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This study attempts to solve the problem of Israel's shortage of qualified teachers for vocational and technical schools by analyzing the problems contained in their preparation, and by suggesting an appropriate program of studies for them, along with recommendations for its effective use. Analysis of the general as well as the vocational and technical educational system in Israel provides a basis for an evaluation of the teacher preparation for vocational and technical education in that country. The problems in Israel of vocational teachers' certification requirements, the status of vocational education, and the sources and recruitment of vocational and technical teachers, are considered in the program that is recommended for technical teachers in engineering and related subjects in electronics and mechanical engineering. Specific recommendations include a need to raise the status of the vocational teacher, to stress scientific and technical subject matter mastery, and to offer occupational experience along with professional education preparation. (MU)

מוסד הטכניון למחקר ופתוח בע
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הטכניון – מכון טכנולוגי לישראל
Technion - Israel Institute of Technology

# PREPARATION OF TEACHERS FOR VOCATIONAL-TECHNICAL SCHOOLS IN ISRAEL

# הכשרת מורים לבתי ספר מקצועיים בישראל



Haifa, Israel, December 1968

חיפה, דצמבר 1968

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Final Report

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U.S. Department of Health, Education and Welfare

Office of Education
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Contract No. OE-5-21-009

by

PERLBERG A., HANANI H., AVIGAD M., BEN SHALOM U., KOHN D.

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TECHNION-ISRAEL INSTITUTE OF TECHNOLOGY

HAIFA, ISRAEL

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## PREFACE

The acute growing shortage of qualified teachers for vocational and technical schools in Israel and the realization that this shortage might impare the government's plans to expand and intensify programs of vocational and technical education, have brought about the inception of this study.

Haim Hanani, Professor of Mathematics, former Vice President for Academic Affairs of the Technion-Israel Institute of Technology, and a former adviser to the Ministry of Education and Culture on the planning of higher education, together with Engineer Meir Avigad, Director of the Department of Vocational and Technical Education in the Ministry of Education and Culture, submitted a research proposal for studying the problems of preparing teachers and instructors for vocational schools and technical junior colleges.

After the approval of the proposal, Dr. Arye Perlberg, former Head of the Science and Technical Teacher-Training Department at the Technion, joined the team of principal investigators and assumed the directorship of this study. Two research associates, Mr. Uri Ben-Shalom (B.A.), State Supervisor in Vocational and Technical Education and Engineer David Kohn (M.Sc.), Coordinator of the Technion's Extension Division, also joined the research team.

Even though the original proposal was approved, only a third of the required budget was appropriated. This forced the researchers to limit the scope of the study and to concentrate mainly on the problems related to the preparation of teachers for the sciences and engineering-related subjects in technical schools and technical junior colleges. Moreover, the proposed procedures for the involvement of administrator and teachers in several selected schools in evaluation of curriculum and teaching activities and the plans for a statistical analysis of student achievements in these schools were curtailed. While in most cases the general discussion of problems is relevant to the whole field of vocational-technical teacher education, the specific curricula have been prepared for teachers of electronics and mechanical engineering only.

Many persons, notably faculty members of the Technion and state supervisors of vocational-technical education, have cooperated with the researchers in attaining the purposes of this study. Experts in vocational-technical education in Israel and various other countries have shared their knowledge and experience with us. We have learned from all of them, and many of their suggestions are incorporated in this report. However, the responsibility for the final analysis and recommendation lies solely with the researchers. The opinions expressed in this report do not in any way represent the opinions of the Technion-Israel Institute of Technology and the Israel Ministry of Education and Culture, who granted the researchers permission and time to carry on this study.

Finally, we would like to thank the U.S. Office of Education for making this study possible through its financial help. We would also like to thank the University of Illinois College of Education which awarded Dr. Perlberg, during his sabbatical year, funds for travel, secretarial help, and time to coordinate and prepare the final report.

## PART I. INTRODUCTION

### 1. The Problem

Changing the occupational profile of the Jewish people was considered as one of the most important roles of the modern Jewish settlement movement in Palestine and later in the State of Israel. Shifting the occupational emphasis from a people engaged mainly in services, "middle-men" occupations, and white-collar professions to a productive agricultural and industrial society, was the goal. The role of vocational-technical education in this social revolution was recognized to be of prime importance even before the establishment of the State of Israel.

However, it was not until the establishment of the State in 1948 that the development of vocational-technical education gained a significant momentum, as compared with previous emphasis on academic, college preparatory secondary schools.

Mass immigration pouring into a relatively small country, poor in natural resources, has convinced its leaders that the country's existence and economic integrity depend to a large extent on a highly developed industrial society which could compensate the lack of natural resources with human resources who have a high degree of technical know-how and high-quality workmanship on all occupational levels. In view of this realization, great strides have been made in reorganizing the existing systems of vocational-technical schools, in increasing the scope of their occupational offerings, in establishing new vocational schools, vocational tracks in newly established comprehensive schools, new prevocational programs in elementary schools and junior high schools, and a whole new system of technical junior colleges. However, it is recognized that the materialization of these plans and the provision of high-quality vocational-technical education in these schools depends on the availability of qualified teachers in the academic and practical subjects of vocational-technical education.

In the past, teachers for these schools were recruited from among industrial workers and engineers who preferred to change occupations and move into teaching. In some cases, candidates for engineering degrees, who for some reason did not graduate from higher education, were recruited for teaching positions in vocational-technical schools. No formal system was available to train vocational-technical school teachers. Various in-service education activities were organized by the Ministry of Education and Culture, the vocational schools, and the teachers' union, but all of these programs were limited in scope and intensity.

In 1959 the Technion-Israel Institute of Technology, the only engineering school in the country, recognized its obligation to prepare teachers more systematically for science and technical subjects in academic and technical schools. A Teacher-Training Department was established and, in addition to their regular studies, engineering and science students were able to obtain professional education courses. Upon completing these courses and student teaching activities, they received a teaching certificate as well as their main professional degree. Similar opportunities were available through the Technion's Extension Division to external students who wanted to obtain a teaching certificate.

It was assumed that some engineering and science students would be attracted to a teaching career even though their first intention at the Technion was engineering or scientific research. Financial aid was available for those ready to sign an obligation to teach a certain number of years.

The program has developed gradually and become part of the regular programs at the Technion. The number of students enrolled increased from year to year. However, it was soon recognized that the number of graduating engineers and science students who obtained a teaching certificate in addition to their degree and who chose teaching as a career, was not sufficient to satisfy the growing needs of vocational-technical teachers. In view of this it was agreed that there was a need to establish in the Technion Teacher-Training Department a special program which would train teachers (and not engineers) for the academic and scientific subjects of a vocational-technical curriculum. The graduates of this program would be awarded a B.Sc.Ed. degree in technical and science subjects. In addition, the Technion established an M.Sc. program in technical and science education aimed at the preparation of researchers in curriculum planning and teaching in vocational-technical education.

To establish such a program in a way that would both answer the needs of the country and suit the academic standards of the Technion, it was necessary to implement a study to clarify the problems involved in Israel and other countries and to propose some directions for action.

## 2. Objectives

The objectives of this study were as follows:

a. To identify and analyze the problems contained in the preparation of teachers for vocational-technical schools and technical junior colleges in Israel and other countries.

b. To identify and analyze programs and innovations in vocational-technical teacher education in selected countries.

c. To prepare a program of studies for the preparation of teachers for the academic engineering-related subjects in vocational-technical schools and in technical junior colleges. This program would be submitted to the Technion and the Ministry of Education and Culture, and would serve as a basis for the discussion on the establishment of a new option in the Teacher-Training Department of the Technion for the B.Sc. degree in the teaching of engineering-related subjects.

d. To recommend ways and directions of action to overcome the great problems involved in vocational-technical teacher education.

## 3. Procedures

Identification and analysis of problems in Israel. The fact that the researchers hold key professional positions in the area of vocational-technical education and vocational-technical teacher education in Israel was cardinal to the pursuance of this study. The major problems with which the researchers were confronted in their daily work were focused and evaluated by the research team. Available written data on the problems were analyzed. The opinions and attitudes of numerous other functionaries in this area were ascertained. Since some of the researchers were personally in charge or involved in the planning of future development of vocational-technical secondary, post-secondary, and higher education in Israel, it could be assumed that any available relevant information was considered by the researchers.

Identification and analysis of programs, innovations, and problems in vocational-technical teacher education in selected countries. These objectives were achieved through a survey of the international literature and study visits in selected countries. The survey of international literature included an analysis of texts and periodicals from several European and English-speaking countries. A great part of this survey was done in conjunction with the preparation of a book of international readings on vocational-technical education by two of the researchers, Perlberg A. and Ben-Shalom U. Surveys of the more recent literature were done through the aid of CIRF (International Vocational Training Information and Research Center of the International Labour Office in Geneva, Switzerland) and ERIC (Educational Research Information Center on Vocational-Technical Education at Ohio State University).

It is important to note that the review of the literature which provided the basis for a discussion of critical issues was constantly updated, thus making it necessary to rewrite some parts of this report. The first survey was made in 1965. Reviewing the international literature from Israel was a difficult task. Even international agencies such as CIRF were in the primary stages of their work. The last phase of the survey saw the publication of Moss (1967), "Review of Research of Vocational-Technical Teacher Education" in the United States on which the researchers relied very heavily.

The research budget provided for only one extensive visit to a foreign country. It was decided that Dr. Perlberg would tour the United States during the fall of 1965. He visited all major universities and institutions engaged in vocational-technical teacher education, exchanged information with national leaders in this field all over the country, and observed programs in vocational-technical schools and vocational-technical teacher education in various parts of the country. *

While this was the only foreign country visit supported by the research budget, the researchers had many other opportunities to study vocational-technical education in foreign countries, before and during the research. Although these visits were primarily arranged to study the general area of vocational-technical education, the researchers had ample opportunities to obtain insight into the perplexing problems of vocational-technical teacher education.

Professor Hanani visited UNESCO Headquarters on behalf of the Technion and the Ministry of Education and Culture to study technical education and spent his sabbatical year (1967-68) in the United States observing and discussing the situation in this area in these countries. Engineer Avigad travelled extensively in many European countries on study tours of vocational-technical education and served as a consultant to an international organization on these matters. Mr. Ben-Shalom studied vocational-technical education in France, Belgium and Switzerland on an I.L.O. study grant. Engineer Kohn studied the English system of vocational-technical education during a year of studies in England. Dr. Perlberg studied the French system of vocational-technical education and especially the teacher education program while visiting France on an invitation from the French Government. Dr. Perlberg also spent the 1966-67, 1967-68 academic years in the United States at the University of Illinois, with the College of Education Department of Vocational and Technical Education and the Department of General Engineering in the College of Engineering. Both departments engage in vocational-technical teacher education

* For a detailed list of persons and institutions visited see Appendix D.

programs. He participated in various national conferences devoted to teacher education and established close contacts with the National Center for Research and Leadership Development at Ohio State University and other research centers on vocational-technical education. He is presently engaged in research in the area of vocational-technical teacher education.

In addition to their own impressions and analyses of the situation in other countries, the researchers had the opportunity to exchange information with other Israeli technical educators who have studied these problems abroad. Some of these educators have served as members of various committees established within this research project.

Within the limits of this report it would be impossible to document all observations and give a detailed account of the study tours made by the researchers in foreign countries. Nevertheless it cannot be stressed enough that in identifying and analyzing the main issues, problems, and programs in other countries, the researchers were able to rely on a relatively large amount of accumulated firsthand experiences, observations, and impressions which were brought together for the purpose of this study.

<u>The research committees</u>. The original research design called for intensive involvement of committees of teachers, principals, state subject-matter supervisors, and faculty members of the Technion to identify the desired qualification of teachers for vocational-technical education and to propose adequate curricula for the preparation of the teachers.

Budget limitation curtailed much of this involvement. Nevertheless, two main curriculum committees were established -- one for electronics and the other for mechanical engineering. The committees consisted of senior faculty members from the Technion in electrical and mechanical engineering, mathematics, physics, and educational faculties. State supervisors in vocational-technical education in the respective subjects were also members of the committees, or were consulted on various matters. The committees examined the present curricula on the technical subjects and the sciences in vocational-technical schools and in technical junior colleges in Israel. They compared similar curricula in a number of other countries. Vocational-technical teacher education programs in selected countries were also studied and examined. Upon consideration of the prevailing practices and present needs, and after extrapolating the desired academic qualification of a vocational-technical teacher in the next decade, the committees submitted a program of studies to prepare teachers for the engineering-related subjects in electronics and mechanical engineering. Engineer Kohn coordinated the committee's activities and prepared their report. *

## 4. Scope

This study should be considered exploratory. Many of the problems identified should be investigated more thoroughly. The proposed programs should be re-examined after experimentation at the Technion. The recommendation regarding prerequisites and qualifications will have to be re-evaluated in view of the problem encountered in recruiting adequate candidates.

## 5. Definitions

The terms vocational education and technical education may have different meanings in different countries. In some cases the division is according to grade level; vocational education refers to secondary education and technical education refers to post-secondary education. In other cases the criteria for division is the level or depth of studies in the technical subjects. For purposes of this report we have accepted the following definitions formulated by the Israeli Ministry of Education and Culture. They define three types of graduates of vocational-technical schools and indicate which type of schooling these graduates receive.

Handesaim (Higher Technicians) study in a technical school which includes secondary and post-secondary schooling for a period of three-and-a-half to four years (grades 11 - 14). After handing in a final project and passing the final examinations, the graduates receive a certificate of Handesai.

Technaim (Technicians) study in a secondary school for technicians for four years plus one semester. The emphasis in the study program is on technical science subjects and laboratory work rather than on practical work.

Skilled Workers study in regular vocational schools where there is an emphasis in the curriculum on shop practice. Studies are two to four years in duration.

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* See Part IV, Appendix A and Appendix B.

## PART II. ISRAEL -- BACKGROUND INFORMATION

### CHAPTER A. DEVELOPMENTAL TRENDS AND THEIR IMPLICATIONS TO VOCATIONAL-TECHNICAL EDUCATION

Rapid Growth.

Sobel (1959), analyzing the nature and extent of industrialization in Israel, states * : "Israel is undoubtedly the most technologically advanced and industrialized nation in the Middle East, and its rate of economic development in the past decade since its independence possibly has been the most rapid in the world. In this ten-year period it has transformed itself, with the aid of massive capital imports from the West, from an essentially agricultural to an industrial economy, has trebled its population, and despite the heavy cost and capital outlays connected with absorbing this population, has experienced a substantial rise in per capita real income. In the space of a half century, since Jewish colonization began under Zionist auspices, an essentially backward, denuded area of primary production has been transformed into a relatively advanced economy balanced between agriculture and industry."

Rapid and continuing expansion has been the cardinal feature of Israel's economy. Over 1950-1966 the gross national product grew by an average of 9% a year and the national income rose by 10% in 1966 to IL. 9,221 million -- $1,080 per capita.** The main characteristics of Israel's economy can be summarized under the following headings:

Mass Immigration.

Israel is unique among the world's countries today in having free immigration guaranteed by its basic law.

The influx of immigrants to Israel has been proceeding at a level unparalleled elsewhere. In the first four years of the State's existence, it averaged 18% of existing population annually; in the next three years the rate dropped to an average of 1.2%, rose again to 3.3% in the years 1955-57, and averaged 2.5% in the past four years. Even with emigration at

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* I. Sobel, "Management in Israel" in F. Harbison and Ch. Myers: Management in the Industrial World, McGraw-Hill Book Co., 1959, pp. 185-186.

** Facts about Israel, 1967, Ministry of Foreign Affairs, Jerusalem, 1967.

the rate of about 0.4%, net immigration - including periods in which there was a low rate of immigration - reached the same proportion as in Canada and Australia. The natural increase is about 1.6% a year. Between the establishment of the State of Israel and the end of 1966, over a period of less than 18 years, the population of Israel soared from 650,000 to 2,600,000, i.e. 4 times.

Israel has had to devote special attention to the newcomers' needs and problems. Other countries could be content with allowing immigrants in and letting them find sources of livelihood on their own initiative, perhaps providing them with some limited assistance in the initial phase. Yet, this could not be done in Israel in which immigrants have been accorded the status of repatriates, involving national responsibility for their housing and support at some minimum living standard up to the time when they could strike roots in the local economy. This involved vocational training (or re-training), teaching the elements of Hebrew, and the provision of sources of livelihood. This formidable task has not been made easier by the fact that large numbers of immigrants have come from backward countries without the educational and cultural background necessary for speedy adjustment to a modern society. Absorption has therefore necessitated a tremendous expansion not only of productive investments, but also of ancillary services of various kinds - educational, welfare, medical, etc. The problem has been aggravated by the erratic movement of immigration which has fluctuated according to unforeseeable political and other circumstances.

Mass immigration to Israel can therefore be said to have brought in its wake two important traits of the local economy: (1) rapid increase of the country's manpower resources, even though a good deal of training and social accommodation has been required to make it fully usable; (2) high level of spending for both investment and consumption purposes.

The index of production in relation to the growth of population, or the rise in production and exports in comparison with it, is the first test to which absorption must be submitted to ascertain its failure or success. Expansion of production has been used as one of the definitive indices of the degree of economic adjustment to a rising population. But only indices of per capita production, and the extent of quantitative correlation of the increase of population and the rise in production, can exemplify the economic integration of the added population in the economic life of the country.

The rise in production per head of population shows that production went up more rapidly than population: in spite of the swift demographic growth, there was a positive gap between the climbing curves of production and population. *

Agriculture.

The growth here was very pronounced. Agriculture in Israel falls into two sections, each characterized by its own distinctive features.

1. Citriculture, based on modern technical methods and high capital investment, employing hired labour, and producing mostly for export.

2. Modern mixed farming, based on intensive cultivation and irrigation, and directed towards the supply of the urban population. Production concentrates on dairy-farming, poultry-breeding, and fruit- and vegetable-growing, with some admixture of mechanized cereal-growing. This type of farming allows the cultivator a relatively high standard of living. Most of the land is publicly owned, and the farms have been financed in the main by public and semi-public funds -- with a view to laying down an agrarian basis for the new economy.

Greater agricultural output, which is among the most valuable components of economic growth, gave the rapidly rising population an ample supply of foodstuffs. In 1949 locally produced foodstuffs met up to 50 percent of the needs of a population of approximately one million; in 1964 it met 85 percent of the needs of a population of $2^{1}/_{2}$ million on a much higher standard of nutrition.

The objectives of agricultural policy, aimed at securing adequate stocks of home-grown food and stepping up agricultural exports, could only be achieved by higher productivity and a shift from less to more remunerative crops.

At the same time, there was an expansion in agricultural exports from $6.5 million (after a decline during the Second World War) in 1949 to $67 million in 1964. The main products exported are oranges, grapefruit and other varieties of citrus. The economic significance of the extension of citrus groves is in the high capital investment per earner and a tendency to substitute capital for space; this matters a great deal for a little country with a high population density. In agricultural exports other than citrus, the rise was smaller.

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* D. Horowitz: The Economics of Israel, Pergamon Press, 1967, pp. 21-31.

## Industrialization.

Israel is undergoing an acceletated process of industrialization. How rapid the process has been is borne out by the figures of imports of industrial machinery over the last 15 years (Table 1). Over $900 million worth of such machinery has come in since 1952.

