes a study of water surfaces on the earth, volcanoes, oceanography (physical shape of oceans), seismology (investigation of internal structure of the earth), and geodesy (measuring the exact shape of the earth). Geochemistry is a study of all phases of atomic elements within the earth.

Most of the career opportunities in geophysics and geochemistry are in the application of the knowledge of the subject to locating new mineral deposits, including oil. Such positions would be found with government agencies, consulting firms, and oil, gas, and mining companies.

Personal qualifications: Ability to get along with others, ability to speak and write clearly and correctly, analytic mind, interest in nature, ability to withstand long hours of hard work, good health, liking of outdoor life (a few positions may be entirely indoors).

Educational requirements: High School: mathematics, especially algebra; physics; chemistry; composition; mechanical drawing. Recommended: freehand drawing. College: bachelor's degree in science (4 year course). Special graduate work necessary for geophysics and geochemistry. Minimum mathematics requirement: 2 years; for geophysics and geochemistry: 3 years.

Suggested references: Chapter VIII--4, 5, 8, 9, 10, 16.

VII. MATHEMATICS

Type of work. A person who majors in mathematics in college has many opportunities awaiting him. This is especially true if an advanced degree is obtained. A mathematician is in demand in many fields of engineering to act as a consultant in phases of work requiring advanced mathematical knowledge. This is frequently the case in the aircraft industry. Aerodynamics involves complex

mathematical analysis often to a degree not in the training of the engineer. Other fields of aviation work such as the study of guided missiles make use of mathematics.

The field of electronics also needs mathematicians, especially the high speed computer field. Although these computers do tremendous amount of man hours of work, it still takes skilled, trained person to get data in a form the machine can handle and to interpret the information in the light of the entire problem at hand. There are also opportunities in electronics research for mathematicians.

A mathematics major with a good background in physics or chemistry is in demand in any of the fields of specialization in physics or chemistry.

Statistical work is another field of mathematical specialization offering opportunities to mathematics majors. Most people are familiar with the famous Gallup polls; behind their reports of public opinion is a great deal of work by statisticians. The work of the statistician on a professional level is concerned with the collecting, compilation, and interpretation of numerical facts by scientific methods. These facts are presented in the form of tables, graphs, charts, and formulas. The work of the statistician falls in four divisions: (1) designing

questionnaires or other methods of gathering facts, (2) supervision of collecting data, (3) supervision of tabulating data, and (4) interpreting the data. The statistician uses his data to show status quo, to show progress or lack of it, and to forecast future events. Areas of employment for statisticians are agriculture, biologic research, economics, engineering, health and medicine, operation of business firms, physical sciences, social sciences, and many others.

One of the most highly specialized jobs in statistical work is actuarial work. An actuary is a person who makes the original calculations for insurance companies. The entire business of an insurance company is based upon statistics; for example, rates for life insurance are based on the life expectancy of individuals according to their present age. These rates must be calculated with extreme care, otherwise the entire system of insurance would break down. In a sense, then, the actuary is the "life blood" of all insurance. To become an actuary one must pass an examination given by the Actuarial Society of America. There are only about eight hundred actuaries in the United States.

Personal qualifications. Ability to get along with

others, ability to speak and write clearly and correctly, analytic mind, high power of concentration, ability to accept facts with unbiased opinion, persistence.

Educational requirements: High School: mathematics, physics, chemistry, economics, social sciences. College: bachelor's degree in mathematics (4 year course); master's degree desirable (5 year course).

Suggested references: Chapter VIII--8, 17, 20, 22, 23, 24, 25, 26, 27, 28.

VIII. METEOROLOGY AND WEATHER FORECASTING

Type of work. Meteorology is concerned with the study of weather and climate. A person employed as a meteorologist or weather forecaster may work out in the field making observations or studying climatic conditions, or he may work in an office preparing and distributing reports.

Some of the services offered in this field are general weather bulletins and forecasts, weather service for aircraft and for ships, hurricane warning, flood forecasting, crop protection against adverse weather, forest fire warning, and research. One of the most recently publicized functions of a meteorologist is that of rain

making.

