THE TECHNICAL INSTITUTE MOVEMENT
A Study and Projection of These Programs in American Higher Education

DISSERTATION
Presented in Partial Fulfillment of the Requirements for the Degree Doctor of Philosophy in the Graduate School of The Ohio State University

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The Ohio State University
1958

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THE TECHNICAL INSTITUTE MOVEMENT

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Many new occupations evolved at the turn of the century when American industry began a rapid period of expansion. As industry accelerated, many thousands of technicians with skill and knowledge in this area were required in ever increasing numbers. Few men were available with an adequate combination of technical training and formal education. The need for skilled personnel has initiated the development of many technical programs to prepare men for these newly created needs.

The purpose of this dissertation is to survey the background, status and future of technical training in American higher education. The fact that the Technical Institute type of education has not been widely publicized makes this survey desirable.

The writer's greatest indebtedness is to his adviser, Dr. William E. Warner, for his many suggestions and excellent guidance in directing this dissertation. In addition, the writer is indebted to Dean Leo F. Smith of the Rochester Institute of Technology for many items of valuable source materials. President Karl O. Werwath, of the Milwaukee School of Engineering, and Professor G. Ross Henninger, Assistant Director of Engineering Extension Service, Iowa State College, at Ames, were also very helpful.

July 1958

CHARLES W. PHALLEN
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Chapter I

PERSPECTIVE OF THE PROBLEM

This chapter introduces the problem. It presents the need, scope and limits, definitions of basic terms, sources of data, and organization of the study.

STATEMENT OF THE PROBLEM

There has been a tendency to think of American education as a single ladder starting with elementary and extending through the university. In this conception, the elementary, secondary school and college have become crystallized. The technical institute, however, is one type of institution that does not fit clearly into the single-ladder scheme. Therefore, one set of purposes of this study is to identify the technical institute, to outline its place in American education, to investigate the needs of American industry for this type of education, and to survey the organization and projection of the movement.

NEED FOR THE STUDY

Since the primary purpose of the technical institute is to prepare graduates for employment in technical and supervisory occupations, the need for this type of education
depends upon, (1) the employment requirement of industry, (2) the number of people in these occupations, (3) the possible sources of trained personnel, and (4) the annual need for new technicians for replacement and expansion.

Studies as far back as 1926 indicated there was a real and increasing need for more technical education. Emerson in 1944 found that the average ratio of technicians to engineers in industry was 5.2 to 1.

Recent surveys indicate that the pattern of industrial development is bringing about an ever-increasing demand for this type of education.

**SCOPE AND LIMITS**

This study deals in general with an area rather than with a specific type of technical education. A provisional definition of technical education is used to mean a program which is industrial or technological in content, more advanced than high school vocational programs, more direct in aim than instruction in engineering, shorter than college courses, more closely related to prospective employment, organized on a terminal basis, and not confined to a single branch, but including related subject matter.

This study does not include higher or vocational education as such, but it does involve forms of training that meet the needs of technicians, foremen, and plant superintendents without minimizing their possibilities for advancement to higher posts, such as that of an engineer or
executive. Furthermore, the technical institute serves a more direct local need than does the college. An attempt will be made to avoid fixing any formal type of school or course of study as a norm.

**DEFINITION OF TERMS**

The reader is given the following definitions in order to avoid the danger of misunderstanding terms which are closely allied and which are often used interchangeably.

**Technology.** The science or systematic knowledge of the industrial arts, particularly of the more important manufacturing processes and the use of their products.

**Technical school.** A school offering instruction in practical arts, usually below the level of higher education, but above that of the high school.

**Technical education.** Those aspects of the program of teacher or industrial education which stress the use of special methods or techniques of teaching, such as the diagnosis of abilities.

**Laboratory.** A place where research and learning take place.

**Industrial arts.** A phase of general education which provides the student with experiences, appreciations, and understandings of tools, materials, processes, and products of the technology.

**Vocational education.** A name for those experiences whereby an individual learns successfully to carry on a gainful occupation.
Curriculum, program and course of study. A sequence of courses leading to a specific vocational objective.

Terminal education. The formal training or type of education which leads to immediate employment.

Technical institute. The following interpretation is given by the Engineer's Council for Professional Development (39, p. 39)* in its Eighteenth Annual Report, 1950:

Technical institute programs are intermediate between the high school and vocational school on one hand and the engineering college on the other. . . . The purpose is to prepare individuals for positions auxiliary to, but not in the field of professional engineering. Curricula are essentially technological in nature, based upon principles of science, require the use of mathematics beyond high school and emphasize rational processes rather than rules of practice. Curricula are briefer, more intensive, and more specific in purpose than engineering curricula, thought they lie in the same general fields of industry and engineering. Their aim is to prepare individuals for specific technical positions or lines of activity rather than for broad sectors of engineering practice.

Many institutions have a mixed character and many times it is easier to identify the type of education which an institution offers than it is to classify the institution. A few quotations from prominent leaders in the field will make this point clear. For example, Spivey (103, p. 1), writing for the Technical Education News, says:

For every American school known as a technical institute there are ten colleges and universities offering technical institute types of

*See reference 39 in the Bibliography.
courses, either on a part-time basis, usually at night, or through their extension departments. For this reason one should think not of Technical Institutes, but of the Technical Institute Principle of Education.

Bogue (17, p. xx), in introducing his book, The Community College, has this to say:

It may be noted that the community college is designated as a movement rather than an institution. While the terms "community," "junior," "general college," "technical institute," "extension center," "undergraduate center," etc., will be seen in this book, they are, nevertheless, really all of a piece in the general movement to extend to larger numbers of people the advantages of education and the kinds of education they need and want.

According to Bogue, when a technical institute is examined, it must be considered as a special phase of this larger movement.

Graney (45, p. 373) has this to say:

Technical Institute education is a relatively broad term in that it may be applied to a rather large number of subject-matter or occupational areas. However, the predominant trend today is to confine the meaning of the term to those subject-matter fields that are closely allied to engineering education.

For this study, the technical institute will be thought of as an institution offering a type of education allied to engineering education. This type of education has developed outside of the traditional educational system.

SOURCES OF DATA

In preparing this study, the writer has traveled extensively from New York to California. Many institutions
of various types were visited and their leaders consulted. A considerable amount of first-hand information was gathered by this means.

The first several days of the field inquiry were spent at Rochester Institute of Technology surveying first the physical plant and then the many other areas of interest under the direction of Dean Leo F. Smith. From Rochester, the writer went to Cornell University at Ithaca, New York, where the staff of Dr. Lynn A. Emerson was consulted at length. The Technical Extension Service Program at Pennsylvania State College was also visited.

Considerable time was spent with President Karl O. Werwath, at the Milwaukee School of Engineering. He is chairman of the Committee on Curriculum Development at the Technical Institute Division of the ASEE. President Werwath's discussion of the final report to the President's Committee on Scientists and Engineers developed by The Working Committee for the Development of Supporting Technical Personnel proved to be most helpful.

Iowa State College, Ames, Iowa, was also visited where Professor G. Ross Henninger, Project Director for the National Survey of Technical Institute Education, was interviewed concerning the progress of the National Survey.

The California Institute of Technology and several Junior College facilities in California were included in the field inquiry.
The literature on the technical institute is somewhat limited, although it is informative. Some of the more important references are given below. The best over-all study of the technical institute to date is, *A Study of Technical Institutes*, released by the Society for the Promotion of Engineering Education (SPEE) in 1931. The *Junior College Journal* has several articles on technical-terminal education in the junior colleges. The *Journal of Engineering Education* has several informative articles on technical institutes. The *Technical Education News* has been the best source of current information on technical institutes. The annual reports of the Engineer's Council for Professional Development have been fruitful sources of information. The United States Office of Education, the Bureau of Labor Statistics, the Census Data, and the Commerce Department have all published bulletins that contain information on technical education, the most important of which is the one Lynn Emerson of Cornell directed, *Vocational-Technical Training for Industrial Occupations*. The Report of the President's Commission on Higher Education contains a large amount of general information. Catalogues from the various technical schools have been of considerable value.

Some of the leaders in technical education who have supplied valuable information are--

*Leo F. Smith*, Director of Research, Rochester Institute of Technology.
ORGANIZATION OF THE STUDY

Chapter I presents the perspective of the problem, the need for the study, scope and limits, definition of terms, sources of data used, and the organization of the study. Chapter II reviews the history of the movement and provides an insight into why technical education has developed as it has. Chapter III analyzes the nature of the technical institute. Chapter IV presents the technical training needs of American industry. Chapter V examines the need for this type of education. Chapter VI is devoted to a study of the organization and projection of technical institute. Chapter VII analyzes the administrative elements involved. Chapter VIII summarizes the results presented in this study, and on the basis of these results certain conclusions are made. The writer has suggested several recommendations, founded on this research, on the basis of what he finds to be the place of the technical institute in the present scheme of education.
Chapter II

HISTORY OF THE MOVEMENT

This chapter presents some of the many factors which have contributed to the development of the technical institute. There are apparently no traceable patterns of growth as such in the United States. Each institute seems to have developed because of the educational foresight of an individual or as a result of a local training need. In many respects, however, the early growth of the technical institute closely paralleled the growth of similar institutions in Great Britain and other European countries. The attention paid to both theory and practice of technical education in this country, during the colonial period, seems to have owed its origin not only to local conditions but to the examples set by the mother country.

HISTORICAL INFLUENCES

Technical Institutes of Europe. Since much of the early development of technical schools was conditioned not only by local circumstances but also by the examples of European schools, a comparison of technical education in America and in Europe should be instructive. European systems for the most part, with their more clearly defined
aims and organization, appear more orderly than American types. Although the present study is not exhaustive, attention must be called to some prominent characteristics of systems in operation abroad.

European, and especially English, models continued throughout the nineteenth century (116) to be a dominant factor in determining the character and function of systematic education for industry in this country. The educational systems of Europe, however, have grown out of economic and cultural conditions somewhat different from our own. The European systems of technical education are based on a system of central or governmental planning and on a different social philosophy. This fact should throw some light on the existing gaps and perhaps on some of the values overlooked in the American system. The European systems have arisen from economic competition, which has been the result of population pressures and struggles between national groups. The American system has as its background the concept of free enterprise. Nevertheless, the merits of European institutions suggest the adaptability of some of the traits to American conditions. Since distinctive types abroad have evolved from a clear perception of their functions and a desire to serve people of different interests with equal effectiveness, they could prove compatible with American ideas of democracy. A Study of Technical Institutes (116, p. 199) states:

... They may, in fact, draw us toward the conclusion that democratic ends are not effectively
served by providing only a professional training of the university type. . . .

The same source further points out a need to create a parallel ladder of technical education with more adjustable entrance and terminal levels as a means of helping personnel already working or experienced.

The European systems represent careful planning, based on a different social philosophy. Their schools are not individual enterprises. Great Britain's system, for example, is operated under parliamentary authority, which is a combination of central and local control. France has a highly centralized system, headed by an Under-Secretary of State for Technical Education, while Germany delegates control to its States. The American examples have never been thought of as a national problem. They are recognized as a necessary part of the free economy, but with no direct control by the professions and industries served. The schools are essentially free and any standardization that exists is self-imposed.

The technical institutes of Europe differ somewhat in name and organization from one country to another. In spite of a great diversity of programs and practices, however, certain distinctive characteristics are common to all of them. Almost without exception, they have no direct connections with secondary schools or universities. They are neither trade schools teaching proficiency in crafts nor preparatory schools for higher education. Their courses are terminal in character and are designed to prepare persons who are already
oriented to industry. Their curricula are shorter and more practical than university schools, for they include very little general education. Physical science and mathematics are not taught as independent subjects, but in direct connection with their technical applications. Most of the student work is done under direct supervision. The emphasis is on higher practical pursuits rather than on specialized intellectual functions.

American and European Experience Contrasted. The American technical institute movement in its early stages closely paralleled that of the mother country. In America as in England, some mechanic institutes still exist, while some have developed wholly or in part into trade, technical, or engineering schools. The majority, however, in England as well as here, have died out.

One of the significant outgrowths of the industrial revolution in England was the movement for the education and welfare of working men. This movement was the chief cause for the development of technical education. When it reached its heyday, it had flowered into 250 or more local technical institutions, with a total enrollment exceeding 100,000 men, mostly part-time and evening classes.

Through the nineteenth century, the English influence continued to have the largest share in determining the character of technical education. The institutes, introduced into this country early in the 1820's, had been developing
in England for several decades. It is true, however, that the early American institutions showed at least some deviations from the English type. The most famous of the institutes of the early 1820's was the Franklin Institute of Philadelphia.

The American institutes seem to have provided a more practical education than did the English. Hudson (51, p. 216), in his *History of Adult Education*, says:

> The perfect mechanics institution can only be found in the Western World, for in no part of Europe can a people's institute be seen in which a machine shop supplied with the necessary mechanical tools for the diligent and for inventors is accessible to all.

In England and America, some institutes have remained in existence and have evolved wholly, or in part, into technical institutes. The Ohio Mechanics' Institute of Cincinnati, for example, which opened in 1828, has developed over a period of time into a technical institute.

The technical schools of France are part of the system of national education. France has two distinct systems of education, each complete in itself. One system prepares for citizenship at large through a base of general knowledge. The other system is designed to transmit the cherished cultural heritage and educates the intellectual elite for leadership. Each system has its own group of higher technical schools. One is predominantly professional and intellectual in emphasis; the other industrial and practical. A small
group of engineering schools, however, occupies an inter-
mediate place. The line of demarkation between the two
systems is mainly social and financial.

Wichenden and Spahr in, *A Study of Technical Insti-
tutes* (116, p. 204) reports:

No sharp line can be drawn between the techni-
cal schools of the higher and middle categories in
France. The Ecoles d'Arts et Metiers, although
accorded recognition as higher institutions by the
Ministry, actually occupy the middle level of
scientific and technical instruction. Their
genius lies in the realm of the mechanic arts,
where they are unsurpassed in Europe.

The Ecoles d'Arts et Metiers supply about 40 percent
of the higher technical personnel in France and two-thirds
of the total in mechanical engineering. They are recognized
by the French as institutions of higher learning.

Technical education in Germany is on three levels:
(1) the technical universities, (2) the higher industrial
schools, and (3) the middle industrial schools. The ele-
mentary forms are within the continuation schools, while the
universities may be entered only after a nine-year attendance
of a secondary school, which terminates with a certificate.
The universities devote themselves to advanced forms of learn-
ing and send their graduates out as accredited members of the
technical professions. The industrial schools of higher
order are open to students who have completed a six-year pro-
gram of secondary studies and who have had two or more years
of industrial experience. Their graduates are prepared for
higher practical pursuits of industry and engineering. They
may qualify for professional recognition after five years of experience. The middle industrial schools receive students who have had four years of education and experience. They train the intermediate technicians and supervisors of industry. These levels of technical education are common in Europe and Scandinavia.

Technical education in Europe (116) is pursued with an intensity unknown in America. What Germany lacks in space and natural resources, she makes up for in the art of fabrication. Wickenden and Spahr, in *A Study of Technical Institutes* (116, p. 268), further point out:

The social and economic ends of technical education are sensibly different in the two areas. Ours is conceived as an aid to the progress of individuals of varying needs and tastes, and only secondarily as a process of recruiting well-defined callings. Our technical professions have no codes of qualifications which make for definiteness of educational aims and standards. Not so in Germany or elsewhere in Central Europe: their technical education is a definitely organized arm of the body economic, controlled by the brain of the system—the State. Standards are set objectively by State examinations; technical education is grade; each type of diploma carries certain career privileges and limitations; and it is difficult to rise from one caste to another by sheer force of personality. Because their aims are more clearly visualized, their educational system is more logically organized. For both reasons it is more efficient in some respects, and in others attains an efficiency equal to our own at far less cost in paternalism.

The engineering profession has taken a constructive part in technical education in Germany (116). In an essentially bureaucratic system, the profession has built up its influence to a level almost equal to the State. In the
United States, technical education has complete freedom, but it is left to grope and fend for itself (116, p. 269):

... Herein are potentially its greatest strength and its greatest weakness, for educational progress depends not alone on experiment and innovation, but equally on clearly visualized aims for both the schools and the professional body.

There is no doubt that Germany is spending far more, in proportion to her means, on research and technical education than any of the other great economic powers.

It is interesting to note that Sweden and Switzerland have developed strong regional types of middle and higher industrial schools. In Sweden, primary education leads to a variety of vocational institutions, both full and part-time, which form a unified system of technical education. It is an interesting fact (116) that housecraft is treated as a vocational type of education on a par with industry. Furthermore, the highest grade of university education requires a long full-time education, but this may be either general or technical in character.

THE MOVEMENT IN THE UNITED STATES

Influence of the Industrial Revolution. The industrial revolution occurred later in the United States than it did in England and on the continent. In England, the great change in industrial life (11) affected by the industrial revolution came about in two distinct stages. The first of these dates from the last years of the eighteenth century and
was focused on helping the workman adjust himself to conditions caused by the new system. The last movement started in the second quarter of the nineteenth century and provided a more powerful incitement for industrial education; namely, aiding England in the international struggle for the markets of the world.

When the machine took over handwork and the progressive division of labor deprived industry of much of its educational value, attempts were made to counteract this problem through educating adult workmen in the sciences most closely related to their occupations. Anderson (11, p. 63), in *History of Manual and Industrial School Education* says:

> The gradual decline of apprenticeship under the influence of the industrial revolution has ever since been one of the most influential of the factors contributing to the movement for school education in the industries.

This statement suggests why mechanics' institutes, lyceums, academies, and other associations for mutual improvement were organized.

**Academy.** One of the very first influences that helped materially to promote technical education in the United States was Benjamin Franklin's Academy, which was opened in 1751. Although Franklin maintained a keen interest in education throughout his life, his views were considered radical for his time. They appeared in a pamphlet (11) called *Proposals Relating to the Education of Youth in Pennsylvania*, which even the liberals of the time would not accept.
British Institutes. The second influence that promoted technical education in the United States was the British type of institute. The institutes introduced into this country in the early 1820's had been developing in England for three decades as an institution for training adult workmen. In both America and England, a few mechanic institutes still exist, but they have developed, wholly or in part, into technical schools.

Lyceum. A third influence was the American Lyceum, established about 1826. Its primary purpose was to meet current educational needs by popularizing useful knowledge in the United States. It was also designed to meet the educational needs of artisans and farmers.

The Lyceum depended for support upon gifts, fees, and grants from the State Legislature. It faded away when the grants were withdrawn after a decade of operation. Nevertheless, it was a significant achievement, for it paved the way to the modern technical institutions at a time when higher institutions were blind to the needs about them.

Manual-training Movement. Another influence that had an effect upon technical education was the Manual-Training Movement. This movement was introduced into the United States about 1880, but it was not popular for a number of years. The theory of general rather than technical education was emphasized by Dr. Woodard. The basic idea of this movement was that the student should spend about half of his time
working at some manual activity and the remainder in academic work. Manual training was based on formal discipline, transfer of training, and faculty psychology.

**Influence of the Morrill Land-Grant Act of 1862.** Just before the Civil War there developed a popular movement for the use of public funds to provide a school education that would promote both skill and intelligence for the occupations of the people. The university system then developing was given an immense stimulus by the Morrill Act of 1862, which led to the establishment of Land-Grant colleges. At the same time, however, other forces were drawing attention away from the education of industrial workers: (1) public high schools, (2) increased immigration, with an influx of well-trained men from abroad, and (3) the ingenuity of an intelligent people. Still, efforts were made to establish flexible technical schools of a practical type. Eventually, the majority was drawn into engineering colleges, but some, through loyalty to the original purposes of their founders or the tenacity of their directors, have evolved into technical institutes. The colleges (116) have reached a high degree of uniformity, while the technical institutes have maintained a high degree of individuality. The college degree, with its standardizing tendency, has become a powerful force, while the absence of formal credentials has been a distinct impediment to the growth of the technical institutes.
THE MECHANIC INSTITUTE MOVEMENT

European, and more especially English, influence continued to play a dominant part in the development of a systematic education for industry throughout the nineteenth century. The first Institute, introduced in this country in 1824, had been developing in England for several decades as an institution for adult workmen. In this country (116), the roots of technical education go back to a voluntary movement of the industrial classes. In 1820, the General Society of Mechanics and Tradesmen established in New York an apprentices' library and a school for the children of mechanics. An apprentices' library was established in Boston in 1820. Thus out of the mechanics' institute movement grew many of the technical schools of today.

Early Technical Institutes. The growing recognition for the necessity of providing a systematic industrial education is reflected in various experiments. For example, the pioneer step in organized teaching of industrial science belongs to the Gardiner Lyceum, established at Gardiner, Maine, in 1822 (116, p. 31), "to give farmers and mechanics such a scientific education as would enable them to become skillful in their professions." The original course of study, published in 1827 (116, p. 31), gave special emphasis to a course of instruction as follows:

First Year. Arithmetic, Geography, Bookkeeping, Algebra, Geometry, Mensuration, and Linear Drawing.
Second Year. Trigonometry, Surveying, Navigation, applications of Algebra and Geometry. Differential and Integral Calculus, Mechanics, Perspective, Chemistry, and Agricultural Chemistry. Instead of the last-mentioned subject Civil Engineering is pursued by those who prefer it.

Third Year. Natural Philosophy, Astronomy, Political Economy, the Federalist, History, Minerology, Natural History, Natural Theology.

The methods of instruction (116, p. 32) were even more prophetic than the curriculum:

It is the constant object in instruction at the Lyceum to familiarize the students' minds with the practical application of their lessons. Surveying and Levelling are taught not only in the recitation room, but in the field. The pupil in chemistry is carried into the laboratory and allowed to perform experiments, and the classes in Mechanics are exercised in calculating such problems as occur in the practice of the machinist or engineer. Habits are thus formed of great importance to pupil, and he becomes familiar with those processes of thought which will be necessary to him in active abstract principles of science, but he has the lesson of bringing his knowledge to bear on any subject to which it is applicable.

The Gardiner Lyceum depended for support upon gifts, tuition fees, and appropriations from the state legislature. When the legislature withdrew its support, the Lyceum faded out after ten years of successful operation. It had, however, pointed the way at a time when many institutions were indifferent to economic needs.

Stephen Van Rensselaer founded the Rensselaer School at Troy, New York, in 1824, and specified many details concerning its management. The principal aim was the diffusion of scientific knowledge among farmers and artisans by preparing them to impart this knowledge and skill to others. The
chief difficulty was the scarcity of qualified lecturers and teachers. Van Rensselaer, who owned a tract of land now comprising three counties in eastern New York, was quick to grasp the situation and prepare a remedy by taking steps, in 1823, to establish a school at Troy. He did this (116, p. 32) . . . for the purpose of instructing persons who may choose to apply themselves in the application of science to the common purposes of life. My principal object is to qualify teachers for instructing the sons and daughters otherwise, in the application of experimental chemistry, philosophy, and natural history to agriculture, domestic economy, the arts and manufactures.