Table 1

Industrial Machinery Imports into Israel, 1952-64 ($ million)

| | | | |
|---|---|---|---|
| 1952 | 38.7 | 1959 | 58.9 |
| 1953 | 34.8 | 1960 | 56.0 * |
| 1954 | 26.2 | 1961 | 64.0 |
| 1955 | 33.2 | 1962 | 86.8 |
| 1956 | 48.0 | 1963 | 79.0 |
| 1957 | 40.5 | 1964 | 85.1 |
| 1958 | 57.7 | | |

* New classification

The growth of industry in the same period is demonstrated in Table 2:

Table 2

The Development of Industry, 1958-64

| Year | Number of enterprises | Personnel (thousands) | Capital invested (IL million) | Consumption of electricity (million KWh) |
|---|---|---|---|---|
| 1958 | 9,271 | 146.7 | 164 | 532 |
| 1959 | 9,138 | 154.1 | 208 | 630 |
| 1960 | 9,754 | 163.4 | 198 | 769 |
| 1961 | 10,140 | 178.2 | 274 | 994 |
| 1962 | 10,165 | 194.7 | 393 | 1,037 |
| 1963 | 10,250 | 210.4 | 472 | |
| 1964 | 10,400 | 221.6 | 516 | |

Table 3

Total Investment and Investment in Industry (IL.million)

| Year | Total investment | Industrial investment | % |
|---|---|---|---|
| 1953 | 304 | 65 | 21.4 |
| 1954 | 419 | 75 | 17.9 |
| 1955 | 612 | 87 | 18.5 |
| 1956 | 655 | 137 | 22.4 |
| 1957 | 868 | 157 | 17.4 |
| 1958 | 1000 | 164 | 15.7 |
| 1959 | 1100 | 208 | 18.9 |
| 1960 | 1200 | 198 | 16.5 |
| 1961 | 1600 | 274 | 17.1 |
| 1962 | 2100 | 393 | 18.7 |
| 1963 | 2300 | 472 | 20.5 |
| 1964 | 2900 | 516 | 17.8 |

NOTE: Investment is at current prices. Industrial investment includes industry, mining and quarrying, and construction.
Source: Bank of Israel, Annual Reports.

Industrialization in Israel is closely bound up with immigration. The capital supply is imported directly by the immigrants themselves or as public capital through the Development Budget. That explains the availability of so much capital in a new country. (Table 3).

Perhaps the key factor in the industrialization of Israel has been the opening of new factories depending directly on rising demand. There is a certain technical minimum of output below which production is not profitable, and it was not until the market was big enough to reach that minimum that many of the new factories could start operating.

According to a survey of Jewish industry taken by the Government in 1962, industrial personnel, investment and production were spread over the difference branches. (Table 4).

There are a number of salient points that concern the structure of individual industries:

(1) In Israel, as in all young industrial countries, manufacturing concentrates on the production of consumer goods

- it is estimated that 65 percent of it is engaged in that production and only 35 percent in turning out capital goods.

(2) It is overwhelmingly dependent on the home market - 77 percent of its total output is consumed locally.

(3) The bulk of Israel's industries use imported raw materials.

(4) The relative weight of industry within the economy is rising -- today the gross value of its production approaches IL.6,183 million.

(5) Capital influx serves a powerful stimulus to industrial investment.

Table 4

Israel's Industry (1962)

| | Personnel | Production (IL thousands) |
|---|---|---|
| Foodstuffs | 23,740 | 730,072 |
| Textiles | 21,487 | 390,809 |
| Clothing | 7,097 | 97,675 |
| Metal products | 12,584 | 186,705 |
| Machinery | 7,574 | 161,891 |
| Wood, wood products & furniture | 12,913 | 203,300 |
| Leather and products | 4,490 | 59,275 |
| Chemicals and petroleum | 8,409 | 301,777 |
| Miscellaneous | 3,367 | 40,704 |
| Paper and products | 3,130 | 89,500 |
| Printing and publishing | 7,586 | 99,409 |
| Rubber and plastics | 4,862 | 127,040 |
| Mining and quarrying | 3,176 | 84,440 |
| Non-metallic mineral products | 11,041 | 256,261 |
| Diamonds | 6,804 | 187,393 |
| Basic metal industries | 4,390 | 129,202 |
| Electrical machinery and equipment | 6,700 | 120,740 |
| Transport equipment | 17,280 | 233,928 |
| | 166,630 | 3,500,121 |

Building.

One of the effects of immigration is a vast investment in housing and construction: it amounted to IL.2,587 million in the last 9 years at 1955 prices. Immigrants generate an incessant demand for housing, which is partly financed by the capital inflow. Import of capital alone could not stimulate economic activity so rapidly.

It is widely accepted that the country's future depends on industrialization. The scarcity of natural resources and raw materials essential for many industries has focused attention on the need to develop industries in which human resources will be the most important factor. There is a growing awareness in Israel that the general educational level and in particular, the scientific and technical know-how are the most important elements determining its existence, and that the vocational-technical education has a major role in furthering the economic development of the country.

## CHAPTER B. THE EDUCATIONAL SYSTEM -- GENERAL VOCATIONAL-TECHNICAL EDUCATION

### 1. The General Education System*

The foundations of the modern Israeli educational system were laid in 1880 with the beginning of a modern movement of Jewish resettlement in Palestine. When the State of Israel was established in 1948, a relatively effective educational system already existed.

The present educational system is based upon two laws. The 1949 Compulsory Education Law established universal, free and compulsory primary education. This law made the state responsible for providing pre-primary education for the five-year-olds, primary education for the age group 6 to 14 and part-time evening education for youth aged 14 to 17 years who had not completed the recognized primary course. The 1950 Education Law banned outside influence (party or political) directed toward the schools, and classified the schools into two major groups: state schools and non-state recognized schools.

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*For an elaborate discussion of the educational system see Braham, Randolf L., Israel--A Modern Education System, U.S. Department of Health, Education, and Welfare, Washington, D.C., 1967. This source also includes an extensive bibliography on the subject and related areas.

The 1949 law specified the aims of education which included, among others, "training in agricultural labour and handicraft" and fulfillment of pioneering principles". These unique specified aims had important implications on the development of vocational-technical education.

Secondary education is not governed by law. It is neither compulsory nor free. The control of secondary education, in most cases, is the function of municipal and local authorities, public bodies or individuals. Nonetheless, the Ministry of Education and Culture has issued a number of regulations concerning the licensing of teachers in secondary schools, the Matriculation Certificate (Bagrut) examination, reduced school tuition for needy students and similar regulations in regard to financial grants and support of certain types of secondary schools.

The main types of secondary schools open to students who have completed a primary education are: general academic (day or evening), academic agricultural, special religious academic, agricultural, industrial vocational, technical vocational, nautical, and nautical academic. There are other formal opportunities for training in schools for practical nursing, commercial subjects, or apprentice training. Duration of studies in these schools varies. Most of them, and especially the academic ones, are four-year schools; however, there are also three- and two-year vocational schools.

Even though not compulsory or free, about 85 percent of elementary school graduates enroll in secondary schools. Among those enrolling, about 60 percent enroll in general academic schools, 30 percent in vocational-technical schools, and ten percent in agricultural, nautical, and other schools.

Since secondary school tuition-fees are high, a "graded tuition" system was established. The government and local authorities pay the entire tuition of about 40 percent of the students in secondary schools. Fifty percent of the students pay only partial tuition. The criteria for governmental support is the economic condition of the parents. The government ties its tuition support to the possibility of guiding and directing the student to a specific type of school according to his intellectual abilities and aptitudes.

Of those who do not enroll in secondary schools or drop out after initial studies, about 70 percent start to work as apprentices. Under the Apprenticeship Law (1953) they are released from work one day a week to study in special apprentice schools, supervised by the Ministry of Labour.

Higher education in Israel consists of six major institutions: The Hebrew University of Jerusalem, The Technion-Israel Institute of Technology of Haifa, The Weizmann Institute for Scientific Research, The University of Tel Aviv, The Bar-Ilan University of Ramat Gan, and The University College of Haifa. A new seventh university has been started in Beersheba. The institutes of higher learning have an enrollment of about 30,000. In addition to universities there is an extensive system of 74 teachers' colleges, technical junior colleges, and many research and professional institutes.

Figure 1 illustrates the structure of the Israeli educational system. Table 1 and 2 describe the development of educational institutions and the growth in number of students from 1948 to 1967-68.

Figure 1 - The Educational Structure: 1963-64

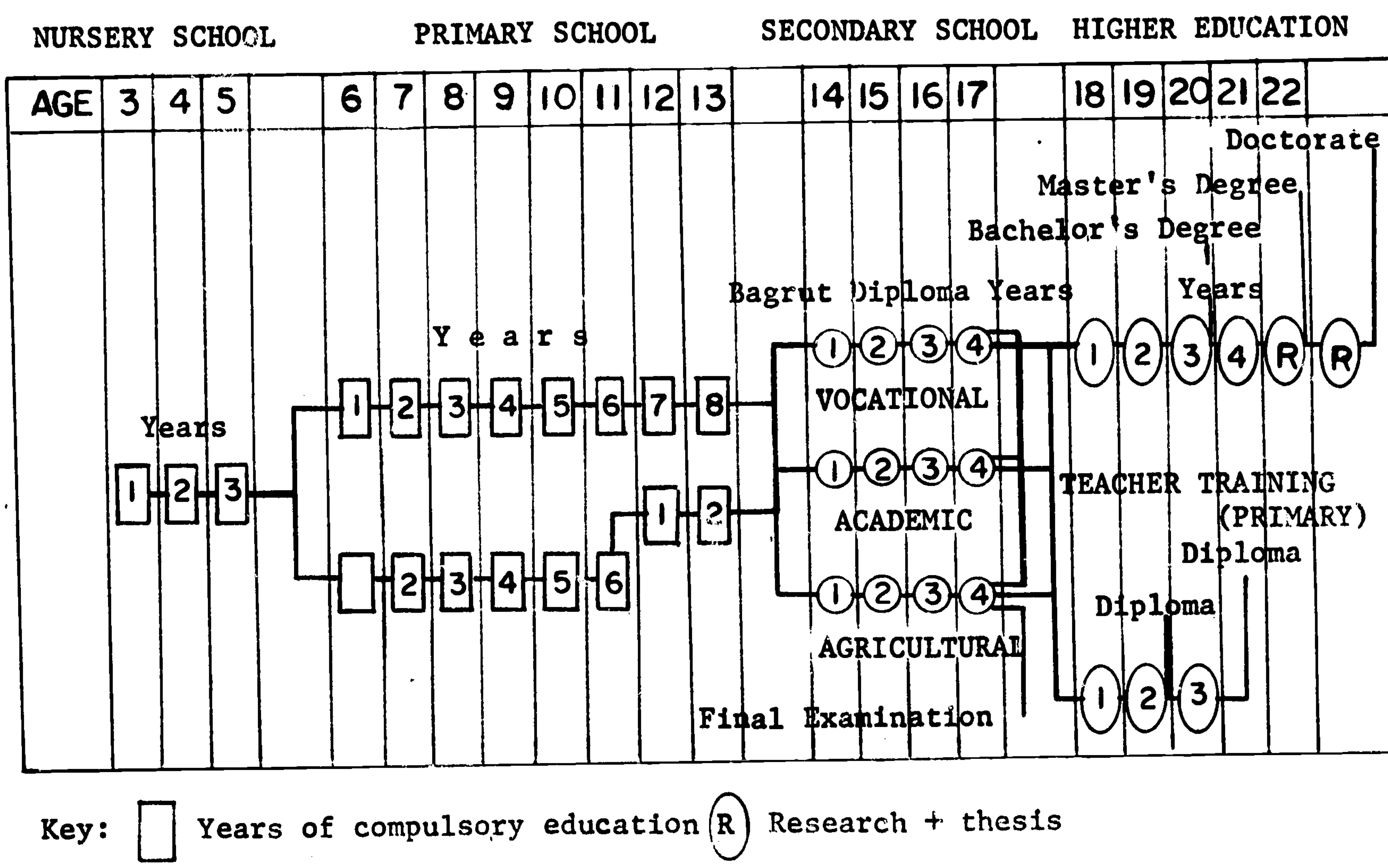

TABLE 1. INSTITUTIONS IN THE EDUCATIONAL SYSTEM, BY TYPE OF INSTITUTION (1948/49 - 1967/68):

| Type of Institution | 1967/68 | 1960/61 | 1948/49 |
|---|---|---|---|
| ALL INSTITUTIONS | 5,356 | 4,228 | 1,342 |
| Hebrew Education - Total | 4,982 | 3,932 | 1,286 |
| Kindergartens | 2,797 | 2,015 | 709 |
| Primary schools | 1,247 | 1,151 | 467 |
| Schools for handicapped children | 146 | 94 | - |
| Schools for working youth | 149 | 208 | - |
| Post-primary schools - Total | 595 | 432 | 98 |
| Secondary schools | 188 | 101 | 39 |
| Secondary evening schools | 17 | 30 | - |
| Continuation classes | 128 | 98 | 33 |
| Vocational schools | 216 | 59 | 26 |
| Agricultural schools | 30 | 29 | - |
| Other post-primary schools | - | 115 | - |
| Preparatory classes to teachers' training colleges | 16 | - | - |
| Teachers' training colleges | 48 | 32 | 12 |
| Arab Education - Total | 374 | 296 | 56 |
| Kindergartens | 159 | 131 | 10 |
| Primary schools | 192 | 152 | 45 |
| Schools for handicapped children | 1 | - | - |
| Schools for working youth | 6 | 2 | - |
| Post-primary schools - Total | 15 | 10 | 1 |
| Secondary schools | 10 | 6 | 1 |
| Vocational schools | 4 | - | - |
| Agricultural schools | 1 | 1 | - |
| Other post-primary schools | - | 3 | - |
| Teachers' training colleges | 1 | 1 | - |

TABLE 2. PUPILS IN EDUCATIONAL INSTITUTIONS, BY TYPE OF INSTITUTION (1948/49 - 1967/68):

| Type of Institution | 1967/68 | 1960/61 | 1948/49 |
|---|---|---|---|
| ALL PUPILS | 774,399 | 599,962 | 140,817 |
| Educational System | 698,612 | 562,814 | 134,887 |
| Academic Institutions | 28,520 | 10,836 | 1,635 |
| Other Institutions | 47,267 | 26,312 | 4,295 |
| Hebrew Education - Total | 691,490 | 548,147 | 129,688 |
| Educational System | 628,907 | 522,046 | 127,470 |
| Kindergartens | 93,395 | 74,995 | 25,406 |
| Primary schools | 385,589 | 361,707 | 91,133 |
| Schools for handicapped children | 12,570 | 8,111 | - |
| Schools for working youth | 6,691 | 7,744 | - |
| Post-primary schools - Total | 123,160 | 66,636 | 10,218 |
| Secondary schools | 58,114 | 30,015 | 6,411 |
| Secondary evening schools | 2,117 | 4,202 | - |
| Continuation classes | 9,654 | 7,587 | 1,048 |
| Vocational schools | 91,044 | 11,560 | 2,002 |
| Agricultural schools | 7,865 | 5,598 | - |
| Other post-primary schools | - | 4,485 | - |
| Prep. classes to teachers' training colleges | 4,366 | 3,189 | 757 |
| Teachers' training colleges | 4,502 | 2,853 | 713 |
| Academic Institutions | 28,520 | 10,836 | 1,635 |
| Other institutions | 34,063 | 15,265 | 583 |
| Arab Education - Total | 82,909 | 51,815 | 11,129 |
| Educational System | 69,705 | 40,768 | 7,417 |
| Kindergartens | 9,243 | 5,546 | 637 |
| Primary schools | 56,946 | 33,739 | 6,766 |
| Schools for handicapped children | 52 | - | - |
| Schools for working youth | 239 | 89 | - |
| Post-primary schools - Total | 2,909 | 1,277 | 14 |
| Secondary schools | 2,357 | 1,086 | 14 |
| Vocational schools | 267 | - | - |
| Agricultural schools | 285 | 47 | - |
| Other post-primary schools | - | 144 | - |
| Teachers' training colleges | 316 | 117 | - |
| Other institutions | 13,204 | 11,047 | 3,712 |

## 2. Vocational-Technical Education*

Background.

Most Israeli leaders have recognized the important role of manual work and occupational education (agricultural and industrial) in laying solid foundations for an economically and politically independent state. Many efforts, through formal and informal education,** were made even before the establishment of the state to induce respect and appreciation for manual work in all occupations. For many of the young people and especially their parents this meant a revolution in their thinking, attitudes, and way of life. It was this realization of the vital role of vocational-technical education that moved the founders of the State to include a special clause in the 1949 Educational Law about preparation for the world of work which should start as early as the primary school level.

Since the establishment of the State, and especially in recent years, it has been widely recognized that the intensive development of vocational-technical education is imperative as a means to establish a comprehensive educational system which will suit the needs of all students enrolling in secondary education, will facilitate the integration of new immigrants into the state economy, and provide the skilled workers and highly qualified technicians needed for the growing industry.

Tables 1 and 2 (see pages 16,17) illustrate the rapid growth of vocational-technical education from 26 institutions with 2,002 students in 1948 to 208 institutions enrolling 41,044 students in 1967/68. The magnitude of this growth is especially significant when compared with growth of other types of secondary schools. It should be noted that these tables refer only to formal vocational-technical schools recognized by the state. In many cases vocational-technical education is acquired in privately owned schools and in factories and workshops as part of on-the-job training. Thus, the exact number of those receiving this type of education is even larger.

The tables also indicate that agricultural education, which was regarded in the pre-state period as the most important facet of occupational education, has given way to other occupations needed for the rapid industrialization of the country.

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* It should be noted that although vocational-technical education may in some countries include preparation for every occupation, the Israeli definition of this term does not include such areas as agricultural education, nautical education, or health occupation.

** Youth organizations.

Administration and supervision of vocational-technical education.

Most vocational-technical schools are owned and administered by local authorities and public and private organizations. However, because of the high cost of vocational-technical education, most schools are subsidized by the government through direct and indirect grants (tuition scholarships).

All of the publically owned and many of the privately owned schools are supervised by the Ministry of Education and Culture. State supervisors visit the schools regularly to ensure adequate standards of education and training. The Department of Vocational Education of the Ministry of Education and Culture prepares curricula and detailed syllabi for vocational-technical courses, organizes final examinations, issues final certificates, and initiates and plans in-service training programs for the staff of vocational-technical schools. It is also involved in evaluation and long-range planning and development of vocational-technical education. In addition to state supervision, some of the larger public organizations which operate vocational-technical schools employ supervisors who are engaged more intensively in activities designed to improve the quality of education in their systems.

Type of schools.

There are two main types of schools where vocational-technical education can be obtained:

a. Vocational-technical schools offering mainly occupational education. These are found in the cities and large towns and are usually operated by public organizations.

b. Regular secondary schools which also offer vocational-technical programs are found more frequently in smaller communities which, because of limited number of students, could not afford to maintain more than one school.

In recent years a new scheme for the establishment of a system of relatively large comprehensive schools was adopted. They are set up at present only in new development areas which are inhabited heavily by new immigrants. Great efforts are made to equip them with the best available facilities for vocational-technical education. They will offer several vocational-technical options according to the needs of students and the community.

The government is also considering adding another year to the compulsory free education program. This addition is tied to an educational reform in secondary education and the establishment of a 6:3:3 pattern. Such a reform will reshape the whole educational system, especially the new comprehensive schools.

The great increase in number of schools in vocational-technical education has some disadvantages, however. Many of these schools are small; about 99 have less than 100 students, another 80 have between 100 and 300 students. Only three have more than 1,000 students. This phenomenon has resulted because even small communities, and especially religious groups in these communities, insist on establishing their own vocational-technical schools. The concept of regional schools or area vocational schools with a school bus system for transportation is not yet fully developed (mainly for economic reasons).