A forecaster may actually prepare forecasts of weather with regard to any of the above, he may analyze data collected, collect data, prepare and analyze weather charts and maps, or he may do research work. A person in this field may find employment with the United States Weather Bureau, with special private industries that hire their own meteorologists, or with a group of meteorologists who have organized their own company to give special weather services to various industries or individuals.

Personal qualifications: Ability to get along with others, ability to speak and write clearly and correctly, analytic mind, intellectual curiosity, good judgement, speed, accuracy, emotional and mental stability, good health for field work.

Educational requirements: High School: mathematics, science, typing, English, modern language, physical geography, chemistry, history. College: bachelor's degree in science (4 year course) plus graduate work if possible. Minimum mathematics requirement: 2 years.

Suggested references: Chapter VIII--8, 23, 36.

IX. PHYSICS

Type of work. The study of physics is the study of matter and motion. It includes the study of mechanics, electricity, magnetism, sound, heat, light, and the study of particles composing matter. Consequently, physics is basic to electrical, communication, radio, heat, and mechanical engineering as well as to developments in radar, guided missiles, and atomic weapons.

A physicist is in demand in any of these fields as a consultant on specialized problems. Often physicists are hired by private industries to do research in the above mentioned fields. The work is more meaningful and there is a better chance of employment if basic engineering principles are understood, since the work is closely related to the engineering field. Developments in nuclear power are providing opportunities for physicists. At present there is a serious shortage of physicists.

The work of the physicist and that of the mathematician are very closely related. A person considering a career as a physicist must have a genuine interest and liking for mathematics.

Personal qualifications: Ability to get along with others, ability to speak and write clearly and correctly,

analytic mind, understand the mathematical of physical laws, intellectual curiosity about the physical world, intellectual honesty, manual dexterity for experimental physics.

Educational requirements: High School: advanced algebra, plane and solid geometry, physics, chemistry. College: bachelor's degree in physics (4 year course); graduate work needed for research work. Minimum mathematics requirement: 3-4 years.

Suggested references: Chapter VIII--4, 5, 8, 36, 38.

CHAPTER VI

CAREERS IN MISCELLANEOUS FIELDS

I. AGRICULTURE

Type of work. As our population increases, greater production of farm products becomes necessary; production methods become more and more complicated. As a result constant research in the field of agriculture is necessary if our growing population is to be adequately fed. This field of research offers opportunities for highly educated scientists with special interests and training. A few of the types of research scientists doing research in agriculture are listed here to give an idea of the opportunities for scientists in the field of agriculture: agronomist applies knowledge of plants and soil toward crop improvement; agricultural bacteriologist studies bacteria in relation to a special area such as animal diseases; animal husbandman applies knowledge of genetics to improve farm animals; botanist identifies and describes plants and seeds; entomologist studies insect pests and beneficial insects; pathologist studies disease in plants and animals.

Personal qualifications: Ability to speak and write clearly and correctly; analytic mind, accuracy, interest in agriculture, ability to do original thinking,

patience, perserverance, intellectual honesty.

Educational requirements: High School: all mathematics and science courses offered, economics, English, speech. College: bachelor's degree in science plus graduate work and a higher degree if possible (4-6 year course). Minimum mathematics requirement: 2 years.

Suggested references: Chapter VIII--5, 8, 38.

II. ARCHITECTURE

Type of work. The architect of today is concerned with designing a building, making the drawings, and supervising the construction. He must be artistic and at the same time be practical and know technical aspects of construction. An architect may work on single residences or on the planning of entire subdivisions. Commercial and industrial architecture has become an important field. The factory or business building of today is functional and useful, and at the same time it is beautiful. Consequently, an architect must be quite skillful.

To become an architect, a person must pass an examination to obtain a license. This usually requires some experience in working for an architectural firm.

Personal qualifications: Ability to get along with others, ability to speak and write clearly and correctly, analytic mind, creative artistic ability, friendly personality, high integrity, must have the qualities of an artist, draftsman, mathematician, engineer, and businessman.