The man behind this undertaking was Amos Eaton, a graduate of Williams, who had done advanced work in natural science. Van Rensselaer had employed Eaton to make a survey for the improvement of agriculture and was deeply impressed by his scientific ability. The primary aim of the school was to train qualified teachers of science who could go into the field. In his plan for the school, Van Rensselaer (116, p. 33) specified:

In every branch of learning the student begins with its practical application and is introduced to a knowledge of elementary principles from time to time, as his progress requires. . . . By this method a strong desire to study an elementary principle is excited by bringing his labors to a point where he perceives the necessity of it and its application to a useful purpose.

Rensselaer might have remained as a school for training teachers of science but for the depression of 1835. By that year it had evolved into an engineering school, and in the same year conferred its first degree of Civil Engineer.
Franklin Institute, Philadelphia, 1824. The second and most famous of the mechanics' institutes of this period was the Franklin Institute of Philadelphia, named in honor of Benjamin Franklin. The resolutions (15, p. 319) that led to its establishment in 1824 show the scope and aims of this organization.

Resolved, That it is expedient to form a Society for the promotion of the useful arts in Philadelphia, by extending a knowledge of mechanical science to its members and others at a cheap rate.

Resolved, That the best mode of attaining this object will be by the establishment of Popular Lecturers, by the formation of a cabinet of models and minerals, and of a Library, and by offering premiums on all useful improvements in the Mechanic Arts.

Resolved, That the Society shall consist of Mechanics, Manufacturers and other friendly to the useful arts.

Although Franklin always had a very keen interest in the mechanic arts, it must be remembered that American society of that time was still relatively simple, and the need for a more dynamic plan for industrial training had not become urgent.

Mechanics' Institute of New York City. While the English movement for technical education was taking place among the working classes, philosophic societies and mechanic institutions were rapidly developing in the United States. Bennett (15, p. 317) states:

Fundamentally, the movements in the two countries were the same; they were both a part of the great effort of the industrial and agricultural populations to better their social and economic
condition through education, and the ruling classes to build up an intelligent and efficient body of workers and citizens.

Since this country was young, it may be said that conditions in America were less uniform. The people were scattered over a vast territory. Movement was less fixed and the schools varied greatly in character. The first institution of this type came into existence in 1820, when the Society of Mechanics and Tradesmen of New York City opened an apprentices' library and established a mechanics' school. The Society itself was organized in 1785, its primary object being "mutual aid." It occupies a commodious structure on West Forty-fourth Street at the present time.

Ohio Mechanics' Institute. The Mechanics' Institute of Cincinnati, Ohio was opened in 1828. Cincinnati at that time was the largest cultural center of the West. Bennett (110, p. 325) reports:

Dr. John D. Craig came to this city, who had been a teacher of natural philosophy in Philadelphia, and who had brought with him a valuable collection of apparatus.

He was subsequently elected first president of the Institute and gave a series of lectures (15, p. 325) on "The mathematical and physical sciences." A statement concerning the scope and methods of the Institute, published in 1841, reads as follows:

A course of lectures is delivered every winter, occupying two or three evenings each week, upon all branches of Natural Philosophy, in regular courses. Classes are established for the
prosecution of any study, whether of Sciences or of the Ancient and Modern Languages, whenever any number of young men choose to organize themselves for this purpose; and they are taught upon the principle of mutual instruction, some important teacher giving his services in the commencement, to enable them to adopt the most suitable method of instruction.

The Ohio Institute was the only one of this early group to evolve into the type with which they study deals.

LEVELS OF TECHNICAL SCHOOLS IN THE UNITED STATES

There are three levels of technical or industrial education in the United States to date that have developed to meet the industrial needs of the country. In each case, society usually devised a particular type of institution to meet its needs. Figure I illustrates the three levels.

Figure I

LEVELS OF TECHNICAL EDUCATION
Vocational-Technical. The oldest type of training was for the trades, that is, for skilled, semiskilled, and manual occupations. In the early days of this country, apprenticeship was an institution devised to maintain a constant supply of skilled and semiskilled craftsmen. Even today, a large percentage of skilled craftsmen are created by the apprenticeship method.

Mechanic Institutes. America's technological development became ever more complex due to the industrial revolution so a quicker and more effective method of training was needed, and science had to supplement the workshop. It was then that the mechanic institute came to the front.

Engineering Colleges. The coming of the railroads brought rapid economic development, and public works, manufacturing, mining, and even urban growth were quick to see the stimulus of mass transportation. Thus there arose a demand for engineers. Except for a few military engineers trained at West Point or abroad (mostly in France) and a small number who were self-taught, there was no established body of practitioners. Thus the engineering schools arose to fill this gap from a simple necessity. Rensselaer was the first to respond in 1835. An engineering curriculum evolved which was rapidly assimilated into a scheme of university education. The influx of well-trained technicians from abroad, however, diminished some of the earlier demand for engineers.
BACKGROUND OF THE TECHNICAL PROGRAMS

Since the beginning of this century, there has been an increase in the demand for public education in the two years beyond the current twelve years of elementary and high school. The growing demand for more free education beyond high school has usually been referred to as the junior college movement. An outstanding example of this movement is the development of California's system of publicly supported junior colleges (87) which in 1937 enrolled 37 percent of the nation's junior college students. This movement is gaining rapidly throughout the country. It must be remembered that the junior college technical approach has been more closely related to the technical high school and to the first two years of engineering than to technical institutes. Since technical institutes grew out of economic needs and junior colleges out of educational needs, this situation is understandable. Therefore, technical institute training has been determined by far more practical considerations than junior college training.

New York State. The project for intermediate technical and supervisory training in New York State follows a middle road between the old established technical institutes. New York epitomizes many of the problems of American industry. In addition, various facts indicate the urgency of New York's efforts to establish technical institutes at this
time. The University of the State of New York bulletin number 1332 (76, p. 74) reports:

The concept of technical education to prepare for highly specialized, interpretive or supervisory work lying between engineering or managerial functions and the skilled trades is relatively new. Now that industries are becoming increasingly aware of a definable technician grade of employment, it is found that there are 350,000 positions of technician grade in New York State. For these positions, approximately 17,600 replacements are needed annually. These numbers are likely to increase.

It is believed that ultimately 75 percent of the workers in technical positions will be recruited from the institution. Through extensive research, New York has established the fact that there is a growing need for technical education at the post-secondary level.

California. Recently some of the junior colleges, especially those in California, have taken some forward steps in the direction of genuine technical institutes. During the war emergency, many of the junior colleges specialized in two-year engineering courses that were of a technical institute character. In fact, the California colleges (17) were instrumental in providing the technical training for the aircraft industry, of which 60 percent was located in the State.

TRAINING IN THE INDUSTRIAL PROFESSIONS

The pioneer life of this country has been comparatively unspecialized (116). Versatility was prized more than expertness. Thus men turned their efforts toward a wide variety of pursuits. There was, however, an increased demand for
specialists once the pioneer phase of the country passed.
The conditions that led to the Morrill Act of 1862 for the
establishment of colleges of "Agriculture and Mechanics
Arts" clearly reflect this attitude.

TECHNICAL EDUCATION AT THE COLLEGE LEVEL

Two movements worked from the time of the Morrill Act
of 1862 to establish technical education at the college level.
The East, with a strong tradition of private initiative,
continued to promote technical professions in private insti­
tutions. Some of the most widely influential schools of
applied science were Columbia, Cornell, and the Massachusetts
Institute of Technology. Meanwhile the West, poor in money
but exceedingly rich in land, and backed by the Morrill Act
of 1862, was under pressure for higher technical education.
Under these circumstances, it was natural that the expanded
need for technical education should have used the college or
university as its means of development. The college was
first in our educational structure. A Study of Technical
Institutes (116, p. 36) reveals that:

. . . It had an ancient lineage; its degrees were
hallmarks of the 'learned professions;' and its
personal associations had begun to take on prized
qualities of social favor and distinction. The
desire to gain these intangible advantages for
the technical pursuits acted as a strong conven­
tionalizing influence.

By one influence or another, a large group of institutions
that had previously fulfilled the functions of technical
institutes abandoned the idea to become four-year engineering colleges. Some well-known examples of this change are the Polytechnic Institute of Brooklyn, first opened in 1855, became collegiate after 1889; the Drexel Institute of Philadelphia, founded in 1891, which remained a technical institute until 1916; and the Carengie Technical School of Pittsburgh, which was designed originally to be a technical school, but in 1912 was reorganized to become a degree-granting college, and its name changed to the Carnegie Institute of Technology. A large percentage of the Land-Grant colleges have undergone similar transformation and offered two-year courses in "industrial terminal courses" at one time or another.

Apparently, the country had no philosophy of technical education to support a unified type of institution. In granting degrees, the colleges enjoyed prestige and tangible advantages. Industry recognized established colleges of engineering as its chief source of supply. There were few incentives to support the technical institute idea except in the field of service, but the sources of discouragement turned out to be many.

THE TECHNICAL INSTITUTE MOVEMENT

The present-day technical institute can trace its history back to early colonial days. However, the past twenty-five years have seen a very rapid development of the movement. The following are some of the most significant
developments which have contributed to the rapid growth of these institutes.

The SPEE Study of Technical Institutes. Interest in the mechanics' institute revived soon after World War I, and the Society for the Promotion of Engineering Education began to show interest in technical education which did not lead to a degree, but which did go beyond secondary education. In 1931, a committee headed by W. E. Wichenden released its now well-known report (116), A Study of Technical Institutes. This was the first complete nationwide study of technical education. At the time of the Wickenden-Spahr report (116), there was considerable discussion among engineering educators, but little happened because of the depression days of the thirties. The technical institute type of education was confined for the next few years to a few well-established institutes. Supplementing these schools during the thirties and early forties was a growing number of Junior and Community Colleges that offered technical-terminal programs and lower division general college courses. Not until World War II was the crucial need for trained technicians thrown into sharp focus. It is interesting to note that before 1940 the technical institute operated under the supervision of the Society for the Promotion of Engineering Education. In 1941, a Division of Technical Institutes for the Promotion of Engineering Education was created.
The Accreditation of Technical Institute Curriculums.

Technical institute education gained considerable status when the Engineer's Council for Professional Development began accreditation of curriculums in 1945. By 1954, the Annual Report of ECPD showed that a total of eighty-four curriculums in some twenty-seven institutes were listed as approved.

The Technical Institute Division of the ASEE. The national plan was organized at the 1948 meeting of the Technical Institute Division of the American Society of Engineering Education with a division of terminal-technical education of the ASEE. The new division was to be controlled by a national committee comprised of representatives from all geographical areas of the national and from all branches of technical education.

The committee structure is composed of the following:

1. Teacher training
2. Credentials
3. Cooperation with the Office of National Defense
4. Curriculum development
5. Membership
6. Student selection and guidance
7. Program committee
8. James H McGraw Senior Award
9. Technical Institute studies
The technical institutes were given division status at the national convention of the American Society of Engineering Education in 1949 as the "Technical Institute Division of the American Society of Engineering Education." With this, the national organization was complete.

The National Council of Technical Schools. The objective of this organization (formed in 1943) was the improvement of educational and business standards. It is composed at the present time of proprietary institutes, although there are now several privately endowed schools that hold associate memberships. The council has been effective in raising the standards in the private schools.

The Granting of an Associate Degree. The SPEE Study in 1931 pointed out that the lack of recognized credentials was a distinct handicap to graduates. As a result of this, a committee on Completion Credentials of the Technical Institute Division, ASEE, gave careful thought to this problem and in 1952 offered a resolution urging the main body to recognize the "Associate Degree" as an appropriate title of accomplishment. No final action has been taken by the Council for the Associate Degree to be recognized. Nevertheless, it is an accomplished fact that at least some forty-four of the forty-eight states permit the granting of the Associate Degree for two years of study above the high school.
Growth of Literature in the Technical Institute Movement. The Technical Institute Division of the ASEE compiled a bibliography in 1953 listing 39 books, 267 articles, and 64 graduate studies. Thus the most important literature has been indexed. In addition, the regular publication of Technical Education News has stimulated interest and has made possible the publication of many articles on technical institutes.

SUMMARY

The preceding study of the historical development of technical education shows no readily traceable pattern of growth in the United States. For the most part, each institution seems to have developed as a result of a local need or because of the educational vision of some individual with little common development of purpose.

The development of technical education, in some respects, has paralleled that in Great Britain. Early in the eighteenth century, the mechanic institutes were established in large cities. The Ohio Institute in Cincinnati was opened in 1828, and became one of the first to evolve into the present type of technical institute.

A century ago there were many other institutes filling similar functions, but most of them discontinued operation and became conventional four-year engineering colleges. Examples would be the Carnegie Institute of Technology and
Michigan State College, which have become degree-granting institutions.

Why was the technical institute function generally abandoned? A fundamental reason may be that this country had no philosophy of technical education to lend support to any variations from the accustomed educational pattern. The college was first, and considerable prestige has been built up around it. The desire for a degree and the social distinction which a college presumably provided were significant factors to students in deciding against the technical institute. As engineering courses came into the universities, and vocational courses came into the high schools, it was erroneously thought that there was no general need for technical institutes. At the time, many administrators and professional societies were in agreement that college status was far more suitable than the technical institute, and generally ignored the fact that there was a special area much greater now than earlier, for which training can be far more adequately provided in a technical institute than in any other type of institution thus far developed. Therefore, the case for or against the technical institute does not rest on its historical past, but upon the interpretation of the needs of present-day industry.
CHAPTER III

NATURE OF THE TECHNICAL INSTITUTE

Chapter II has shown that the history of technical education can afford but little help in solving its problems. The case for or against technical education need not rest upon the past, but rather upon the functions and needs of both industry and education. Therefore, this chapter endeavors to present the nature of the technical institute.

NATURE OF TECHNICAL EDUCATION

The technical institutes have never achieved a uniformity of type, nor have they increased in any consideration number. Primarily through the efforts of the Society for the Promotion of Engineering Education, the term technical institute has come to signify a type of technical education (45) that lies between "skilled crafts" education on one side and engineering on the other. Because of the content of their curricula and the length of their programs, they neither operate on a secondary level nor have college rating. Technical institute administrators, however, are quick to point out that many of their institutions are concerned with an area of "service" rather than with an area between skilled crafts and the professions. Furthermore, studies of
technical institute graduates (116) reveal that they assume positions of responsibility in research work, construction, and supervisory sales. In addition, many technical institutes offer curricular in graphic arts, home economics, health services, and agriculture, which are not included in the foregoing definition. Thus specialized training should be provided for the intermediate groups engaged in supervisory and technical occupations at the level between vocational and professional pursuits.

The programs of most technical institutes are terminal in nature. In other words, the graduate is trained for immediate employment in some restricted area. This, of course, need not imply that the technical institute graduate is disqualified from continuing his education into the area of professional engineering, for many have done so successfully. It does mean that technical institute training at first pays little attention to training in skills, but rather that it emphasizes the why through adequate study of college level chemistry, physics, and mathematics. These science courses familiarize the student with the application in industry of the fundamental sciences.

STATUS OF TECHNICAL EDUCATION

A Study of Technical Institutes, published in 1931 (116) by the Society for the Promotion of Engineering Education provided the only data on the status of technical
education until Leo F. Smith of the Rochester Institute of Technology initiated his annual survey (97) in 1945, published in *Technical Education News*.

**Geographic Area Served to 1931. A Study of Technical Institutes** (116), p. 45) reported in 1931 that the geographical distribution of schools offering the technical institute type of education

... extends in an easterly-westerly direction from Massachusetts to California. ... Based upon the characteristics of this education and upon the experiences of the past, the major geographical field for technical institutes is in the present dominantly industrial area east of the Mississippi and north of the Ohio and Potomac rivers.

In view of the industrial advancements which are being made in the southeastern part of the country, rapid growth developments may be expected there. Also, with the expansion of industry on the West Coast, many institutions in that part of the country are now offering technical instruction to an ever-increasing degree.

**Geographic Areas Served, 1952-53.** Since 1945, an annual (107) survey has been published by the McGraw-Hill Book Company in its *Technical Education News*. The 1952-53 survey included 67 schools. It is interesting to note the increased activity in this field since 1931. Figure 2 shows the number of technical institutes in 1931, while Figure 3 shows the number of technical institutes in 1953. A review of the two maps clearly shows that technical institute has
Figure 2
NUMBER OF TECHNICAL INSTITUTES IN 1931

Figure II
SOURCES OF TECHNICAL INSTITUTE EDUCATION
1931
UNITED STATES

Key
- Sources of Technical Institute Education
- Main School-Extension Centers Elsewhere in the State
- Center of Manufactures
- Center of Population
SOURCES OF TECHNICAL INSTITUTE EDUCATION
1931
UNITED STATES

Technical Institute Education—Extension Centers Elsewhere in the State, manufactures, population.
Figure 3
NUMBER OF TECHNICAL INSTITUTES IN 1953

Figure III
SOURCES OF TECHNICAL INSTITUTE EDUCATION
1953
UNITED STATES

Key
- Sources of Technical Institute Education
- Main School-Extension Centers Elsewhere in the State
- Center of Manufactures
- Center of Population
Figure III

SOURCES OF TECHNICAL INSTITUTE EDUCATION

1953

UNITED STATES

of Technical Institute Education
hool-Extension Centers Elsewhere in the State
of Manufactures
of Population

Prepared by Henry M. Lepperd
Published by the University of Chicago Press, Chicago, Illinois
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spread rapidly throughout the West and Southwest, while there has been little change in the East and Midwest.

CHARACTER AND FUNCTIONS

Education of the technical institute type differs qualitatively from both trade and engineering courses and has its own distinctive characteristics. Broadly considered, the characteristics of technical institutes (116, p. 17) may be summarized as follows:

1. Post-secondary
2. Training men and women for jobs between skilled crafts and scientific professions
3. Training those with industrial experience who want intensive preparation
4. Training for technical and supervisory pursuits
5. Courses shorter than professional levels
6. Admission and practical experience
7. Teachers have practical experience
8. Teaching emphasis on doing
9. Instruction follows industrial usage

Since the training offered by technical institutes varies in length, this classification includes only those institutes that offer at least one full year of academic instruction or the equivalent of post-secondary work.
The Technical Institute in Relation to Other Types of Education.

1. Secondary Education. Secondary education has become a fairly universal heritage for all youth, with some 75 percent (116) of the age group from 14 to 18 inclusive already enrolled in the country at large. The dominant aims of secondary education are exploratory and appreciative, and are therefore concerned with social adjustment and assimilation rather than with vocational training of a specialized nature. Vocational training and technical studies are included in some high school programs and serve as aids to self-discovery and orientation for careers in industry and business. It should not be assumed, however, that students will have the qualifications that lead to assured mastery of scientific processes. No such condition has existed in the past, and the present trend of general education is away from it.

Some distinctly technical high schools exist in larger cities, but most of them give vocational courses of the trade type. Many of them have the equipment, but very few of them have the personnel which would permit them to do work of the technical institute in a post-graduate department. Another drawback to the high school entering the field of technical work is the difficulty of creating an adult attitude toward work in the center of an adolescent environment.
2. Vocational Education. The Smith Hughes Act, under which the federal government extends financial aid to states, will in time modify the present concept of vocational training in secondary education. The law (116, p. 20) limits the granting of financial aid at the secondary level by the words "that such education shall be of less than college grade and shall be designed to meet the needs of persons over fourteen years of age who are preparing for a trade or industrial pursuit." With the growth of trade level vocational education, it has become increasingly important to make provisions for technical education of a higher level and a more flexible type of institution related directly to industry. The technical institute could well fill this need, where the college would not. It could also provide advanced apprentice training in industry.

3. The Junior College. The junior college is an extension of secondary education. Its courses are mostly introductory college courses. It is vital to the junior college to be accredited by regional associations. In many of the technical junior colleges, the courses offered are duplicates of the first two years of university work. Thus, such institutions cannot be expected to do the work of a technical institute.

4. Colleges and Universities. The question has often been raised, "Why cannot the proposed work of the technical institute be done by an extension division connected with a
college or university?" At first there appear to be no insurmountable difficulties. For example, the same kind of equipment is needed, the staffs have many points in common, and much of the teaching is generally alike. Nevertheless, the practical difficulties are highly involved. Colleges and universities must protect their standing with accrediting agencies, and their credentials must have a definite valuation.

It is interesting to note that (116) while some of the German technical universities tried in their early days to make different periods of the same course serve as preparation for different occupations, the plan was abandoned and distinct types of schools were created to do each task well.

There are some examples in America of institutions with combined functions where the day work is collegiate in character and the evening work is strictly of the technical institute type. A classical example is the Lowell Institute, at the Massachusetts Institute of Technology.

5. Schools of Engineering. While the first few courses in these schools are elementary, specialization increases rapidly with the length of the curriculum. Certain basic sciences, such as mathematics, physics, chemistry, and mechanics are covered intensively. Experience has shown that the least time in which this can be done is four years. Such a period, however, is insufficient for the more exacting analytical problems encountered in engineering.
A great many people with engineering training, who hold positions in industry, never had a chance to utilize their wide range of technical knowledge, but their positions, which are classed as engineering, are stepping stones to higher responsibilities in the organization. The technical requirements of these positions can be fairly met by an intensive engineering course which avoids the highly advanced features and which can be given in reasonable thoroughness in two or three years. A Study of Technical Institutes (116, p. 24) reports:

In Great Britain, where engineering courses for university degrees have attracted relatively limited numbers, much the greater part of the technical recruitment of industry comes from engineering courses of this more intensive type, given in evening and part-time schools for engineering apprentices and other employed men.

Technical Education in Relation to General Education. While there is a trend toward more general education in educational programs, it is almost entirely absent in the technical institute. "General education" is needed in all walks of life, especially in the technical field where social activity is somewhat restricted. In any educational program, the development of good citizens should be as important an objective as vocational training. There is no doubt that the technical institute neglects this aspect of education.

Technology of Specific Industries. Courses for specific industries involve a higher degree of specialization than engineering, but they need not be narrow. A Study of
Technical Institutes (116, p. 24) defines the term technology as a "generalized science of an industrial art." Any technical pursuit has a foundation of scientific knowledge. Each draws selectively on many sciences, but one need not master all phases of science to gain proficiency in a special field. One need not know all the physics and chemistry to become a technician for a specific industry such as paper making. Needful knowledge can be predetermined, and subject matter can be selected in unit form. Thus industrial technology can be taught in a more intensive form than engineering.

No sharp limits can be drawn between craftmen, technicians, and engineering education. For example, foundry work (16) could be studied as an individual trade, industrial process, or as the profession of ferrous metallurgy. The needs of industry for supervisory personnel cannot be filled by the skilled trades or the college graduate. Technological supervision training, by its very nature, belongs to the technical institute and constitutes the primary function of this type of institution. The extensive experience of Europe strongly reinforces the more limited experience of America in supporting the view that craft training, no matter how excellent, is not in itself enough to qualify men for supervisory positions.