In order to fulfill their functions, vocational-technical schools have to offer a variety of vocational options for boys and girls. The school size and financial difficulties, however, make it impossible to offer an adequate choice of options. From 136 schools surveyed in 1966/67, 78 offered one option, 31 offered two, another 21 offered three or four options.

The need to limit the range of options offered also determine their nature. Schools tend to offer training in "basic trades" such as mechanics which enables graduates to adjust easily to a wide range of related trades rather than in specialized trades like printing or textile manufacturing. The following table describes the distribution in percentages of students according to areas of specialization.

| Area of specialization | Percent |
|---|---|
| Metal trades | 43.0 |
| Automotive trades | 15.0 |
| Electricity | 15.0 |
| Electronics | 13.0 |
| Carpentry | 6.0 |
| Draftsmanship | 5.0 |
| Printing | 1.5 |
| Textile manufacturing | 1.5 |
| Total | 100.0 |

Duration of training.

Duration of studies in vocational-technical schools before the establishment of the state was three years. In order to attract more talented students, standards were raised, new options (electronics) were introduced, and the study time was lengthened to four years. However, many of the new students in vocational schools coming from Oriental countries did not have the intellectual ability to complete a four-year course. As a result, one-, two-, and three-year vocational schools (courses) were established.

Today there are three kinds of vocational-technical schools. The trend in recent years is to establish in one school different options of study of different durations. It is assumed that such an arrangement will reduce the number of dropouts which still constitutes a serious problem in vocational-technical schools. However, the small size of many of the schools does not permit the introduction of this system. In 1966-67 only 35 of all schools offered two options of duration and eight schools offered the desired three options.

Curricula.

The detailed curricula differ according to area of specialization and duration of studies, but there is a general pattern of time allocation in all options which is as follows:

| Subject | Hours per week |
|---|---|
| Shop work | 18 |
| Related subjects | 8 |
| Mathematics and science | 8 |
| Humanities | 9 |
| Physical education | 3 |
| Total | 46 |

At present about 57 percent of the time is allocated to direct trade training, either practical or theoretical. The proportion between time spent in trade and general subjects changes constantly in favour of the latter. This trend may be expected to continue in view of the rapid scientific development and technological change.

Workshop practice is based on exercises that progress gradually in complexity until the student is able to produce some typical products of the trade. When useful products are produced they are marketed or used in the school. Receiving orders on a commercial basis is done only in a few schools and to a limited extent.

The related subjects are generally taught with little relationship to what is done in the shop. When the teacher happens to be the shop instructor of the same class, some coordination is expected to be established between theory and shop work. In other cases related subject instruction is as theoretical as other general education subjects.

General subjects are taught by teachers who have the same qualifications as their colleagues in academic high schools. Their teaching, therefore, does not differ from that in other kinds of secondary schools. Actual differences refer rather to the scope of the subjects which is forcibly more restricted than in high schools, and when pupils with lower abilities are involved, the level of the subject is also lowered.

Graduates and their privileges.

A follow-up carried out in 1965 with graduates who terminated their training in technical trades ten years earlier found them in the following positions:

| Position | Percent |
|---|---|
| Working in the trade learned | 39.2 |
| Working in a similar occupation | 16.7 |
| Working as engineers | 15.3 |
| Not working in the trade learned | 28.8 |
| Total | 100.0 |

The follow-up also showed that the greater part of those who graduated from four-year courses were actually working as technicians and foremen. This led the Ministry of Education and Culture to plan for the transformation of the four-year vocational schools to schools having programs of five and a half years duration preparing Handasaim (higher technicians).

When entering work, graduates of three-or four-year courses are considered skilled workers of initial grade, but according to arrangements with employers and trade unions, they are eligible to advance quickly in professional grading after passing proficiency tests. Graduates of two-year courses, however, are not yet considered skilled workers and must complete their training as apprentices.

Graduates of the four-year course, who passed successfully special additional examinations in general subjects, are eligible to apply for admittance to the Technion-Israel Institute of Technology in Haifa. The above-mentioned follow-up indicated that a considerable number (15 percent) was admitted to the Technion and graduated as engineers.

## PART III. VOCATIONAL-TECHNICAL TEACHER EDUCATION

### CHAPTER A. VOCATIONAL-TECHNICAL TEACHER EDUCATION IN ISRAEL

#### 1. Teacher Education in Israel -- The General System

In Israel there are two main systems for teacher training: teacher-training colleges, which train kindergarten and primary school teachers, and the universities, which train secondary and post-secondary school teachers.

Admission to teacher-training colleges is generally limited to applicants who have a matriculation certificate or an equivalent foreign certificate. Exception is made to applicants for the village teacher-training institute and prospective kindergarten teachers who are admitted on proof of having completed 11 grades.

Students completing two years of study can graduate as qualified teachers. They have an option of completing a third year of studies immediately after the second year or at a later period, and acquiring the title of "senior teacher", which will grant them several privileges.

Students in teacher-training colleges can specialize in the following areas: infant grades (kindergarten and grades 1 and 2), junior grades (grades 2 through 5), senior grades (grades 6 through 8), or practical subjects (agriculture, art, manual training, music, physical training). The majority of students in these colleges are female.

Teachers for secondary schools are trained in the universities. Governmental regulations require that teachers of ninth and tenth grades have a B.A. or B.Sc. degree and a secondary school teaching certificate. Teachers of the eleventh and twelfth grades need to have a master's degree and a secondary school teaching certificate.

Schools or departments of education in the various universities are in charge of teacher training. Students from the faculties of sciences, humanities, and social sciences enroll for a special program leading towards a teaching certificate. In the Technion they can start with education courses in the second year of studies in the institutions; in the Hebrew University they must complete all, or nearly all, of the requirements for the bachelor's degree. In general, studies towards the teaching certificate require an additional year. The universities' teaching certificate is accredited by the Ministry of Education and Culture.

The universities cooperate with the Ministry of Education and Culture in conducting in-service training courses for uncertified teachers and enrichment courses for certified teachers. The Ministry of Education and Culture provides many scholarships to students preparing themselves for teaching and to experienced teachers who work towards an advanced degree. It should be noted that although the government and institutes of higher learning have pursued energetic measures in this area since the establishment of the state, there is still a shortage of qualified academic teachers. Moreover, a significant number of those teaching in secondary education (approximately 40 to 50 percent) do not have the required academic degrees.

## 2. Vocational-Technical Teachers -- Requirements and Present Status

Teachers of general subjects in vocational-technical schools (humanities, social science, mathematics, and science) are required to have the same qualifications as teachers in secondary education. These qualifications have been discussed above. The following will deal only with teachers of technical subjects.

For many years, especially before the establishment of the state, it was expected that teachers in technical and related subjects would be qualified engineers. Even in times when the size of the vocational-technical educational system was very limited, this desirable standard could not always be achieved. Moreover, due to rapid industrial development in Israel in the last 20 years, and the growing gap in salaries and status of teachers and engineers on the one hand, and a rapid expansion of vocational-technical education on the other hand, this desired standard has become more remote.

Many vacant academic positions were filled by instructors who were not qualified academically. Many experienced technicians without formal training in subject-matter and pedagogy were recruited as teachers. Although leaders in the field had great misgivings about this situation, they tended also to indicate that some of these shop instructors and technicians were more suited to teach, even subject-matter, to a significant number of average- and low-ability students in vocational-technical schools. Graduate engineers, especially those without any formal professional education and any previous background in teaching, found it difficult to communicate with students of lower intellectual ability. This difficulty has probably resulted in students dropping out from programs and in frustrated engineers who had to leave the teaching profession.

Consequently, in 1966, the Ministry of Education and Culture defined the qualifications for three groups of teachers for technical related subjects. Technical subjects were divided into two categories: 1) "basic subjects", e.g. trade technology or elementary technical drawing. These are practical subjects closely related to the trade. 2) the more theoretical "advanced subjects", e.g. thermodynamics and electrical theory.

An engineer is qualified to teach both basic and advanced subjects in all grades. A teacher holding a certificate of higher technician is qualified to teach the basic subjects in all grades and the advanced subjects in the ninth and tenth grades. A technician (a graduate of a four-year technical school) is qualified to teach the basic subjects in the ninth and tenth grades. He must be qualified as a shop instructor before he is trained for classroom teaching.

Shop instruction in technical trades is often dispensed by people who are qualified only for this task. These "instructors" are, in general, graduates of three-year courses and have at least three years of industrial experience. On the other hand, teachers who are engineers or Handesaim (higher technicians) are not required to have such industrial experience.

Table 1 provides a profile of the teaching manpower for technical-related subjects, as far as formal education is concerned. It refers to only three groups of teachers according to subject-matter taught; nevertheless, these subjects may be considered as representative since they are taught most frequently in vocational schools and comprise the greater part of technical teaching.

Table 1. Distribution (in Percentage) of Teachers for Three Groups of Related Subjects According to their Formal Education (1966).

| Education | Metal and machinery | Electricity & electronics | Technical drawing | Total |
|---|---|---|---|---|
| University | 32.7 | 61.1 | 39.6 | 42.4 |
| Partial university | 10.3 | 14.8 | 16.8 | 13.7 |
| Post-secondary | 35.2 | 14.8 | 32.9 | 29.2 |
| Post-elementary | 21.8 | 9.3 | 10.7 | 14.7 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 |

Teachers and instructors in vocational-technical education are required to obtain pedagogical training in order to qualify for teaching. However, a structured, intensive program of pedagogical training for engineers and shop instructors began only in the early 1960's, and for the two other groups, two years ago. During this short period a minor fraction of the technical teaching force was able to obtain the necessary training, while its total number was growing constantly. This is well reflected in Table 2 which shows the situation in 1966. It does not include the results of courses for teachers from the second and third groups which at the time of this census were only beginning.

Table 2. Distribution (in Percentage) of Teachers for Three Groups of Related Subjects According to Their Pedagogical Preparation (1966)

| | Metal and machinery | Electricity & electronics | Technical drawing | Total |
|---|---|---|---|---|
| University teacher training | 7.3 | 12.0 | 10.1 | 9.5 |
| Uncomplete university teacher training | 4.8 | 7.4 | 5.4 | 5.7 |
| Qualified for primary school teaching | 5.5 | 2.8 | 6.0 | 5.0 |
| Qualified for shop instruction | 29.1 | 13.9 | 14.8 | 20.1 |
| Without pedagogical training | 50.9 | 60.1 | 56.3 | 55.2 |
| Not specified | 2.4 | 3.8 | 7.4 | 4.5 |
| | 100.0 | 100.0 | 100.0 | 100.0 |

## 3. Vocational-Technical Teacher Education at the Technion

### Background

The first teacher-training program was established in 1959 in the Department of General Studies at the Technion. The program consists of professional education courses leading towards a teaching certificate in secondary education for teachers in the exact sciences and technical subjects.

Full-time Technion students in the engineering and science departments are eligible to enroll in this program from the sophomore year on. Those who do not finish their studies in the program, upon graduation from the Technion, are able to continue their studies as part-time students.

Studies in the program are in addition to the requirements in the regular departments. Since it is an extra load to Technion's regular program which is considered very demanding, students have to obtain approval to enroll, and only above-average students are granted such approval. It is assumed that talented students can cope with the additional load without endangering the successful completion of their regular studies.

The following table is a description of the courses in the certificate program.

DEPARTMENT OF GENERAL STUDIES 1963-64

Teachers' Training Course

| Subject | Number of Hours Per Week | | | | | |
|---|---|---|---|---|---|---|
| | First Sem. | | | Second Sem. | | |
| | L | CE | LE | L | CE | LE |
| Principles of Education | 2 | - | - | 2 | - | - |
| General Psychology | 2 | - | - | - | - | - |
| Social Psychology | - | - | - | 2 | - | - |
| Educational Psychology | - | - | - | 2 | - | - |
| General Methodology | 2 | - | - | 2 | - | - |
| Organization of Education in Israel and Other Countries | 2 | - | - | 2 | - | - |
| Science, Technology and Society | - | - | - | 2 | - | - |
| Methodology of Teaching Mathematics | 2 | - | - | - | - | 3 |
| Methodology of Teaching Physics | 2 | - | - | - | - | 3 |
| Methodology of Teaching Chemistry | 2 | - | - | - | - | 3 |
| Methodology of Teaching Technological Subjects | 2 | - | - | - | - | 3 |

Practical Work:

a) Attendance at 25 high-school lessons before the start of the academic year at the Technion (in October).
b) Attendance at 15 high-school lessons during the academic year and preparation of detailed reports on the lessons' progress.
c) Delivery of 6-8 lessons during the academic year.
d) Visits to educational institutions.

Note: The course is open to all second, third and fourth year students, who may study parts of it on an optional basis in addition to their regular courses of study.

The fourth year students in the Departments of Mathematics and Physics, who elect the Teachers' Training Course, may be exempted from certain subjects of their regular course.

L - Lectures. CE - Class Exercises. LE - Lab Exercises.

Evaluation of the program

From the beginning there were those who doubted the feasibility of establishing a teacher-training department in an engineering school. They asked: What would motivate talented students who enrolled in the Technion in order to become engineers or scientists, to study education courses and become teachers? (Especially in view of the relatively low status and low salary of the teaching profession).

The answer to this dilemma was that even among talented students intending to become engineers and scientists there are those who change their minds after initial studies. The occupational image of the engineer and the scientist is somewhat idealized among young people. They are attracted by the glamour of these professions. A more realistic view is formed already during studies at the Technion when the students have many opportunities to observe and work with professionals in these occupations. Some of them find the teaching profession more challenging and attractive and enroll in the teacher training program.

It is also assumed that because of the existing wage structure many beginning engineers and scientists engage in part-time teaching as the most convenient way to supplement their relatively low starting salaries. Some of them find the combination of work in their area of specialization and teaching very rewarding, and continue this pattern of work for many years. A significant number of students were aware of this phenomenon and enrolled in the program in order to receive a teaching certificate and enhance their opportunities to obtain a part-time teaching job.

From the beginning, the Ministry of Education and Culture provided financial grants to those enrolling in the program. The recipients are obligated to teach a certain number of years after graduation. This incentive was instrumental in increasing the enrollment in the program. However, with the growing demand for engineers and scientists caused by the rapid industrialization of the country, many other grants and scholarships were offered by government and private industry to prospective engineers and scientists. Some of these were much larger than the grants for teachers and reduced the attractiveness of the teaching grants.

Functioning in a system which has a rigorous program and very high standards added to the difficulties of recruiting candidates. For example, students who were not so successful in engineering and science could not enroll in the program. Their weakness, however, was relative to the very talented population and the rigorous program in the Technion. Many of them could have been successful in any other institution of higher learning. Given the opportunity, some of them could have been good teachers, but accepting them would put a stigma on the program as one that absorbs the weaker students. This would even lower the already low status of the teaching profession. They were barred, therefore, from the program.

During the first five years of the program's existence, the number of students enrolling and graduating increased steadily. However, the number of those who made full-time teaching their occupational choice was not so large and was far from satisying the needs for vocational-technical teachers. Moreover, the majority of those receiving certificates specialized in teaching mathematics or physics in academic and technical schools. Very few specialized in the teaching of technical subjects.

These developments focused attention on the need to establish a separate Teacher-Training Department which would award students an education (B.Sc.Ed) degree and prepare teachers (and not engineers) to teach technical and science subjects in academic and vocational-technical schools. The Teacher-Training Department, established in 1965, offers several programs: one is the B.Sc.Ed. program which could be completed in three academic years and three summer sessions. This is equal to the four academic years required in the Technion to obtain a B.Sc. degree. The second is a graduate program leading to a master's degree in the teaching of science and technology. The third is the teaching certificate program. Practicing teachers who are engineers or graduates of science departments and who do not have a teaching certificate are allowed to enroll in the certificate program through the Technion's Extension Division.

Besides the degree and certificate programs, the department, through the Technion's Extension Division, conducts regular professional education courses for technicians enrolling in a special program leading to a teacher's certificate for the lower grades of vocational-technical schools. Since its establishment, the department has engaged in in-service programs for vocational-technical teachers in subject-matter areas and pedagogy.

Table 1, page 30, describes the number of students enrolling in the various programs offered by the Teacher-Training Department.

## Table 1.

The number of students enrolled in the various courses offered by the Teacher-Training Department at the Technion, February 1967 - 1968.

1. Students in Teacher-Training Courses at the Technion - three years intensive training for a teaching diploma for secondary schools, 1967.

| | Total number of students | Males | Females |
|---|---|---|---|
| Course A (first year) | 41 | 14 | 27 |
| Course B (second year) | 30 | 17 | 13 |
| Subjects of specialization: | | | |
| Chemistry ............ 5 | | | |
| Mathematics/Physics .... 20 | | | |
| Electronics & Mechanics...5 | | | |
| Course C (third and final year)<br>All specializing in Science Teaching | 20 | 11 | 9 |
| Total number in morning classes | 91 | | |

2. Students in the different faculties studying for a teaching diploma in the Teacher-Training Department - (additional to regular studies) - afternoon and evening classes, 1967.

| The Faculty | Students expected to graduate 1967 | Students continuing studies from former years | Students registered and commencing studies in 1967. |
|---|---|---|---|
| Science (Mathematics<br>(Physics | 2 | 12 | 9 |
| Chemistry | - | 9 | 5 |
| Electrical Engineering | 9 | 31 | 20 |
| Structural Engineering | - | 11 | 23 |
| Mechanical Engineering | 2 | 8 | 9 |
| Chemical Engineering | - | 7 | 4 |
| Areonautical Engineering | 1 | 4 | 11 |
| Industrial & Management Eng. | - | 2 | 5 |
| Agricultural Engineering | 1 | 2 | 2 |
| External Teachers | 4 | 4 | 14 |
| Total in evening classes | 19 | 90 | 102 |

Total number of students = 211

3. New Students registered for the academic year 1968/69

New registrants in Morning Classes ....... 40
New registrants in Evening Classes ...... 130

CHAPTER B. CRITICAL ISSUES IN VOCATIONAL-TECHNICAL TEACHER EDUCATION IN SELECTED COUNTRIES AND ISRAEL

The following analyses of critical issues in vocational-technical teacher education in selected countries and Israel are based on a review of the literature and numerous discussions held by researchers in the countries they visited, while studying the general problems of vocational-technical education and, in particular, the problems of teacher education. The many impressions accumulated by the researchers during a period of several years have been transformed into many generalizations. Considering the limitations of the literature survey, reference will be made either to the most significant or the available sources of information in the countries studied. These generalizations were not derived from structured social research. They should be viewed as issues deserving further research and investigation.

The order in which these problems are discussed does not indicate their relative importance. They are arranged in a certain developmental, logical sequence. This list of critical issues does not exhaust all possible issues; moreover, the limits of this report do not allow for an extensive discussion of the issues mentioned. Most of them could be a focal point of separate reports. Nevertheless, bringing all of them together even for a brief analysis might serve to illustrate the magnitude and the complexity of the problem.

## 1. The Status of Vocational-Technical Education and its Impact on the Problem of Teacher Education

From the limited discussion of this problem in the literature and from observations and numerous discussions with general and vocational-technical educators, it seems that vocational-technical education is perceived by the public at large, by general educators, and even by vocational-technical educators as having lower status and esteem than general academic education. Moreover, there is common agreement among educators, and in particular among vocational educators, that its low status is one of the most important deterrents to the recruitment of highly qualified teachers and sufficient numbers of highly qualified candidates for teacher education programs.

There has been a growing realization in recent years that in the technological society in which we live and expect to live in the future, technical knowledge and skills are and will be of prime importance to most segments of the population. There is also a growing recognition that there are individual differences in the school population and that large proportions of this population should receive vocational-technical training at all levels of sophistication, from skilled workers to highly qualified technicians. As a result of these trends, international organizations, national governments, private organizations and professional groups have given greater attention to developments in this area. Much effort has been made and many economic resources invested to improve existing programs and develop new ones, especially in the growing field of technical,post-secondary education which has been neglected in the past. One could describe these new developments as the renaissance of vocational-technical education.