Educational requirements: High School: general course with special attention to art, mathematics, English, Latin, French. College: three plans: (1) 2-4 years in a liberal arts college plus 3-4 years in a school of architecture plus three years employment with an architect. (2) 4-5 years in a school of architecture plus 3 years employment with an architect. (3) No formal college education; work in an architect's office plus many years of self study and evening classes. Mathematics is listed as one of the important academic subjects studied.

Suggested references: Chapter VIII--8, 36.

III. DRAFTING

Type of work. The draftsman prepares the plans and drawings which must be followed in producing any article. This may be a detailed drawing of a very intricate part of an instrument or it may be drawings for a huge

skyscraper. The draftsman may be given rough sketches or fairly detailed sketches and specific dimensions. With these he must have the technical background to produce accurate working plans. This may require making changes and calculating dimensions as he proceeds. For this reason draftsmen usually specialize in one field. The principal fields and the type of drawings made in each are: (1) architectural: bridges, buildings, etc., which use structural steel in construction, (2) mechanical: mechanical devices, all types of machines, (3) marine: structural or mechanical features of boats or of harbor facilities, (4) map: all types of maps and map work, (5) patent: highly specialized field concerned with drawings of mechanical devices in patent applications.

Personal qualifications: Ability to get along with others, ability to speak and write clearly and correctly, analytic mind, ability to concentrate, orderly mind, artistic ability, patience, initiative, keen power of observation, manual dexterity, good health, good eyesight.

Educational requirements: High School: algebra, plane and solid geometry, trigonometry, 4 years English, art, mechanical drawing, physics, chemistry. College: it

is not necessary to attend college. However, opportunities for advancement are not too great without a college degree. There is a growing tendency on the part of industry to require some college training and to employ more and more graduate engineers for certain drafting jobs. It is a general practice for engineering firms to employ only young engineers who work as both designers and draftsmen. Many graduate engineers prefer drafting to engineering work and remain in the drafting field. Minimum mathematics requirement: 2 years.

Suggested references: Chapter VIII--1, 7, 8, 12, 21, 34.

IV. ECONOMICS

Type of work. An economist must have a complete knowledge of the principles of economics. He is concerned with all factors in earning a living: selling, buying, and producing commodities. He gathers and analyzes facts, plans and organized research work, compiles data on production and distribution, determines costs and prices of products, and makes a study of import and export costs. He uses the results of his work to advise others in their business ventures.

An economist may find employment as a teacher of economics in high schools and colleges, as an advisor on economic problems for government agencies, or as an advisor for business concerns.

A comparatively new field in special economics is that of mineral economics. Economists in this field are concerned with the distribution of mineral resources, the political control of mineral resources, and the effects of the distribution of mineral resources on national policy.

Personal qualifications: Ability to get along with others, ability to speak and write clearly and correctly, analytic mind, objective outlook, competent in handling statistics, integrity, good eyesight.

Educational requirements: High School: mathematics, English composition, languages, natural science, history, civics, economic geography, social problems, economics. College: bachelor's degree in economics (4 year course; doctor's degree recommended (7 year course). Minimum mathematics requirement: 2 years.

Suggested references: Chapter VIII--8, 36.

V. INDUSTRIAL DESIGNING

Type of work. The industrial designer creates designs for the products of industry such as electric mixers, waffle irons, plumbing fixtures, etc. He is more concerned with the actual form of the object than with any ornamentation added to the surface. The industrial designer must keep three things in mind regarding the product he is designing: (1) it must not be too expensive to manufacture, (2) it must be attractive, and (3) it must indicate the purpose for which it is intended. To be able to do these things the industrial designer must have a background of knowledge of the mechanical requirements of the product as well as artistic ability.

Personal qualifications: Ability to get along with others, ability to speak and write clearly and correctly, analytic mind, imagination, understanding of principles of engineering, tact, observing, intellectual curiosity, originality, resourcefulness.

Educational requirements: High School: all courses in mathematics, physics, chemistry, 4 years English, history, general business economics, foreign language, mechanical drawing, manual training, shop work. College:

Some industrial designers attend art school after high school graduation, some attend university or technical schools offering courses in industrial designing. Still others take post graduate training in art after a 4 year engineering course. This 4 year course would require a minimum of 2 years of mathematics.