Training for Specific Technical Functions. An example of a still higher order of specialization is presented in A Study of Technical Institutes (116, p. 26) as follows:

... the quantity surveyor, whose function it is to take off from building plans complete schedules
of the quantities of materials, areas, volumes, numbers of unit items, etc. from which bidders may estimate their costs with a minimum of guess work and on a strictly comparable basis. To perform this work one must have intimate knowledge, not only of plans and conventions, but also of specific details of construction not represented on the plans. On the other hand, a limited knowledge of design calculations for strength and resistance, and the like, will suffice.

When educational courses of this type are set up, it is practicable to proceed from a detailed knowledge of the requirements of the job. Such a program can be trimmed to the strict essentials. Most of these specific, technical jobs have immediate placements in posts of responsibility. They are usually more executive than technical in nature. There are few such courses in the United States, but they are quite common in Europe, where specialization is looked upon as an advantage.

Technical Institute Fields of Service. Many of the positions in industry are classed as engineering but do not require the advanced scientific features of pure engineering. The field of technology of specific industries involves a higher degree of specialization than engineering, but not necessarily a narrower type of training. Since the limits of scientific knowledge can be more closely determined and subject matter introduced more selectively, industrial technology can be taught in a more intensive form than engineering. Training for specific technical functions represents a
rather high form of specialization. Training programs are developed from an analysis of a specific job.

Some Principles at Issue. The actual issue between the technical institute and professional training narrows down to the alternative of using the by-products from professional schools for industrial supervision or providing a distinctive training for semiprofessional functions.

A Study of Technical Institutes (116, p. 26) states:

A considerable part of the present demand on the engineering colleges could be filled by technical institute graduates, and often with greater satisfaction to both parties if an adequate supply existed. Thus relieved, the colleges could emphasize more truly professional aims and standards. From the viewpoint of industry, a thoroughly trained technician or operating supervisor ought to be more acceptable than a half-baked or ill-adjusted engineer.

The report goes on to say that colleges have acquired an unwarranted prestige. The colleges would be better if they had more competition and a second educational ladder parallel to at least part of its range but more flexible in its entrance and terminal levels, thus leading to greater educational opportunity.

The colleges cannot serve many men well who have had wide experience in industry and wish to make intensive preparation along specific lines. Men in such categories are not as a rule "bookminded." Their attitude is not that of the "student," but of a "learner" progressing through experience rather than books. Schools that teach primarily by doing
enable such men to develop rapidly through a select program of shop experiences.

CLASSIFICATION OF TECHNICAL INSTITUTES

Types of Institutions. Since 1945, Leo F. Smith (100, p. 1), of the Rochester Institute of Technology, has published an annual survey of technical institutes in Technical Education News. He classifies technical institutes into categories with the corresponding enrollments for 1953-54, as shown in Table 1.

Table 1

<table>
<thead>
<tr>
<th>Type of Institution</th>
<th>Enrollments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Federal</td>
<td>1,670</td>
</tr>
<tr>
<td>State and Municipal</td>
<td>18,141</td>
</tr>
<tr>
<td>Privately endowed</td>
<td>11,489</td>
</tr>
<tr>
<td>Extension divisions</td>
<td>12,930</td>
</tr>
<tr>
<td>Proprietary</td>
<td>8,157</td>
</tr>
<tr>
<td>YMCA schools</td>
<td>350</td>
</tr>
<tr>
<td>Total</td>
<td>52,737</td>
</tr>
</tbody>
</table>

These enrollments do not take into account the work done in junior and community colleges that have the technical institute type of curricula. The community and junior colleges are becoming increasingly important in post-secondary education. This is especially true in the far West and the Southwest. It will soon be necessary to reckon with the community college in forecasting the total contributions of technical education. So far, the ECPD accrediting
program only recognizes curricula that lie in the field parallel to engineering instruction.

CURRICULUM OF THE TECHNICAL INSTITUTE

The influence of the SPEE report in 1931 has been great. When the Engineer's Council for Professional Development set up a crediting and procedure committee for technical institutes, much of the 1931 report was carried over into the crediting procedure.

When the Engineer's Council for Professional Development publishes its annual report, it includes a definition of the type of curricula included in its accrediting procedure. Because of the importance of this statement (17, p. 40), it is quoted completely as follows:

Curricula to be considered are technical in nature and lie in the post-high school area. They differ in content and purpose from those of the vocational school on one hand and from those of the engineering college on the other. Curricula in this field are offered by a variety of institutions and cover a considerable range as to duration and content of subject matter, but have in common the following purposes and characteristics:

1. The purpose is to prepare individuals for various technical positions or lines of activity encompassed within the field of engineering, but the scope of the programs is more limited than that required to prepare a person for a career as a professional engineer.

2. Programs of instruction are essentially technological in nature, based upon principles of science and include sufficient post-secondary school mathematics to provide the tools to accomplish the technical objectives of the curricula.
3. Emphasis is placed upon the use of rational processes in the principal fundamental portions of the curricula that fulfill the stated objectives and purposes.

4. Programs of instruction are briefer, and usually more completely technical in content than professional curricula, though they are concerned with the same general fields of industry and engineering. They do not lead to the baccalaureate degree in engineering. Such designations as Engineering Aide, Technical Aide, Associate in Engineering, and Engineering Associate are appropriate designations to be conferred upon the graduates of programs of technical institute type.

5. Training for artisanship is not included within the scope of education of technical institute type.

The technical institutes have always been remarkably independent of other educational institutions in developing their own curricula and operational procedures. Their programs differ in length of training and types of instruction used in proportion to the technical work, but these factors are strongly influenced by the objectives for which they were designed. In addition, technical institute administrators point out that their institutions are also concerned with an area of "service" as well as the intermediate, or the area between skilled craft and the scientific professions. Recent studies of technical institute graduates reveal that they assume positions of responsibility in sales and service, designing research occupations, and supervisory work.

Examples of Technical Institute Program. The primary distinction of the technical institutes is that their curricula are confined to industrial production. Their teaching is
concentrated on training rather than on education. The main emphasis is on technical subjects, which usually take precedence over scientific subjects. In general, science and mathematics (116) together do not exceed 30 percent of the entire instruction. Such subjects are frequently given in applied science, such as applied chemistry, physics, or the like. Very little general education is included in the programs, or it is reduced to a minimum, which comprises business English or business correspondence.

Among the more notable technical institutes are—

1. Ohio Mechanics' Institute
2. Drexel Institute of Technology (mechanical engineering)
3. Franklin Technical Institute (industrial electricity)
4. Lowell Institute (structural course, evening)
5. New York State Technical Institute at Canton
6. Purdue University, Division of Technical Institutes (evening, technical aids)
7. Rochester Mechanics' Institute (Instrument Makers Cooperative)
8. Wentworth Institute (steam and diesel engineering)

All of these institutions have made important contributions to technical education.

The nature of the work of technical institutes may be well illustrated by the program at the Ohio Mechanics' Institute. The requirement for admission to the day program
is high school graduation. The day program includes a two-year course in industrial engineering, while the evening program offers such subjects as Building Estimating, Electrical Design, and Time and Motion Study. A three-year program is offered in Mechanical Technology, Electrical Technology, and Industrial Chemistry, with students in attendance for three evenings per week.

Another typical program is the two-year course in Instrument Making at the Rochester Institute of Technology. In the first year, the student devotes 4 hours a week to mathematics, 5 hours to mechanical drawing, 12 hours to machine shop, 3 hours to psychology, 4 hours to heat and mechanics, and 2 hours to English. The second year includes economics, Electricity, Instrument Making, etc. During the third year the schedule includes Optics, Instrument and Tool Design, Materials Laboratory, Industrial Management, and technical projects.

Experience in Developing Institute Curricula. The recent experience of New York State (76) in developing programs for its task in offering an education that leads to technical competence. This calls for curricula in which the emphasis will be on both applied technical and general courses. The development of curricula to meet known replacement demands in industry and personal-social needs of youth is their primary objective.
1. Identifying Programs and Curricula. The New York State occupational survey provided the basis for identifying the eight programs. In identifying technical jobs, several hundred occupational titles were found. Each one was carefully analyzed according to the classification and definition provided by the Dictionary of Occupational Titles of the United States Department of Labor.

It became evident that many occupations were sufficiently alike to be classified together into educational groups or job clusters. Then their curricula were drawn up to include fundamental training for jobs in the basic group. It then became possible to propose a curriculum for each job cluster. This led to the ultimate planning of 42 curricula, grouped into eight comprehensive programs in Agriculture, Construction, Business, Design, Industry, Home Economics, Personal and Business Services, and special programs.

2. Developing a Curriculum Pattern. Preparatory education of the vocational-technical type had been recognized as the primary purpose. It must be recognized, however, that the process of earning a living, with its multiple relationships, cannot be separated from the process of living. In other words, occupational competence and family life are inseparable parts of the organic nature of both society and the individual. Therefore, the primary concern of the curriculum planners was to obtain a balance between vocational-technical and general education.
The New York committee on institute curricula (76, p. 47-49) has set forth the following guide in developing technical education, general education, and elective courses:

a. Principles Underlying Technical Courses. Occupational preparation, largely vocational-technical in character, is recognized as the primary purpose of the curriculum and as the principle objective which will prompt students to enroll in the institutes.

b. Principles Underlying General Courses. Instruction in general fields is needed for the adequate personal, social, and occupational development of the individual.

c. Principles Underlying Elective Courses. Provision should be made in the program of each student for electives and extracurricular activities.

It was the opinion of the committee that the applied character of institute instruction did not justify the separate instructional divisions of social science, humanities, natural science, and health.

3. Developing Content for Technical Courses. The development of a course content for technical education involved a detailed job analysis of each occupation in a given job cluster. This included the listing of skills and special abilities to obtain occupational competence. Then the requisites were grouped into tentative course titles. With a list of required skills established, the next step was the preparation of a statement of objectives for the course. Then the content within the time limits of the curriculum was developed. Generally, the sequence of the course was determined by a desire to provide an increasing degree of
occupational specialization as the student nears the end of the course of instruction.

4. Developing Content for General Courses. The committee started its development of general education sequences with a "Job Analysis of a Good Citizen." The committee proposed four broad course sequences of basic ideas to be emphasized in their occupational and general applications. These broad ideas provided titles for comprehensive general courses: "Science and Technology," "The Modern Community," "Communication Skills," and "Personal and Community Health." The basic ideas desired from the courses are an indication of the committee's concern for a practicable framework that will permit a continuous application to special fields and make for broader perspectives.

5. Relating Technical and General Courses. The committee has given extensive consideration to general education courses for their institutes. General courses have been considered in relation to technical courses at every stage.

Their proposed curriculum pattern (76, p. 61), with its interplay of basic ideas, is designed to promote several kinds of coordination: "(1) coordination among allied general courses; (2) between general and technical courses; and (3) between institute and community activities." The committee proposed two means of implementing these relationships; the lecture-demonstration extension series and the coordinating conference.
ORGANIZATIONAL PATTERNS OF TECHNICAL INSTITUTES

The definition of the technical institute as given in the SPEE report shows that the technical institute is distinctly different from the junior college, the engineering college, or the trade and industrial school. Yet technical institute departments are operated as integral parts of, or in close cooperation with, some schools of these types. The technical institute program is the dominant element in some institutions, while in others it is a subsidiary to other forms of general vocational education. Some of the junior colleges in California are operating programs which are recognized as technical types of training by the State Department of Education. Some of the New York State institutes operate both trade and technical training on the high school and post-high school level.

Many institutions refer to themselves as "Technical Institutes," but meet few of the conditions as outlined by the SPEE report. Apparently, the name "Technical Institute" has certain prestige, for both public and private institutions are using it, although in many cases their programs are operated essentially for the skilled trades.

Private Technical Institutes. Over the years, private institutes, both proprietary and philanthropic, have taken the lead in developing the technical institute type of education. In the past, philanthropic institutes have played an important part in the development of this type of education and even today occupy an important place in the field. Although there
are not many of them, such institutions as Rochester
Institute of Technology, Franklin Institute, Boston, and
Pratt Institute, have all made contributions to the prac­
tice and philosophy of training technicians for industry.

The proprietary institutions have also played an impor­
tant role in vocational technical training. Some have catered
to local needs only, while others draw their students from a
wide geographical area, and in turn place their graduates all
over the United States. For the most part, private technical
institutes limit their offerings to relatively restricted
fields and concentrate their efforts. As a result, they are
able to go deeper into the specialized field and provide
extensive equipment. A brief description of three of these
private technical institutes will help in providing a picture
of their facilities, programs, and organizations.

1. Rochester Institute of Technology was founded in
1829. The institute has a productive endowment in excess
of $3,000,000 and secures annual support of approximately
$100,000 from local industry. This income is supplemented
by student tuition.

The educational offerings are considerable. They
include fulltime day and cooperative instruction. The even­
ing courses cover a wide range of unit courses and diploma
programs. The fulltime day curricula include two-year pro­
grams in Publishing, Printing, and Photographic Technology,
and a three-year program in Applied Art. A three-year
cooperative curriculum offers Industrial Chemistry, and Electrical and Mechanical subjects.

Admission requirements are high school graduation or its equivalent. All applicants are given classification examinations. The institute gives considerable attention to counseling students prior to and after admission. Its evening program includes a number of specialized courses of a technical type. During the past five years the total enrollment has averaged over 3,000 students annually.

2. The Ohio Mechanics' Institute was founded in 1828, and began by offering evening lectures in mathematics and science. Day school courses were established in 1900. It is financed by an endowment fund, supplemented by tuition fees. The institution is a combination of trade school, technical high school, and technical institute. Full-time day courses, cooperative, and evening courses are offered. Instruction is provided for both men and women. Technical institute courses that are offered in the day program require high school graduation for entrance. This program includes a two-year course in Industrial Engineering and a two-year course in Commercial Art.

The evening courses include both three-year curricula and unit courses. Three-year curricula are offered in Electrical Technology, Power Generation, Commercial Design, Industrial Chemistry, and Mechanical Technology. The unit courses include such subjects as Building Estimating,
Electrical Design, Time and Motion Study, Steel Treating, and Air Conditioning.

**Public Technical Institutes.** There are only a few public educational institutions in the United States that meet specifications for technical institutes as prescribed by the Society for Promotion of Engineering Education. Some public institutions have divisions of instruction which offer technical training and some of these have technical institute types of programs. Brief examples of two such programs follow:

1. New York State Technical Institutes. These include seven agricultural and technical institutes operated under the auspices of the State Education Department. The purposes and offerings of the institutes vary with the regions that each serves. The institutes are helping to meet the increased demands for education beyond high school by people not primarily interested in completing a college education.

   The institutes have a general collegiate pattern for admission and graduation requirements. High School graduation is required for admission, although special students with less preparation who are matured or have suitable experience are often admitted to work in short curriculum courses. Residents of New York State pay tuition fees.

2. Division of Technical Institute of Purdue University. This is a land-grant university that carries on a large off-campus service. The Technical Extension Division
of the University (99) carries on three types of work: (1) courses for credit in the degree programs, (2) noncredit offerings, and (3) technical institute work.

The program represents an effort to continue the large-scale war services in science, engineering, and management. It is designed to offer people technical training of a subprofessional nature in the field of engineering. It is an off-campus program designed to serve the people and industries of the State where such training is needed.

The training offered in these courses differs from the engineering type of training in that it emphasizes practical phases of engineering. It is available to all in the state who wish to qualify as engineering aids, draftsmen, designers, technicians, and persons with skills of a semi-engineering character.

The curricula extend over three years and are to produce technical aids in engineering. They lead to three certificates: (1) the Junior Technical Aid certificate, which is given after the completion of one full year; (2) the Associate Technical Aid, which is awarded after the two full years of work; and (3) the Technical Aid certificate, which is given after completion of the three-year program.

Corporate Technical Institutes. Still another type of technical institute training is the factory of plant school, which is now generally referred to as a corporation school. The origin of many of these schools had been due to
the inability of corporations to get necessary technical personnel. Because of this, some corporations were obliged to establish their own type of technical program. According to Sears (169), one of the first factory schools was that of Hoe and Company of New York City. In 1872 this corporation established a plant school to train apprentices in the skilled trades, especially the machinist trade. Sears further states that other plant schools soon followed, including Westinghouse Electric Company in 1888, General Electric Company and Baldwin Locomotive Works in 1901, and the International Harvester Company in 1907. After 1905 there was a general trend toward the establishment of corporation schools, and by 1920 most of the larger manufacturing corporations had established such schools. Some of the later ones are Caterpillar Tractor Company, General Motors.

Most of these have arisen to meet a definite need in the industrial world. Very often these schools have been merely apprenticeship programs and not technical institutes. Corporation schools usually train their personnel in their own particular type of activity or work and as a result seldom contribute to the total reservoir of trained technicians. A brief description of two corporation schools follows:

1. Caterpillar Tractor Company. The main purpose of this program is to maintain a constant flow of skilled technicians for the company's complex operations. The offerings
include four-year apprentice courses, two-year courses for engineering graduates of superior scholastic ability, and a three-year business training course concerned with the business aspects of production. In cooperation with seven other industrial concerns, Caterpillar is formulating plans for a cooperative technical institute. The program will be made up of two-year curricula in Drafting, Inspection, Metallurgy, Chemistry, Mechanical and Electrical Technology.

2. RCA Institutes, Inc. The history of this company dates from 1909, when ship-to-shore communication was relatively new. By 1912 it could not meet the demand for trained operators. Therefore, the Marconi Wireless Telegraph Company took over. In 1919 Marconi Institute of America was made a part of RCA, and in the 1920's the Institute added courses in broadcast receiver service.

Their students must have at least two years of high school, including physics and mathematics. RCA Institute's two-year course in advanced technology covers Radio Communication, Sound and Television. The training during the first year concentrates on fundamentals; in the second, on specialized techniques of audio, video, and radio frequencies. Oral and written English is part of the course. Upon receiving their certificates, the graduates are prepared for many areas of work.

Other Types of Institutes. Oklahoma's School of Technical Training is a division of the Oklahoma Institute of
Technology, which comprises all of A & M's technical and engineering activities at Stilwater. This is one of the few technical institutes operating on a regular college campus.

Both special and regular students are well prepared for the work they intend to do. Their regular courses are so designed that any student unable to complete the full two years may leave at the end of a training period and still have enough training to handle a skilled job. Emphasis throughout the course is on shop and laboratory work in conjunction with ample training in related sciences and mathematics, English, speech, and industrial management. Graduates, when certified, are qualified for such positions as Production Supervisors, Maintenance Supervisor, Engineering Aid, and Technical Specialist. The staff has eighteen regular members and eight members of the industrial arts and engineering staffs.

Wayne State University follows the principle that its educational programs will meet the needs of the individual citizens of the community it serves. Its leaders realize that they cannot attain such an objective for their students while insisting on conventional degree curricula. Therefore, Wayne offers a number of one- and two-year certificate curricula as well as a variety of elective courses. Many students in the complex industrial community of Detroit have specialized needs that can be satisfied only by sequences of courses taken on an individual basis. These types of curricula are for the most part vocational.
Jointly with Chrysler Corporation, Wayne State University sponsors an industrial training curriculum. The School of General Studies at Wayne also conduct a junior college for students who wish to pursue employment in local industry. The curricula offered include Accounting, Distributive Education, Practical Nursing, and Mortuary Science.

SUMMARY

After a long period of development, the technical institute has finally established itself in the normal or regular pattern of American education. Although it is a distinct or specialized type of institution, there is an increasing need for it to be included in larger urban centers.
CHAPTER IV

TECHNICAL TRAINING NEEDS OF AMERICAN INDUSTRY

This chapter presents information that will be helpful in visualizing industry's needs in the light of the rapid expansion of technology. New processes, new materials, and new products are being developed at an ever-increasing rate, creating a continuous demand for more technicians. In addition, the current international situation has greatly stimulated America's need for scientists and engineers. It is apparent that professional workers can improve their efficiency and increase their output by having technicians perform the more routine tasks. Thus technicians have an increased role in strengthening the technical and military position. The demand for technicians has been rising sharply since the present defense program began and probably will continue to increase in the foreseeable future.

INDUSTRIAL NEEDS NOT BEING FILLED

A review of recent literature reveals rather clearly that industrial needs are not being met by the existing educational program. The Society for Promotion of Engineering Education reports that the needs of industry warrant a
greater expansion of technical education. The SPEE (116, p. 7) further states:

Past efforts to keep pace with the recruitment of industry have led to a great increase in the numbers and size of engineering colleges giving courses of higher professional training for degrees, with the result that only this one phase of technical education has been adequately provided for in the United States. To gain higher efficiency there should be a greater diversity of technical education and industrial needs. To maintain but one type of school and to ask it to meet all purposes is to invite blurring of aims and compromise of standards. The need is for schools having more definite purposes and more clearly visualized aims.

A SPEE study of industry reports that manufacturing industries estimate their requirements for engineering graduates from 2.2 to 2 percent of their total forces while the same industries estimate that from 6 to 8.3 percent of their forces need approximately two years of training beyond the secondary level. This implies that there is a need for at least three technicians for every engineer in industry. At the time (1926) the actual ratio (116) of technicians to engineers was 1 to 5.

The continued need for technical institute education is clearly indicated when a comparison of the 1926 figures is made with the data gathered from 16 states in 1944, as shown in Table 2.

Emerson reported that the number of technicians required for each college-trained engineer ranged from 2.2 to 1 in industrial chemistry to 20 to 1 in wood processing. Booher (18) reports that the present ratio is one technician
<table>
<thead>
<tr>
<th>Industry</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automobile manufacturing</td>
<td>4.2</td>
</tr>
<tr>
<td>Electric power production and distribution</td>
<td>5.3</td>
</tr>
<tr>
<td>Electrical equipment manufacturing</td>
<td>10.0</td>
</tr>
<tr>
<td>Hydroelectric development</td>
<td>2.0</td>
</tr>
<tr>
<td>Industrial chemistry</td>
<td>2.2</td>
</tr>
<tr>
<td>Iron and steel production</td>
<td>6.0</td>
</tr>
<tr>
<td>Lumbering and wood processing</td>
<td>20.0</td>
</tr>
<tr>
<td>Machine tool manufacturing</td>
<td>5.5</td>
</tr>
<tr>
<td>Metal mining</td>
<td>5.2</td>
</tr>
<tr>
<td>Metal products manufacturing</td>
<td>8.0</td>
</tr>
<tr>
<td>Petroleum and butadiene production</td>
<td>5.3</td>
</tr>
<tr>
<td>Pulp and paper manufacturing</td>
<td>10.3</td>
</tr>
<tr>
<td>Rail transportation</td>
<td>9.1</td>
</tr>
<tr>
<td>Shipbuilding</td>
<td>13.6</td>
</tr>
<tr>
<td>Telegraph and telephone communications service</td>
<td>9.7</td>
</tr>
<tr>
<td>Textile manufacturing</td>
<td>9.8</td>
</tr>
<tr>
<td>All industries</td>
<td>5.2</td>
</tr>
</tbody>
</table>

to three engineering graduates, which is still an inverse relationship to the need. In manufacturing, the present status of sources of personnel and the desired status are shown in Table 3.