However, the problem of low status and prestige still seems to have a strong impact on many facets of vocational-technical education -- particularly teachers. In the occupational status system, the general field of education, and in particular classroom teaching, does not enjoy high esteem. The problem becomes more acute since vocational-technical teachers do not have the high prestige in the educational community itself. Moreover, in the field of vocational-technical education one may find many technical educators who are trying to disassociate themselves from vocational educators in order to enhance the prestige of their own field. It should be realized that unless there is a drastic change in the attitudes and actual behaviour of the public at large, and educators in particular, towards vocational-technical education, it will be very difficult to recruit adequate, high-quality candidates for teacher-training programs..

As already mentioned, vocational-technical educators realize this state of affairs and will admit it in an oral discussion, but relatively little has been written on the problem. It is doubtful if the problem is investigated at all by vocational educators and social scientists. There seems to be a feeling of apathy, almost a fatalistic attitude about it and, as some educators have expressed it, "Well, that's reality and there is a lot of truth in what is said about the quality of our programs, students and teachers. Even if it is not always true, that is the image, and we have to learn how to live with it."

In recent years there is some awareness of the seriousness of the problem in the literature in the United States. Grant Venn (1964) in a discussion in Man, Education and Work, states bluntly that the prestige and status of vocational education is very low:

> "Its students too often are the dropouts or cast-offs of the academics curriculum. Its teachers, often less academically oriented, enjoy relatively low status within the teaching profession in many states. Its buildings are often the oldest, its facilities frequently the poorest,its extracurricular programs usually the weakest. Its subject-matter suffers from the general debasement of manual and blue-collar occupations in contemporary social values.

"These generalizations are quite unfair to the several outstanding vocational and technical programs in this country. But the generalizations persist, and almost all programs find themselves typed to the extent that their struggle is uphill. And because criticisms are applied more readily to the older vocational programs, there is an undercurrent in some quarters to disassociate the newer technical programs from their vocational counterparts, to seek a separate and more lustrous identity.

"The low repute of a program is harmful in many ways: good students shy away, teachers are difficult to recruit."

Frank (1965-1966) in the M.I.T. Study of Occupational, Vocational and Technical Education reports the opinions of over a hundred educators from all over the United States who feel that the status problem is a deterrent to the development of vocational-technical education. The report describes the obsession of the American public with the college degree as a status symbol of unique importance:

"Our system does in fact tend to look upon those who cannot deal quickly and easily with abstract ideas and their verbal or written embodiments as somehow lower than those who can.... We can no longer condone or support a system which considers people without a college degree as automatic failures and liabilities in our national development."

Mead and Feldman (1966) go one step further and suggest that general educators have contributed to "educational apartheid" by keeping the vocational system separate and away from the regular operation of the schools. They refer to general educators who claim that "vocational education is not academic, it is not respectable. It is good and necessary, but not for my kids!"

In reference to the role of universities in preparing highly qualified vocational-technical teachers, they state that institutes of higher education have not given full attention to the problem of vocational teacher education despite the fact that they freely find fault with the existing teacher preparation pattern. They "are quite content to build up fine vocational schools in medicine or law or even engineering, yet they sneer at vocational education... partly perhaps out of intellectual snobbery."

These observations are common in the countries the researchers have visited or studied through the literature. It is a poignant problem in highly industrialized and developing countries alike. Within the limits of this discussion, it would be impossible to analyze this phenomenon in depth, but it is important to mention two elements which would seem to be quite universal. There is a general trend to attend general or academic high schools which facilitate directly or at least leave the door open to higher education. There is a common feeling that attending vocational-technical schools does not prepare students for higher learning. Moreover, it does tag them as students who are not qualified to continue their studies or to work in jobs which are nonmanual in nature. The strong desire - and, sometimes, even obsession - for academic education is somewhat related to another general trend reflecting the affluent society.

The second element is the legitimate desire the world over for the "better life". In many cases this desire is associated with alienation from the world of work and especially from manual and physical work. This may be detected even in countries where physical and productive work is highly respected. The Soviet Union, for example, had to reform its educational system in 1958 in order to counteract this growing trend.

In Israel the status and prestige problems of vocational-technical education is more acute. Being away from a homeland for centuries, the Jewish people, dispersed through many countries, concentrated on white-collar and intermediate occupations. Although much has been done in the last half century in Palestine and later in Israel, to reverse this occupational pattern and to enhance the status of manual and physical work, the development of vocational-technical education still suffers from the obsession of most Israeli parents that their children enroll in academic high schools and receive a matriculation certificate, so that they may continue their studies or engage in a white-collar occupation.

Stereotypes and prejudices about vocational education are common, even among new immigrants from underdeveloped countries and culturally deprived groups who have a strong desire to achieve social status by sending their children to academic high schools. In many cases these children are not suited for an academic, college preparatory program and drop out very soon with no real skill or occupation to enable them to enter the world of work.

In his discussion, Venn (1964) states that vocational-technical teachers might be instrumental in changing the present image but, as previously mentioned, in many instances vocational-technical teachers seem to have a fatalistic view about the status problem and accept the classification of vocational education as inferior to general education. This fatalistic attitude has an impact even on some of the more talented graduates of vocational-technical programs who could have been excellent candidates for vocational teacher education programs.

From their experience at the Technion, the researchers have found that most students in the teacher-training program preferred to specialize in the science subjects and teach in academic high schools. In many cases, graduates of vocational schools and engineering departments who are required to specialize in one technical and one scientific subject, have asked to study two of the scientific subjects, so that they could teach the scientific subjects in general academic schools.

The status and image of vocational-technical education is a complicated phenomenon determined among others by many social forces beyond the control of educators. However, if educators want to break this vicious circle of low status, lack of adequate students and lack of highly qualified teachers, they must be ready to openly admit the existence of the problem. They must develop their own philosophy and rationale for a system of equal status, and must develop their own esteem and prestige about their profession and work.

At no time in the history of vocational-technical education has there been such a growing realization of the importance of this field. It is up to vocational-technical educators to take advantage of this trend and work towards establishing a status equilibrium between vocational and general education. As was mentioned previously, the teaching profession as a whole suffers from a low occupational status. Efforts should be made, however, to attract some of the ablest candidates who are willing to enter the occupational field of education.

## 2. Job and Certification Requirements of Vocational-Technical Teachers

What is the role of a teacher in a vocational or technical school? What is the range and nature of his activities? What is required to perform these activities? What is the role of the teacher in vocational-technical schools of the future and what should his qualifications be?

The present formal and informal certification requirements for vocational-technical teachers in the countries studied are generally based on tradition and conventions rather than on a systematic study of job descriptions, analyses and the derived necessary qualifications.

In the United States, more than in the other countries investigated in recent years, there has been some awareness of the need for a more scientific study of the role and qualifications required of vocational-technical teachers. Several studies in agricultural, distributive and industrial education deal with some aspects of job description, analysis and requirements.* Nevertheless, far too little has been done in this field. The critical question is the extent to which these few studies have had an impact on present recruitment and selection practices and teacher-training programs. As far as the role of teachers in the future scientific technological era is concerned, nothing is reported in the literature.

The present requirements for vocational-technical teachers may be classified in three main areas: formal and informal education in subject-matter to be taught; occupational working experience in the area of specialization; and innate pedagogical qualifications and formal professional education training. Requirements in these areas vary among the countries studied and may be inconsistent even within the same country, especially when the educational system is decentralized and diversified as is the case in the United States.

a. Qualifications in subject specialty. The range of qualifications in the subject specialty extends from craftsmanship in a trade to a university professional degree. The trend is that those who have only craftsmanship experience are assigned in general to shop instruction or teaching on a lower level in trade and vocational schools, while technicians and engineers in general are assigned to the teaching of theory of technical subjects and related subjects in the higher grades of vocational schools and in technical schools.

This wide range exists in nearly all of the countries surveyed. In the United States, however, there was always a stronger emphasis on university degrees in the subject specialty, and it is safe to assume that proportionally the number of teachers in vocational-technical education who hold university degrees in the United States is higher than in any other country. There is a growing realization in the European countries we have studied, and especially in Germany and France, that teachers in vocational education, and especially in technical education, should have a higher education degree, since it is required from all secondary and post-secondary school teachers. It is becoming accepted that competence in subject-matter gained during industrial experience is not adequate to satisfy the needs of vocational and especially technical education. Moreover, the prevailing notion in many countries that any person who holds an academic degree in the sciences or technology could teach in vocational-technical

* Moss (1967)

schools is changing, and there is a growing realization that there is a need for special preparation. For a more elaborate discussion of this subject see Section 7.

b. Occupational working experience. Occupational working experience is accepted as a most important facet in the qualification of teachers for vocational-technical education and especially for those teaching technical subjects or shop. However, there is a wide range in regard to the nature of the occupational experience. In some cases, teachers are required to have direct occupational experience in the area they are certified to teach, while in others all that is required is some experience in a certain field.

Requirements in regard to duration of the occupational experience also vary. In France three months of occupational experience are required, while in some states in the United States seven years of occupational experience are required. A more elaborate discussion on the problems of occupational experience and new approaches in this area will be presented in Section 8.

c. Pedagogical qualifications and formal professional education training. Of the three areas of qualification, pedagogical competence and professional education have the least attention. In many cases, and especially in European countries, it is not even a prerequisite for obtaining a teaching position. Even in the United States, where extensive professional education training is almost a universal requirement in elementary and secondary education, it is not required in vocational-technical education. In some places one could identify even among leaders in vocational-technical education a certain skepticism towards existing programs in professional education training, or no regard for the problem at all.

In recent years there has been a growing awareness in practically all countries studied of the importance of some innate pedagogical competence and some formal training in education. This growing awareness is also present in many other organizations that engage in education and training, such as higher education, industry and the armed forces. It would seem that this general recognition has had an impact on vocational-technical educators. A more elaborate discussion on the nature and content of professional education for teachers in vocational-technical teacher education will be presented in Section 7.

## 3. Supply and Demand of Vocational-Technical Teachers

Many countries are beginning to realize the need for planning human resources development. The growing shortage of qualified manpower in many occupations has stimulated international bodies, governmental agencies and professional organizations to collect and analyze data that will enable them to assess and forecast the supply and demand of manpower in various occupations. Universities and research centers are also involved in the development and improvement of this new discipline and the methods and techniques of manpower planning. It is assumed that such data should guide those in charge of manpower development in considering the number of people to be prepared and, to some extent, such information could provide guidelines for the content and nature of the programs.

While manpower planning and development in any given occupation depend mainly on the present manpower status and future plans of the occupation, planning and development of vocational-technical teacher education depend on data from its own occupation and on predictions from a whole variety of other occupations. Since the needs in vocational-technical education are related to those in many other occupations, forecasting for this field is much more complicated than for the general field of education.

The literature on vocational-technical education that we surveyed in Europe had elaborate reports in this area. However, we assumed that in countries having centralized systems of education, the ministries of education or manpower authorities have some realization of supply and demand. The C.I.R.F. Monograph (1964) does mention some general assessments for each country surveyed. Reference to supply and demand of teachers in general, and vocational-technical teachers in particular, were also found in the reports of the manpower authority in Israel. In the United States Moss (1967) mentioned three studies, all published in 1967.

From the analysis of these few studies and reports, one phenomenon prevails in many countries. We refer to the different assessment of present situations and the wide range of forecasts for future demand. It appears that different results are obtained sometimes even between two governmental departments in the same country. The major problems are availability of reliable data and agreement on future trends of student enrollment in vocational programs, the economic feasibility of expanding vocational programs, occupational trends and manpower demands, and the occupational behaviour of teachers such as temporary and permanent dropouts or mobility. These are some of the essential factors for greater accuracy and uniformity. Evaluation of present procedures indicates that these factors are not always considered, while in other cases there is a very vague assessment of the magnitude of each factor.

Development of data processing and manpower planning and forecasting techniques (Davies, 1966; Lester, 1965; O.E.C.D., 1967) enables much more reliable and accurate forecasting of teachers' supply and demand. There is not, however, enough awareness among educators of the need for such data.

Another problematic area is the use of such data by governmental and other agencies when they are available. There is probably a marked difference in this matter between a centralized system of education such as is found in several European countries and Israel, where central government agencies control the rate of development, and a decentralized system like the United States, which could be considered a continent with great mobility between states. The difficulties in forecasting future needs and establishing policies as a result of these forecasts are difficult in any country, but they are enormous in the United States.

The growing involvement of the federal government in education in general, and in vocational-technical education in particular, could help in developing greater awareness for the need of coordination and planning. However, the basic decentralized system of education in the United States and the economic system built on private enterprise shows marked reluctance to allow any central administrative or economic interference. This makes it very difficult to obtain and make the proper use of reliable data.

The present and future shortage in qualified teachers in the United States, on the one hand, and the great mobility between various parts of the country on the other hand, have reduced the danger of manpower surplus. This has also reduced the awareness of the need for planning. Smaller countries with limited economic sources must be more careful in calculating their development in this area and should base it on reliable and accurate assessments and forecasts of supply and demand.

### 4. The Sources for Recruitment of Vocational-Technical Teachers

From the literature in European countries, and especially from reports in C.I.R.F. Monograph (1964), it appears that there are three main sources for recruiting vocational-technical teachers.

One group of countries places particular emphasis on recruiting vocational teachers who have acquired their vocational skill through long experience in employment. Here, the teachers are normally recruited at a comparatively advanced age -- 30 years or over. The principal selection criterion is that the sucessful candidate should have proved his ability for skilled work in his trade or occupation; his general educational background and scholastic achievements are taken into account only in a secondary capacity.... In the second group of countries the training of vocational teachers is seen principally as a continuation of the vocational training system itself.... The third group of countries makes little distinction between the recruitment of vocational teachers and the recruitment and training of teachers for general education. Candidates for vocational teacher training are selected among persons who leave general education at the university entrance level.

From the analysis of practices documented in the C.I.R.F. Monograph (1964), it seems that few countries in western Europe have adopted one single approach in recruiting candidates; they tend to use all three approaches. The literature from several eastern European countries and Israel indicates similar approaches. The same sources mentioned above are the main contributors of teachers also in the United States. Moss cites Beaty's (1966) study which indicates that for the 1965-66 school year, for both high school trade and industrial positions, the sources yielding the greatest number of teachers were, in rank order, (a) men employed full-time in industry, (b) teachers of nonvocational subjects, (c) graduates of college or university programs, (d) evening-school instructors, (e) full-time industrial employees attending degree programs on a part-time basis, and (f) ex-military personnel. The rank ordered sources of teachers for technical education programs were (a) men employed full-time in industry, (b) graduates of college or university programs, and (c) part-time industrial employees attending degree programs on a part-time basis.

In comparison to European and other countries, the United States has a larger number of university graduates teaching in vocational-technical schools, and this is rapidly becoming one of the important sources of teachers, especially on the technical education level. Another important source for technical education teachers in the United States has been retiring personnel. Several recent studies (Moss, 1967) in the United States have studied the potential of this source and its advantages and disadvantages.

The sources of teachers and the recruitment procedures from these sources are identified in the literature in very general terms. Little has been done to investigate quantitative patterns of supply and demand as they reflect in the past experiences. Moreover, reports are available concerning assessments and forecasts of flow of candidates, as previously indicated in the discussion on supply and demand. To forecast the flow from each source is very complicated and depends on many things, some of which are not in the area of vocational-technical education. Therefore, national studies of past and present sources to forecast the future flow from these sources should be established.

Methods and practices of recruitment of vocational-technical teachers are another important area which determines to some degree the contribution of each source. The problems in the area of recruitment range from communication with potential candidates and their families and dissemination of information about the profession to the various techniques and incentives.

## 5. Recruitment and Selection of Vocational-Technical Teachers

In many countries the growing shortage of qualified manpower and the strong competition for talented candidates for various professions and occupations have focused attention on the problem of recruitment and selection. Innovative approaches are being used to attract candidates to certain occupations, but very little has been done to attract candidates in the area of teacher education in general, and in vocational-technical teacher education in particular. Activities in the area of recruitment can be divided into two major groups: communication and dissemination of information about the profession, and the various techniques and incentives that may attract candidates and retrain them in the profession.

In the area of communication there is an increasing use of varied advertisement techniques being employed in mass media. Many of these techniques are based on research and are quite sophisticated. If vocational-technical education has a chance to compete with prestigious professions for talented candidates, it must use the most sophisticated and effective methods of disseminating its message to prospective candidates. Such methods should be designed and applied after a thorough study and identification of promising resources and techniques.

Efforts should be directed toward changing the many prevailing and unjustified ideas, stereotypes and images about the teaching profession in vocational-technical education. Information about the nature of the work and its advantages and disadvantages should be made available. There is further need to adjust working conditions and financial and nonfinancial incentives to attract talented qualified candidates.

We have already stated that the professional expectation from vocational-technical teachers are greater than what is expected from other secondary school teachers, but the social status and the remuneration is the same or even lower. Unless there are significant changes in this area, the difficulties in recruiting high-quality candidates will continue.

The formation of public opinion, attitudes and behaviour through the proper use of sophisticated mass media communication is constantly being investigated and evaluated. There is also a need to investigate the most viable and innovative techniques and procedures that might attract and retain candidates for teaching in vocational-technical education. Several studies reported on the most influential incentives to attract desirable candidates to vocational-technical teaching and the most effective techniques for transmitting this information to them. In one study, Parks (1965), former tradesmen indicated that their major reason for moving to teaching was the failure of industry to satisfy their need for self-realization, especially in the realm of social service. From our observations in Israel and other countries, we found this motive to prevail even among previous engineers or college graduates in the exact sciences who had moved to teaching because of unfulfilled needs for self-realization in the world of business and industry. While financial incentives attracted some to professions and occupations other than teaching, they chose teaching later on in order to satisfy higher needs. It would seem that many of those who could be desirable candidates for the teaching profession are attracted to science and engineering on the assumption that everybody employed in these areas is engaged in challenging activities and receives high salaries. This is not always true and efforts should be directed to correct these misconceptions.

Little has been done to study promising recruitment techniques. One of the few studies conducted, Jahrman (1964), concluded that the practice of sending teacher educators to the high schools to conduct recruitment activities was probably much more effective than mailing brochures or advertising in newspapers.

From our many discussions with teacher educators we believe they are apprehensive about being "salesmen" for their occupation. They tend to believe that they should remain on the campus and wait for candidates as do their colleagues in the academic world. However, vocational-technical teacher educators must realize that unless they conduct an aggressive recruitment program to mobilize the aid of vocational-technical teachers and counsellors in secondary schools and junior colleges, they will continue to have difficulties in recruiting adequate candidates.

The problem of selection of proper candidates for vocational-technical teacher positions may sound very theoretical in the light of the growing shortage of qualified teachers. Nevertheless, many educational leaders with whom we discussed the problem admitted that because of the shortage and the lax selection procedures, a significant number of teachers in the profession do not fit into this role.

The problem is strongly related to job description and required competence. In most countries the most important criteria for selection were experience in the trade or occupation and knowledge of the subject-matter. Little attention is given to teaching qualifications which are a composite of academic and nonacademic factors and which should be included among the prerequisites for teacher selection. Moreover, the problem of vocational-technical teachers towards the world of work in general, and in particular towards their specific area of specialization, is of great significance. Many of those who choose teaching after some industrial experience are disillusioned with their expectations from the world of work. Some of them are frustrated and disappointed. They easily transfer their feeling and attitudes to their students, and in some instances cause students to drop out of vocational-technical schools.