Suggested references: Chapter VIII--8, 19.

VI. MEDICAL RESEARCH

Type of work. Medical research includes all research affecting problems of disease and health. Medical research may be done by specialists such as chemists, bacteriologists, and physiologists. It is the specialist in medical research that is responsible for new drugs, for new techniques in treatment of disease, and for improved operative procedures. Examples of problems of research are: study of viruses in relation to certain diseases, cancer research, the chemistry of proteins, the functioning of the nervous system.

A person engaged exclusively in medical research may be employed by government agencies, medical colleges, privately endowed foundations for medical research, or pharmaceutical firms. Most research workers have an M.D.

degree or a Ph.D. in a related field such as chemistry.

Personal qualifications: Ability to get along with others, ability to speak and write clearly and correctly, analytic mind, ability to withstand long, formal education, good memory, inquisitive mind, capacity to learn from experience, patience, perserverance.

Educational requirements: High School: 2 years mathematics, 1 year science, 2 years Latin, 1 year history, 4 years English, 3 years modern language. College: M.D. or Ph.D. in related field (7-9 year course). Minimum mathematics requirement: 2 years.

Suggested references: Chapter VIII--2, 5, 8, 17, 31, 36, 38.

CHAPTER VII

CAREERS IN TEACHING

Teaching is probably the most important profession in the field of science and mathematics. Without teachers very little of our scientific advancement would have been possible. In all the professions that have been discussed in previous chapters basic knowledge is essential. This can only be obtained from teachers trained in a particular field. A person who chooses teaching for a career can feel that he is performing a great service to his country and to his fellow men. It is only by education that we can advance, and teachers are essential to education.

In the past teaching has often been considered a woman's work. This concept is changing; more and more men are entering the field and finding great satisfaction in their work. A person with interest and ability would do well to consider some phase of teaching as a career.

I. HIGH SCHOOL TEACHING

Type of work. A high school teacher with interest and ability in mathematics would probably teach algebra, geometry, trigonometry, solid geometry, general mathematics, physics, or chemistry. In addition a teacher usually

participates in the activities of operating a school; these duties are assigned according to the teacher's interests and abilities. Examples of such duties are sponsoring of a club, being in charge of an assembly, being in charge of a graduating class, assisting in one of the offices.

In one sense the most gratifying of all teaching for an individual in the mathematics field is high school teaching. It is in high school that individuals with mathematical ability are located; a mathematics teacher can feel that he is doing a most important job in furthering scientific advancement. It is the mathematics teacher who provides these able students with a background of knowledge enabling them to advance. Just as important is the fact that the mathematics teachers can do much toward stimulating interest in those fields requiring a knowledge of mathematics.

Advancement to administrative work is possible with additional training and experience. Principals, supervisors, superintendents, and all administrators begin their career as teachers.

Personal qualifications: Ability to get along with others, ability to speak and write clearly and correctly,

attitude of helpfulness and understanding, mental alertness, emotional and moral stability, wholesome personality, sense of humor, good health, interest in people, impartial attitude, sympathy.

Educational requirements: High School: all mathematics offered in high school; follow a college preparatory course. College: bachelor's degree plus one year of graduate study; major or minor in mathematics. (5 year course) Minimum mathematics requirement: $2\frac{1}{2}$ years.

Suggested references: Chapter VIII--8, 17, 22, 27, 29, 30, 36, 37.

II. COLLEGE TEACHING

Type of work. Opportunities for college teaching in the fields of mathematics and science are offered in liberal arts colleges, vocational colleges, and vocational schools. College teaching differs from high school teaching in that the emphasis in college is more on the subject matter, on teaching the background of knowledge, rather than on the individual students in class each day. It is very important that the college teacher be an expert in his field; he is responsible for teaching factual information and procedures that his students will be using in

their work.

Often college teachers have an opportunity to spend part of their time doing research in the field of their specialization and thus have an opportunity to make an additional contribution to scientific advancement.

Personal qualifications: Ability to get along with others, ability to speak and write clearly and correctly, analytic mind, competency in field being taught, interest in community affairs, willingness to continue studying and adapting new ideas.