Table 3
STATUS OF TECHNICAL INSTITUTE PERSONNEL

<table>
<thead>
<tr>
<th>Source of Personnel</th>
<th>Supervisory and Technical Forces</th>
<th>Total Forces in Manufacture</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Percent Present</td>
<td>Desired</td>
</tr>
<tr>
<td>Technical institute graduates</td>
<td>0.08</td>
<td>46.0</td>
</tr>
<tr>
<td>College graduates</td>
<td>13.0</td>
<td>17.0</td>
</tr>
<tr>
<td>From ranks and other training</td>
<td>86.2</td>
<td>37.0</td>
</tr>
</tbody>
</table>


Information gathered from 22 states (111, p. x) indicates a growing need for technicians. Data from 117 industrial establishments indicate that—

1. College-trained men are used to perform 'less than college level' jobs in more than 40 percent of the plants.

2. In more than two thirds of these plants such jobs could be filled by persons with vocational-technical training.

3. Technological developments in industry are increasing the need for technically trained personnel, in the opinion of nearly 80 percent of the industrial representatives interviewed.
4. Increased need is indicated in such fields as supervision, inspection, technical sales, technical research assistants, technical production assistants, drafting occupations, and operation and maintenance.

5. Definite need is expressed for both supplementary and preemployment training.

6. Nearly 60 percent of the persons interviewed feel that cooperative training programs, with half time in school and half time on the job, are practical and feasible.

7. Two thirds of those interviewed expressed doubts that women would continue to be employed in present vocational-technical jobs after the war.

8. Most industries now are planning postwar developments in products and services which will require increased numbers of technicians as compared with prewar years.

New York State conducted a survey (76) in 1945 to determine the need for technical institute education. It was found that manufacturing industries employed 1,000,000 persons, of whom 9 percent were engaged directly in technical occupations. The non-manufacturing industries employed roughly 2,500,000 persons, of whom nearly 11 percent were engaged in technical occupations. Based on a 5 percent annual replacement, it has been estimated that New York State alone would need 17,600 additional technicians each year.

Dr. Kenneth Beach (13) conducted for New York State one of the best surveys ever made in the technical field. The study included a comprehensive review of the needs for technicians in the industries of New York State. The survey not only enabled the state intelligently to localize the
need for technicians on a geographic and population basis, but also revealed the surprising need in these areas for 7 technicians to each engineer.

Industry recruits most of its technicians at the present time from experienced employees on the job, or from the ranks of recent college graduates. However, the New York State survey committee estimates that 75 percent of the yearly replacements for technical jobs could be filled by technical-institute graduates if an adequate system of institutions existed.

One study after another has shown the need for technical-institute education. Recent surveys suggest that the pattern of industrial development is bringing about an ever-increasing demand for this type of education. In response to this demand (76), eleven new technical institutes have been established in the past six years.

Today, after hundreds of thousands of ex-soldiers have been trained with government money, the demand for technicians is still unfilled. The air force, unable to secure enough technicians for its immediate needs, is negotiating with private schools to train additional personnel, but the need goes unfilled.

Nature of World in Industry. Technicians work with engineers and scientists in a variety of industries and in all stages of production, from drawing boards to selling. Draftsmen aid engineers in translating their design work into
production when new products are being developed. By the
time actual production approaches, still other technicians
help in working out specifications for materials and methods
of manufacture. Other technicians serve as inspectors and
supervisors during production. In addition, manufacturers
very often depend on salesmen with technical backgrounds to
sell a product, especially if it is used in industry.
Although many technical salesmen are professional engineers,
others with less professional training can sometimes sell
equally well.

Technicians assist scientists in laboratory research
and development work and perform functions related to testing
or production control. Their tasks may be simple testing,
or highly technical analytical work, depending upon their
experience and training.

A technician's work, whether in production or research,
varies considerably among industries. Even within the same
plant, technicians may perform duties ranging from routine
tasks to those of a highly technical nature. It is the wide
variation in the types of duties performed by technicians
that makes it difficult to present an over-all description
of their work. Nevertheless, the following definition by
Emerson (110, p. 2), quoted from the Employment Outlook for
Technicians, captures the "flavor" of the work involving
many technical occupations:

The technician is a person who works at a job
which requires applied technical knowledge and
applied technical skill, His work, in this respect, is somewhat akin to that of the engineer, but usually the scope is narrower. His job also requires some manipulative skills—those necessary to handle properly the tools and instruments needed to perform the technical tasks.

In his special field, he has considerable technical knowledge of industrial processes, and in this field he knows how to apply the necessary principles of the physical sciences and of mathematics. In general, contribution is mainly through mental effort, in contrast with muscular exertion.

The job of the technician is not easy to define. On the one hand, it has many of the characteristics of engineering, on the other, many of the qualities associated with the skilled trades. Some technicians' jobs lean toward the engineering type, jobs which consist mainly of drafting, computations, and laboratory testing. Others border on the skilled crafts, such as those which deal with repair of mechanical or electrical equipment where much technical 'knowhow' is demanded but which also require considerable manual skill. It hardly seems practical to set up clearly defined boundaries within which lie all technician jobs.

... We also find great differences in the 'levels' of jobs of technician type. A job may be definitely technical in character, yet be extremely limited in scope and of a repetitive type. Certain simple inspection jobs are in this category. Yet other technician jobs may require a high quality of technical knowledge and technical skill, such as all-round tool and gage inspection, which requires the use of many types of instruments.

The kinds of technical ability found in the various technician jobs are of considerable variety. Some require visualization of drawings, or a flair for creative design. Some demand a high degree of applied mathematical ability. Some require a knowledge of practices in the skilled trades, but not the ability to perform the skilled tasks. Some require extensive understanding of industrial equipment and processes. Sometimes the job involves supervisory responsibilities, and combines skill in handling people with skill in dealing with technological matters.
Since all positions held by technicians who work with scientists and engineers have some common characteristics, such as a knowledge of mathematics and physical science, the nature of their work varies considerably among occupations. Therefore, the kind of work done by some of the larger groups of technicians is described in the following sections.

1. Draftsmen. Their work involves preparation of exact detailed drawings from sketches or specifications furnished by design engineers. The work usually demands the use of small instruments. They must make use of their knowledge of mathematics and refer to engineering handbooks for information on tolerances, strength of materials, and related matters.

Most draftsmen are mechanical draftsmen who draw machine parts, but some are specialists in electrical, aeronautical, marine, geological, topographical and related fields. Draftsmen usually begin as tracers. At first their work is routine and requires little knowledge although it does require some skill. With additional experience and training, workers advance to detailers, junior or senior draftsmen, and chief draftsmen.

2. Engineering Aides. These assist engineers in planning and research. For the most part, they work under the supervision of an engineer and perform specialized functions requiring less theoretical training than a professional engineer. Their work usually requires a knowledge of a specialized field—mechanical, electrical, or other branch
of engineering. Engineering aids often assist engineers in production by helping to design and analyze layouts. They often help make tests, record data, check materials, or make computations. In the research field, engineering aids perform tests such as stress, strain, motion, and impact. They operate and calibrate instruments. Two of their basic tools are slide rules and micrometers for making exact measurements.

Engineering aids entering the field often start by doing routine tasks under close supervision. As they gain experience, they are given more responsible jobs. In the more advanced work, they are expected to utilize their educational training by performing highly technical work with little or not supervision.

Laboratory Technicians and Physical Science Aids. These assist physicists, chemists and engineers. A considerable part of their work consists of routine tests and recording results in reports, charts, and graphs for later interpretation by professional workers.

Laboratory technicians must be familiar with a large amount of testing equipment such as temperature control instruments, balances, centrifuges, etc. The technicians who assist physicists prepare samples for testing, and perform such tasks as measuring and weighing materials. Technicians who work with chemists do both qualitative and quantitative analysis.

4. Electronic Technicians. These should have a background of physical science, electronic theory, and mathematics
which will enable them to perform duties above the routine operating and repair level. Most of their work requires practical application of theoretical knowledge. This practical part requires the use of tools. The theoretical part of their job calls for the use, understanding, and interpretation of results obtained from instruments. Their work calls in many cases for a combination of manual skills and a knowledge of complex testing equipment. They must be able to read and interpret complicated diagrams, use mathematical formulas, and wire intricate electronic units.

Electronic technicians while working in laboratories construct, test, install, modify, and under some conditions, design experimental electronic apparatus. However, in industry, these technicians perform functions such as troubleshooting, complicated types of testing, and inspection work. They are often called upon to build testing equipment. Some of them work in radio, television, and telephony operations. The more specialized applications include radar, sonar, radio navigational equipment, and radio sonde.

5. Related Technician Occupations. Beside the occupations described above, a wide range of related jobs are available to trained technicians. For example, electronic technicians can often qualify as broadcasting engineers and as technicians in radio and television, or as estimators in electric light and power industries. They can move from one industry to another, and into many different jobs within the
same industry (see Appendix A). Trained technicians doing the same type of work are often given such titles as Engineering Aid, Junior Engineer, Physical Science Aid, or Laboratory Assistant.

EMPLOYMENT POTENTIAL OF TECHNICAL INSTITUTE GRADUATES

The outlook and employment for well-trained technicians will rise over a period of time. Use of technicians since the Korean War has increased sharply, as it did during World War II. In both periods a great expansion occurred in development and research activity and in areas of production which continually employ large numbers of engineers. This situation led to an acute shortage of scientists and engineers and thus created a demand for technicians who could handle routine tasks, enabling the more professional personnel to concentrate on advanced aspects of the work. A continued shortage of scientists and engineers is expected for the next several years, so the demand for technicians should remain high. The present prospect is that not enough trained technicians will be available to meet this demand. Furthermore, the general advance of science and its practical application to industry should continue to expand employment possibilities.

Past Trends. Employment of technicians has markedly increased over the past four decades. However, of all those associated with scientists and engineers, draftsmen were the first group to establish themselves as a separate occupation.
At the present time, they still outnumber every other group of technicians. The number of draftsmen in this country (110) rose from 12,000 in 1910 to some 88,000 in 1940. Moreover, in 1940 the census included 67,000 laboratory technicians and 8,000 technicians of other types, but a large number, such as medical technicians were not covered by the report. Prior to 1940, these were not considered important enough to be reported by the census as a separate group.

A sharp increase has taken place in the employment of technicians since 1940. One reason for this is the increase in the number of employed engineers from 250,000 in 1940 to over 400,000 in 1952. The employment of chemists (the largest group of nature scientists) increased sharply from 55,000 in 1940 to nearly 100,000 in 1952. It is therefore probable that the number of technicians working with these scientists and engineers has also increased greatly. The National Manpower Council (78) reported in 1954 that there were about 400,000 "technical workers."

During the last decade, the best evidence of the continued increase of technicians is from the National Research Council's Directories of Industrial Research Laboratories (see the Chart which follows), as quoted in Employment Outlook for Technicians (110, p. 14);

These studies show a greater relative growth from 1940 to 1950 in employment of technical workers than of professional personnel or in the
EMPLOYMENT OF TECHNICIANS IN INDUSTRIAL LABORATORIES IS RISING RAPIDLY

Numbers of Technical and Other Laboratory Employees, 1940, 1946, 1950

total staff of industries research laboratories. Over the decade, the number of technical workers in these laboratories increased by nearly 150 percent (from 16,400 to 40,800), whereas professional personnel increased only 93 percent (from 36,500 to 70,570) and the total number of laboratory workers rose by 136 percent (from 70,000 to 165,000).

One technical worker was employed for every 2.2 professional workers in 1940, but by 1950 the ratio was 1 to 1.7. The rapid rise in employment of technicians occurred during World War II (1940 to 1946). Employment of technicians during the last four years of this decade increased only 18 percent compared with an increase of 111 percent from 1940 to 1946, while professional personnel increased only 30 percent compared with a 49 percent increase over the earlier period.

Outlook. There is a great need for persons with technical knowledge as a result of defense activities and the generally high level of production throughout the present decade. The continued heavy demand for such personnel has created shortages of technicians in some fields, and is expected to bring increased employment opportunities for all technicians.

The United States Department of Labor "List of Critical Occupations" (see Appendix B) indicates a shortage of three types of technicians: Electronic Technicians, Tool and Die Designers, and Design Engineer Draftsmen.

The shortage of experienced mechanical draftsmen is indicated by the numerous listings in "Help Wanted" sections of local newspapers, especially those in large industrial
Draftsmen are also listed among the occupations in short supply by the Employment Service of the United States Department of Labor. Shortly after the outbreak of the Korean Action, the demand for draftsmen began to increase. Between July 1950 and March 1952, the demand rose from 150 to more than 3,000. This later figure probably does not represent the total number of openings for draftsmen, since not all employers report their job requests, to the Employment Service. However, the figures do indicate a continuous demand for draftsmen.

The United States Civil Service Commission's current announcements of job opportunities emphasizes the federal government's need for technicians. The Commission, in May 1952, listed Engineering Draftsmen, Engineering Aids, Junior Scientists, Tool Designers, and Electronic Mechanics among the personnel for which there was urgent need.

There will be a great demand for technicians as long as the defense program continues. The present shortage of scientists and engineers has renewed the impetus noted during World War II toward greater use of technicians. If the shortage of scientific personnel continues, alert industrialists will probably employ additional technicians in order to make more efficient use of their professional employees.

Many sources now recognize the need for better utilization of highly trained professional personnel, and to this end the employment of greater numbers of technicians is
recommended. In line with this trend, Mitchell (74, p. 134), writing on *Engineering Manpower for Industry*, notes:

> It seems to me that we have been giving thousands and thousands of young men a 4-year training in the fundamentals of engineering at considerable expense to them, and then putting a great many of them in jobs that could be done as well by people with a fraction of their training.

It has also been suggested (74) that the research program could be expanded if Europe's method of research were adopted which endeavors to employ many more assistants as aids to professionals.

The greatest demand for technicians in the next few years is expected to be in the defense-related industries. For example, the electronics industry will need more technicians to help in the manufacture and servicing of electronic equipment important in military operations. Draftsmen and many other technicians are reported in short supply in aircraft manufacturing, but the industry is still expanding. The current high rate of production will continue to increase for several years. Therefore, other industries important in defense-connected research and production, such as machine tool, industrial chemical, and petroleum are expected to need additional technicians.

The Federal Communications Commission announced in April 1952 that 2,053 new television stations would be allowed to open. This will further intensify shortages of trained electronic technicians, since sizeable numbers will
be needed to maintain and service the additional stations when they are established.

The supply of experienced technicians available in the near future will not be sufficient to meet the above demands. Because of the wide variety of sources from which industrial technicians may be recruited, it is impossible even to estimate the supply of workers available at any time. However, placement officers of technical institutes and junior colleges (110) report that they have more calls for their graduates than can be filled.

Employment of technicians should continue to expand. Some of the factors which are expected to favorably affect long-term employment for technicians are the general advance of scientific knowledge and its practical application to industrial operations, and the increasing use of technically trained personnel in supervisory jobs, sales, and other types of work. It is also probable that the high level of expenditures for research and development will persist. Major companies continue to establish research programs, and many existing programs are being expanded to meet strong competition in the development of new products and processes. Furthermore, in view of the continued defense mobilization, it is probable that the demand for research personnel will be high. If trends toward more use of technical workers continue (see the Chart on page 79), employment prospects for technicians will be excellent. In addition to new positions
made possible by the growth within the field, many employment opportunities should occur each year because of retirements, deaths, or transfers of experienced workers.

The economic situation, however, will reflect the number of job openings available to technicians. If international conditions should improve and defense programs are cut, the demand for technicians would be reduced. Furthermore, technicians often face severe competitive problems when jobs become scarce, since they are in occupations which can be filled by persons with a wide variety of backgrounds. During periods of unemployment in the past the serious contenders for technicians' jobs have been professional workers. In periods of low employment, employers are more selective because they can hire highly trained employees at salaries equal to that of lesser-trained workers. The greater flexibility and broader background of the four-year college graduate may influence employers' preferences. Thus it is recommended that technicians would be wise to consider taking additional courses of a general nature, as well as specialized courses in their fields, to better prepare themselves to meet competition.

CENSUS DATA

The basic source of data on technicians in this country is the United States Bureau of the Census. All census reports are based every ten years on a detailed enumeration of the total population. In the 1950 census (78), there
were 375,000 technicians listed among the professional technical and kindred workers.

An indication of the newness of the technician group appears in the recency and paucity of census data on it. Up to 1950, the decennial census confined itself almost entirely to surveyors and draftsmen. However, in the last count (1950), the Bureau tabulated information on a variety of technical occupations which are briefly summarized in the following paragraphs.

The draftsmen are the only clear-cut supporting group. They were the first to become established as a separate technical occupation. They are closely associated with engineering and other scientific professions. Therefore, data on draftsmen have been available for some decades. Their number increased from 32,000 to 88,000 between 1910 and 1940, and to 122,000 by 1950. Table 4 shows that draftsmen still are the largest group of technicians in the country.

Testing technicians are the newest of the technician's groups to be enumerated separately in the 1950 census. Like draftsmen, they are closely allied with scientists and engineers specializing in specific production processes. The enumeration of technicians "not elsewhere classified" is presented for contrast. It is made up mostly of technical personnel in direct support of professional people in the entertainment field, especially radio and television.
Table 4

CHARACTERISTICS OF SELECTED TECHNICAL SUPPORTING PERSONNEL IN THE LABOR FORCE

<table>
<thead>
<tr>
<th></th>
<th>Percent Medical and Dental Technicians</th>
<th>Percent Testing Technicians</th>
<th>Percent Technicians n.e.c.*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>122,000</td>
<td>81,000</td>
<td>77,000</td>
</tr>
<tr>
<td>Median age</td>
<td>31.0</td>
<td>29.8</td>
<td>31.4</td>
</tr>
<tr>
<td>Percent white</td>
<td>89.7</td>
<td>96.4</td>
<td>98.2</td>
</tr>
<tr>
<td>Percent urban</td>
<td>89.7</td>
<td>90.0</td>
<td>78.9</td>
</tr>
<tr>
<td>Percent male</td>
<td>92.9</td>
<td>42.6</td>
<td>77.5</td>
</tr>
</tbody>
</table>

*Not elsewhere classified


The data highlight the fact that technicians are a relatively young group of workers. Their average age is close to 30 years compared with an average age of 38 years for all workers in 1950.

Women now constitute only about 7 percent of the draftsmen, but 57 percent of the dental and medical technicians. The supporting groups in the medical field have a much larger proportion of women than do those associated with engineers. In addition, technicians are more highly concentrated in urban localities and are predominantly white, with nonwhites accounting for only 2 or 3 percent of the total. However, nonwhites account for 10 percent of the draftsmen.

There is considerable variation in the educational background of technicians according to census data. This is illustrated in Table 5.
Table 5

EDUCATIONAL ATTAINMENT OF SELECTED TECHNICAL SUPPORTING PERSONNEL IN THE LABOR FORCE

<table>
<thead>
<tr>
<th></th>
<th>Percent Medical and Dental Technicians</th>
<th>Percent Testing Technicians</th>
<th>Percent Technicians n.e.c.*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 4 yrs.</td>
<td>13.9</td>
<td>18.9</td>
<td>28.2</td>
</tr>
<tr>
<td>high school</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High school graduate</td>
<td>41.1</td>
<td>30.7</td>
<td>39.0</td>
</tr>
<tr>
<td>One to 3 yrs.</td>
<td>28.6</td>
<td>25.4</td>
<td>19.8</td>
</tr>
<tr>
<td>college</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>College graduate</td>
<td>14.0</td>
<td>23.4</td>
<td>11.5</td>
</tr>
<tr>
<td>Not reported</td>
<td>2.4</td>
<td>1.6</td>
<td>1.5</td>
</tr>
</tbody>
</table>

*Not elsewhere classified


A significant number had less than four years of high school education, but one in four among the medical technicians and one in five of the technicians "not elsewhere classified" had a college education. The majority had less than four years of college, but they had at least four years of high school.

The record (78) shows that more and more technicians are being trained in technical institutes of a post-high-school level and those performing higher-level jobs are obtaining college degrees. The vast majority of technicians
work for private industry or government. About 8 percent, mostly men, own their own businesses.

Unemployment was low in 1949, and most technicians worked the entire year. The earnings for this period are shown in Table 6.

Table 6

INCOME OF SELECTED TECHNICAL PERSONNEL

<table>
<thead>
<tr>
<th>Income</th>
<th>Percent Draftsmen</th>
<th>Percent Medical and Dental Technicians</th>
<th>Percent Testing Technicians</th>
<th>Percent Technicians n.e.c.*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than $2,000</td>
<td>15.0</td>
<td>40.5</td>
<td>23.4</td>
<td>22.4</td>
</tr>
<tr>
<td>$2,000 to $2,999</td>
<td>22.4</td>
<td>33.7</td>
<td>29.0</td>
<td>18.6</td>
</tr>
<tr>
<td>$3,000 to $3,999</td>
<td>30.7</td>
<td>15.7</td>
<td>29.6</td>
<td>29.6</td>
</tr>
<tr>
<td>$4,000 to $4,999</td>
<td>16.7</td>
<td>3.7</td>
<td>9.7</td>
<td>15.8</td>
</tr>
<tr>
<td>$5,000 and over</td>
<td>9.9</td>
<td>2.0</td>
<td>4.7</td>
<td>11.3</td>
</tr>
<tr>
<td>Not reported</td>
<td>5.3</td>
<td>4.4</td>
<td>3.6</td>
<td>2.3</td>
</tr>
</tbody>
</table>

*Not elsewhere classified


The median incomes in 1949 were: draftsmen, $3,310; medical and dental technicians, $2,189; testing technicians, $2,856; and technicians "not elsewhere classified," $3,212. It is interesting to note that medical technicians had the highest proportion of college graduates, but they also had the lowest earnings. No doubt the major reason is the high proportion of women in the group.
A study of some 2,000 electronic technicians conducted by the United States Bureau of Labor Statistics in 1952 reveals some important characteristics about the technician group. The electronic technicians are comparative newcomers in terms of their current specific functions. For example, the number of electronic technicians was negligible before World War I, but because of military developments in communications, a small group entered the field between 1917 and 1920. Up to 1930, there was a gradual increase along with the growth of radio industry. Then came World War II, with its emphasis on military communications and the phenomenal growth of television. As a result of these facts, two out of every three electronic technicians came into the field after World War II.

The difficulty of defining technical occupations in terms of educational requirements can be shown by the wide variety of education and training received by them. Armed Forces instruction, civilian schools, some shop training, on-the-job training, learning at home, apprenticeship, and correspondence courses were among the many ways in which these technicians were trained. About one half had a high school education, one fourth had some college training, and one fourth had less than four years of high school. Only about one out of every ten electronics technicians employed by the electronics industry was a college graduate.
Patterns of Utilization. The next few paragraphs summarize some of the recent trends on employment of technicians, and data on their employment in regard to professional workers. But for this purpose much more detailed information is needed about the use of technical personnel in specific situations, their working relationship with professionals, the number of hours of professional time saved, the division of work between the two, and personnel problems generated by changes in functions of related personnel. Unfortunately this kind of information is almost nonexistent.