In summing up the research in this area in the United States, Moss (1967) states that it is evident that little direct effort has been made to identify the specialized competencies prerequisite to entry into teacher education programs. This is a problem in all areas of teacher education. Attempts should be made to base the recruitment and selection of new candidates for teaching in vocational-technical education on more significant criteria.

### 6. The Institutional Model for the Preparation of Vocational-Technical Teachers

Where should vocational-technical teachers be trained? Should there be special institutions where both subject-matter and education courses are taught? Should these be academic institutions awarding degrees? Should teachers' colleges assume this role? Should departments or schools of education and engineering assume separately the full responsibility and establish programs for both subject-matter and education courses? Or should they cooperate and divide the responsibilities for such a program? What kind of degree should be awarded?

From the literature and observation in the countries visited it is evident that vocational-technical teachers are trained in institutions which vary in their level and organizational pattern and, in some cases, these variations occur even within the same country. Several trends emerge, however, from the multitude of practices.

In the United States, the preparation of vocational-technical teachers is concentrated in colleges and universities. Graduates are awarded academic degrees. It should be emphasized that teachers for all levels of vocational-technical education are trained today in the United States in institutes of higher learning. Most programs are provided by special vocational-technical departments in state colleges for teacher training or schools of education within a large university system.

In European countries vocational-technical teachers are trained in special institutions designated for this purpose. In the past most of these were not equivalent to institutes of higher learning, and the teaching diploma awarded from these institutions was not considered a university degree. In recent years, however, there has been a change in attitude in European countries. It is recognized that the preparation of highly qualified vocational teachers who will teach in a highly developed technological era requires training of higher standards than is prevalent. Such training is provided in separate institutions which are, however, equivalent to academic institutions. For example, in France, the Ecole Normale Superieure de l'Enseignement Technique prepares teachers in vocational-technical and general subjects. Most of its graduates teach in secondary and post-secondary technical schools and some pursue work towards a higher degree and teach in schools of engineering.

A similar institute was established in Pisa, Italy, as part of a general teacher-training college. The scientific subject-matter is studied at the University of Pisa. In West Germany, the training of vocational-technical teachers was shifted after the war from special institutes to universities. However, in more recent years this responsibility was delegated to higher technical institutes (Technische Hochschule). Similar institutes are also functioning in East Germany and the Soviet Union. The growing recognition of the social status of a university degree is also an important factor in these new trends.

This trend in European countries is by no means popular. There still exists the dichotomy in what is expected from teachers in academic high schools and vocational schools. It should also be noted that these differences between the United States and European countries also prevail in other areas of professional training, such as certified nurses who hold an academic degree in the United States.

It should be emphasized that these differences do not always reflect the quality of training. Thus, graduates of professional schools in Europe without an academic degree may have a better general and professional education than a comparable college graduate in the United States. Much depends on the graduate's high school background, the curriculum and rigor of studies in the professional school.

The establishment of special academic institutions in which both subject-matter and education courses will be taught has several advantages. There could be greater flexibility in recruitment, selection of students and curriculum. It would probably eliminate some of the psychological problems confronting students preparing themselves for a teaching career in an engineering school. The constant confrontation with status comparisons, intellectual competition with other students and the need to discredit stereotypes about the teaching profession will be greatly reduced. On the other hand, there is a problem of standards. The number of candidates who will enroll in these institutes will be relatively small. Would it be possible to mobilize the human and economic resources to establish high standards, which are essential in order to attract students and faculty alike? Would it be considered economical to make such an investment?

The establishment of a comprehensive program in a college of education or a teachers' college raises similar problems. While the education courses may be effectively secured, the teaching of subject-matter remains the main problem. It is questionable whether a teachers' college could provide adequate faculty and facilities to secure high standards of teaching subject-matter in the technical areas. Here, again, one is confronted with the economics of such an investment and the possibility of attracting adequate faculty.

Establishing teacher-training programs in schools or departments of engineering, however, also poses several problems. In contrast to teachers' colleges, it is possible to secure high standards of subject-matter teaching; the problem is whether the high standards prepare teachers for their job. There are those who advocate that teachers who will study subject-matter on a high level will always be able to prepare themselves to teach a lower level curriculum. Theoretically, this is a correct assumption, but in practice, many teachers who hold engineering degrees find it difficult to adjust to the needs of vocational-technical schools. Such adjustments require much time for new course construction. In order to avoid this time-consuming work, many of them teach the way they were taught, but on a lower level -- a solution which does not work in many cases.

The range and intensity of education courses in programs conducted in departments of engineering depend, in the first place, on the philosophy of those in charge of the program, and whether they consider education courses as essential and equivalent to engineering courses in their importance to prospective teachers. Some of those who are critical of present education courses tend to minimize their importance in relation to subject-matter courses. Very few regular departments of education exist in engineering schools. As a result, faculty from other schools is employed. This, too, may have an impact on the range and depth of education courses.

What is an optimal organizational model? It would seem that a program designed and carried out cooperatively by departments of engineering and education in a college or a university might be best. An engineering school with an adequate department of education could also satisfy the needs of training technical teachers.

Another facet of the institutional organizational model is the duration of the program. This, too, varies between countries and between institutions in the same country. Existing programs could be categorized in two main groups: short-term and long-term programs.

Short-term programs are conducted, in general, for qualified engineers or other candidates with equivalent professional preparation. They last from one-half to one year. Their purpose is to provide professional education courses or enrichment in subject-matter of specialization, or a combination of both. Examples of these programs can be found in the United Kingdom, United States, Sweden and Israel.

Programs of longer duration are from one to four years. Since they lead towards an academic degree or its equivalent, they are similar in their curriculum and structure to regular academic education.

The preparation of teachers for industrial education programs or other vocational programs could be achieved through colleges of education in large universities or special teachers' colleges, provided that they have adequate facilities and staff also to teach subject-matter. However, it should be noted again that the United States is at present probably the only country where there is a growing trend toward awarding vocational teachers academic degrees. This trend is greatly facilitated by the fact that higher education and academic degrees are more common in the United States than in any other countries studied in this project.

## 7. Curricula of Vocational-Technical Teacher Education Programs

Basically, the desired objectives and curricula for vocational-technical teacher education programs are very similar in the countries studied. The existing differences originate in the variations in organizational patterns of training systems and recruitment practices. Because of these variations, the participants in the C.I.R.F. Seminar (1964), which examined practices in twelve European countries, found it impossible to recommend a specific line of training which could be universally applicable. Nevertheless, they have suggested the following list of objectives which a curriculum should try to achieve:

(a) a level of general education considerably higher than that acquired by the average vocational school student;

(b) broad technical education or scientific instruction corresponding to that of a higher technician in his own field of specialization;

(c) considerable practical experience, gained by working in industry, of conditions of work, including safety measures, ergonomics, and the organisation and practices of industrial production and maintenance operations;

(d) a knowledge of the philosophy and principles of education and of general and applied pedagogy, including principles and practices of planning training programs; of general and industrial psychology, physiology and sociology, with particular emphasis on the problems of youth at work, and of the social institutions of industry;

(e) advanced training in the didactic methods of teaching technical subjects, with special emphasis on methods of teaching based on experimentation.

These objectives seem to represent also the thinking in European countries which were not represented in the C.I.R.F. Seminar and in the United States. These objectives are advocated in the literature and were reiterated in the papers presented in the National Vocational Technical Teacher Education Seminar (1967) and in Arnold, et. al. (1967) Guidelines for the Development of Baccalaureate Technical Teacher Education Programs.

One should note that even though it may seem evident, it is stressed time and again that the teacher's level of general and scientific technical education should be higher than the level acquired by the average vocational-technical student. The need to stress this point stems from the fact that many of the vocational-technical teachers recruited from trades and occupations do not possess any formal education.

(a) General Education. This area of the curriculum contains courses which broaden the teacher's academic technical-scientific background and intend to improve his prowess as a teacher and a citizen. These should include instruction in the social sciences and humanities and incorporate courses and activities which will improve the teacher's ability to communicate his thoughts and knowledge, orally and in written form. Even though the objective of general education is mentioned first, it is not considered the most important. The I.L.O. Recommendation states:

> When it is not possible to recruit for practical courses teaching staff with all desirable qualifications, greater importance should be attached to technical competence, occupational experience and teaching ability than to a high level of general education.

In the United States more than any other country studied, the academic curriculum for vocational-technical teachers does include a significant proportion of general education courses.

The tendencies or practices in some countries to consider general education courses as least important and as the most likely ones to be dropped from the curriculum when difficulties arise will, in the long run, perpetuate the stereotype of vocational-technical teachers as a group lacking a broad education and having lower status in comparison to other teachers in the school system.

(b) Scientific Subject-Matter. Science subjects such as mathematics, physics and chemistry are considered in some cases as part of the general education, and in others as part of the technical theoretical subjects. The importance of adequate knowledge of scientific subjects by vocational-technical teachers is emphasized throughout the literature in all countries. It is accepted as imperative that the education of teachers be beyond or at least equivalent to that expected from graduates of various programs. It is emphasized also that scientific subject-matter should not remain theoretical. Practical applications for the skilled worker and the technician should be emphasized in teaching mathematics and science. Teachers should learn and teach the scientific principles underlying each occupation and clusters of occupations, so that students can transfer this knowledge in the future to problem solving situations in daily life. Students should have opportunities for experimentation and active participation in science classwork. The emphasis on applied science and active participation is directed especially at engineers or science teachers who tend in many cases to be too theoretical; they do not attempt to relate the general science subjects to the technical studies.

(c) Technical Subject-Matter. The curriculum in the technical subjects should provide the teacher with a thorough knowledge of the subjects he intends to teach and a broad knowledge of related subjects. He should be able to relate the scientific principles underlying these technical subjects and point out the principles which apply to families or clusters of jobs.

The extent of depth and breadth in preparing teachers to teach technical subjects or science subjects varies in different countries. Warren (1967, p.166) suggests that

> Countries such as France encourage the teaching staff of the Lycees techniques to specialize to the extent even of teaching only one subject, e.g. mathematics. Others like the Federal Republic of Germany formerly practiced in the Berufschulen the one class one teacher type of program in which a teacher took a group or class for all subjects on a given day. This is now giving place to the use of two separate teachers, one for theoretical subjects and one for practical. In the United Kingdom, the tendency in skilled worker training of the one teacher to take both the practice and the theory of the course of study... At technician level it is common that lectures be given by individual specialists perhaps only seeing the class or group once in a day or even in a week.

In the United States practices vary, but in many cases teachers of technical subjects, both on vocational and technical levels, are expected to teach both the theory and the practice. In Israel there are separate teachers for the theoretical subjects and the practical subjects in vocational-technical schools.

The technical related subjects taught in vocational and especially technical programs require increasingly more thorough knowledge and specialization. The chances of recruiting adequate numbers of candidates with industrial or any other practical experience, who would enroll in a university program and teach both theory and practice, seems very remote, and the concept of division of responsibility between teachers for theory and practice is gaining acceptance in most countries.

Even though there is a growing trend towards specialization, teachers in the theoretical subjects are expected to be familiar with the practical aspects of occupations in which their future students will specialize. This is imperative in order to synthesize theory and practice, and is essential in order to qualify them as authorities to their colleagues who teach in shop and laboratories and to their students.

Another phenomenon which balances the trend towards specialization is that specialization in the theoretical or practical subjects is given in broad groups. In the French Institute of teacher training (E.N.S.E.T.), there are only two technological departments: mechanics (industries mechaniques) and building (industries du batiment). In several universities in the United States and in Israel the main areas of specialization are

Mechanical Engineering and Electrical Engineering. In Switzerland, one area of specialization combines metallurgy, machine construction and electricity and the other, building and wood industries. These combinations are based on local conditions and tradition rather than on a systematic study of theoretical principles that are common to clusters or families of occupations.

(d) Professional Education. Erickson (1967, p.82) describes three views of professional preparation for technical teachers in the United States:

> The oldest and still prevalent viewpoint would hold that competence in one's area of technical specialty ipso facto assures possession of all the skills necessary to teach the specialty to others.

This viewpoint seems to be prevalent in many countries.

The second viewpoint holds that there are other competencies needed by vocational-technical teachers that should be provided through professional education. Such education should enable him to:

> Understand the purpose and value of education in general, and technical education in particular -- understand the structure of the educational system in the United States and the function of technical education within this structure -- present a logical position relative to his "philosophy" of education -- understand the basic psychological principles underlying the teaching-learning process -- effectively measure and evaluate the consequences of his instruction -- draw from a variety of teaching methods and design effective learning experiences -- adjust his instruction to meet the various student needs, problems, abilities, personality traits, and environmental conditions -- evaluate and use the findings of educational research to improve his instruction -- remain cognizant of the current and professional issues in education.
>
> Supporters of this second viewpoint hold that technical teacher education curricula should include a segment of "professional" as well as technical coursework. They would recommend that the prospective teacher be enrolled in "Technical Education in America", "Principles of Teaching Technical Subjects", "Measurement and Evaluation in Technical Education", "Special Methods of Teaching Technical Subjects", and/or other "professional" courses.

In the past this view has been more prevalent in the United States than in other countries; however, Warren (1967), in a recent survey of vocational-technical education, states that pedagogical training is required by many countries and that it takes place before (pre-service) or during (in-service) professional employment as a teacher.

The recommendations of C.I.R.F. Seminar on this subject were already mentioned. These recommendations are no indication that such an extensive program is already functioning. To our knowledge, there is not yet a system among the European countries which has implemented the full range of the proposed program. Most existing programs in Europe are still limited. These recommendations are no indication that such an extensive program is already functioning. To our knowledge, there is not yet a system among the European countries which has implemented the full range of the proposed program. Most existing programs in Europe are still limited.

Dobrovalny (1967) describes the following typical baccalaureate degree program for engineering technology in the United States which contains twenty-four semester hours of professional education in addition to general education courses:

| Major Subject-matter Areas | Semester Hours |
|---|---|
| Basic science (mathematics, chemistry, physics) | 32 |
| Engineering science (drawing, descriptive geometry, statics, dynamics and strength of materials) | 14 |
| Technical specialty (machine design, AC and DC circuits, etc.) | 38 |
| Education courses (educational psychology, practice teaching, supervised work experience) | 24 |
| General education (communication, psychology, social sciences, humanities) | 25 |
| | 133 |

The third view related to professional preparation, as Erickson (1967) states, sees the

> importance of including a "professional segment" of coursework in technical teacher education curricula. However, holders of this viewpoint would, in addition, raise the following question with respect to the efficiency of this segment of coursework. How does the usual professional course compare with other

courses in the curriculum in terms of value derived per unit of effort put forth?

Advocates of this third viewpoint would submit that the professional segments of our technical teacher education programs are very inefficient and that this inefficiency is due to (1) a failure to "bridge the gap" between technical and professional coursework, and (2) a failure to advantageously employ the technological developments in communication media.

This view is probably part of the general movement in the United States to reevaluate existing traditional programs in the general area of teacher education. New models are being advanced and tested in pilot programs and some vocational-technical teacher educators advocate similar changes.

Roney (1967) describes a new undergraduate program of technical education at the University of Oklahoma. The professional education courses in this program include

> a carefully structured block of four courses taken in sequence and designed to provide an introduction to technical education and the essentials of curriculum and program planning. *

Since structured programs in vocational-technical education are relatively new in many countries, there are not yet many divorced from tradition, and it would be easier to adopt new and innovative patterns of professional teacher education.

8. Occupational Experience

The qualifications of vocational-technical teachers are varied, but occupational experience is generally regarded as imperative. The following are several of UNESCO's (1962) recommendations regarding occupational experience of technical teachers:

> The teaching staff for the education of technicians should possess either a degree or a higher technician's qualification in an appropriate field and should have had industrial or comparable experience in their particular discipline.
>
> Whenever possible, teachers of technical or specialized subjects should have at least three years'

* For a full description of the Oklahoma syllabus, see appendix C.

practical experience of the trade or specialty which they are to teach.

Workshop instructors are expected to possess even greater occupational experience.

Similar recommendations were adopted by I.L.O. (1964). Both shop instructors and teachers in the theoretical technical courses should have, in addition to training, "several years practical experience in the occupation they are to teach".

The importance of occupational experience was manifested before these recommendations were adopted. Most vocational-technical teachers were recruited from the occupations and, in many cases, this was their only "preparation" for the teaching profession.

Venn (1964) describes the constant shortage in qualified teachers in certain areas in the United States and the prevailing recruiting practices. From Venn's description it seems that such occupational experience was not always advantageous:

> The most common 'solution' has been to take willing craftsmen or technicians (often an older worker or other person whose earning power in industry has become limited), run him through three or six credits of education courses (for teaching techniques) and put him in front of a class.

In this case the instructor did not have much formal or informal education in mathematics, English, speech, industrial relations or civics and cultural subjects. His subject-matter knowledge tended to be circumscribed by his job experience. He had little experience with the related skills and knowledge that should be taught. Moreover, the teacher was not abreast of newer thinking in the field. *

In reviewing existing requirements for occupational experience it is possible to find much variation in the required length of this experience and its nature. In some cases it must be related to the field taught and in others not. In France, for example, three months of occupational experience are expected, while in some states in the United States seven years are required.

Little has been published in the international literature about this topic. Meyer (1967) suggests that periodical articles

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* Venn (1964, p. 35).

and teacher education textbooks reveal the following purposes of occupational experience requirements for vocational teachers in the United States:

1. To enable the teacher to learn the technical competencies and apply them in an occupational situation for better teaching in the classroom, laboratory and shop.

2. To enable the teacher to gain the confidence and support of business and industrial personnel, and of students and school personnel.

3. To provide the teacher with self-confidence in dealing with school, business and industrial personnel and with students and parents.

4. To aid the teacher in acquiring an appreciation of the problems of beginner workers in adjusting to the total work environment and of the problems of supervisors and employers relating to new workers.

5. To facilitate the teacher's formulation of realistic occupational images and concepts of career opportunities.

6. To strengthen community-school relationships.

However, in a discussion of new approaches to occupational experience, Meyer (1967) raises some critical questions. Supposedly, he says occupational experience is a criterion of certain abilities deemed essential to good teaching. However, this criterion is very vague. How does experience contribute to quality of vocational-technical education? What are its values? Were they the same in 1917, 1937, 1967? What are the criteria for evaluating occupational experience of candidates for teacher certification? Quantity? Occupational level? Variety? Recency? Size and reputation of the employing firm? Is the value of occupational experience of equal importance to instruction in all of the recognized vocational education fields? Does each occupation within the vocational field call for the same amount and quality of occupational experience?

The importance of occupational experience was taken for granted. But there is a need for evaluation and re-examination of this widely accepted concept. Venn (1964) says:

> The assumption has been that it is better to convert a journeyman into a teacher than to have a teacher acquire the necessary skills and related knowledge. Perhaps within the present situation this assumption

is warranted, at least to the degree that shop-oriented instruction does require shop-oriented instructors and to the degree that such instructors may have greater empathy with their students than the person who has never worked in a production job. However, the future role of shop- and lab-oriented instruction and the potentialities of a work-study program of teacher preparation suggest that cooperatively higher education and industry could bring about important breakthroughs in vocational and technical teaching. This is particularly true of teaching on the technical and semi-professional level, where content and level of instruction lessen the experience and empathy factors.

The problem of occupational experience touches upon one of the most critical problems in vocational-technical teacher education -- recruitment. Even if a re-examination of the problem would reveal that experience of several years is imperative, the question still remains - of how to acquire it. The difficulties are greatest in the area of technical education. If we accept the notion that teachers on this level should have an academic degree, it is very unlikely that one could recruit a sufficient number of adequate candidates from the field. If they are very competent, they are probably earning more in their occupation than they could earn in teaching and probably would not be willing to accept the decrease in earning power. If they are not highly competent, will they be able to graduate from an academic technical course?