Educational requirements: High School: all mathematics offered in high school; follow a college preparatory course. College: doctor's degree usually required; beginning positions may be obtained with a master's degree (5-7 year course). Minimum mathematics requirement: 5-7 years.

Suggested references: Chapter VIII--8, 17, 22, 27, 29, 30, 36, 37.

III. TEACHING IN INDUSTRY

Type of work. Often industries offer additional specialized training for their employees. These classes

may be taught by college instructors, or they may be taught by people within the industry. For example, the aircraft industry frequently offers classes concerning new aspects of a particular problem taught by its advanced engineers.

The employee assigned to such a teaching position usually has met the requirements of his own field and is a specialist in that field. He must also have leadership ability and a sympathetic attitude.

Personal qualifications: Same as those for field of specialization.

Educational requirements: High School and College: same as those for field of specialization.

Suggested references: Chapter VIII--1, 22.

CHAPTER VIII

SUGGESTED REFERENCES FOR FURTHER STUDENT READING

I. BOOKS

1. Burger, Samuel, Careers in Aviation. New York: Greenberg, 1946. 209 pp.

   A presentation of opportunities in aircraft manufacturing industries; includes discussion of teaching and of electronics.

2. Carlisle, Norman V., Your Career in Chemistry. New York: E. P. Dutton and Company, 1943. 251 pp.

   A complete description of various fields using chemists.

3. Hartzell, Karl D., Opportunities in Atomic Energy. New York: Vocational Guidance Manuals, Inc., 1951. 144 pp.

   An explanation of atomic energy, the importance of the field, and a discussion of types of positions available in the field.

4. Patrick, Gene, Opportunities in the Petroleum Industry. New York: Vocational Guidance Manuals, Inc., 1952. 95 pp.

   Describes the general scope of the industry and workers needed in each field. The chapter on petroleum engineering is of interest to chemists, physicists, and geologists.

5. Pollack, Philip, Careers in Science. New York: E. P. Dutton and Company, Inc., 1945. 222 pp.

   A survey of opportunities in chemistry, physics, biology, and geology. Includes a bibliography.

6. Ranson, Jo, and Richard Park, Opportunities in Television. New York: Vocational Guidance Manuals, Inc., 1950. 128 pp.

A section of this book is devoted to opportunities for technically trained personnel such as audio engineers, development engineers.

II. PAMPHLETS

7. Can I Be An Engineer? Department of Public Relations, General Motors, Detroit 2, Michigan. 1951, 24 pp., free.

   General discussion of engineering and about personal qualifications necessary; written for the high school student.

8. Careers. The Institute for Research, 537 South Dearborn Street, Chicago, Ill. $1.00 each.

   A series of over one hundred monographs, each devoted to one career field. Dates of publication are between 1937 and 1954; most are about twenty-five pages long. Topics such as the following are discussed for each career: description of type of work, historical development, importance, specialized fields, principal jobs, description of a typical day's work, attractive and unattractive features, personal and educational requirements, salaries, how to get started, opportunities for women, bibliography.

9. Careers in Petroleum. American Petroleum Institute, 50 West 50th Street, New York 20, New York. 1951, 32 pp., free.

   Of particular interest is the section titled, "Science-Math-and-Go-to-College Group."

10. Careers in the Mineral Industries. John V. Beall and George P. Lutjen, American Institute of Mining and Metallurgical Engineers, 29 West 39th Street, New York, N.Y. 1953, 32 pp., free.

    A brief discussion of the entire field followed by discussion of various fields in the industry.

11. Ceramic Engineers and Artists. Occupational Briefs No. 239, Science Research Associates, Chicago 4, Illinois. 1948, 4 pp., 15 cents.

    Brief but informative presentation of work and qualifications of a ceramic engineer.

12. Chemical Engineering. Charles Eli Reed, Bellman Publishing Company, Inc., Boston, Mass. 1944, 24 pp.

    A thorough study of all phases of opportunities for chemical engineers.