The 1950 census provides some general clues as to the size of the supporting technician groups. Separate data on six technical groups are shown in Table 7.

Table 7
SIZE OF SUPPORTING TECHNICAL GROUPS

<table>
<thead>
<tr>
<th>Technical Groups</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>All selected technician occupations</td>
<td>358,354</td>
</tr>
<tr>
<td>Working with engineers and scientists</td>
<td>255,411</td>
</tr>
<tr>
<td>Draftsmen</td>
<td>124,749</td>
</tr>
<tr>
<td>Surveyors</td>
<td>26,229</td>
</tr>
<tr>
<td>Testing technicians</td>
<td>76,962</td>
</tr>
<tr>
<td>Technicians not elsewhere classified</td>
<td>27,471</td>
</tr>
<tr>
<td>Working with doctors and dentists</td>
<td>102,943</td>
</tr>
<tr>
<td>Medical and dental technicians</td>
<td>78,038</td>
</tr>
<tr>
<td>Therapists</td>
<td>24,905</td>
</tr>
</tbody>
</table>

These six groups of some 358,000 technicians account for about 7 percent of the five million workers in the entire professional and technical fields. It should also be noted that the census lists 117,000 persons under the heading of "professional, technical, and kindred workers, not elsewhere classified." While the number of supporting technicians in this group is unknown, there is no indication that it is large.

A better understanding of the numerical importance of supporting personnel can be gained by relating each specific group to the professional personnel it supports. A total of 676,000 people (78, p. 57) reported in 1950 that they were members of the natural science and engineering professions. The census reported 255,411 technical supporting personnel for this group, as shown above, giving a ratio of only 0.38 technicians for every professional. There is reason to believe that this ratio is on the low side because a sizeable number reporting their occupations as engineers are in fact employed in jobs of lower grades, namely as technicians. Nevertheless, it is quite apparent that professional scientists and engineers far outnumber the technical personnel who assist them.

While this may be true for the country as a whole, many specific industries use technicians much more extensively. The ratio between these and professionals is much higher in some larger organizations, where there is an opportunity to divide professional work into segments manageable by less-trained persons.
In industries such as metalworking, for example, the engineers are outnumbered by technical supporting personnel. The Bureau of Labor Statistics (78, p. 57), in October, 1952, made a survey of more than 8,000 metalworking plants. The survey shows that 64,500 of the 3,110,000 employees were reported as engineers, while 35,900 were engineering aids and 48,400 were draftsmen, a total of 84,000 technical supporting workers, or a ratio of 1.31 for every engineer.

This ratio (78, p. 58) varies greatly among industries, as shown in Table 8.

Table 8

<table>
<thead>
<tr>
<th>Industry</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aircraft</td>
<td>0.83</td>
</tr>
<tr>
<td>Electrical machinery</td>
<td>1.21</td>
</tr>
<tr>
<td>Machinery</td>
<td>1.49</td>
</tr>
<tr>
<td>Metal fabricating</td>
<td>1.92</td>
</tr>
<tr>
<td>Automobiles</td>
<td>2.47</td>
</tr>
<tr>
<td>Shipbuilding</td>
<td>3.17</td>
</tr>
</tbody>
</table>


These figures do not necessarily indicate that the shipbuilding industry, which has three technicians for each engineer, utilizes its engineers more effectively than the aircraft industry. Some of the differences may lie in the nature of the work; the type of technology; and the amount of research done, with its heavy demand for professional
people. All these contribute to the differences in the ratio of technicians to engineers.

One might expect less variation in the ratio among plants within individual industries, but the data from individual plants shows considerable diversity. Table 9 shows a distribution of plants (78) in two industries by individual plant ratios:

Table 9

<table>
<thead>
<tr>
<th>Ratio of Engineering Aids and Draftsmen to Engineers</th>
<th>20 Aircraft Engine Plants</th>
<th>103 Agricultural Machinery Plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 1.0</td>
<td>7</td>
<td>29</td>
</tr>
<tr>
<td>1.0 to 1.99</td>
<td>5</td>
<td>37</td>
</tr>
<tr>
<td>2.0 to 2.99</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>3.0 to 3.99</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>4.0 to 4.99</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>5.0 and over</td>
<td>-</td>
<td>7</td>
</tr>
</tbody>
</table>


Differences in amount of research carried on may be one factor for this diversity. Nevertheless, such data may be useful to industries employing relatively few technicians; for instance, it might be helpful for them to consider possible uses for technicians already developed by other industries engaged in similar types of work.
There appears to be a tendency for the larger plants in the metal-working industries to have the highest ratios of engineers to all employees, and the lowest ratios of technicians to engineers. This situation does not necessarily reflect poor utilization of scarce professionals, but probably a concentration on research activity in the larger plants.

The chemical industry, in contrast to the metal industries, uses more professional workers than technicians. An unpublished survey by the Bureau of Labor Statistics (78) shows that 102 plants in the chemical industry had 6,200 professional workers, but only 2,900 laboratory assistants. These figures would indicate a measure of the importance of research to the chemical industry.

A study by the National Research Council (78) of the personnel in industrial research laboratories shows a high ratio of professional workers to technical supporting personnel where research activities are involved. These laboratories employed 40,800 technicians and 70,570 professional workers in 1950, a ratio of 0.58 to 1.

The directories issued by the National Research Council (78) show that employment of technicians has been increasing more rapidly than that of professional personnel. From 1940 to 1950 the number of technicians increased nearly 150 percent, while professional workers increased 93 percent. Thus the ratio of each technician to each professional increased only from 0.48 to 0.58. This increase reflects the growth of
many laboratories to the point where it is possible to break down the work to routine jobs which technicians can perform.

The preceding paragraphs concerning professional workers and their supporting personnel show that technicians, though fewer in number, are increasing more rapidly. In industrial production, more technicians are employed than engineers; in the field of research, technicians are still outnumbered by professional people. There are also wide differences in the number of technicians employed among industries which suggests, but does not prove, that some industries could improve their utilization of professional workers by observing the experience of their associates in the use of technical supporting personnel.

Medical and Health Professions. At this point, it is interesting to contrast what has happened in the medical field with technical personnel already examined. The relationships of the registered nurse and pharmacist to the physician are somewhat similar to that of a draftsman to the engineer. Unlike engineering technicians, they have obtained professional status with high standards of qualifications including licenses, four years of post secondary education, and strong professional societies. Within the medical field other occupations such as osteopaths and optometrists have followed similar paths toward professional recognition.

The distinction between occupations is much clearer in the medical field than in engineering. Many capable engineers
have become professional, without having completed college, by beginning in a subprofessional job and gradually working up. Thus, there is both a downward and upward mobility between semiprofessional and professional occupations in engineering. There is also considerable mobility among engineers themselves, for many of them shift from one branch of engineering to another. However, in the medical field there is very little mobility in the occupations. Each area has its prescribed course of training, and only by going through the course and qualifying for a license can an individual change occupations.

If the limited definition is taken of a technician of less than professional grade (78), there are close to 100,000 technicians to about 275,000 doctors and dentists. This is close to the ratio of technicians to engineers. However, the figure for nurses and medical technicians, who have at least semiprofessional stature are added together, the result for supporting workers approaches 600,000, or more than double the physicians and dentists.

**SUMMARY**

**Some Unanswered Questions.** As the information in this field is reviewed, there are two major questions which bear specifically on the problem of utilization of technical personnel.

The first deals with the reasons for the sizeable differences in the ratio of technicians to professionals.
Tentatively, there appear to be two fundamental factors which affect the variation in utilization of technical supporting personnel: the historical development of the profession and the nature of the work involved. Different historical patterns among the professions and their supporting personnel could explain the present utilization of technicians. For example, the professionalization among the supporting personnel in medicine is more advanced than in engineering. Also, the intimate and direct relationships involved in areas of teaching as compared with engineering would suggest that teaching medicine, for example, is much less amenable to being broken down into work which can be performed by workers with less-than-professional training. Thus it may be that the very nature of the work involved in some professions helps to bring about the development of professional status for supporting personnel.

Several intriguing questions arise with these two points. For example, in accordance with the population growth, the number of physicians has been increasing more slowly than engineers. Has this fact helped or made it necessary for the supporting groups to grow so fast that they now outnumber physicians or have the cause and effect relationships been the other way? Has the rapid growth of supporting personnel made it unnecessary for doctors to increase as rapidly as engineers? One point can be emphasized whatever the answers may be. Consideration should be made of the relation of
technicians to professionals and the possibilities of better utilizing people who need less training to ameliorate shortages of professionals.

This leads to the second major unanswered question: why do ratios of supporting technicians to professionals differ from one industry to another and from plant to plant within an industry? This point need not be emphasized again except that more knowledge of why one industry or one plant differs from another should give further insight into the problems of utilizing technical personnel.
CHAPTER V

TECHNICAL INSTITUTES NEEDED

There has been a tendency to think of American education as a single ladder from elementary school to the university. In this conception, the present positions of elementary, secondary, and university level programs are for the most part well conceived.

The one type of program that does not fit into the single-ladder scheme of education is the Technical Institute. The purpose of this chapter is, therefore, to present the need for these institutes and to outline their place in American education.

THE EDUCATIONAL GAP

Traditionally, this country has three levels of education, commonly known as elementary, secondary, and higher education. Elementary education embraces all forms of preschool and grades 1 through 6 or 8, according to the current practice. Secondary education embraces either grades 7 through 12, or 9 through 12. One exception is Pasadena, California, where schools are organized on a 6-4-4 plan, which means the thirteenth and fourteenth years of education are an integral part of the public schools of the city.
However, the tradition in most school systems of the United States embraces the six grades of elementary plus six grades of secondary school, to which a junior college may be added. Higher education is usually defined as all education beyond the twelfth grade.

Some forty years ago, there was a gap between the elementary and secondary schools. Hundreds of studies have shown why the old 8–4 plan should be modified so that all youth may be offered subjects more suited to their needs. Hughes and Lancelot (52, p. 47) state:

The first duty of each state is to see that every child who is able to do so completes the eight grades and therefore can read, write, and use the common language reasonably well, and perform ample processes with numbers. About 97.5 percent of all children apparently can complete the eighth. . . . About 95 percent of the total number of youth from fourteen to seventeen apparently can be enrolled in the high schools. . . .

Hughes and Lancelot believe that 27.5 percent of the youth from eighteen to twenty-one can enroll in college. They further state that 13 percent of all youth could graduate. These percentages are taken as attainable goals for education in the United States.

The available statistics indicate that the educational gap between elementary and secondary education has been closed in all but a few southern states and should be completely closed within the next decade. Apparently the gap is no longer between the eighth and ninth grades of school, but between the tenth and fourteenth.
Orton (81, p. 401) states:

For three decades the junior college movement has been proving that it is not a junior to anything, and that it is an educational form with a particular social mission not fulfilled by any other institution.

According to Stoddard (104, p. 1), a new level of education has recently come into being:

'Tertiary education' imposes a concept between secondary and higher education in order to give recognition to an academic level that needs more explicit designation than post-secondary education or lower division of collegiate education.

Proctor (84), p. ix) in writing on the junior college, states:

. . . It is a necessary corrective of inadequacies of the long-established American system. It symbolizes the cessation of the fetish worship of the numeral four years in the high school, four years in the college, which has resulted in those artificial divisions of American education along certain social lines regardless of the requisite training of the mind.

The primary problem is that the gap between high school and college is too great. Thus there are many students who could profit by more education than the high school provides, but who cannot profit by the type of education offered by traditional colleges and universities.

The President's Commission on Higher Education (83, p. 37) says:

The time has come to make education through the fourteenth grade available in the same way that high school education is now available. . . .
This means that tuition-free education should be available in public institutions and to all youth for the traditional 2-year junior college course.

To achieve this, it will be necessary to develop much more extensively than at present such opportunities as are now provided in local communities by the 2-year junior college, community institute, community college, or institute of arts and sciences. The name used does not matter, though community college seems to describe these schools best. The important thing is that the services they perform be recognized and vastly extended.

Such institutions make post-high-school education available to a much larger percentage of young people than otherwise could afford it. Indeed as discussed in the volume of this Commission's report, 'Organizing Higher Education,' such community colleges probably will have to carry a large part of the responsibility for expanding opportunities in higher education.

The Commission goes on to say that 49 percent of the high school population has the mental ability to complete fourteen years of school, and at least 32 percent of our population has the mental ability to complete an advanced liberal or specialized professional education.

The SPEE study (116, p. 11) of 1931 states:

... The actual needs and the potential demands are beyond the resources of voluntary and private agencies... The needs of the country could scarcely be met by less than 250 institutes, and seems to call for the creation of a great chain of community institutions having an organic place in city and state educational systems, yet free to achieve their own distinctive character.

It is interesting to note that Leo F. Smith, in his 1953-54 national survey of technical institutes in the United
States, lists only 62 schools, while the SPEE report calls for not less than 250 institutes.

At the time of the SPEE report, approximately 9,000 engineers were being graduated annually by 150 colleges and universities. Data in the report show that about 1,800 technicians were being turned out by technical institutes. The ratio of graduates at the time was 5 engineers to 1 technician, which was far removed from the desired ratio of 1 engineer to 3 technicians. In 1950, there were approximately 50,000 engineers to 15,000 technical institute graduates. By 1951, this ratio had improved from the condition reported by the SPEE report. But it is still in reverse proportion of 3 engineers to 1 technician graduate. Thus the scarcity of technical institutes in comparison to need is almost tragic.

Apprenticeship has all but disappeared in America, thus schools must be relied upon for training. Engineering colleges alone cannot fill the void. There is need for many short courses broad enough to encourage vision and outlook, yet efficient and practical enough to bridge the gap toward employment. Williston (117, p. 635) goes so far as to say:

In the place of one or two score of such schools in the United States, there should be at least one thousand scattered throughout the country furnishing training for fully half of the youth in our population. This obviously is the missing link in our educational system. Dr. Conant, of Harvard, has stated that post-high-school students, in the main, profit most by two-year terminal courses, and reports that advanced education should be largely met by expansion in this area.
There is no doubt that the opportunities for such expansion are many. These include privately endowed schools, commercial technical schools, and state-supported two-year institutions. There are also university extension departments, evening schools like the Westinghouse Graduate School, and schools within industry like the one operated by General Motors Company, and lastly the junior college. Of all these, the phenomenal growth of the junior college furnishes the outstanding opportunity for a genuine national service in the area of technical education.

CAUSES OF THE GAP IN TECHNICAL EDUCATION

An Evolving Economy. In the early history of the United States, new lands were constantly being opened in the western part of the country, creating a demand for trained personnel in agriculture. At the same time, the factory system became firmly established. Many trained people were needed in the mechanical occupations. Thus the necessary motivation was established to provide agricultural and mechanical colleges to train personnel for these two purposes. In addition, from then until now, a continuous flow of new inventions and mass production techniques has created considerable need for technical personnel which is not being fulfilled.

Restricted Immigration. Immigrants from such countries as Germany, Switzerland, and England, supplied a large percent of the technically trained personnel. As a result,
America was caught short in not having developed institutions which could supply the type of trained personnel needed.

**Mechanics' Institutes Become Accredited Colleges.**

These developed with the country, but as many became strong, they evolved into accredited engineering colleges. This left an "educational gap" where there were no institutes to provide technical training for those not going to college.

**Inertia of Tradition.** Traditions are difficult to change, for any changes of a habitual routine means many adjustments. New endeavors are looked upon with suspicion until they have been tried and proven. Orton (81, p. 401), referring to the junior college, states "Although the old-line liberal-arts colleges, fearful of competition for students, threw up barriers against these new institutions, students flocked to them." As a result, many educational innovations have been forced on academic educators.

**Attempts to Close the Gap.** About the turn of the century, William Rainey Harper (father of the junior college movement), of Chicago, began writing about the apparent weaknesses of the educational system of his day. At the time, for lack of a better name, Harper suggested "the junior college."

There have been several attempts to supply the type of education believed necessary in the intermediate level. According to Lange (69), the earliest was the university "amputation" idea. Agitation for the transferring of the
first two grades, thirteenth and fourteenth, from the university to the secondary level began in Minnesota in 1869, and in Michigan in 1883.

A second attempt is referred to as "high school extension." During the decade 1890-1900, there was agitation in Michigan to extend the high school into the thirteenth and fourteenth grades. It was felt that it could do better work than colleges at this level. A fourth attempt was the independent creation of junior colleges. California was first to pass a law, in 1907, establishing permissive legislation to give postgraduate work. However, these attempts to close the educational gap was only partially successful.

The Smith-Hughes Act in 1917, attempt to bridge this gap by establishing programs to provide education "of less than college grade." This went far in supplementing and extending the high-school program into vocational areas. The Act was a forward step, but it does not meet the need for technicians.

Closing the Gap in Technical Education. The more recent development of the technical institute has come from the engineering colleges themselves. Several studies of engineering education have been made by the Society for Promotion of Engineering Education. One of these (116) concerned admission and the elimination of engineering students. The report states that two fifths of the students entering engineering colleges never graduate. Engineering colleges,
being aware of their high mortality rate, felt that something should be done for the drop outs. Therefore, they have created an active interest in promoting the technical institute type of education simply because they have become keenly aware that the engineering colleges were not filling the great industrial need for technicians.

WEAKNESSES IN THE TECHNICAL INSTITUTE MOVEMENT

The present movement came to the forefront at the close of World War II when the tremendous influx of veterans started to school. But even after these had received their training and entered employment, there was still a great need for technicians. Today the requests exceeds the number of trained men. The Civil Service Commission has continued to post announcements for positions for trained technicians. There are several reasons why the technical institutions are unable to meet the need, a few of which will be presented here.

Professional Leadership Lacking. The 1931 SPEE Report on Technical Institutes (116, p. 10) makes the following comment about professional leadership:

The technical institute needs a director and staff who are in intimate touch with industry and especially proficient in blending scientific and practical instruction rather than leadership of the 'educationist' type.

The leadership of the technical institute has not been effective. In contrast, the junior colleges have had the leadership of the professional educator and they have been very effective. This would imply that the technical institute
movement needs the leadership of a professional educator, but it is also apparent that it does not have it.

**Need for Junior Colleges.** At this point it is interesting to note that in two states, New York and California, the technical institute is organized very successfully as a junior college on a state-wide basis. The junior college is in a better position to articulate a technical program with the high schools than are other types of institutions interested in the technical movement. There is no doubt that it should and will have a more prominent role.

**The Technical Institute Base Too Narrow.** One reason that the junior college has grown so rapidly is that it has become a community institution and shares in the community life. The President's Commission has suggested another name for the technical institute, "Community Institute." When the programs of most accredited institutes are examined, it becomes apparent that they offer very little that would make the student in any way a better citizen. The technical institutes as now organized make no attempt to develop the whole individual.

**General Education Insufficient.** Most institutions are injecting more general education into their programs. This is especially true of engineering colleges. However, general education is almost entirely absent in technical institutes. In a free society, there is much to be said about developing the "whole individual" rather than merely
training him for his daily vocation. There is need for general education in all walks of life, but this is especially true in the technical field where the social graces are somewhat restricted. Being a good citizen should be as important in an educational program as the vocational training. The technical institute has suffered from the lack of it.

Technical Institute Programs May be Too Short. It is the consensus that the technical institute program should be completed in two years or less. This limitation, however, may be dangerous. At present, it is not clear just how far new technical courses can be developed. It is reasonable to assume that in view of rapidly-expanding technical knowledge, the programs of technical institutes could be four years long, culminating with the awarding of some sort of technical degree.

Technical Institutes Inadequately Financed. As mentioned before, the Land-Grant colleges and the Smith-Hughes Act have both received continuous state and federal aid. On the other hand, the technical institute has had no continuing income. In California, the institutes have been well financed by becoming an extension of the public school system. Another alternative is to have them administered by a state board of technical education and financed in a way similar to the Smith Hughes program.
Need for a Licensing Law. The interest in technical education could be materially strengthened if each state would set up a law to license each new institution before it goes into operation. One such law exists in Minnesota.

SUMMARY

The technical institute has done much to fill the gap in technical education, yet the needs of industry for trained technicians have not been filled. The technical institute movement still remains a potential means of filling the gap but it has not done so to date. However, if the weaknesses that have been discussed could be corrected, this movement should help extensively in supplying the needed technicians for industry.

Technical institute education as it is known today has developed slowly in the United States. In this country, the emphasis is still on degree-granting programs and very little emphasis has been placed on education between secondary and four-year colleges. One must conclude that in view of the needs of industry, the need for technicians has not been fulfilled.
CHAPTER VI

ORGANIZATION AND PROJECTION OF THE TECHNICAL INSTITUTE

This chapter is devoted to a presentation of the problems and techniques involved in each of the following areas: determining objectives, surveying the demand, developing curriculums, selecting the instructional staff, selecting students and student personnel.

DETERMINING OBJECTIVES

All educational institutions were originated to serve some basic purpose or need. The educational objectives of many institutions have grown out of this need. For example, the elementary schools have as their purpose the development in each child of a degree of competence in the use of the English language and arithmetic, and the socialization of each individual child. In the past several decades the secondary schools have changed from being primarily college preparatory to the point where most of them have as their purpose the adjustment of youth to work, family living, and good citizenship. The universities have as their primary objective the preparing of young people for the professions, the dissemination of knowledge, and fundamental research.
More than two decades ago, Charters (23, p. 7), in writing about the objectives of the technical institute made this discerning statement, "The objectives of an educational institution are the product of three factors: social needs, student interests, and institutional facilities."

The technical institute attempts to fill the social need by filling the needs of industry for qualified employees for the technical occupations. The preparation to serve these occupations fulfills the needs of the students who may be interested in the occupational duties as well as financial rewards, advancement, and security. Thus the facilities of an institute will determine, for the most part, the occupations to be served.

The very nature of the institute makes it possible to define its objectives with a greater degree of clarity than many other educational institutions. Stated briefly (99, p. 105), "The primary objective of a technical institute is to provide education which will qualify graduates for a series or cluster of related jobs within an occupational field."

At this point, it may be noted that a distinctive pattern of education has evolved around the technical institute. Leo P. Smith (99, p. 103) states that the most effective programs have been established as the result of seven definite steps:

1. Determine the broad objectives of the institution.
2. Survey the demand for one or more curriculums on the part of industry and potential students.

3. Select a curricular area which is appropriate in terms of demand, objectives, and institutional facilities.

4. Study job requirements in the occupational field selected.

5. Allocate each of the required knowledges, skills, and understandings to a course of instruction.

6. Determine the type and amount of general education.

7. Plan a balanced and integrated program of study.

Not all technical institutes have utilized these seven points, and it is probable that no institute has completed these steps every time a curriculum has been initiated.