Arnold, et al (1967) suggest the following guidelines for the provision of occupational experience in baccalaureate technical teacher education programs:

1. Technical level occupational experience should provide the teacher with depth and breadth as well as knowledge of current industrial or business practices at a level minimally commensurate with that associated with the employment expectations of graduates of technical programs of the type and level for which the prospective teacher is being prepared.

2. Occupational experience requirements for the prospective teacher should emphasize prearranged, supervised, cooperative programs rather than evaluation of previously obtained employment experience.

3. The amount and emphasis of occupational experience required of the technical teacher should relate to the requirement of the technology.

4. The major portion of the occupational experience of the teacher can often follow graduation from the baccalaureate program.

It seems that these guidelines would be adequate also in the case of vocational teachers. Effective, intensive, prearranged and supervised occupational experience, though short, might prove to be more profitable than long occupational experience which is often an accumulation of a certain limited experience which was repeated for many years. New innovative approaches to the problem of occupational experience will increase the number of candidates and will improve the quality of the educational process.

9. Student teaching* and internship.

Student teaching and internship are the two main systems for providing teaching experience to prospective vocational-technical teachers. They are considered part of the professional education segment in their curriculum. In each of these systems there are variations of practices. Similar to other disciplines in teacher education in some institutions, student teaching consists of individual lessons taught by a student teacher in a regular classroom of a "master" ** teacher to whom he is assigned. The critique is provided by the "master" teacher, the college supervisor and the student teacher's colleagues, if they attend the lesson.

Another common pattern is to assign a student teacher to a "master" teacher for a period of four to eight weeks. In this case, the student teacher will spend most of his time in a regular school and will have opportunities to assume many of the teacher's classroom roles. The "master" teacher assumes any major supervision responsibility during this period. The college supervisor, however, visits several times and evaluates the student teacher's progress. This concentrated period of student teaching is arranged towards the end of the regular studies or immediately after the student has completed his course work.

The internship system, common in the training of physicians and lawyers, is recognized as another system to provide teaching experience to vocational-technical teachers. The main difference between this system and student teacher is that the intern has already completed his formal studies and the internship or probationary period is much longer, between one to two years.

Very few programs are described in the literature. Among European countries, West Germany has developed an internship or

* The more common term in the European literature is "Practice Teaching".

** Another term is "cooperating" teacher.

probationary system for vocational-technical teachers. The candidate is assigned a school; he works, in general, on a part-time basis, 18-24 months. A "master" teacher is assigned to supervise him. The intern participates in regular seminars conducted by the educational authorities and the training institutes. Every three or six months he prepares a report on his experiences. In the second year he prepares an elaborate report (dissertation) which includes an evaluation of his experiences and an analysis of a selected educational problem. A variation of such an internship program is cited also in the literature in the United States.

The rationale of student teaching or internship is derived from one of the fundamental methods of vocational education, which is the apprenticeship system. Historically, this system was the first method of teacher education. The "master" teacher was at times the only one in charge of teacher training.

In recent years, research efforts have been directed to identify the major contributing variables during the student teaching and internship period. Different models of student teaching have been evaluated. There is some research evidence (Schueler and Lesser, 1967) which indicates that the "master" classroom teacher has the greatest impact of all upon the prospective teacher. There is not, however, any definite conclusion as to the most effective model and the specific goals and roles of the college supervisor and the "master" teacher.

The re-evaluation of student teaching and internship models calls for some bold thinking and experimentation with new ideas and techniques that will best suit the needs of vocational-technical teacher education.

10. In-service Education

In-service education is considered in all countries surveyed as one of the most important methods to secure adequate standards in vocational-technical education. UNESCO (1964) recommends that:

> The training of teachers in technical and vocational education should be considered as a process continuing throughout their teaching career. Arrangements should be made for the periodic release of teachers in order that they may keep abreast of modern processes and methods of production and management through periods of work in their specialty.

Similar recommendations were made by I.L.O. (1964) and the literature in European countries and the United States. It is suggested that in-service programs are more imperative to vocational-technical teachers than to any other group of teachers. The following reasons are advanced in support of this contention. (1) The rate of change in scientific and technological theory and practical know-how is faster than in any other field. (2) A great proportion of vocational-technical teachers were recruited to teach before they had any formal preparation for teaching. Some of them may have had only partial preparation either in the scientific technical areas or professional education. (3) There are vocational-technical teachers who have graduated from formal teacher education programs but did not have adequate industrial experience. In these cases, some in-service programs combine formal learning and supervised structured industrial experiences.

In each of the countries surveyed, there are a variety of in-service education programs. The most common are short courses or workshops conducted by academic institutions, professional organizations, local education authorities, individual schools and industry. A common practice in the United States is to enroll in an institute of higher learning during the academic year and especially during the summer vacation. These are university credit programs which are taken for a degree.

The content of the short programs vary. Some of them focus on a specific subject-matter or professional education and some combine issues from both areas. University programs are more specialized and focus on specific areas.

One of the most important problems in this area is providing incentives for participation in such programs. In the United States, according to certification requirements, teachers are supposed to attend University courses every several years. This would be considered a legal incentive. Some school systems condition yearly salary increments with participation in in-service education programs.

The relative low salary of vocational-technical teachers forces many of them to devote their free time during the year, and especially during the summer, to seek extra work to supplement their income. Their proficiency in various technical occupations and the shortage in highly qualified technical manpower enables many of them to find extra part-time jobs without great difficulties. Thus, the problem of stimulating vocational-technical teachers to attend in-service education programs is more problematic than with other teachers.

In addition to the financial problem, it would seem that vocational-technical teachers are more concerned with the practical outcome of in-service programs. If they attend in-service training programs and give up opportunities to improve their financial conditions, they expect the programs to be more meaningful and to have a greater impact on the solution of their daily school problems.

Considering these two observations, it is essential that vocational-technical teachers should receive adequate financial aid and incentives to attend in-service education programs. It is also imperative that such programs will be meaningful to those attending and that the participants will see the implication of these programs to classroom situations.

## 11. New Media and Innovative Approaches to Vocational-Technical Teacher Education

In several of the countries studied, and especially in the United States and France, there is a growing awareness that greater use should be made in teacher education of new media and innovative techniques. Schueler and Lesser (1967) analyze in great detail research and experimental programs using new media in teacher education. Pomeroy (1967) states the following in regard to the use of new media in teacher education:

> The old prejudices against realia and audiovisual aids are being replaced by a more enlightened acceptance of the role of the newer media in teacher education.
>
> Many of the problems of supervision, practice teaching, and classroom observation are being overcome by the means of closed circuit television, video-tape recording, and 8 mm. film. These techniques offer exciting and new possibilities for simulation and control of the classroom situation. The result is the birth of a new field within teacher education where such mediated situations provide content for analytical discussions on student-teacher behaviour and performance at a level of precision and actuality which has never before been possible. Thus, the newer media are adding a new dimension to the teacher training program. They also involve an additional responsibility for the teacher educator. If teachers are to be adequately prepared for a world in which the miracles of technology have become accepted as an essential but commonplace facet of everyday living and for schools which are now being built to use media in every classroom, then teacher educators have a responsibility to provide student teachers with a sound conceptual framework to help guide their use of the newer media in their own teaching.

Another new development in the general area of teacher education is an attempt to establish a better scientific foundation to teacher education. Verdwin (1967) brought together some of the main new concepts in teaching and learning which have a direct meaning to teacher education.

The above-mentioned references illustrate the awakening in teacher education to the application of new approaches and new media. Vocational-technical teacher educators should be aware of these new developments and introduce them in the existing and newly established programs.

## PART IV. A PROGRAM OF STUDIES FOR TECHNICAL TEACHERS IN ENGINEERING AND RELATED SUBJECTS - ELECTRONICS AND MECHANICAL ENGINEERING

### PROCEDURES

#### 1. The Curriculum Committees

Two curriculum committees,* comprised of senior faculty members of the departments of electrical and mechanical engineering, were established in order to prepare a program of studies for teachers in electronics and mechanical engineering. State supervisors in vocational-technical education in electronics and mechanical engineering were also consulted. Senior faculty members of the science departments, in charge of undergraduate science courses, were consulted on problems of the science curriculum, and the professional education curriculum was discussed with the Teacher-Training Department.

The committees were appointed by the Technion's Vice President for Academic Affairs, after consultation with the departments' deans. Thus, the committees were assigned a regular academic role in order to make certain that their reports would be considered official documents by the various academic bodies of the Technion.

#### 2. Guidelines for Preparation of the Program

The committees were asked to concern themselves with short- and long-term needs. One concern was the need to prepare a program which would suit both the present and the near future needs of standards and requirements of vocational-technical teachers. The committees studied the present curriculum and development plans of the Israeli vocational-technical education system. The immediate needs of the Israeli industry were also considered.

The committees had also to deal with the fact that teachers trained during this decade will be expected to teach at least in the next two decades. All indications suggest that we are moving in the direction of a highly sophisticated scientific and technological era. It is difficult to pinpoint exactly what kind of knowledge and information will be needed for teaching in the next three decades. However, an adequate basis, from which they will be able to constantly update themselves through formal in-service study programs and self-study, is imperative for teachers. To design a curriculum that will meet future needs, the committee had to study technological and industrial plans abroad and,in particular, the predicted directions of Israeli industrial and economic development. One of the committees' assumptions, for example, was that electronic graduates who are

* For a list of committee members, see Appendix A.

employed at present as radio technicians, will, in the future, probably be employed in fields of electronic computers, industrial control, medical electronics, nuclear instrumentation and television.

The discussions on the professional education courses were based on the accepted practices in the Technion and other institutes of higher learning in Israel, the Teaching Certificate of the Ministry of Education and Culture, and similar programs in the United States and several European countries.

3. Optimal Goals and Reality

The committees were assigned the difficult task of proposing an optimally desirable program that could be implemented in the prevailing conditions. They had to consider the conflict between their criticism of the present teaching in vocational-technical education and their aspirations of the future in this area, and between their opinions about the role of the Technion in science, technology and teacher-training and the existing conditions in the Technion and the country.

As previously indicated, the Technion maintains very high standards and is the only institute of higher learning that awards degrees in engineering. The competitive entrance examinations to the Technion are very rigorous. In the past, only a small number of the students enrolled in the Teacher-Training Department specialized in teaching technical subjects. In view of the present social and economic status of the teaching profession as a whole, and vocational-technical teachers in particular, some committee members doubted if it would be possible to increase the number of students preparing to be teachers.

It should be admitted that the prevailing system of requiring equal prerequisites from students majoring in engineering, science, or teaching was not established by a scientific job analysis of the teacher's role in vocational-technical education. In this respect, the committees had to follow the present Technion procedures as far as equal entrance requirements for all candidates was concerned. Moreover, some committee members felt that there was no demonstrable need for equal standards such as those required at present and that a different set of standards would probably increase the number of candidates. However, in spite of this objection, it was agreed that it would not be advisable for the Technion to lower entrance requirements for candidates to the Teacher Training Department.

Another area considered was the Technion's manpower and economic resources. In the past, because of the small number enrolled, students in the Teacher-Training Department studied their subject-matter in the departments of science and engineering, together with engineering and science students. There had been a growing realization that students in the Teacher-Training Department should be separated in order to study specific subject-matter. Experience has shown that the exact sciences and related subjects taught to engineers do not always meet the needs of prospective teachers. Moreover, when these subjects are taught separately to prospective teachers, attempts have been made to have an instructor or professor available who is familiar with high school or junior college teaching and who is able to incorporate many worthwhile suggestions in teaching methods and curriculum problems and to provide a positive model for teaching.

In conclusion, the committees were restricted in their deliberation by the fact that the Technion is the only institute in Israel that could train academic vocational-technical teachers. They have attempted to suggest an optimum between the Technion's standards and the needs of vocational-technical education.

The committees' proposals were discussed and adopted by the Teacher-Training Department and approved by the Technion's Senate. However, until the publication of this report, only a small number of candidates from those enrolled in the Teacher-Training Department did specialize in teaching engineering related subjects; the great majority specialize in teaching sciences.

### 4. The Programs

The Teacher-Training Department accepted the courses of studies included in the committees' reports, thus setting down the following program of studies:

a. Proposed course of undergraduate studies for training teachers of Electronics Option in Vocational Secondary Schools -(B.Sc.Ed).

First Year

| | Hours per week | | | | | |
|---|---|---|---|---|---|---|
| | Semester I | | | Semester II | | |
| Subjects | L | CE | LE | L | CE | LE |
| Mathematics: analysis | 3 | 2 | - | 4 | 2 | - |
| Mathematics: algebra | 4 | 1 | - | - | - | - |
| Physics I | 3 | 1 | 3 | 3 | 1 | 2 |
| Chemistry | 2 | 1 | 3 | - | - | - |
| Engineering mechanics | - | - | - | 2 | 1 | - |
| Logical structure of computers | - | - | - | 2 | 1 | 2* |
| Properties and structure of materials | - | - | - | 2 | - | - |
| Principles of Education | 2 | - | - | 2 | - | - |
| Humanities | 2 | - | - | 2 | - | - |
| Total | 16 | 5 | 6 | 17 | 5 | 3 |

* The exercises will be given in the Computer Center.
L - Lectures CE - Class Exercises LE - Lab. Exercises

First Year (contd.)

| Subjects | Hours per week Semester I L | CE | LE | Semester II L | CE | LE |
|---|---|---|---|---|---|---|
| English (as regular Technion requirement) | 2 | 2 | - | 2 | 2 | - |
| Hebrew ( " " " " ) | 2 | 2 | - | 2 | 2 | - |
| Physical Education ( " " ) | - | - | 2 | - | - | 2 |

Summer Term - (6 weeks)

| Lectures | L | CE | LE |
|---|---|---|---|
| Psychology - General and Social | 5 | - | - |
| Organization of education in Israel and in other countries | 3 | - | - |
| (An additional 10 hrs. of lectures will be given during the pedagogical visits) | | | |
| Descriptive geometry and technical drawing | 2 | 3 | - |
| Modern physics | 5 | - | 3 |
| Total | 15 | 3 | 3 |

Visits and Practical Work

Practical work in secondary schools under guidance 1 week - 30 hours
Guided study tour of secondary schools in Israel 1 week - 30 hours

Second Year

| Subjects | Hours per week Semester I L | CE | LE | Semester II L | CE | LE |
|---|---|---|---|---|---|---|
| Mathematics: analysis | 3 | 2 | - | - | - | - |
| Physics II | 4 | 1 | 2 | - | - | - |
| Introduction to solid state physics | - | - | - | 2 | 1 | - |
| Electrical machines | - | - | - | 3 | 1 | 2 |
| General Methodology | 2 | 2 | - | 2 | 2 | - |
| Electrical Engineering Calculations | 2 | 1 | - | 3 | 1 | - |
| Introduction to Electrical Eng. | 3 | 1 | 3 | 4 | 1 | 3 |
| Humanities | 2 | - | - | 2 | - | - |
| ucational psychology | 2 | - | - | 2 | - | - |
| Total | 18 | 7 | 5 | 18 | 6 | 5 |

L - Lectures CE - Class Exercises LE - Lab. Exercises

Second Year (contd.)

| Summer Term (about 7 weeks) | L | CE | LE |
|---|---|---|---|
| Transistor physics | 5 | 2 | - |
| Industrial electronics | 4 | - | - |
| Electronic circuits I | 4 | 2 | - |
| Electronics and industrial electronics laboratory | - | 1 | 3 |
| Total | 13 | 5 | 8 |

Third Year

| | Semester I | | | Semester II | | |
|---|---|---|---|---|---|---|
| Subjects | L | CE | LE | L | CE | LE |
| Methodology I | 2 | 2 | - | 2 | 2 | - |
| Methodology II | 2 | 2 | - | 2 | 2 | - |
| Selected topics in mathematics | 2 | - | - | - | - | - |
| Networks | 3 | 2 | - | - | - | - |
| Control theory | - | - | - | 3 | 1 | 2 |
| Electronic circuits, II, III | 4 | 1 | 4 | 4 | 1 | 4 |
| Electronic instrumentation | - | - | - | 2 | - | - |
| Waves and transmission lines | 2 | 1 | - | - | - | - |
| Communication systems | 2 | 1 | - | - | - | - |
| Television | - | - | - | 2 | - | - |
| Electronics laboratory | - | - | 6 | - | - | 4 |
| Humanities | 2 | - | - | 2 | - | - |
| Total | 19 | 9 | 10 | 17 | 6 | 10 |

Summer Term (3 weeks)

Electronic circuits projects.
Practical work in schools under supervision of instructor in the Chanukah Term (till December). From Chanukah to Passover (January to March approx.) one seminar per month with the teacher of the subject methodology.

b. Proposed Course of Undergraduate Studies in the Teacher-Training Department for Teachers of Mechanical Engineering Option in Vocational Secondary Schools (B.Sc.Ed).

Entrance Requirements: Students who have completed 12 years schooling will be eligible for registration. Those coming from High Schools will be required to do work in the Technion Workshop, as is usual in the Faculty of Mechanical Engineering.

Those coming from Vocational Schools will be exempted from work in the Workshop.

L - Lectures CE - Class Exercises LR - Lab. Exercises

## First Year

| Subjects | Semester I L | CE | LE | Semester II L | CE | LE |
|---|---|---|---|---|---|---|
| Mathematics I | 5 | 2 | - | 4 | 2 | - |
| Physics I | 3 | 1 | 3 | 3 | 1 | 2 |
| Chemistry | 2 | 1 | 3 | 3 | 1 | 3 |
| Technical Drawing | 3 | 3 | - | 3 | 3 | - |
| Descriptive geometry | 2 | 3 | - | 3 | 3 | - |
| Principles of Education | 2 | - | - | 2 | - | - |
| Humanities | 2 | - | - | 2 | - | - |
| Total | 19 | 10 | 6 | 20 | 10 | 5 |
| English * | 2 | 2 | - | 2 | 2 | - |
| Hebrew ** | 2 | 2 | - | 2 | 2 | - |
| Physical Education | - | - | 2 | - | - | 2 |

## Summer Term

A. Education Subjects

Psychology (General and Social)
Organization of education in Israel and in other countries

B. Mechanical Engineering Subjects

Mechanical technology - 180 hours
(processes, metrology, mechanical engineering laboratory)

C. Workshop - For those not coming from Vocational Schools.

## Second Year

| Subjects | Semester I L | CE | LE | Semester II L | CE | LE |
|---|---|---|---|---|---|---|
| Dynamics | - | - | - | 2 | 1 | - |
| Mathematics (A special course including plane geometry) | 4 | 2 | - | 4 | 2 | - |
| Physics | 1 | 1 | 2 | - | - | - |
| Mechanics (strength of materials) | 3 | 2 | - | 2 | 1 | - |
| Thermodynamics (special course) | - | - | - | 3 | 1 | - |
| Mechanical technology(sp.course) | 3 | 2 | 2 | 3 | 3 | 2 |
| Introduction to Electrical Eng. | 2 | 1 | 2 | 2 | 1 | 2 |
| Machine design topics (sp.course) | 3 | 3 | - | - | - | - |
| Machine parts (special course) | - | - | - | 3 | 3 | - |
| General Methodology | 2 | 2 | - | 2 | 2 | - |
| Humanities | 2 | - | - | 2 | - | - |
| Total | 20 | 14 | 6 | 23 | 14 | 4 |

* Advisable to split students into two groups - advanced (from vocational schools) and beginners.