13. Employment Outlook in Electronics Manufacturing, Bulletin No. 1072, United States Department of Labor, United States Government Printing Office, Washington, D.C. 1952, 30 pp.

    Gives an overview of the entire industry as well as an outlook for employment in individual occupations.

14. Engineering A Creative Profession. Engineers' Council for Professional Development, 29 West 39th Street, New York 18, N. Y. 1954, 32 pp., 25 cents.

    An excellent pamphlet dealing with the general field of engineering as well as the five main divisions of engineering. It includes information regarding personal and educational requirements, information regarding educational plans after high school graduation, and a well selected bibliography.

15. General Electric Looks At Engineering Tomorrow. General Electric Company, Dept. 2-119, Public Relations, 1 River Road, Schenectady 5, New York. n.d., 4 pp., free.

    An article for high school students about the importance of an engineer's work and how to prepare to become an engineer.

16. Geophysics as a Profession. Vocational Booklet No. 5, United States Department of Labor, United States Government Printing Office, Washington, D.C., 1947, 16 pp.

    Brief description of various branches of work in geophysics, how to get training, places of employment.

17. Guidance Pamphlet in Mathematics for High School Students. National Council of Teachers of Mathematics, 1201 Sixteenth Street, N.W., Washington 6, D.C. 1953, 40 pp., 25 cents.

    A discussion of various occupations and their relationship to mathematics; includes list of mathematical organizations and a list of references.

18. Highway Jobs. R. E. Royall, Occupational Monographs No. 8, Science Research Associates, Chicago, Ill. 1940, 48 pp.

    A study of employment in highway construction and maintenance; includes the work of the highway engineer.

19. Industrial Designers. Occupational Briefs No. 192, Science Research Associates, Chicago, Ill. 1947, 4 pp., 15 cents.

    The work of the industrial designer, requirements for a job, how to get started, good and bad features of the work are presented, as well as a list of selected references.

20. Invitation to Youth; Careers in Life Insurance. Educational Division, Institute of Life Insurance, 488 Madison Avenue, New York 22, N.Y. 1954, 32 pp., free.

    The section on careers for mathematicians describes statistical and actuarial work in life insurance.

21. Math At General Electric. General Electric Company, Dept. 2-119, Public Relations, 1 River Road, Schenectady 5, New York. 15 pp., free.

Sample mathematics problems typical of those solved by employees in various fields at General Electric. Included are problems solved by design engineer, chemical engineer, laboratory assistant, draftsman, personnel worker, meteorologist.

22. Mathematics--Its Vocational Aspects. Bulletin No. 13, Vol. 42, Oklahoma A. and M. College, Stillwater, Okla. May, 1945, 30 pp., free.

Jobs available to college graduates with four or more years of mathematics.

23. Meteorology As a Profession. Vocational Booklet No. 4, United States Department of Labor, United States Government Printing Office, Washington, D.C. 1946, 17 pp.

Description of the work of the meteorologist, related fields, beginning jobs, necessary qualifications. Bibliography included.

24. Opportunities for Statistical Workers. Occupational Monograph No. 1, Science Research Associates, Chicago, Ill. 1940, 56 pp.

General description of the field and types of training and experience necessary for employment. Contains a bibliography.

25. Opportunities in IBM. International Business Machines Corporation, 590 Madison Avenue, New York 22, N.Y. 32 pp., free.

Career fields indicated include engineering and research, sales and systems service, customer engineering, special fields. Of special interest is discussion about electronic computers.

26. Preliminary Actuarial Examinations. Society of Actuaries, 208 South La Salle Street, Chicago 4, Illinois. 1954, 32 pp., free.

Primarily information concerning the examinations, including sample questions. Six pages are devoted to a discussion of a career as an actuary.

27. Professional Opportunities in Mathematics. Mathematical Association of America, University of Buffalo, Buffalo 14, New York. 1943, 24 pp., 25 cents.

    Opportunities for college graduates in mathematics are discussed for the following: teaching, statistical work, industry, government, actuarial work.

28. Statistical Workers. Occupational Brief No. 185, Science Research Associates, Chicago, Ill. 1947, 4 pp., 15 cents.

    Importance of statistical work, places of employment, educational requirements, and how to enter the profession are discussed.