In summary, educational objectives are the changes one hopes will take place in a student as a result of his enrollment in the curriculum of the school. These objectives may be evaluated by noting the difference between measurements at the beginning and at the completion of an educational program.

Special Objectives of Technical Institutes. All institutions of higher learning in the United States, including the technical institutes, have as one of their major objectives the preparation of students for effective participation in a technological and free society. In addition to this broad objective, the technical institutes of today have several objectives which they are particularly qualified to achieve, the most important of which are listed below.
1. The technical institute prepares its graduates for occupational competence in clearly identified cluster of industrial occupations.

2. The technical institute serves the needs of industry within a geographical area. This is well illustrated in New York State, where a series of technical institutes were established as a result of a statewide surveys of industry (76).

3. An objective that appears to be well suited for technical institutes is to provide instruction in the technology of specific industries. Some examples of highly specialized curriculums designed to meet the needs of specific industries are the food technology curriculum in the New York State Agricultural and Technical Institute at Morrisville, the Oklahoma State University's fire protection curriculum at Stillwater, and the photographic and screw machine technology curriculum in the Institute of Technology at Rochester.

4. Technical institutes are especially well adapted to provide the needs of employed adults by providing evening courses in technical fields such as drafting and technical mathematics.

Some Factors Affecting Objectives. There are several factors which cannot in themselves be considered objectives, but which do play a part in determining the kind of program offered by an institute. The two most important are--

1. The emphasis placed upon general education.
Technical institutes in the past have concentrated almost entirely upon occupational objectives and omitted courses in English, the humanities, and social sciences. Their reasoning was that all or most of the time available must be devoted to the technical areas. Within the past two decades educators and the public have begun to feel the need for improvement in the social, civic, and moral areas. Thus there has been a trend toward increasing the offerings in general education.

2. The administration's point of view concerning student personnel services. If institutes adopt the concept of educating the "whole" individual, the amount of consideration given to admissions, housing, health, services, and placement will influence the objectives and program.

Preparing the Objectives. There is probably no institute in which the objectives were formulated in a single way. In some cases an outstanding individual or a small group has seen the need for such training and organized a new program. It then became the task of the educator to translate these needs into a workable situation. In still other cases an institution has felt the need to re-examine its entire program to determine the technical needs of the area are being met. A well-known illustration of this approach is the experience of the Rochester Institute of Technology (99) which will be briefly described here.
Following World War I, the Rochester Institute decided to reformulate its general objectives, the first step being taken by the president and board of trustees. The Institute engaged a committee of outstanding consultants to study the institution. After considering the report of the consultants, the broad outlines of policy were determined. A more complete formulation of objectives was undertaken in 1929. At that time each member of the faculty (99) was asked to make a statement of his contributions and outline his objectives by responding to the following questions:

1. What characteristics should mark Institute graduates?

2. What educational objectives do you think the Institute stands for?

3. What are your objectives in teaching Institute students?

4. What changes in educational objectives would you suggest?

The faculty statements were assembled first departmentally and general objectives formulated from them. The departmental heads and the president used these statements as a basis for formulating the general objectives of the institution. These were referred back to the faculty members, so that the instructional program could be checked against them.
This process has been repeated periodically and many revisions of objectives have resulted. The Rochester Institute (88, p. 7) objectives from the 1954-1955 catalogue are condensed as follows:

The basic objective of the Rochester Institute of Technology is to prepare students for effective and satisfying participation in a technological society. The Institute attempts to attain this by providing each student with a well-rounded program which will assist him to (1) earn a living in a suitable occupational field; (2) acquire appropriate attitudes toward work; (3) develop the capacity for intelligent voting, effective parenthood, and assumption of other community responsibilities; (4) understand himself and improve his abilities to get along with other people, and (5) develop appreciations and interests that are personally rewarding.

In the area of technical education, examples of preparing objectives are not easy to find. However, L. V. Johnson, Director of Southern Technical Institute (63, p. 185), has contributed to the background of thinking which has served as a basis for formulating institute objectives, operating as divisions of Land-Grant colleges. He states that institutes serve four definite needs:

1. To meet industrial demands, technical institutes train high school graduates for an estimated 150,000 positions opening annually.

2. Technical institutes meet a social need. Pro-vision is made for the thousands of students who do not seek engineering degrees or who are handicapped by lack of mathematical ability.

3. There is an economic need, because existing college facilities are inadequate to handle the increasing college population, despite a growing desire for free education beyond the high school. A two-year college system, including technical
institutes would often develop American youth more than a system composed entirely of four-year schools.

4. Technical institutes meet military needs. The national defense program is based upon technical superiority to potential enemies.

After the general objectives of an institute have been formulated and the need has been determined for one or more curriculums, the following steps should be considered:

1. Determine job requirements in the occupational fields selected and apply those to the courses of instruction.

2. Provide a balance between technical and general education.

3. Select a staff having the necessary experience.

4. Review student personnel services to be offered, such as housing, counseling, and job-placement.

5. Provide for the selection of students and carry on a well-rounded program of public relations.

6. Provide a sound administrative organization.

The foregoing steps will be considered in detail in the following paragraphs, except point 6, which will be dealt with in Chapter VII.

SURVEYING THE DEMAND

All technical institute curriculums endeavor to prepare students for some occupational field or cluster of jobs. The potential employment opportunities also determine the types of curriculums appropriate for technical institutes and the number of students that should be accommodated. Equally
important is the demand for technical education by prospective students. These points imply the need for some type of survey to determine the demands of local industry for technical education.

The Scope of Technical Occupations. One of the major problems in determining the demand lies in the fact that all statistics refer to the past, while this type of education is concerned with the future. Some types of industries and occupations are expanding while still others are contracting. However, most changes develop gradually within the labor force. This fact keeps current statistics valid for a reasonable period of time. Fortunately education is concerned with long-range activities; thus some idea of the potential field can be shown by examining Table 10.

The United States Census includes draftsmen, engineers, designers, and technicians in Occupational Class 1. Most technical institute objectives fall within this occupational category. However, a few graduates doing supervisory work requiring a technical background find employment in Classes 3 and 6. A technical education background is also suitable preparation for many sales jobs in Classes 4 and 5.

The occupational objectives involve various census classifications. It is impossible, therefore, to obtain an exact estimate from this source of the total number of jobs for which technical education preparation may be appropriate, but the census figures do indicate that there is a very
<table>
<thead>
<tr>
<th>Occupational Class</th>
<th>Number Employed</th>
<th>Percent of total Labor Force</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Professional, technical, and kindred</td>
<td>4,909,241</td>
<td>9</td>
</tr>
<tr>
<td>2. Farmers and farm managers</td>
<td>4,306,253</td>
<td>8</td>
</tr>
<tr>
<td>3. Managers, officials, and proprietors</td>
<td>5,017,465</td>
<td>9</td>
</tr>
<tr>
<td>4. Clerical and kindred</td>
<td>6,894,374</td>
<td>12.5</td>
</tr>
<tr>
<td>5. Sales workers</td>
<td>3,926,510</td>
<td>7</td>
</tr>
<tr>
<td>6. Craftsmen, foremen, and kindred</td>
<td>7,772,560</td>
<td>14</td>
</tr>
<tr>
<td>7. Operatives and kindred</td>
<td>11,146,220</td>
<td>20</td>
</tr>
<tr>
<td>8. Private household workers</td>
<td>1,407,466</td>
<td>2.5</td>
</tr>
<tr>
<td>9. Service workers, except private household</td>
<td>4,287,703</td>
<td>8</td>
</tr>
<tr>
<td>10. Farm laborers and foremen</td>
<td>2,399,794</td>
<td>4</td>
</tr>
<tr>
<td>11. Laborers, except farm and mine</td>
<td>3,417,232</td>
<td>6</td>
</tr>
</tbody>
</table>

substantial number of jobs involved and that they represent a large proportion of the labor force.

Four principal approaches have been used to date to determine the realistic demands for graduates for either existing or proposed institutions. However, the area of service should be defined in terms of both geography and occupation.

1. The undertaking by public authorities, as in New York State and Louisiana, of state-wide surveys is needed by technical education.

2. Some institutions have provided occupational services in their areas. For example, Weber College in Ogden Utah.

3. RCA Institute serves a particular industry.

4. Rochester Institute serves a particular field on a national basis with its photography and printing curriculum.

Preliminary Steps in Making an Occupational Survey.
The primary purpose of any occupational survey is to answer the question, "What technical curriculums should be provided?" At this point it is important to clarify the meaning of "technical occupation." The New York State committee (76, p. 27), in making a statewide survey, started with the following definition of terms:

A "technical occupation" is a vocation requiring skillful application of a high degree of specialized knowledge together with a broad understanding of operational procedures; involving the frequent application of personal judgment; usually
dealing with a variety of situations; and often requiring supervision of the work of others. It offers opportunity for the worker to develop an ever-increasing personal control over the application of his knowledge and usually requires fewer motor skills than a trade of skilled occupation and less generalized knowledge than a profession.

This definition (99, p. 117) provided a check list for identifying technical jobs.

1. Emphasizes technical knowledge.

2. Emphasizes technical skill (and the ability to use technical knowledge).

3. Deals with rational processes as contrasted with empirical rules.

4. Has concern with cause and effect.

5. Emphasizes analysis and diagnosis.

6. Requires frequent exercise of ability to use involved judgment.

7. Deals with many factors and a number of variables.

8. Contends with a variety of situations.

9. Requires a knowledge of skilled work, but not necessarily skill in doing it.

10. Requires a background of science and mathematics.

11. Involves the use of instruments.

12. Requires the effective use of language to interpret orders and make reports.

13. Involves elements of leadership in supervisory occupations.

14. Required understanding of industrial tools, equipment, and processes.

15. Involves the visualization of plans and drawings, and a degree of creative design.
Technical Training for Industrial Occupations. Examination of job descriptions in a cross section of industries (111, p. 22) revealed that those occupations requiring technical training may be classified into four categories:

1. Engineering and science aides, such as drafting specialists and laboratory technicians, requiring a year or two of employment training.

2. Technical specialists or limited technicians, such as certain specialized instrument repair men and certain types of inspectors, who can be trained in relatively short preemployment or preproduction courses.

3. Technical production and maintenance supervisors, who must have a background of industrial or trade experience, plus supplementary technical and foremanship training.

4. Semitechnical men, such as salesmen, whose basic training is in the field of distributive education, but who must have some knowledge of the things they sell; factory accountants, whose basic training may be in the field of accounting, but who must have some technical knowledge of the plant and its products in order to understand and evaluate the figures they use.

Survey Methods and Procedures. The first step in making an occupational survey is to determine the desired information. In many cases a single curriculum (99) survey of one occupation will achieve results more meaningful than a community-wide gathering of statistics. Surveys involving a single curriculum in many cases yield more specific information which can be applied directly to the curriculum. Nevertheless, very useful results have been obtained by broader surveys, such as the New York Survey, and in other areas.
It is generally agreed that a committee of specialists can best determine the broad outlines of an occupational survey. But there is also general agreement that it is more efficient to make one person responsible for organizing and gathering the data. In addition, a fundamental decision must be made on the source or sources of information. Information for most occupational surveys (121) is obtained from employers, but it is also possible to obtain information from employee groups. Again, the purpose, content, and scope of the survey determines the best sources of information.

Another major point involves the techniques utilized in obtaining information. The most common is the questionnaire, usually sent to the employer. This method, though relatively inexpensive, has limited accuracy and usually produces no more than a 50 percent return. Such factors as careful wording, advance publicity, and brevity help to increase questionnaire returns.

It is particularly important in the development of a questionnaire to determine precisely what information is desired and formulate questions which will be understood clearly by those answering them. To avoid misinterpretation, it is recommended by authorities in the field that the questionnaire be pretested on a sampling of the survey population to determine its clarity and effectiveness.

The alternative to questionnaires are personal interviews. This method permits more comprehensive replies if the
interviewers are carefully selected and trained, when help is needed to get the person being interviewed to understand the kind of information sought. Interviews may be used as a supplement to questionnaires where returns are insufficient or not representative. It is often helpful to refer to a standard source of job description (109), such as the Dictionary of Occupational Titles.

Marguerite Zapoleon's bulletin (121) on the subject gives detailed information on survey techniques. Phoebe Ward (113) also has an extensive bibliography on occupational surveys. It should be made clear that a poor survey may be worse than none at all.

Determining the Need for Technical Curriculums. It is not enough to determine the number of persons employed in the various occupations. There are some expanding and contracting demands for labor in all occupations. However, it is estimated (13) that the annual replacement of employees amounts to about 5 percent of the total employed. This figure is used by educational institutions in planning long-range programs.

The expected drop-out rate in a curriculum is another factor to be considered. A study by Leo F. Smith (99, p. 298) shows that only 60 percent of all enrollees completed the three-year cooperative program of a technical institute. Taking into consideration the drop-out rate, more students need to be enrolled than are required by an occupation.
Morrison (76, p. 31) estimates that for New York State an adequate system of technical institutes could take care of 75 percent of annual replacements, if this type of education were available.

Surveying the Needs of Youth. Regardless of the demands of industry, a technical curriculum will meet these demands only to the extent that students are graduated. It is, therefore, essential to evaluate the interest of potential students in a curriculum. Thus, in any field where a need on the part of industry has been established, it would be reasonable to offer a pilot program.

DEVELOPING CURRICULUMS

As was pointed out in Chapter II, technical institutes were first developed to fill certain needs in industry. At first the requirements for these positions were analyzed informally, and teachers with appropriate skills and knowledge were then recruited. The more academic element was provided by teachers of science and mathematics while the skills were provided by draftsmen and machinists. The clearly defined objectives of each curriculum provided a common bond. Nevertheless, the development of appropriate curriculums has long been of primary concern to technical institute educators.

The authors of the SPEE study in 1931 (116) encouraged technical institutes to submit problems for consideration.
The most frequently mentioned was curriculum content. The goal of immediate employment makes faculties keenly aware of the relationship between student achievement and the curriculum. In other institutions of higher learning, it has always been possible to broaden the curriculum to include anything useful to the graduate, but technical education courses are terminal, and must be limited to the essentials. Over the years this has caused a constant struggle between including additional curriculum content and the time factor.

Students are recruited on the premise that the essential curriculum involved is the best approach to a specific occupational objective. This clear purpose makes the curriculum relatively inflexible, but at the same time it places considerable responsibility on curriculum planners.

Some Approaches to Curriculum Construction. In education, unfortunately, a common approach to curriculum construction is the "scissors and paste method," in which existing curriculums in the same field are reviewed and adopted either in whole or in part. Obtaining the opinion of experts about curriculum content is a slightly more penetrating approach. Using this method, the technical institutes have drawn upon both industrial experts and educators for curriculum development.

Probably no one method of curriculum construction is best for every situation. Technical institutes have often used a combination of methods.
Curriculums Identified from Job Clusters. A basic step in building a curriculum is to ascertain the initial requirements for employment and advancement. These requirements can be clarified by the preparation of a job-cluster chart. Such a chart shows related jobs in a particular field of endeavor. The job chart serves as a guide in visualizing the training necessary for an employee before he can reach his goal. It is also possible to take into consideration the fact that a person may wish to divert to a related job which may require similar knowledge and skills.

Using the following criteria, the New York State Committee (76, p. 46) determined the appropriateness of the job-cluster chart as a basis for institute curricula:

1. The curriculum is designed to prepare persons for a cluster of jobs in a given field, rather than for one specific payroll job.

2. The jobs included in the cluster meet the following conditions:

   a. There are a sufficient number of different jobs in the cluster to provide a reasonable spread of job opportunities for the graduate.

   b. Each job in the cluster is of technician character (see check list, Appendix 4).

   c. The jobs are of the level that normally require post-high school maturity with one to two years of training.

   d. The jobs are closely associated with each other so that shifting of the worker from one job to another in the cluster is readily possible and one job leads naturally to other more advanced jobs.
e. Important elements are found which are common to all the jobs, or in the preparation needed for them, such as basic science and mathematics, common industrial terminology, and similar technical skills.

3. The content meets the following conditions:
   a. The range of the content needed in the cluster is reasonable.
   b. The content lends itself to organized instruction.
   c. A substantial portion of the total content consists of technical courses peculiar to the job cluster.
   d. The difficulty level is such that it can be mastered by a reasonably high proportion of all high school graduates.
   e. Most students pursuing the curriculum can complete the required work in two years or less of full-time study.

4. The curriculum title describes it so clearly that it is easily identified and understood by employers and students.

5. The placement opportunities in the cluster are sufficiently large to justify a special curriculum.

6. It will be feasible to secure and maintain the special equipment required.

7. Satisfactory facilities for training in this field are not available.

Activity Analysis to Determine Curriculum Content. In determining the scope of a curriculum, the job chart is a valuable aid although it does not indicate the content of the courses. It is necessary to analyze the jobs from the standpoint of responsibilities and duties in order to determine the essential skills, knowledge, and attitudes for the basic
job. Emerson (111, p. 267) suggests such information might be classified into the following:

1. Basic technical information
2. Specialized technical information
3. Basic technical skills (ability to apply technical information to practical jobs)
4. Technical judgment
5. Supervisory skills and knowledge
6. Manipulative skills
7. Industrial organization practices
8. Human relationships

A further study of this problem should reveal an improved list of categories into which these data can be classified.

Developing Courses of Instruction. In developing a curriculum based upon an analysis of job responsibilities, a next step is to assign each major duty to a course of instruction. A practical technique is to make a list of the courses that represent the major areas of content. It is then possible to place each course title as a heading under which are placed the activities which fit into the course. In this type of curriculum construction, Smith (99, p. 138) suggests the subsequent steps.

1. Obtain faculty agreement on the allocation of duties to courses.
2. Organize instructional materials into units.
3. Arrange units according to logical and psychological considerations.
4. Set up schedules and appropriate allocations of credit.

Ellingson (35), p. 129) claims that the foregoing method has the following advantages as compared with other approaches to curriculum construction:

1. Facilitates the elimination of duplication and of superfluous materials.

2. Tends to provide greater incentive by virtue of its showing relationship between activities and content.

3. Assists in providing stabilized and validated courses even though instructors may change.

4. Aids in providing content prepared for specific vocational objective in contrast to general content.

Most curriculums are derived from procedures similar to those just described, but in many instances the techniques employed are less elaborate.

The Place of General Education in the Technical Institute. Although the primary goal continues to be the development of occupational competency, there is a mounting feeling that occupational preparation alone is not enough. This has stimulated the trend toward offerings in general education which the Harvard Committee (49) has defined as "that part of a student's education which looks first of all to his life as a responsible human being and citizen."

There is increasing agreement that all students need courses in general education. Engineering educators have emphasized more general education since World War II but there is very little agreement as to what the content of
these courses should be. Nevertheless, it is hoped that the
next few paragraphs will identify some of the more important
factors that should be kept in mind in formulating such a
program.

Davis (43, p. 272) believes there are six areas of
education in which a technical institute should concern
itself:

1. Occupational competence
2. Citizenship effectiveness
3. A reasonable understanding of nature and
   her laws
4. Recreational and aesthetic activities
5. Participation in general social activities
6. Proper use of leisure time.

Courses such as drafting will do relatively little toward
meeting these objectives. Instead, work in the humanities,
social sciences, and the arts are suggested.

The following principles were proposed by the New York
State Committee (76, p. 48) as a guide for developing general
education courses:

1. Science and Mathematics should be utilized as
   a broad base for technical specialization as well
   as a means of personal and social orientation.

2. A level of oral and written expression should
   be developed which is appropriate to the student's
   vocational, personal, and social needs.

3. An improved understanding of personal, social,
   and civic problems should be developed to assist the
   student in discharging his responsibilities as an
   individual, a citizen, a worker, and a home
   administrator.
4. Reading and the other communication arts should be utilized for their potential contribution to personal, social, and occupational life.

5. Emphasis should be placed on the improvement and maintenance of the student's personal health and the sharing of responsibility for community health.

The nature of the technical institute makes it important to study not only the content of general education courses, but also their organization within the curriculum. Since technical institute programs are terminal, there is insufficient time to develop a general education program such as is possible in a liberal arts college. Almstead (3) suggests instead of vertical curriculum building, "General studies for a two-year program built horizontally,—drawing knowledge from across the board, so the student may receive integrated knowledge about any event."

**Planning General Education Content.** Specialists usually agree regarding the essential elements to be included in a curriculum designed to prepare students for a job. However, in general education, there may be legitimate disagreement. Thus the opinion of specialists may have a more important place in determining the content of general education than in building technical courses. In addition, the administrator's underlying philosophy is likely to determine which persons are to be consulted.

The institute's common purposes and characteristics have led to some identifiable patterns in general education offerings. Most institutes include English and a limited
amount of social science. The languages are not taught. Education in the physical sciences is felt to be adequate because of the courses in chemistry and physics which form such an important part of the technical side of the curriculum. A survey by Edward E. Booher (20) in 1954, covering 249 curriculums, listed frequencies for general education subjects as follows:

<table>
<thead>
<tr>
<th>Subject</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Report and technical writing</td>
<td>169</td>
</tr>
<tr>
<td>Psychology and human relations</td>
<td>106</td>
</tr>
<tr>
<td>Social science survey and government</td>
<td>86</td>
</tr>
<tr>
<td>English grammar and composition</td>
<td>67</td>
</tr>
<tr>
<td>Public speaking</td>
<td>57</td>
</tr>
<tr>
<td>Economics</td>
<td>55</td>
</tr>
</tbody>
</table>

Representative Curriculums. The last few paragraphs have been devoted to the importance of curriculum content and the various approaches to its construction, the techniques involved in analyzing job requirements, and the place of general education in the curriculum. What is actually offered can best be visualized by studying the curriculums in radio, electronics, and television as offered by a publicly supported institute, a privately endowed institute, and a proprietary institute. These curriculums are presented in (99, pp.282-289).

General Principles. On the basis of the most successful technical institutes, and in light of the research which
has been done, Smith and Lipsett (99, p. 145) have listed twelve fundamental principles underlying the technical institute curriculum:

1. The objectives of the curriculum should be clearly defined.

2. Curriculums should be offered only in those occupational fields in which a potential demand for graduates has been established.

3. Each curriculum should be designed to prepare a student for a related cluster of technical occupations. Competence is an essential objective of each curriculum.

4. The curriculums should reflect the needs of industry.

5. An analysis should be made of the skills and knowledge essential for successful employment.

6. The occupational objectives for which the curriculums are designed should be attractive.

7. The curriculums should take into account the level and capacity of the students.

8. The curriculums should be so organized that they prepare a student for immediate employment.

9. The institution should have or be able to obtain adequate plant, faculty, and facilities to achieve the objectives of the curriculums.

10. Attention should be paid to the relative values of different portions of the curriculum when determining time distribution.

11. The type and amount of general education in each curriculum should be determined with care, or in light of the objectives of the institution.