** As normal requirements at the Technion.

L - Lectures CE - Class Exercises LE - Lab. Exercises

Summer Term

A. Education Subjects - Visits and Practical Work.

Practical work under guidance in secondary schools 1 week - 20 hours
Pedagogical tour of Israeli education system 1 week - 30 hours

B. Mechanical Engineering Subjects

Workshop practice (in modern workshop). The work will be carried out under the guidance of instructors and the students must present a report according to the instructions of the Department.

Third Year

| Subjects | Semester I L | CE | LE | Semester II L | CE | LE |
|---|---|---|---|---|---|---|
| Methodology I, II | 4 | 4 | - | 4 | 4 | - |
| Fluid mechanics and hydraulic machines (special course) | 2 | 1 | - | 2 | 1 | - |
| Machine dynamics | 3 | 2 | 1 | 3 | 2 | 1 |
| Engineering thermodynamics | 2 | 2 | - | 2 | 2 | - |
| Machine parts (special course) | 3 | 1 | 1 | 3 | 1 | 1 |
| Metrology | 1 | 1 | - | 1 | - | 1 |
| Electronics | 3 | 1 | 2 | - | - | - |
| Control theory | - | - | - | 3 | 1 | - |
| Humanities | 2 | - | - | 2 | - | - |
| Total | 20 | 13 | 4 | 20 | 11 | 3 |

Summer Term

Mechanical Engineering Subjects (for 7 weeks)

| | |
|---|---|
| Power and heat plants * | 8 |
| Refrigeration * | 8 |
| Production technology * | 8 |
| Automatic control * | 8 |
| | 32 |

Practical work in schools under the guidance of an instructor from September to Chanukah (December). From Chanukah to Passover (January to March approx.) one seminar per month in which the prospective teachers will discuss educational problems with the teachers of the subject methodology.

Syllabi and Recommendations of the Committees - See Appendix A and Appendix B.

* The students will prepare limited projects in these subjects.

L - Lectures CE - Class Exercises LE - Lab. Exercises

## PART V. SUMMARY AND RECOMMENDATIONS

The purpose of this study was twofold: (1) To prepare a program of studies for the preparation of teachers for the sciences and engineering-related subjects in vocational-technical schools and in technical junior colleges. (2) To recommend ways and means to overcome the general problems involved in developing vocational-technical teacher education programs in Israel.

Part IV of this report deals with the first purpose and includes a program of studies for vocational-technical teachers. The following recommendations based on the discussions in other parts of this report and on the researchers' practical experience in the field of vocational-technical teacher training fulfill the second purpose of this study.

As was already stated this was an exploratory study. Many of the problems identified should be investigated more thoroughly. The recommendations should also be considered as topics for further studies and re-evaluated in the light of new evidence obtained by continuous research.

The order in which these recommendations are presented does not indicate their relative importance. They are arranged in a certain developmental logical sequence identical to the discussion of critical issues in Part III, Chapter B.

1. <u>The Status of Vocational-Technical Education.</u> Governmental agencies and public organizations concerned with vocational-technical education should indulge in an intensive campaign to raise the status and change the image of vocational-technical education. Efforts in this area should be directed toward the general public and the educational community alike.

The status of vocational-technical education is relatively low and its image is warped. Improving the quality of vocational-technical education and increasing its role in the educational system is of utmost importance to the economic and social development of the country. This, however, is interrelated with the status awarded to vocational-technical education by the public in general, and by parents and children in particular. The recruitment of adequate candidates for vocational-technical education depends to a great extent on this problem. It is of prime importance that governmental and public agencies involved in vocational-technical education should indulge in a cooperative, intensive campaign to raise the quality and status and change its images. Activities in this direction should be based on a thorough study of the problems and the means to attack it. The use of mass media communications and especially the new state television system should be explored.

2. <u>Job Description and Requirements</u>. The Department of Vocational Education in the Ministry of Education and Culture should initiate the preparation of job descriptions and job requirements of different types of vocational-technical teachers at different educational levels.

The present formal and informal certification requirements of vocational-technical teachers are based on tradition and conventions rather than on a systematic study of job descriptions and the derived qualifications and requirements. Even in this particular study the investigators and the curriculum committees based their proposed program on intuitive observations of the role of vocational-technical teachers rather than on a qualified job description.

3. <u>Supply and Demand of Vocational-Technical Teachers</u>. The Department of Vocational Education in the Ministry of Education and Culture should prepare estimates of supply and demand of vocational-technical teachers for short- and long-term periods. These estimates should guide the development of vocational-technical teacher education programs.

There is not any detailed planning of supply and demand of vocational-technical teachers for short- and long-term periods. The present development of teacher education programs is based on very general estimates of future needs. The effective use of the limited financial and manpower resources requires detailed planning of future needs. Forecasts of future needs should be based on: (a) the projected plans in the industrial development of the country, (b) the projected need for technical labour force in different levels, (c) the development of the vocational-technical school system, (d) analysis of the present teacher force, (e) the possibility to upgrade the academic status of the teacher force, (f) the possible development of the program for preparation of new teachers.

4. <u>Sources of Recruitment</u>. The analysis of the present teaching force in vocational-technical education should include an analysis of the sources for recruitment of candidates for teaching. New sources such as retired military personnel or graduates of technical junior colleges should be explored.

There is no statistical analysis describing the sources which have contributed mostly to the teaching force in vocational-technical education. Little attention has been paid to the identification of new sources and the exploration of conditions and incentives to enhance such recruitment.

5. Recruitment and Incentives. The government, public and private organizations involved in vocational-technical education and institutes of higher learning should plan a vigorous program for recruiting candidates for vocational-technical teacher education.

In order to compete with other occupations on a limited number of adequate candidates, a vigorous recruitment campaign should be planned. Both mass media and direct individual approaches should be employed to communicate information about the profession.

Within the limits of this study it was impossible to discuss the role of salaries and other financial and nonfinancial benefits in the problem of recruitment and retaining of vocational-technical teachers. It cannot be emphasized enough that these factors have a strong impact on the problem . The financial compensation of vocational-technical teachers is part of a general problem of the teaching profession and could not be attacked separately; however, special attention should be given to the introduction of financial incentives, other than salary, and nonfinancial incentives, which would attract adequate candidates.

6. Selection Procedures. Existing selection procedures should be strictly adhered to and new ones should be introduced in order to insure that only adequate candidates be admitted to the profession.

Because of the shortage of qualified teachers in vocational-technical education, there has been a tendency to overlook selection procedures. It became impossible to continue emphasizing that, in spite of the shortage, only those who fit in a teaching role should be admitted. At present, there is no structured way to identify candidates who should not be admitted because of psychological problems, attitudes and other nonacademic factors. The problem nevertheless exists and merits more attention.

7. Development of the Teacher-Training Department. The Teacher-Training Department in the Technion-Israel Institute of Technology should be developed and expanded so that it may effectively fulfill its role of preparing academic vocational-technical teachers.

The Teacher-Training Department in the Technion is most suitable for the task of training academic teachers for vocational-technical education. At present, the Department is hampered in fulfilling its function by limited facilities, staff and budget. In order to fulfill its functions there is an urgent need to establish facilities which will include special laboratories and workshops in scientific and technical areas. The Department should have a larger full-time staff which would devote itself to teaching and research in the problems of teaching of scientific and technological subjects. It is essential that the number of students in the Department be increased so that it would be possible to conduct special classes in subject-matter geared to the needs of those preparing themselves to be teachers.

8. Academic and Administrative Standards for the Teacher-Training Department. The Technion should consider the objective needs of the Department of vocational-technical teachers in determining standards and academic and administrative regulation.

By functioning at the Technion, in strong collaborati with its engineering school, the Department is able to facilitat studies in subject-matter on a high level and in the most economical way. Considering this environment, the Department - in the first years of its existence - had to adopt standards and regulations geared to the needs of training engineers and scientists. In the future greater consideration should be given to the unique needs of the Department and its students in view of the special calling of its graduates.

9. A Program for Part-Time Students. The Technion should examine the feasibility of establishing a program which will enable experienced teachers who do not have an academic degree to enroll as part-time students working toward a degree.

The degree program in the Teacher-Training Department is designed for full-time students who are expected to devote three full years, including summer sessions, to studies. There is a significant number of young teachers in vocational-technical schools who have tenure yet do not possess an academic degree. Many of them have families, and even the available grants and scholarships would not enable them to enroll as full-time students in the existing degree program. Efforts to raise the standards of teachers in vocational-technical education should be directed toward those who are already teaching and new teachers alike. Many teachers who do not have academic degrees are expected to teach for many more years in vocational-technical education, and it is essential that they obtain formal education.

10. Relationship with the Junior Technical College.
The Teacher-Training Department should develop close relationship with the Technion's Junior Technical College and its various branches around the country.

At present students in the Teacher-Training Department are fulfilling their requirements of student teaching mainly in academic and vocational secondary schools. The growth of technical junior colleges in the country requires that students receive adequate practice of teaching also on this level. Functioning on the same campus and in the same town, makes the Technion's Junior College a most suitable place for regular teaching demonstrations, experimentation and practice teaching by students.

11. Candidates from the Junior Technical College. The Technion should examine the feasibility of accepting talented graduates of the Junior Technical College to the Teacher-Training Department and award them transfer credits for part of their studies at the Junior College.

There is growing realization in many countries that graduates of technical junior colleges or training programs for senior technicians could provide an excellent source to recruit candidates for teacher-training programs. Many of them are graduates of vocational-technical secondary schools and some have had industrial experience. They are more familiar than other candidates with the mentality and needs of students in vocational schools and junior colleges. It should be possible to accredit some of their previous studies equivalent with studies towards a degree and on the other hand to oblige them to take some courses in liberal arts.

12. The Curriculum of the Teacher-Training Department.
The Technion should encourage the preparation of a subject-matter curriculum for the Teacher-Training Department which will be geared to the special needs of teachers.

The present program of studies in the Teacher-Training Department (which is presented in Part IV of this report) is based on the general pattern guiding all the Technion's departments. The curriculum committees did not consider it feasible in the present conditions to alter this basic pattern. The balance and relationship between general education, sciences, technology and professional education courses, and the content of courses in these areas should be re-examined in order to propose an optimal program suited to the needs of vocational-technical teachers.

13. Special Classes for Students in Teacher-Training Department. Considering the economic aspects and the avilability of staff, constant efforts should be made to arrange special subject-matter classes for students in the Teacher-Training Department.

In the past, most classes in subject-matter were taken with engineering or science students. This was done mainly because of administrative and economic reasons. In the recent years, more courses were given separately to students in the Teacher-Training Department. With the growth of the number of students in the Department it will be possible to design separate courses in most subjects.

14. Industrial Experience. The Teacher-Training Department should examine the feasibility of establishing a special program to provide intensive structured and supervised industrial experience to students in the Department who did not have any previous industrial experience or background for vocational-technical education.

At present, because of the small number of students in the Department and the difficulties in recruiting candidates, little attention is given to this aspect in the requirements. At times the teacher shortage forces schools and governmental agencies to overlook this aspect of teacher preparation. It is contemplated, however, that conditions will change and that it will be possible to pay greater attention to this aspect of the requirement. Various options of a program designed to provide industrial experience should be examined empirically. The feasibility of involving in the program graduates of the Department who already teach in vocational-technical schools but who have not received any such experience in the past, should also be examined.

15. Professional Education Curriculum. The Teacher-Training Department should re-evaluate its professional education curriculum, including the student teaching requirements, to determine whether it is the optimal curriculum to satisfy the needs of vocational-technical teachers. The feasibility of adapting innovative practices in teacher education such as microteaching, simulation and independent work should be examined.

The present professional education curriculum in the Teacher-Training Department was adopted when the Department was established in 1959. The pattern of the Hebrew University's certificate program guided the Department in determining its own program. Today there is a standardized pattern in all universities accredited by the Ministry of Education and Culture for certificate purposes; nevertheless, there is room for experimentation even within the limits of this pattern. Moreover, if a different program would be developed which would seem to promise better results, it should be brought to the attention and approval of the proper authorities in the Ministry of Education and Culture.

16. Student Teaching. The Teacher-Training Department should devote greater attention to the student teaching phase of its program, and make it a more intensive, structured and meaningful experience to its students.

In the past the Teacher-Training Department found it difficult to implement its requirements in regard to student teaching. The students preferred to complete all their course work first. Fulfilling the requirements of practical lessons was dragged out in some cases for years. It is of utmost importance that students realize that student teaching is regarded by the Department as just as important as other parts of the program. Moreover, the student teaching program should be structured in a way that it will become a more meaningful experience for students.

17. In-Service Education. The Departments of In-Service Education and Vocational Education in the Ministry of Education and Culture should explore ways and means to increase the number of vocational-technical teachers participating in in-service education programs.

The Technion's Extension Division and other academic institutions, in cooperation with the Teacher-Training Department, have regularly been conducting in-service education programs for vocational-technical teachers. In many instances it was felt that a more effective system of incentives would stimulate a large number of teachers to participate in such programs. Attempts should be made to conduct in-service education programs in the major cities in the country.

18. Research in Vocational-Technical Teacher Education. The problems of vocational-technical teacher education should be investigated more thoroughly as part of a general intensive research program in vocational-technical education.

The rapid development of vocational-technical education in Israel and the world over has resulted in many problems. There is a growing realization that optimal solutions to these problems must be based, among other things, on research. In the

United States, for example, several research centers were established to devote themselves fully to the study of problems in vocational-technical education. Intensive research in these areas is being conducted also in universities and general research centers. There is a need for such efforts also in Israel in the general field of vocational-technical education, and in particular in the area of teacher education.

The following are some of the pertinent problems that should be investigated:

a. To what extent is there a cause and effect relationship between the status of vocational-technical education and the problem of teacher recruitment?

b. What are the optimal ways and means to raise the present status of vocational-technical education?

c. The effectiveness of various incentives to attract candidates for vocational-technical teacher education.

d. Optimal qualifications, requirements and selection procedures.

e. Various aspects of the curriculum in vocational-technical teacher education programs.

# APPENDICES

Appendix A - Recommendations of the Committees

Appendix B - Syllabi
Electronics Option
Mechanical Engineering Option

Appendix C - A Syllabus of Professional Education Course Work for an Undergraduate Program of Technical Education - Oklahoma State University

Appendix D - People and Institutions Visited by Dr. Perlberg During September-October 1965.

APPENDIX A - Recommendations of Committees

On the initiative of Prof. H. Hanani and with the authorization of the Office of the President, and the Deans of the Faculties of Electrical and Mechanical Engineering at the Technion, two Professional Committees were set up in March, 1966 and were thus constituted:

A. The Committee for Electrical Engineering Subjects

| | |
|---|---|
| Assoc.Prof. M. Zakai | - Chairman |
| Dr. R. Sivan | - Member |
| Dr. Y. Wallach | - Member |
| Eng. D.Kohn, M.Sc. | - Coordinator |

B. The Committee for Mechanical Engineering Subjects

| | |
|---|---|
| Assoc.Prof. K. Levi | - Chairman |
| Dr. A. Ber | - Member |
| Dr. A. Stotter | - Member |
| Eng. D. Kohn, M.Sc. | - Coordinator |

These committees held a considerable number of sessions to look into and study the following topics:

1. The syllabus structure and development trends in the Vocational and Technological Secondary Schools in Israel. For the sessions dealing with this topic, representatives of vocational education were coopted to the committees.

2. Development trends in Israeli industry in the light of technological changes.

3. Courses for basic and undergraduate studies in the Faculties of Electrical and Mechanical Engineering at the Technion. For these sessions, representatives of the Faculties of Physics, Mathematics, Electrical and Mechanical Engineering were coopted to the committees.

4. Teacher-Training Programs abroad - in the U.S.A., France, the U.K.

The enclosed memoranda of the Committees and the proposed syllabus of studies constitute the recommendations of the Professional Committees as a result of the discussions held on the various topics.

As to student entrance, the Committees agreed that the Department can regard as eligible for registration students who have graduated from High Schools and Vocational Secondary Schools. The duration of studies is to be three years (including Summer Terms of about six weeks duration).

Haifa, 29th May, 1966

To: Prof. H. Hanani
From: The Committee set up to prepare a Course of Studies for the Teacher-Training Department: Electronics Option.

Re: Proposed Course of Undergraduate Studies for the Training of Electronics Teachers in Vocational Schools.

We have pleasure in enclosing our proposals for a Course of Studies and Syllabi for Electronics and Basic Science Subjects.

These proposals are based on the following considerations:

1. The teachers of Electronics in 4-year vocational schools must reach an academic level sufficient to enable them to continue and advance their studies independently, and particularly to enable them to teach any new subjects which may appear in the course of the development of technology.

2. At present, the main employment of graduates of the Electronics Option in Vocational Schools is as radio technicians. However, the coming years will no doubt show a rise in the demand for electronics technicians in the fields of electronic computers, industrial control and electronics, medical electronics, nuclear instrumentation and television. Consequently, studies in these fields are also included.

We wish to thank Prof. A. Evyatar, Prof. A. Ron, Dr. A. Perlberg and our colleagues in the Faculty of Electrical Engineering for their help in the preparation of the recommendations.

Yours faithfully,

Prof. M. Zakai    Dr. Y. Wallach
Dr. R. Sivan    Eng. D. Kohn

Copies: Prof. Y. Cederbaum
Dr. A. Perlberg

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Haifa, 14th June, 1966

To: Prof. H. Hanani
From: The Committee set up to propose a Course of Studies for the Teacher-Training Department: Mechanical Engineering Option.

Re: Proposed Course of Undergraduate Studies for the Training of Mechanical Engineering teachers in Vocational Schools.

We have pleasure in enclosing our proposals for a Course of Studies and Syllabi for the specific subjects of the Option.

The proposal is based on the following considerations:

1. The teachers of Mechanical Engineering in 4-year vocational schools must reach an academic level sufficient to enable them to continue and advance their studies independently, and especially to enable them to teach any new subjects which may appear in the course of the development of technology.

2. We felt it our duty to give the prospective teacher a firm basis of both theoretical and practical knowledge to enable him to advance his students in both directions. The study of mathematics and design will enable him to approach the solution of engineering problems methodically. The special emphasis on design in the framework of the technological subjects will bring the teacher closer to the problems of industry and to a certain extent fill the gap left by his lack of practical experience normally gained after the completion of his studies. The teachers who will have completed the course, will be able to teach in Schools for Technicians after acquiring experience and completing their studies in the appropriate mechanical engineering subjects at the Technion.

We wish to thank Prof. E. Jabotinsky, Prof. A. Evyatar, Eng. I. Sarig, Eng. Hitron and our colleagues in the Faculty of Mechanical Engineering who helped us to prepare these recommendations.

Yours faithfully,

Prof. K. Levi    Dr. A. Stotter
Dr. A. Ber    Eng. D. Kohn

Copies: Prof. E. Lenz
Dr. A. Perlberg

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MINISTRY OF EDUCATION AND CULTURE
Department of Vocational Education

Jerusalem, 3rd July, 1966

Prof. M. Zakai
Technion, Haifa.

Dear Sir,

Re: Course of Studies for Training Teachers of Electronics.

I hereby forward to you my comments on your proposed Course of Studies for training vocational secondary school teachers of electronics.

A. Where the entrant is a graduate of a 4-year Vocational School - Electronics Option, or of a High School - Electronics Option, the number of study hours in your proposed Course of Studies is sufficient both as regards laboratory work and theoretical studies.

B. It would be desirable to divide the laboratory periods (356 hours) in such a way as to enable the student already at the beginning of his second year to carry out experiments in electricity.

C. It would be desirable to teach the subject, Electrical Machines, in the second semester of the third year and replace it by advancing the study of Electronic Circuits - thus making feasible the suggestion proposed in B.