29. Teaching As a Career. Benjamin W. Frazier, Bulletin 1947, No. 11, Office of Education, United States Government Printing Office, Washington, D.C. 1947, 43 pp.

    A thorough review of the profession with references for obtaining additional information.

30. Teaching As a Career. Cyril Houle, Occupational Monographs No. 5, Science Research Associates, Chicago, Ill. 1940, 48 pp.

    A comprehensive treatment of the profession dealing with the general nature of the work, living and working conditions and specific information regarding training, experience, personal qualifications, chances of employment. Includes a list of references.

31. The Chemical Profession. American Chemical Society, Washington, D.C. 1951, 46 pp.

    A discussion of the work done by chemists and chemical engineers.

32. The Metallurgist in the Federal Civil Service, Pamphlet 42, United States Civil Service Commission. March, 1951, 43 pp.

Information concerning civil service examinations and the nature of work performed by metallurgists in civil service.

33. Television. Western Personnel Institute, Pasadena, California. 1950, 51 pp.

A general description of the entire television field. Sections on administration and engineering are helpful and informative.

34. What's Engineering? Stevens Institute of Technology, Hoboken, New Jersey. n.d., 16 pp., free.

Definition of engineering and what an engineer does discussed in general terms.

35. Why Study Math? General Electric Company, Dept. 2-119, Public Relations, 1 River Road, Schenectady 5, New York. n.d., 8 pp., free.

An article about the importance of mathematics including a listing of occupations that need considerable mathematics.

36. Why Study Mathematics? The Canadian Mathematical Congress, McGill University, Montreal, Canada. n.d., 33 pp., 50 cents.

Description of careers requiring varying mathematical backgrounds.

37. Your Career in Teaching. Education Department of the National Association of Manufacturers, 2 East 48th Street, New York 17, New York. 1953, 15 pp.

A series of questions about personal qualifications is included for the reader to answer. Also discussed is the teacher shortage and opportunities for teaching various subjects.

38. Your Opportunities in Science and Engineering. National Association of Manufacturers, 2 East 48th Street, New York 17, New York. 1952, 30 pp., free.

Opportunities in biology, physics, and chemistry emphasized; good chapter on developing necessary personal qualifications.

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A. BOOKS

Brewster, Edwin Tenney, Vocational Guidance for the Professions. Chicago: Rand McNally and Company, 1917. 211 pp.

Much of the information is out of date, but the book is still valuable for its discussion of a profession and the rewards other than monetary of professional work.

Leonard, J. Paul, Developing the Secondary School Curriculum. New York: Rinehart and Company, 1946. 580 pp.

A textbook on the history of the curriculum; traditional curriculum; newer theories of curriculum organization.

Lingenfelter, Mary Rebecca, Vocations in Fiction. Chicago: American Library Association, 1938. 99 pp.

An annotated bibliography of fiction books that are about certain vocations; books listed according to vocations; age suitable for reading indicated.

Myers, George E., Principles and Techniques of Vocational Guidance. New York: McGraw-Hill Book Company, Inc., 1941. 377 pp.

A thorough presentation of all aspects of vocational guidance.

Price, Willodeen and Zelma E. Ticen, Index to Vocations. New York: The H. W. Wilson Company, 1938. 122 pp.

Books listed according to vocational fields; also a list of biographies in vocational fields; an annotated bibliography for vocational teachers and counselors.

B. PERIODICAL ARTICLES

Astin, A. V., "Some Facts on the Current Shortage of Technical Personnel," Education, 73:405-08, March, 1953.

Need for a long range program of recruitment of scientific workers emphasized.

Bernhard, Ida May, "Materials Available for Counseling in Mathematics," The Mathematics Teacher, 47:279-80, April, 1954.

A brief discussion of vocational counseling as a part of the work of the mathematics teacher followed by a partial list of available materials.

Brune, Irvin H., "Vocational Opportunities in Mathematics," The Bulletin of the National Association of Secondary-School Principals, 38:20-31, May, 1954.

Brief discussion of various fields such as industry, skilled workers, engineering, research.