12. Provision should be made for continual evaluation of each curriculum.
THE INSTRUCTIONAL STAFF

All technical institutes have as their clear objective the development of occupational competency. This is a key factor in determining the type of instructor wanted. To achieve this objective, instructors are required who are experienced in the technical area which they teach. The American Council on Education (9, p. 38) states that for instructors in general education subjects, "The first requisite is that general education and occupational education . . . be thought of as complementary parts of a larger whole." In addition to these basic qualifications (9, p. 3), the special nature of a technical institute creates a need for instructors

. . . Who do not shy away from the language and ways of everyday business,—who find satisfaction in careers in which they will be expected to identify themselves actively with working communities, as well as qualify for membership in a professional community.

Qualifications. The SPEE study of 1931 (116) found that only 4 percent of the faculty lacked industrial experience. In a recent study, Holderman (50, p. 2) surveyed 533 full-time instructors at eighteen institutes whose curriculums were accredited by the ECPD. His survey revealed that the average industrial experience of these instructors was five and one half years.

The Wickenden and Spahr report of 1931 (116, p. 150) stated, "It is evident that formal academic qualifications are not the primary criterion in selecting teachers." But
in many cases the competence required in technical instructors depends upon the completion of a certain amount of formal education. This is especially true in the academic fields, such as physics, mathematics, and general education. At the time of the study, 70 percent of technical institute instructors held degrees.

Holderman (50, p. 1) found that—

Forty-four percent of 533 full-time teachers employed in 18 institutes developed as teachers through their training at technical institutes and trade schools or by serving apprenticeships and gaining practical technical experience. They are not college graduates. The other 56 percent hold degrees.

His study also revealed that the range of the number of instructors having degrees varied from 8 to 100 percent, with a medium of 65 percent for the eighteen institutions studied.

Of all the qualifications for a technical instructor, the intangible personal qualities that contribute to making a good teacher are usually rated as more important than a degree or year of work experience. These qualities were expressed by one administrator (116) as "knowledge of his subject, sympathetic understanding of the students' difficulties, ability clearly to present the subject, and its relation to industry."

Van Zeeland (112, p. 2), in a paper presented in 1951 at a meeting of the Technical Institute Division at Michigan State College, said:

It is obvious that the technical institute instructor must possess many characteristics. These
qualities can be classified into three groups: the predominantly psychological, those which are largely technical, and the physical and manual.

The American Council on Education called a special conference in 1945 to study the specific problem of preparation of teachers for junior colleges and technical institutes. The bulletin (9, p. 8) published following this conference concludes:

In short, this is a job for thoughtful, stout-hearted men and women, with certain traits--willing to step outside traditional academic circles in any important cause, not afraid of pioneer confusions and growing pains, or of temporary junior status, or of the direct speech of the factory, the farm, the store, the newspaper office, or the city hall.

All technical institutes are continually alert for instructors who possess the desired qualities.

Preparation of Instructors. Ability to teach in most types of institutions and adequate preparation can be obtained in an educational program designed for that purpose. However, the preparation of a technical instructor is often complicated by the need for industrial experience and for adjusting to an institution which does not always fit into the traditional patterns. As Jarvie (59, p. 6) states:

... the goal should be the production of instructors who possess the following: (1) a clear and realistic understanding of the philosophy and purposes of technical institutes; (2) knowledge and techniques for analyzing and putting such a philosophy into action; (3) a functional ability in dealing with the complex factors of human growth and development; (4) mastery of a field of knowledge in a relevant and broad sense; and (5) the ability to develop
new curriculum patterns and to bring to the entire undertaking an objective, evaluative point of view.

A degree from an engineering college indicates a level of achievement which is desirable for most technical instructors. In some cases graduation from a technical institute itself may be appropriate. A technical course foundation, however, is only one of the requirements. The required experiences in industry must be obtained apart from the educational preparation.

Because of the difficulty of finding adequately prepared instructors, the faculty members of the California Junior College Federation (9, p. 40), passed the following resolution in November of 1946:

... that the California Federation of Junior Colleges request the presidents of the teacher training institutions to establish a program of teacher education that will train instructors in engineering and science in order to create a supply of appropriately trained instructors for the technical institutes.

There has been an attempt more recently to meet this critical need. The Oklahoma Institute of Technology now makes it possible for a student to combine a technical curriculum with the preparation for teaching in a four-year program. In an unpublished manuscript (99, p. 155), Adams cites the following advantages of the Oklahoma plan:

1. The adoption of this program by several well-recognized industrial teacher training programs would result in providing an outlet for well-qualified technical institute graduates who wish to secure a four-year degree.
2. It definitely established that ECPD-approved technical institutes programs are of college level.

3. This program provides a most effective group of educational and vocational field counselors who are almost certain to be enthusiastic ambassadors of technical institute education.

4. It provides a proving ground for prospective teachers which should result in an increasing supply of more efficient teachers.

5. The plan will also provide a new source of exceptionally well-qualified teachers of industrial subjects. Many of the ECPD-approved curricula offer more practical courses than those offered by the leading industrial teacher-training institutions.

This is being accomplished by giving full credit to the technical courses in the baccalaureate degree program.

A 1950 workshop for technical institute teachers and administrators at Purdue University was another step in the development of technical faculties. The workshop (44, p. 1) at the time had two objectives:

1. To bring together both administrators and teachers for an intensive study of the many issues now being resolved in the operation of technical institute programs.

2. To make rather definite recommendations regarding the establishment of training programs for prospective technical institute teachers.

Much was accomplished toward the first objective, but there was less achievement on the second. Nevertheless the workshop stimulated other schools to consider similar programs.

In-service Training. Although most faculty members come to their jobs with a reasonable mastery of technology, the majority of them must be made into teachers on the
job (9). Instructors frequently lack skills and knowledge in educational techniques and principles. Smith (99, p. 157), in his 1954 survey of technical institutes, asked them to indicate their in-service training programs for faculty members. The list follows:

<table>
<thead>
<tr>
<th>Training Program</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-campus training programs in pedagogy and related subjects</td>
<td>11</td>
</tr>
<tr>
<td>Faculty meetings, committees, and other informal training</td>
<td>6</td>
</tr>
<tr>
<td>Encourage or require off-campus training</td>
<td>3</td>
</tr>
<tr>
<td>On-campus training in technical subjects</td>
<td>1</td>
</tr>
</tbody>
</table>

In-service training programs consist of discussions, seminars, and sometimes lectures. Sessions usually cover instructional methods, history of technical education, philosophy, finance, and community relationships. Smith (99, p. 291), includes an outline of the in-service course of training at the New York City Community College of Applied Arts and Sciences.

Technical competency and pedagogical skill are requirements of all technical instructors, but these factors will provide optimal results only if the conditions of the institute are appropriately stimulating. These intangible factors have been summarized by Jarvie (59, p. 6) as follows:

If teachers are to continue to grow in technical institutes, faculty members must be given an opportunity and encouragement to work on specific
problems related to the improvement of their teaching. Provision must be made for the interchange of ideas and techniques between all faculty members, regardless of their fields of specialization. Consultation services need to be provided, but these must be such that consultants function as stimulators of thought on local problems. Consideration, encouragement, and opportunity must be given instructors to participate in all types of community activities and to become one with their community. Leaves of absence should be provided for instructors to obtain jobs outside the institution and away from the educational profession. Above all, the in-service program must be a program that evolves through group thinking of the faculty. Each faculty member must feel that the particular problems upon which he is working are significant to his becoming a more effective instructor.

**Instructional Methods and Materials.** The technical institute endeavors to teach both the "how" and the "why" of an occupation. But in order to develop occupational competency in a limited time, the theoretical aspects of subject matter are less emphasized than in the engineering colleges. Application of principles is stressed instead. Wickender and Spahr (116, p. 157) stated in 1931, "There is a manifest endeavor to teach underlying physical principles thoroughly, but not profoundly." Through the years, the institutes have retained a greater degree of their individuality than have the secondary schools and colleges. For this reason it has been necessary for many instructors to prepare their own textbooks and manuals. In the past, the institutes have been severely handicapped by the lack of adequate text material. College engineering books presupposed a knowledge of calculus and were too abstract. Books prepared for trade schools
were inadequate because of the lack of attention paid to basic principles. Recognizing the need for such textbooks, McGraw-Hill has encouraged instructors in technical-terminal programs to prepare texts.

THE APPROPRIATE SELECTION OF STUDENTS

At some colleges, a student may enroll because of a beautiful campus, a renowned athletic team, or because of the social contacts. In sharp contrast to this, students interested in technical education place less emphasis on these factors and consider specific courses of study leading directly to an occupational job.

Successful Recruiting Techniques. Smith (99, p. 171), in his 1954 survey, asked the technical institutes to list the recruiting techniques which they had found most successful:

<table>
<thead>
<tr>
<th>Technique</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recommendations of graduates</td>
<td>15</td>
</tr>
<tr>
<td>Visits to high schools</td>
<td>6</td>
</tr>
<tr>
<td>Radio and television programs</td>
<td>3</td>
</tr>
<tr>
<td>Direct mail</td>
<td>2</td>
</tr>
<tr>
<td>Newspaper advertisements</td>
<td>2</td>
</tr>
<tr>
<td>Contacts with high school counselors</td>
<td>2</td>
</tr>
<tr>
<td>Personal contacts</td>
<td>2</td>
</tr>
<tr>
<td>Sending literature in answer to inquiries</td>
<td>1</td>
</tr>
<tr>
<td>Illustrated talks on visits to high schools</td>
<td>1</td>
</tr>
</tbody>
</table>

Some 38 percent of the student body at Aeronautical University is recruited through the activities of graduates. Thirty-four percent of the freshmen at Rochester Institute of Technology became interested through a student or alumnus, while
22 percent were recruited through high school principals, counselors, and teachers.

Admissions. No technical institution tries to serve the needs of all types of potential students or occupational fields. Therefore the selection and admission of students who can best profit from its courses is more important than it is for most institutions. The relatively specific goals of most institute programs make them suitable for students who have made an occupational choice and possess the appropriate ability and preparation.

Self-selection by students is the most significant aspect of the selection process for technical institutes. Students who choose technical programs of study are usually interested in some particular field. They look for an institution that can prepare them for this type of work. Thus as students look for such educational offerings, they tend to match their own aptitudes and abilities with curricular requirements. A high percentage of applicants meet admission requirements as a result and complete the courses of study successfully.

It should be pointed out, however, that self-selection should not be the sole criterion for admission. Institutes have responsibilities to faculty, students, and financial supporters to admit only those applicants who have a reasonable chance of success.
The admissions requirements most frequently set by technical institutes include—

1. Graduation from high school.
2. Completion of specified high school subjects.
3. Satisfactory entrance test scores.
4. Satisfactory personality and character.

Among the most common high school subjects required are algebra, geometry, and physics, and in some cases two and one half years of high school mathematics.

**STUDENT PERSONNEL SERVICES**

In the early days of technical education, occupational needs were the only objectives it attempted to meet. However, over the years social, economic, educational, and philosophical developments have greatly broadened the concept of occupational needs.

As the concept of human needs has become broader, institutes have moved toward the objective of educating the whole individual by a unified program designed to provide occupational competencies and also to bring about social development in a broader sense.

Student personnel work has developed within the last few years to the point where it can now be broken down into manageable proportions. These areas of student personnel work have been classified by Wrenn (118), p. 24) as follows:

1. Admissions
2. Orientation
3. Housing and food service
4. Health services
5. Counseling
6. Remedial services (reading, speech, study habits)
7. Student activities
8. Financial aids and student employment
9. Job-placement service
10. Cumulative personnel records

It is not the purpose of this chapter to analyze the major principles and practices under these headings. However, educators with specific interest in student personnel work are referred to the rather large body of literature in this field, a partial list of which follows:


Professional specialists have developed in each of the areas listed by Wrenn. Achieving a well-balanced and coordinated program of student personnel services is a difficult task which few have accomplished, although some progress has been made.

**SUMMARY**

All technical schools have executive duties that must be performed so the objectives of the institution may be accomplished. The administration must be concerned with finances, sources of control, business administration, instructional staff, student personnel, public relations and evaluation of the total program. Although administration consists primarily of making policies and decisions, the final test of its proficiency is the extent to which the objectives have been reached.
CHAPTER VII

ADMINISTRATION

An educational institution, whether it be secondary school, college, university, or technical institute, has certain administrative duties that must be performed in order that objectives of the institution may be accomplished. The administrative concern for a technical institute according to Smith (99) and others includes the basic control, finances, organizational structure, business administration, the plant, instructional program, administration of student personnel, public relations, and evaluation. Although administration consists essentially of making policies and decisions, the final test of its efficiency is the extent to which the educational goals or objectives have been reached.

The many activities and functions of technical institutes have been analyzed in the preceding chapter. It was implied at the time that some administrative head was responsible for the initiation and supervision of these functions. Therefore, the purpose of this chapter is to analyze the administrative patterns and problems of technical education, and to present the principal responsibilities of the administration.
BASIC SOURCE OF CONTROL

All technical schools have their origin in some objective conceived in the general terms of a group, legislative body, or (99) individual. The original interest according to Smith (99) determines the basic plan of financing.

Technical institutions have three principal means of support:

1. Public support by municipalities or states
2. Private endowment with nonprofit operation
3. Proprietary institutions operating for a profit

The major consideration for determining the composition of a policy-making body is the source of financial support. The typical plan for the control of institutions of higher learning in the United States (93) provides for a board of directors which has final authority. The board is legally responsible as the ultimate source of control for an educational institution.

The board's primary concern on long range policies suggests terms of office long enough to permit members of the board to become thoroughly familiar with the institution. A term of at least six years (79) has been recommended. It has been proposed, as in the United States Senate, that terms of office expire at different times. Furthermore, the selection of board members should be determined by the objectives of the institution. Public supported institutions
choose board members to represent the public interest. Board members for privately endowed institutions are usually chosen to represent local industrial and business interests that are served by the institution. Frequently, they are important donors. Proprietary institutions often function like other businesses where the principal owner exercises both financial and administrative direction and control.

Board members are usually conceived of as a group which determines policy but which does not administer its policies. Since most boards are composed of laymen, their main concern is with broad goals. Thus the implementation of these goals is logically left to the professional educators and specialists employed by the board for that specific purpose. Typically, the basic administrative or executive functions of the board are delegated to the chief executive officer, either as president, director, or principal. The board delegates to the executive head (43) the responsibility for making operational decisions consistent with the basic policy. He also has the responsibility of pointing need changes in policy out to the board. To have a clear-cut line of authority requires that all employees be subordinate to the chief executive officer.

An additional function of a board of control is discharged when it employs a chief executive officer and delegates to him the appropriate responsibilities and authority to act. There are, however, additional matters so very basic
to the general welfare of any institution that they cannot be delegated entirely to the chief executive officer. These functions include determining general policies and obtaining and investing funds. Bogue (17, p. 282) describes the function of a board of control in some detail:

1. To determine general policies for organization, administration, and operation. . . .

2. To act as court of final appeal in all matters which may properly be referred to it.

3. To approve the budget and authorize changes within the limits of the budget and authorize changes within the span of the fiscal year.

4. To assume the responsibility for securing funds for . . . proper operation.

5. To employ the chief executive, unless otherwise specified, and delegate to him powers and responsibilities under a written contract.

6. To elect major staff members and teaching personnel on recommendation of the chief executive unless otherwise specified. In this respect, the chief executive should have just as free a hand as possible in the selection of his staff . . .

7. To authorize investment and provide protection for all funds given in trust . . .

8. To authorize by formal vote the granting of degree of graduation of candidates certified by the faculty, registrar, and chief executive.

ORGANIZATIONAL STRUCTURE

Goetsch (43, p. 161) points out that there are four divisions of administrative structure in institutions of higher learning: "(1) academic administration, (2) student personnel administration, (3) business administration, and (4) administration of field services and public relations."
It is customary in smaller (99) institutions for department heads to report directly to the president. However, in larger institutions it is more common for the departments to be grouped in various ways for administrative efficiency. One outstanding pattern which has been successfully utilized is illustrated by Figure IV (79, p. VII 5), which follows.

The president in such an organization is directly responsible for employing and supervising department heads, who in turn supervise the instructional staff. Under such a plan, it is recommended that department heads at least share in the responsibility for selecting their faculty members.

Line organizations in larger institutions often have additional echelons or may be supplemented with additional staff personnel, such as business office workers, librarians, and counselors, who serve the entire institution, reporting either to the president or some other line executive. In some cases, a line and staff type of organization is supplemented by various committees for determining general policy involving curriculum construction, awarding scholarships, or for other purposes.

In considering administrative structure, it is particularly important to remember that administration exists only to serve the institution's objectives. Therefore, the best pattern is that which fits the particular needs of the institution in question.
Figure IV
ORGANIZATION STRUCTURE OF A TECHNICAL INSTITUTE

Board of Directors

President

Comptroller

Dean of Instruction

Dean of Students

Director of Public Rel'ns

Investments
Buildings & grounds
Purchasing Office

Library

Teaching departments

Admissions
Registration
Counseling
Student activities
Athletics
Residence halls
Medical Scholarships

Publicity
Publications
High School contacts
Alumni
Radio-TV
Special assignments

FINANCES

Once an institution has appointed a president, financial policy becomes one of his most critical responsibilities, subject to the advice and approval of the board of control. The president in public institutions must always prepare a budget and obtain the necessary funds from his legislative body. The budgetary problems for private institutions are similar, but the usual source of funds is different and the techniques may vary. Proprietary institutions have financial problems common to other profit-making businesses.

Endowed institutions obtain a high percentage of their operating funds from tuition. In addition, the return from invested endowment funds is a major source of income. Finally, institutions have special funds from vested interested groups.

Individuals who have possessed both wealth and philanthropic interests have been the principal source of endowment. While private endowment remains an important source of income, the number of private fortunes are decreasing. The present tax structure may encourage philanthropy by wealthy individuals, but it also limits the development of new fortunes.

All higher education institutions faced with monetary problems have given considerable attention to fund-raising techniques, such as canvassing alumni and banding together
into regional associations to raise funds. In the future, one of the most productive sources of funds for technical institutes will be business and industrial companies, because large, successful companies have substantial funds. In addition, the technical institute curriculum is becoming more and more important to industry, and the tax structure now permits corporations to contribute to this type of school without excessive sacrifice. An outstanding example (99) is the Rochester Institute of Technology, which has made considerable progress in this field. At present, its operating budget is approximately one half from tuition, one fourth from endowment returns, and one fourth from annual grants by industrial corporations.

All technical institutions can materially benefit by gifts of equipment from interested corporations. Many times it is to the financial interest of a manufacturer, either to give or to lend equipment for instructional purposes. Students graduating from technical schools are often potential executives. Thus their familiarity with a certain piece of machinery may, and often does, influence them to purchase that type of equipment when they reach executive positions. In still other cases, it is frequently worth-while for a manufacturer to lend equipment either used or made by that firm, so that students who train on these machines will be better prepared for employment.
BUSINESS ADMINISTRATION

The finances obtained by any technical institution serve its objectives only to the extent that the money is efficiently managed. Specialized business management services (93, p. 77) are required (1) to care for administrative details which permit academic officers and faculty members to devote their time primarily to instructional activities and (2) to conserve financial resources for the maximum support of the institution's educational services. The business functions of an educational institution include financial accounting, budgeting, purchasing, payroll, and other activities commonly found in all businesses. In addition, all institutions have special problems in collecting tuition and fees, and in supervising the finances of student activities and special insurance coverage.

Many of the relevant problems of business administration within technical institutions are so common to all business management that they do not warrant special attention in this chapter. Nevertheless, it should be pointed out that the budget has become widely recognized as the best method for the control of finances to reconcile expenditures with income. Russell and Reeves (93, p. 94) have suggested that the following items should be included in a budget:

1. Proposed budget of last completed year.
2. Actual results of last fiscal year.
3. Budget for current year.
4. Present estimate of outcome for current year.
5. Proposed budget for next year.
6. Increases or decreases from last year.

The usual procedure calls for all departments to submit their budget requests, with the chief administrative head exercising final authority to reconcile requests with expected income. These requests, of course, must be submitted so that all steps can be completed in time for the last source of control, the board of trustees, to act.

Because of the annual turnover of student officers, the financing of student activities often presents problems. In many cases, the business office collects separate fees for student activities. In some instances, such as athletic events, fees are collected at the gate. But most student organizations need professional guidance for efficient management of their funds. The most available source is usually the business office.

PLANT

The plant required by a technical institute is determined by the objectives of the program. Most technical programs require considerable floor space for laboratories and shops. These explicit needs make it especially important to design buildings "from the inside out," for equipment has a direct bearing on the type of building which will house it. A building primarily for classrooms can be more flexible in
its exterior design, although it is still important to have the interior properly arranged for rooms of suitable size with appropriate types of seating. Generally, in institutions of higher learning, the campus plant has become traditional. Smith and Lipsett (99, p. 232) believe that this type has several advantages:

1. It can utilize the esthetic properties of landscaping.

2. Each building can be designed for a specific purpose.

3. A campus of sufficient size offers opportunities for convenient expansion through the construction of new buildings.

4. A campus can create a sense of unity or group feeling on the part of students.

Most technical institutes have developed along the lines established by colleges and universities. However, many institutes derive their primary source of strength from close ties with industry in a specific metropolitan area. An urban location influences a plant toward a small number of buildings placed in close proximity to each other. The cost of land is also a controlling influence. The accessibility to the whole commuting area is important to both day and evening adult students. It should be kept in mind, however, that location on a public transportation line may cease to be important since a large majority of students drive their own
cars and will require parking space. A plant consisting of either one or a few buildings has an advantage, in that maintenance costs are significantly less than for equal space on a campus.

When planning a technical institute plant, the following pertinent questions (99) should be answered:

1. What buildings are available?
2. What will be the enrollment in five years, in ten years, or in twenty years?
3. What does the curriculum require in facilities and equipment?
4. What are the needs of extracurricular activities for students?
5. What opportunities does the site provide for expansion?
6. How do the transportation facilities meet the needs of students?
7. What is the maintenance cost of the proposed plant?
8. What relevant esthetic factors are there?
9. What facilities are needed to provide for adequate housing?

ADMINISTERING THE INSTRUCTIONAL PROGRAM

What takes place in the individual classroom is a primary factor in the effectiveness of any technical program. Some of the recruiting and training problems involving the
faculty have been analyzed in Chapter VI. However, from the administrative standpoint, there are several important considerations which should be reviewed.

Financial problems enter significantly into the consideration of student-faculty ratio. It is more economical to instruct students in large classes, if possible. Research indicates that this is feasible in some subject areas where the lecture method can be used. Relatively small classes, however, are required for effective class discussions and especially for individual attention in the shop or laboratory. But it should be borne in mind that small classes are not necessarily best in every situation. It is essential that administrators review their institutional objectives and evaluate the extent to which they may be attained by the various approaches available to them.

Few instructors interested in technical work seek their positions primarily because of salary. However, income opportunities continue to play an important part in the type of individual who may be recruited. In order to obtain a person of sound technical competence, an institute usually must pay a salary comparable to what the individual could earn in industry or elsewhere. General education instructors can be recruited if salaries are comparable with those offered by other educational institutions.