Hobbs, Nicholas, "Some Notes on Science and Guidance," Education, 73:434-36, March, 1953.

A discussion of guidance to overcome the shortage of scientific personnel.

Johnson, Philip G., "A High School Teacher's Opportunity for Guidance Toward Science," Education, 73:439-441, March, 1953.

Specific suggestions for the science teacher.

Lee, D. C., "Guidance Toward Electronics Research and Development," Education, 73:451-53, March, 1953.

Discussion of need of trained workers in electronics with special reference to the contribution of the Westinghouse Corporation in recruitment.

Kitson, Harry D., "Vocational Guidance Through School Subjects," Teachers College Record, 28:900-15, May, 1927.

Discussion and examples of introducing vocations through subject fields; two given for arithmetic.

Langer, Rudolph E., "Why We Teach Mathematics," The Bulletin of the National Association of Secondary-School Principals, 38:5-9, May, 1954.

An excellent discussion of the importance of mathematics.

McWilliams, R. L., "Guidance Toward Engineering," Education, 73:409-13, March, 1953.

Answers questions concerning requirements, rewards, opportunities for engineers; also gives causes for the shortage.

Murphy, Walter J., "Guidance Toward Chemical Engineering and Research," Education, 73:418-21, March, 1953.

Lists qualifications of students entering chemical engineering or research.

Packard, Vance, "Youngsters Wanted for Jobs Unlimited," The American Magazine, 155:27-28, June, 1953.

An article about the seriousness of the shortage of trained workers in scientific fields, the ways in which industry is recruiting young people, and opportunities for talented youth.

Reynolds, Neil B., "Mathematics and the Needs of Industry," The Bulletin of the National Association of Secondary-School Principals, 38:31-35, May, 1954.

The industrial jobs needing a knowledge of mathematics are mentioned; steps industry has taken to recruit workers are related with special reference to General Electric Company.

Rogers, T. H., "Supply and Demand of Technical Personnel in American Industry," School Science and Mathematics, 53:87-96, February, 1953.

An analysis of statistical data on the problem of technical personnel; proposed solutions for relieving the shortage include the role of the high school teacher.

Schaaf, William L., "Guidance: The Case for Mathematics," The Mathematics Teacher, 44:130-34, February, 1951.

Guidance in the mathematics classroom; includes a good bibliography.

Welch, Harriet A., "What Can the Teacher of Mathematics Do About Vocational Guidance?" The Mathematics Teacher, 36:99-101, March, 1943.

An article which mentions a few occupations needing mathematical training; emphasizes importance of mathematics in various branches of military service.

Wilson, Leland L., "Guidance Toward Research and Development in Physics," Education, 73:414-17, March, 1953.

An article concerning the need for physicists, finding potential physicists, and guiding capable students toward a career in physics.

C. PUBLICATIONS OF LEARNED ORGANIZATIONS

Careers. Chicago: The Institute for Research.

A series of over two hundred monographs, each a discussion of one career field. Each contains approximately twenty-five pages; the dates vary from 1937 to 1954.

Guidance Pamphlet in Mathematics for High School Students. Washington, D.C.: National Council of Teachers of Mathematics, 1953. 40 pp.

A discussion of various occupations and their relationship to mathematics; includes list of mathematical organizations and a bibliography.

United States Department of Labor, Dictionary of Occupational Titles. Part I, Definitions of Titles. Washington, D.C.: United States Government Printing Office, 1939. 1287 pp.

The standard definition of the work performed in a particular job.

United States Department of Labor, Dictionary of Occupational Titles. Part II, Titles and Codes. Washington, D.C.: United States Government Printing Office, 1939. 330 pp.

Listing of jobs by major occupational groups; explanation of code numbers.

United States Department of Labor, Occupational Outlook Handbook, Bulletin Number 998. Washington, D.C.: United States Government Printing Office, 1951. 475 pp.

A publication specifically for use in guidance; gives employment information on the major occupations.

Why Study Mathematics? Montreal: The Canadian Mathematical Congress, n.d. 33 pp.

Description of careers requiring varying mathematical backgrounds.