A technical school can usually offer a faculty member pleasant working conditions, advancement, stable employment,
and adequate provisions for retirement. However, these advantages do not come automatically, but exist only if administrators make suitable provisions and carry out appropriate policies.

STUDENT PERSONNEL ADMINISTRATION

The attitude of the administration toward students and student life is a key factor affecting recruitment, student morale, alumni relationships, and many other aspects of a technical program. A review of some of the administrative attitudes which exist in technical institutes either consciously or unconsciously (99, p. 235) are listed below:

1. The high school attitude prevails, with students being told what to do and generally treated as too immature to carry independent responsibility.

2. Students are treated as adults and left mainly on their own.

3. A paternalistic attitude is the basis of faculty-planned activities designed to be of value to students.

4. Attention is concentrated on the curriculum and other aspects of student life are ignored.

5. Student activities are tolerated as a necessary evil but are not encouraged or exploited for the attainment of educational objectives.

6. Opportunities are provided for student leadership and responsibility in developing out-of-class activities which will meet their needs and foster their development.

The philosophical justification can be found in a variety of administrative policies toward students. It is not the purpose of this chapter to analyze these philosophies at
any length. However, from an administrative viewpoint (99), the following principles apply:

1. Regulations and activities affecting students are important enough to justify careful study.

2. To eliminate moving from crisis to crisis, the development of a consistent long-range policy is essential.

3. If a policy is to be effectively carried out, the administrative responsibilities must be clear to all concerned.

4. Administration at all levels is most effective if authority and responsibility are equal.

Written constitutions have been found effective to clarify responsibility for student organizations. In most institutions it is an implicit fact that the seat of authority is the board of control, and that this authority, in turn, is delegated to the administration. Students do not always understand these facts. Thus, if a particular area of responsibility is delegated to students, it should be in written form. A frank discussion of the subject can eliminate possible sources of conflict.

PUBLIC RELATIONS

It is not the purpose of this section to include a thorough discussion of public relations involving technical schools. An attempt will be made rather to highlight some of the more important public relations factors which have special significance for technical schools.
The source of financial support may be a key factor in determining the area in which relationships outside of a school count the most. Appropriate contacts with a legislative body may be particularly important for institutions needing public support, whereas private institutions are usually more concerned with groups or individuals interested in their programs.

It is essential that all technical institutions have satisfactory relationships with the industries they serve. This is important for curriculum planning, for gifts and loans of equipment, for placement of graduates, and for financial support. To implement these functions, advisory committees are important as a medium for continuing communications and good will.

High schools within the institute's recruiting area are always important to its public relations program. The development of a favorable attitude toward an institute is important, but it is also important to develop a favorable understanding of the institute's program, which is often unfamiliar to high school teachers and students.

So far as public relations are concerned, it is important to remember that the feeling of students, faculty, and alumni toward any institution will have a more significant effect than a mass of publicity material prepared by a public relations expert. The many individuals continually connected with an institute are constantly in contact with the general
Therefore, public relations will be more effective if staff efforts are closely coordinated.

EVALUATION

The responsibility of evaluating all aspects of an educational program belongs to the chief administrator. The most important areas of evaluation are plant and equipment, public relations, financing, student personnel activities, instruction, and curriculum content.

In any institution, executive decisions are sound only to the extent that they are based on reliable data. The most important source of such data lies in the extent to which the objectives of an institution are being achieved.

Student achievement is one of the key aspects in educational evaluation. Tyler (108, p. 215) has outlined in some detail the steps involved in this type of evaluation:

1. Formulation of the objectives of each course or curriculum and definition of these in terms of the changes in knowledge, information, skills, attitudes, or appreciation desired in students.

2. Collection of situations which give students opportunity to demonstrate the extent to which they have achieved each objective.

3. Organization of these situations into tests, check lists of observation, etc., and the administration of these to students.

4. Scoring of the tests, check lists, and other devices used.

5. Critical review of entire procedure of evaluation in terms of relevance to the objectives, reliability, validity, and practicability of use.
Instructors develop their own tests, according to their best judgment, in most institutions. These, however, are not always adequate and reliable measures of content, because instructors without specialized training cannot be expected to be expert in so complicated a field.

The objectives of an institution whose attainment cannot be measured in black and white has a more acute problem. For example, how can the development of initiative and self-reliance on the part of a student be measured? How can the extent of a student's constructive attitude toward work be measured? Nevertheless, if an institution has such objectives, it is important that their achievement be measured.

To fulfill these obligations of evaluation, an administrator has several possible courses open to him. He can (1) encourage a faculty member to obtain special training in evaluation, (2) employ a specialist, or (3) engage a part-time consultant.

Many institutions make major use of educational consultants. Where these are used, the faculty usually determines the problems to be presented and the possible steps to be taken toward a solution of the problems. Ellingson and Jarvie (35, p. 83) have outlined the philosophy underlying this program:

Throughout the program it is evident that the consultants and the chairman of the Research Committee are considered as counselors to the staff; . . . that the real steps toward the solution of problems and improvement of program must be taken
by the persons most vitally concerned; that consultants as counselors must to a large extent be stimulators of teacher development; and that they must aid teachers in visualizing problems more clearly and provide aid in exploring possible patterns of attack.

Evaluation of the instructional staff involves some of the same problems which are directly related to student achievement. Thus, systematic procedures may be used to measure the effectiveness of instructors. One method is to use the same test in class sections taught by different instructors. Another method is to question students through meetings between instructors and department heads. It should be pointed out here, however, that many administrators feel that effectiveness within the classroom is only one of several important qualifications of an instructor. Some of the other factors may include effectiveness in committee work, public relations, and student personnel activities.

An important aspect of evaluation includes the techniques utilized to obtain relevant facts. Still another aspect is the way these facts are interpreted. Only in terms of some set of values can "good" or "bad" be ascertained. Furthermore, in the final analysis these values are based on opinion rather than on facts, which leaves room for legitimate differences of opinion. Whatever the philosophy of administration in an institution, it can be most effectively implemented if it is consciously understood, so that proper measures may be taken to achieve the goals desired.
Among technical schools, there is a considerable variety of objectives, community influences, financial resources, and other factors which logically lead to a corresponding variety of administrative practices and patterns. There are, however, a number of general principles of administration (99, p. 242) which expressly apply to technical schools:

1. The objectives of the institute and its various activities are most likely to be achieved if they are clearly formulated and understood.

2. Each activity of the institution exists primarily for the purpose of achieving the basic objectives. This includes not only instruction but also student personnel services, public relations, business management, and plant maintenance.

3. Policies are likely to be carried out more effectively and enthusiastically if the persons concerned participate in the formulation of those policies.

4. Sound decisions require accurate information. Obtaining it requires effective techniques of evaluation and fact-gathering.

5. At each echelon of administration, the policy-makers need effective channels of communication from subordinates as well as methods of communicating policies to subordinates and supervising the carrying out of those policies.

6. Administration is effective only to the extent that authority is commensurate with responsibility.

7. Effective coordination of various individuals and departments requires a clear understanding of the respective responsibilities and authority of the participants.

8. Orderly administration requires that subordinates be selected and trained systematically to fill vacancies in administrative posts.
9. Most people are able to adapt to progress and change gradually but not suddenly. This suggests that smooth administration is evolutionary rather than revolutionary.

This chapter has been devoted to a survey of the problems and techniques involving technical institute objectives, surveying the demand, curriculum development, staff, selection of students, and student personnel services.
CHAPTER VIII

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This dissertation has been concerned with the collection and correlation of facts, opinions, and philosophies reflecting the status and trend of "Technical Institute Movement." Chapter II pointed out that a study of the historical development of technical education contributes little to the understanding of its present-day problems, although it does reveal several negative influences upon it.

The evidence of the past two decades strongly indicates that the technical institute type of education will materially increase in size in the years ahead. This trend is indicated by the great increase in the total number of youth who will be of college age by 1960, 1965, and 1970. The recent national study by the American Council on Education, A Call for Action (8), has revealed that in the United States there would be an increase of 16 percent from 1953 to 1960, 46 percent by 1965, and 70 percent by 1970. Indications are strong that a larger number of students will enroll in technical institutes, since industrialists and educators have been giving increased recognition to technical education.

Chapter III showed that after a long period of development, the technical institute has finally established
Itself in the pattern of American education, and that although it does not fit clearly into the single-educational ladder of American education, there is an increasing need for the technical institute type of education.

Chapter IV points out that the current international crisis has greatly stimulated America's need for scientists and engineers. It is now apparent that professional workers can improve their efficiency and increase their total output by having technicians perform the more routine tasks. Thus, technicians have an increased role in strengthening both the technical and military effort. As a result, the demand for technicians has been rising sharply since the present defense program began and will continue to increase in the foreseeable future. Furthermore, the long-term outlook is for a continued expansion in the employment of technicians.

Chapter V reveals that the needs of industry for trained technicians have not been filled, although the technical institute has done much to fill the gap. The technical institute movement should help extensively to supply the needed technicians if the weaknesses in the technical institute are corrected.

Chapter VI presents the organization and projection of the technical institute.

Chapter VII reports that the administration of a training program for technicians is somewhat different than the administration of other educational programs. The
administrator must be thoroughly trained from a technical standpoint, yet sensitive to the viewpoint of the man in industry.

The first part of this dissertation has described the existing technical institutes in respect to historical background, general characteristics, and the needs of American industry. The last part has outlined the many problems involved in initiating, developing, and administering technical programs. It has also shown the large amount of development through which many technical institutes have passed. The technical institutes are still in a dynamic state of evolution, and are presently undergoing a rapid change. As these institutions work toward the fulfillment of their objectives, there are indications that the direction of their progress will take some of the following pathways.

CONCLUSIONS

Technical institutes have been fairly free from the restrictions of tradition. Consequently, they should be more easily guided by the results of modern educational research. However, the number of such schools in comparison to need is almost tragic.

Industrialization in America is still increasing. Apprenticeship has all but disappeared, and schools must now be relied upon for technical efficiency. Even if Colleges of Engineering trained men for industrial production, they could not fill the void. Courses that are intense enough to
provide vision, as well as practice, are essential to a technically trained working force.

In the place of two hundred such schools in the United States, there should be nearer one thousand, in order to fill the need. This is obviously the missing link in the educational system. Dr. Conant of Harvard University has stated that many post-high-school students could profit from two-year terminal courses, and that needs for higher education should be met largely by expansion in this area.

On the basis of the census data presented in this study, it may be expected that technical institutes will be enrolling larger numbers of students. Population studies have indicated that the number of students of college age will greatly increase in the next two decades and it is reasonable to expect that many of them will attend technical schools. The need of industry for technicians is another factor indicating that technical schools will enroll a large number of youth. This need has been estimated to be as high as seven technicians to one engineer. The President's Commission on higher education has reported that the demand for technical institute graduates in New York State is more than five times the need for graduates of four-year engineering schools. Nevertheless, enrollment in technical institutes and engineering schools is in inverse ratio, or approximately three engineering students for every technical institute student. This is a very significant finding and should prove to be an effective stimulus to the technical institutes.
The technical institutes are beginning to clarify their position on the educational scene. In the early period of their development, technical institutes offered courses to non-high-school graduates of a trade level now commonly offered in technical high schools. Other institutes offered programs which were close to engineering in extent and difficulty. However, in the last few years, there has been a tendency to standardize on post-high-school courses which last from one to three years and which are clearly neither trade nor engineering courses. As technical institutes have clarified their position, the public is likewise beginning to have a clearer concept of their role in education. Evidence of this is reflected in the increasing public support for the technical institute type of education. In the past decade, public-supported institutes have been founded in Connecticut, Georgia, Indiana, New Hampshire, New York, Oklahoma, Oregon, and Pennsylvania.

More and more, the technical institutes are accepting adult education as their responsibility. The same faculty and facilities which educate young men to be technicians are equally appropriate for offering courses to help adults upgrade themselves in industry. Institutes are increasingly meeting the demands of adult students.

Both the amount and quality of general education in technical institutes has been increasing. Society has become increasingly aware of the need of all persons for skills and
knowledge which will make it possible to participate effectively and satisfactorily, not only in work, but also in leisure pursuits, and in social and civic activities. Technical institutes are meeting this educational need more and more effectively.

There are many indications that technical training has arrived at a point where the needs of technological development can be more nearly met by an increased emphasis on the technical institute type of education. There are many elements of strength to support the movement. Many different kinds of technical institutes are acquiring status in education and industry. There appear to be no basic problems which will prevent the development of the technical institute movement. How fast this type of training will develop depends upon the acceptance of its potential contribution to economic achievement.

RECOMMENDATIONS

The findings suggest the following recommendations:

1. More adequate facilities are needed for training technical institute teachers and administrators.

2. Textbooks on the technical institute level are urgently needed.

3. State boards of technical education should be established in each state.

4. The community college should be considered as an important aspect of the institute program.
5. Technical institutes should let secondary school counselors know more about their work.

6. The curricula of technical institutes should be better balanced by including more general education.

7. There is a need to establish better relations with industry in many areas.

8. The continued shortage of technicians in industry warrants a greater expansion of technical education above the high-school level.

9. Technical education needs to be made more available locally, because most cities of 50,000 population or more could support a technical school.

10. Whenever possible, technical schools should have an evening department as one of their objectives.

11. Technical-school graduates should receive nationally recognized educational credentials.

12. There is an increasing need for technicians to obtain higher status.

13. Better use should be made of all types of technical personnel.

14. Greater financial assistance is needed.

15. More qualified teachers with technical specialties are needed.

16. Industry should give financial aid to worthy students.

17. Annual national statistics are needed.
18. A technical institute specialist is needed in the U. S. Office of Education.

19. Coordination of institutes would be desirable.

20. Private institutes need additional revenue.

21. A master plan is needed to supplement technically trained manpower sources.

22. A plan to upgrade technical personnel is needed in industry.

23. Technical societies should aid technicians.
BIBLIOGRAPHY


6. Alters, William and Hoelzhauer, J. Quantitative Analysis of Subject Matter in Technical Institute Type Curricula as Accredited by the National Council of Technical Schools as of January 1, 1951. Milwaukee School of Engineering.


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114. Werwath, Karl O. "Final Report to the Presidents Committee on Scientists and Engineers." From the Working Committee for the Development of Supporting Technical Personnel. 1957. ( Mimeographed)


Appendix A

Job-Cluster and Promotion Sequence

Technical institutes aim to prepare their students for any of the basic positions in a particular field rather than for one specific type of job. The purpose of a job-cluster chart, such as the one given below, is to show a technical institute graduate how his training enables him to apply for a wide area of related jobs. The chart and the example of a promotion sequence indicate how one can go up the employment ladder with additional experience.

Some technical institutes advise their students that they probably will find their first jobs at the "entry or training" level. It is believed that most of the graduates will probably advance to the "intermediate" jobs. The "terminal" positions represent the highest level of responsibility for technicians, because they are jobs to which graduates may advance only if they have demonstrated their personal ability and acquired greater experience. The positions classified as "basic" in the job-cluster chart are those closest to the field of training. The "supplementary" and "related" jobs illustrate some of the other types of work for which the training institutions consider their graduates qualified.

Job-Cluster Chart for Graduates of Mechanical Technology Curriculum

<table>
<thead>
<tr>
<th>BASIC</th>
<th>SUPPLEMENTARY</th>
<th>RELATED</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Entry or Training:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stock clerk</td>
<td>Meter testman</td>
<td>Chief engineer</td>
</tr>
<tr>
<td>Assistant inspector</td>
<td>Meter adjuster</td>
<td>Catalog and instruction book illustrator</td>
</tr>
<tr>
<td>Machine tool operator</td>
<td>Power test assistant</td>
<td>Calculator</td>
</tr>
<tr>
<td>Tracer</td>
<td>Toolroom assistant</td>
<td>Chief of stockroom</td>
</tr>
<tr>
<td>Tool crib attendant</td>
<td>Time study observer</td>
<td>Technical assistant</td>
</tr>
<tr>
<td>Maintenance man</td>
<td>Parts inspector</td>
<td>Product engineer</td>
</tr>
<tr>
<td>Time study assistant</td>
<td>Tool draftsman</td>
<td>Serviceman</td>
</tr>
<tr>
<td>Laboratory attendant</td>
<td></td>
<td>Superintendent of buildings</td>
</tr>
<tr>
<td>Foundry worker</td>
<td></td>
<td>Maintenance supervisor and comparable positions</td>
</tr>
<tr>
<td>Heat treater</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patternmaker</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tool grader</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>See Outline on page 25</td>
<td></td>
</tr>
</tbody>
</table>

2. Intermediate:             |                         |                        |
| Checker or inspector        | Technical correspondent  |                      |
| Layout man                  | Order clerk             |                      |
| Detailer                    | Assistant foreman       |                      |
| Process technician          | Draftsman               |                      |
| Time study man              | Reinforcer               |                      |
| Toolmaker                   | Job setter               |                      |
| Assembler                   | Cost analyst             |                      |
| Draftsman                   | Instrument maker         |                      |
| Powerplant operator         |                          |                      |
| Foreman                     |                          |                      |
| Test engineer               |                          |                      |
| Toolroom foreman            |                          |                      |
| Operation planner           |                          |                      |
| Cost estimator              |                          |                      |
| Tool estimator              |                          |                      |
| Expediter                   |                          |                      |

3. Terminal:                 |                         |                        |
| Machine designer            | Chief of standards       |                      |
| Tool designer               | Chief draftsman          |                      |
| Powerplant supervisor       | Technical supervisor     |                      |
| Production supervisor       | Foreman of experimentation |                   |
| Field engineer              | Chief of testing         |                      |
| Process engineer            | Chief of inspection      |                      |
| Consultant on power work    | Chief of maintenance     |                      |
| Building equipment supervisor| Chief of installation    |                      |
| Consultant on air-conditioning| Designer of powerplant equipment |                     |
|                             | Refrigeration plant supervisor |                      |

Probable Promotion Sequence in Radio and Electronics Field

Training Level Jobs:                        | Intermediate Level Jobs:                        | Upper Level Jobs:                          |
| Laboratory Assistant             | Assistant Laboratory Engineer                    | Radio or Electronic Engineer               |
| Assistant Draftsman              | Manufacturing Engineer                            | Radio or Electronic Laboratory Engineer    |
| Tester or Inspector              | Foreman of Radio and Electronic                  | Supervisor of Radio or Electronic         |
| Assemblyman                      | Manufacturing Department                          | Manufacturing Department                   |
| Machine Operator                 | Test or Inspector                                  |                                      |
|                                 | Draftsman                                          |                                      |
|                                 | Foreman of Radio and Electronic                   |                                      |
|                                 | Manufacturing Department                          |                                      |

*Adapted from "If You Are Considering a Career in the Electrical Field, Vocational Guidance Series, Pamphlet No. 5, Rochester, N. Y., Rochester Institute of Technology, 1916.

See Outline on page 25.
Appendix B

Technical Occupations Listed as Critical

Criteria for Inclusion on List of Critical Occupations

(1) Under the foreseeable mobilization program an over-all shortage of workers in the occupation exists or is developing which will significantly interfere with effective functioning of essential industries and activities;*

(2) A minimum accelerated training time of 2 years (or the equivalent in work experience) is necessary to the satisfactory performance of all the major tasks found in the occupation;

(3) The occupation is indispensable to the functioning of the industries or activities in which it occurs.

Definitions of Technical Occupations Appearing on List of Critical Occupations

Electronic Technician.—Fabricates, installs, maintains, and repairs intricate electronic apparatus and equipment used in communication, detection, measurement, and control systems, such as: aid-to-navigation systems, including radar and sonar; proximity fuses; guided missiles; fire-sighting and control systems; electronic computers; complex X-ray equipment; and electronic instrument and control devices, including those for special application in meteorological, geophysical, medical, and industrial-process fields. Constructs and modifies complex electronic assemblies and components, following engineering drawings, sketches, or verbal instructions and using a comprehensive knowledge of complex and varied test, assembly, and repair procedures to insure proper diagnosis, adjustment, and operation of such equipment. Tests, calibrates, adjusts, and repairs complex electronic equipment, replacing and interchanging component parts with precision machinist's and electrician's tools and electronic testing and auxiliary equipment. This title excludes those concerned with service and repair of radio and television broadcasting equipment and receivers, public-address systems, diathermy devices, electric organs, and similar equipment.

Engineer Draftsman, Design (General Definition).—Makes design drawings of machines, products, processes, instruments, or structures, to assist in developing experimental ideas evolved by Design Engineers. Prepares working plans and detail drawings, working from rough or detail sketches and specifications and employing his knowledge of engineering methods and practice to solve fabrication or construction problems. Designs lesser parts and assemblies or limited structures in harmony with over-all engineering plans and designs. Verifies dimensions of parts and materials, and relationship of one part to another as well as of the various parts to the whole structure, using an extensive knowledge of the various machines, products, or processes peculiar to the specialized activity in which the work occurs.

Tool and Die Designer.—Plants, sketches, and makes detailed drawings of tools, dies, jigs, fixtures, and gages. Determines type and kind of tool or die required. This definition includes only: Die Designer and Tool Designer, defined as follows: Die Designer (Die Designer, 0-48.42, D. O. T. p. 385). Makes drawings of dies necessary to form a complete stamping, forging, or other part. Decides on the number of sets of dies (each set representing a stage of development of the part to be made) necessary to change the metal blank into the finished piece, basing his decisions on a blueprint of the finished part and on his knowledge of dies and machines, and of their possibilities and limitations. Compares blueprints with wooden patterns of dies to determine if corrections, changes, or improvements should be made in patterns. This title includes only those related titles with the same Dictionary of Occupational Titles Code number (0-48.42). Tool Designer (Tool Designer, 0-48.41, D. O. T. p. 1381). Designs special tools and fixtures, such as boring bars and milling-machine tools. (Frequently is a Machinist, using types of machines for which he is designing tools.) This title includes only those related titles with the same Dictionary of Occupational Titles Code number (0-48.41).

* For List of Essential Activities, see release of April 8, 1951, U. S. Department of Commerce.

AUTOBIOGRAPHY

The writer of this dissertation was born in Galion, Ohio, on February 3, 1917, and given the name of CHARLES WELLINGTON PHALLEN. His elementary and secondary schooling was accomplished in the local schools.

A Bachelor of Science Degree in Education was achieved at Otterbein College in 1946, and a Master of Arts Degree in (Industrial Arts) Education was achieved at The Ohio State University in 1947. The General or matriculation examination for the Ph.D. was passed at The Ohio State University in 1950.

By way of teaching experience, beyond a year on the technical instructional staff of the Armored Forces School at Fort Knox, Kentucky, the writer has had five years in Industrial Arts and Physics in the High School at Richwood, Ohio, and two years in Industrial Arts and Physical Science in the high school of Whittier, California. The position next year is to be that of Associate Professor Industrial Arts Education in the University of the State of New York at Oswego.

The military experience of the writer includes service in the African and European campaigns. In the latter, a Purple Heart was earned on the Anzio Beachhead of Italy in 1944.