D. 15 - 20 hours should be devoted to tuned amplifiers including transistors.

E. In Electronic Materials Technology, a number of hours should be devoted to printed circuits, microminiaturisation, modern production methods of integrated circuits, etc.

F. The terminology appearing in the Course of Studies issued by our Ministry of Education should be made use of throughout.

As agreed, I am forwarding to you the Course of Study of Electronics in the 4-year Vocational School. But I should add that we are at present in the process of working out a new Course of Studies which we will forward to you in due course.

Yours faithfully,

M. Meron
Inspector of Electronics Option

Copies: Mr. M. Avigad
Mr. D. Kohn

Encl: Course of Studies.

## APPENDIX B - Syllabi

### Electronics Option

Note: These syllabi are represented in order to clarify the proposed Course of Study. They should not, therefore, be regarded as detailed syllabi.

### FIRST YEAR

#### Mathematics: Analysis

Basic concepts of real numbers and topology of the straight line and in the Euclidean plane. Functions of real variable. Continuity. Maximum. Minimum. Derivatives. Rolle's Theorem. Inflexion points. Indefinite integral. Methods of integration. Definite integral. Functions Inx., $e^x$. Connection between integral and derivative. Mean value theorem. Applications. Generalised integrals. Sequences. Convergence sequence. Tests for convergence. Integration and differentiation. Power series. Functions of several variables. Jacobians. Fourier series. Vectors as function of single variable. Differential geometry of curves in space. Frenet's formulae. Applications to mechanics.

Algebra: Algebraic structures. Groups. Normal subgroups. Mappings. Basic concepts of rings. Vector spaces. Linear transformations. Matrices and their techniques. Euclidean spaces. Orthonormal bases. Orthogonal transformations. Matrices.

Note: It must be remembered that this is a teacher-training program where the intention is to widen the student's horizon. Hence it is preferable to deal with few theorems but to explain them thoroughly.

Physics I. Equilibrium conditions of a rigid body in the case of a spatial system of forces. Center of gravity. Elements of elasticity. Kinematics of a particle. Composition of motions. Dynamics of a particle. D'Alembert's principle. Conservation of linear momentum. Rotation of a rigid body about a fixed axis. Equations of motion of a free body. Conservation of angular momentum. The gyroscope. Conservation of energy. Flow of liquids. Viscosity and capillarity. The atmosphere and the barometric formula. Natural and forced vibrations. Mechanical resonance. The wave equation. Huygen's principle. Reflection and refraction. Elements of acoustics. Doppler effect.

Electrostatics. Displacement, Gauss' law, field intensity, potential. Energy of electric field. Electric current. Kirschhoff's laws. Charge and discharge of magnetic field. Theory of galvanometers. Electromagnetic waves. Reflection and refraction of plane waves. Interference of light. Diffraction polarization, double refraction. Photometry.

Chemistry. Introduction. Chemical and physical change. Brief survey of stoichiometric laws. Structure of matter. Chemical bond. Chemical reactions. Gases. Liquids. Solids. Changes of state. Solutions. Acids and bases. Applications of the ionic theory (aqueous solutions and chemical equilibrium). Complexes. Electrolysis. Nuclear reactions. Chemical elements and the periodic table. Brief survey of organic chemistry.

Engineering Mechanics. Engineering fundamentals of statics, dynamics and strength of materials.

Logical Structure of Computers. Switching circuits and computers. Boolean algebra. Binary arithmetic. Memory Cells. Sequential systems. Elementary computers.

Properties and Structure of Materials. Crystal structure of matter, solid state. Material phases, mechanical properties of materials (such as coefficients of elasticity). Electrical properties of materials (not semi-conductors).

Principles of Education. Introduction. Theory and practice in education. Possibilities and limitations of education. Education as a necessity of life. Education as transmission of values. Education as preparation for life. The various forms of education: socialization, training, instruction, teaching. Educational values and aims. Indoctrination, propaganda and education. Agencies of education: the family, the peer group, the school, the youth movements, the mass media (press, radio, cinema, television). The aims of education: humanistic and religious, socialistic and democratic education. The curriculum: general education versus specialization, the humanistic, scientific and technical trends in education. Some problems of secondary school education in Israel: the problem of pupil selection, the content of the secondary school curriculum, secondary and higher education.

Summer Term.

General Psychology. Psychology as a science and its main methods. Learning, motivation, remembering and forgetting, thinking, perception. Personality, individual differences, tests of intelligence and of personality, attitudes. Discussion of relevant research.

Social Psychology. Social learning and perception. The influence of culture on social behaviour. Group processes and norms. The individual in the group and his social role. Status and leadership. Discussion of relevant social psychological research.

Organization of Education in Israel and in Other Countries. Historical outline of Jewish education in Palestine. The establishment of the State of Israel and its system of education. Compulsory Education Act 1949. Enforcement of the law. Trends in Israeli education. The State Education Law 1953. The aims of education in Israel. The structure and organization of the educational system. Selected problems in elementary, secondary and vocational education. The social structure of education in Israel. A comparative analysis of education in Israel, England, France, U.S.A. and U.S.S.R.

Descriptive Geometry and Technical Drawing. Introduction. Technical drawing and workshop. Standards and drawing instruments. Application of plane geometry in technical drawing. Projections of models in technical drawing (freehand sketching and instrumental drawings). Axonometry. Section, partial sections and complex sections. Drawing of elementary machine parts. Assembly drawings. Organization of drawing sets. Design of simple assemblies. Orthogonal projection. Representation of points, straight lines and planes. Representation of plane-bounded and curved solids. Parallelism. True size of plane configurations, segments and angles. Perpendicularity. Axonometric projection. Fundamentals. Representation of plane-bounded and curved solids. Sections and intersections. Cylindrical, conic and spherical sections. Simple intersections of plane-bounded and curved solids. Developments. Developments of cones and cylinders.

Modern Physics. Relativity theory. Michelson-Morley experiment. Concepts of relativity theory. Lorentz-Einstein transformations. Addition of velocities. Change of mass with velocity. Equivalence of mass energy. Atomic and nuclear physics. Electrons and ions. X-rays. Radioactivity. Concepts of quantum theory. Hydrogen spectrum (Bohr). Dualism of matter and radiation. The nucleus of the atom. Atomic energy. Cosmic radiation.

SECOND YEAR.

Mathematics - analysis. Functions of a complex variable. Cauchy-Rieman equations. Integration. Power series. Conformal mappings. Laplace transformation. Differential equations. Existence theorems. Technique: ordinary, linea etc. Fourier series. Vector analysis: fields, operators, Stokes and Gauss theorems etc. Physical meaning. Harmonic functions. Examples for partial differential equations.

Physics II. Thermodynamics. Thermodynamic systems, parameters, equations of state, internal energy. First law of thermodynamics and some applications. Enthalpy. Liquefaction of gases. Efficiency of heat engines. Carnot cycle. Second law of thermodynamics. Entropy. Kinetic theory of gases. Kinetic theory of the equation of state. Maxwell distribution of velocities. Degrees of freedom, specific heat, mean free path. Viscosity.

Introduction to solid state physics. The Valence-Bond Model of a Semiconductor. Introduction. Atoms and their arrangement in matter. Conductors, Insulators and Semiconductors. Intrinsic conduction, Conduction Electronics and Holes. The Role of Impurities. Extrinsic conduction. The Conduction process. Other electronic processes. The Energy-Band model of a Semiconductor. Introduction. Atomic States and Energy Levels. Band structure of an "Intrinsic" Semiconductor. Band structure of an "Extrinsic" Semiconductor. Arrangement of State in the Band Structure. The equilibrium distribution of electron in the bands. Distribution Functions. Boltzman distribution for Noninteracting Entities. Transition probabilities. Fermi-Dirac distribution function for entities subject to the exclusion principle. Temperature dependence of the intrinsic carrier concentration. Some consequences of the equilibrium condition. Nonequilibrium transport of charge carriers. Introduction. The equations of continuity. Gauss's Law. Solution of the flow equations. Laboratory experiments. General discussion. Majority carrier effects. Production of Electron-Hole pairs, and the energy gap. Dynamics of excess carriers. Manufacture of an "Alloy" Diode.

Electrical Machines. Basic laws, structure of machines and their fields, electromotive forces, armature reaction, energetic relations. Performance, conversion diagrams and characteristics of induction motors, D.C. and synchronous motors. Speed control. Transients.

Electrical Engineering Calculations. Calculation of magnetic circuits. Electromagnets (permanent, polar, inductive) and their design. Memory cores. Non-linear circuits. Arcing and extinguishing. Fuses. Magnetic amplifiers. Heat calculations (coils, instruments, bimetal, etc.) Calculations of electrodynamic forces, measurements of electricity. The aim of this subject is to follow up and apply the material studied in Introduction to Electrical Engineering. The teaching, therefore, should be coordinated with this course.

Introduction to Electrical Engineering. Electrical forces and fields. Magnetism and electrodynamics. Foundations of electric circuit theory. The measurement of electrical quantities. Transients in simple RCLM circuits. The steady-state solution of A.C. networks. Introduction to network topology and network equations. Reduction techniques for networks. Reciprocity. Energy and power relationships. A.C. measuring instruments. The transformer. Equivalent diagrams. Polyphase systems. Power measurements. Balanced and unbalanced three-phase systems. Fourier analysis of nonsinusoidal waves. Amplitude and phase spectra. Frequency characteristics. Transient response and zero-pole locations. Transfer functions. Steady-state sinusoidal response from zeros and poles. Energy conversion. Magnetic and electric field type transducers. Introduction to feedback systems. Introduction to electronic devices. Vacuum tubes. Principles of P-N junctions and transistors.

Summer Term.

Transistor Physics. Semiconductor junction devices. Introduction. Junction Diodes. Junction transistors. Physical operation of pn-junction diodes. The abrupt pn-junction diodes. The pn-junction in equilibrium. The effect of a Bias Voltage on the pn-junction. Analysis of the space-charge layer. Graded pn-junctions. The behaviour of pn-junction diodes. The idealized pn-junction diode. Charge distribution and flow in the idealized diode. Minority-carrier distribution and flow. The idealized pn-junction equation. Majority Carrier distribution and currents. Other effects in pn-junction diodes - limitations of the idealized model. Voltage drops in the neutral regions. Carrier generation and recombination in the Space-Charge layer. Deviations from reverse-current saturation. Junction breakdown. Ohmic contacts. Surface recombination and the thin-base diode. Dynamic behaviour of pn-junction diode. Dynamic effects in diodes. The dynamics of excess minority carriers. Junction diode switching transients. Small signal sinusoidal behaviour of the junction diode. Dynamic change in the charge stored in the space-charge layer. Lumped models for junction diodes. Introduction. A lumped model for a junction diode. Use of the lumped model. Structure and operation of transistors. Introduction. Transistor operation in the active mode. The transistor as an amplifier. Current actuated circuit models. A small signal dynamic circuit model. Small signal transistor models. Introduction. Collector signal Voltage and base-width modulation. Base resistance - dc large signal. Small signal base resistance effects. Small signal models which include space charge capacitance. The Ebers-Moll model for transistor volt-ampere characteristics. Nonlinear transistor operation. Internal dc behaviour of the idealized transistor. dc volt-ampere characteristics. Regions of operation. The effects of a graded base on large-signal behaviour. Transistor models for dynamic switching. Introduction. Basic ideas: Charge definition of device properties and charge control. The two-lump model of the transistor. Conditions of validity of the two-lump model and charge-control equations. Example of the use of the lumped model for transient calculations. Representation of charge storage in space-charge layers. Charge storage in the collector and remote regions of base.

Industrial Electronics. General specification of rectification, working of rectifiers - loaded and unloaded. Current analysis. Effect of type of rectifiers. Methods of voltage control. Invertors with self commutation and excitation. Stabilisers. Other applications.

Electronic Circuits I. Note I: Emphasis to be placed on analysis of electronic circuits (rather than on circuit design).
Note 2: Rectifiers and stabilisers will be presented in Industrial Electronics. Voltage and power amplifiers (low frequency).

Educational Psychology. The scope of educational psychology methods of research in educational psychology; Causation in behaviour. Development psychology: heredity and environment, maturation, development until adolescence. The adolescent and his world. Exceptional children, normal children, disturbed children. Motivation for learning. Group dynamics and its meaning for the teacher.

Methodology I, II.

General Methodology. The essence and aims of general methodology. Education and teaching as a science, art and skill. The learning situation and its interacting factors: the teacher, the student, the group (class in the school). The curriculum. The lesson plan. Herbert and Morrison as contributors to methodology. Teaching skills; knowledge and evaluation. Teaching methods: the lecture, discussion, questions and answers, experiments, demonstrations. Technology of learning, the use of Audio-Visual aids. Evaluation of students; discipline in the classroom. Extra curricular activities.

Methodology in Teaching Mathematics. Principles in learning theory and their effect on the teaching of mathematics in secondary schools. Basic concepts in mathematics: the inductive, deductive and axiomatic approach in elementary mathematics.
The teaching of algebra in secondary schools: elementary functions. Functions with restricted domain. Series, mathematical induction.
The teaching of geometry in secondary schools: combination of inductive and deductive approach; Euclidean geometry as an abstraction from the world around us; integration of plane and solid geometry. Axiomatisation of geometry; non-Euclidean geometry. Analytic approach to geometry; geometrical loci from the synthetic and analytical view-points.
The teaching of differential and integral calculus in secondary schools.
Seminar on extra-curricular mathematical material suitable for work with special groups in secondary schools.

Methodology in Teaching Physics. Aims of physics teaching in secondary school. Place of physics in the sciences. Ways of realising aims. Demonstration and individual work of the pupil. The problem of planning the curriculum. The text-book and the teacher; the text-book and the pupil. Class testing and matriculation. Methodological problems of the junior level. Methodological problems of the senior level. The role of the teacher in the organization and management of the laboratory. The problem of further studies for the teacher.

Methodology in Teaching Technical Subjects. Introduction: knowledge of curricular structure and aims for principal technical subjects. Problems in carrying out the curricula; adapting teaching to place of study (various types of schools; courses). Selection of teaching methods appropriate to technical subjects. Preparation of technical and graphic aids. Exploitation of audio-visual aids of various trends. Integrating laboratory work and teaching; conclusion.
Practical work: preparation of reports on visiting school lessons. Demonstration lessons with prepared lesson plans.

Electronics and Industrial electronics laboratory. Laboratory topics similar to those given in Fourth Year Electrical Engineering. (Including, among others, subjects which will complement experimentally the theoretical subjects studied without laboratory work - such as transmission lines).

THIRD YEAR

Selected Topics in Mathematics. Aim: To allow the student to prepare lectures, to teach him how to prepare a bibliography, to demonstrate the use of mathematical reviews, to extend his mathematical horizon.
Concept of measure. Lebesgue measure. Riesz theorem. Riesz-Fisher theorem. Numerical analysis: iterations, gradient method. Finding Eigenvalues of matrices. Inequalities in $E^n$. Linear programming. Games. Duality. Projective geometry. Non-Euclidean geometry etc. Probability. Sample space. Events. Statistical independence. Distribution functions. Special distributions. Variance.

El. ctrical Network Theory I. Differential equations of electrical and mechanical systems. Laplace's transform method. Transforms of elementary functions and operations such as derivatives, integrals, time shift. The use of tables of transforms. Initial and final value theorems. Steady and transient response. Direct calculation of the inverse Laplace transform. Fourier's transform and its relation to Laplace's. Parceval's theorem. Input and transfer impedance and admittance functions. Representation of two-ports by impedance, admittance, cascade and hybrid matrices.
T,II and lattice sections. Image impedances and the image transfer function. Symmetrical two-ports and Bartlett's bisection theorem. The insertion voltage ratio and insertion loss functions. Theory and design of constant k and m derived filters.

Electrical Network Theory II. Fundamental concepts of network theory. The graph, circuits, trees, cut-sets. Incidence-, fundamental circuit-, and cut-set matrices. General Kirchhoff's laws formulation. Nodal and circuit analysis. Superposition principle. Thevenin's and Norton's theorems. Representation of network functions. Representation of network functions by poles and zeros. Frequency response. Bode diagrams. Minimum phase networks. Relation between attenuation and phase shift, Routh-Hurwitz stability criterion. Foster's reactance theorem. Feedback and stability. Signal flow graphs. Active networks. Stability. Nyquist criterion. Root locus.

Control Theory. Transmission functions of electrical mechanical, pneumatic components used in control. Closed and open loop systems. Stability: overshoot, damping, constant positive errors, sensitivity to noise, sensitivity to parameter changes. Bode, Nyquist planes and root locus. Examples of industrial processes control.
Laboratory: Use of analog computer. Examples of servo systems.

Electronic Circuits, II, III. Transistor amplifiers. Pulse techniques (beginning). Oscillators, frequency inversion circuits, demodulation of FM and AM. Noise in tubes and transistors. Pulse techniques (completion).

Electronic Instrumentation. Industrial instrumentation (inventors etc.). Electronic instrumentation in nuclear physics (radiation detectors, radiation detectors amplifiers, counting circuits, coincidence, analysers, etc.). Electronic instrumentation in medicine (E.K.G., E.E.G., etc.)

Waves and Transmission Lines. Transmission lines: Wave equation. Pulse reaction and reflections. Reaction to sinusoidal excitation. Waves: Wave equations, planar waves, waves in galve, fundamentals of mácrowave circuits. Antenae.

Communication Systems. Resolution of periodic signals to harmonics, spectrum concept for non-periodic signals and for arbitrary signals. Frequency inversion: AM, FM, PM, SSB, DSBSC, Time multiplexing, frequency multiplexing, PFM, PDM, PCM, and effect of noise on various methods. Radar.

Television Engineering. TV Standards. Theory of scanning and picture reproduction. Camera tubes and the picture tube. Synchronization. Closed circuit TV. Vestigial sideband transmission. Receivers. Video tape recording. Principles of colour TV.

Electronics circuits projects (Summer term - 3 weeks).
The projects will include electronic instrument design. The methodological aspect of the preparation of the project and its way of presentation will be emphasized.

## Mechanical Engineering Option

### FIRST YEAR

Mathematics I. Determinants. Systems of linear equations. Vector algebra. Applications to space analytical geometry. Finite dimensional vector spaces. Linear transformations and matrices. Matrix algebra. Euclidean spaces. Orthonormal bases. Symmetric transformations. Quadratic forms. Conics and quadrics in canonical form. General quadratic equation in two and three variables. Complex numbers. Sequences. Functions of a single variable. Limits and continuity. Differential calculus in one variable. Basic theorems and various applications. Indefinite integration. The definite integral and its physical and geometrical applications. Differential calculus for functions of many variables. Applications.

Physics I. See Electronics Option - First Year.

Chemistry. See Electronics Option.

Technical Drawing. See Electronics Option.

Descriptive Geometry. See Electronics Option.

Summer Term.

Mechanical Technology (180 hours) - See Second Year.

Workshop for those not coming from vocational schools.

SECOND YEAR

Dynamics. Rectilinear translation. Curvilinear translation. Rotation of a rigid body about a fixed axis. Plane motion of a rigid body. Relative motion.

Mathematics. (A special course including plane geometry). Plane geometry. Axiomatics. Constructions. Various devices for various constructions. Second degree curves. Translations, rotations, reflection, symmetry and their uses. Groups of transformation of the plane. Revision of fundamental theorems in space geometry. Regular polyhedra. Symmetry. Semi-regular polyhedra. Trigonometry: plane and spheric. Functions of several variables. Jacobians. Integrals. Volume computations. Note: One hour per week should be devoted to a seminar, in which the students will give a lecture, and this should be utilized to teach them how to prepare a bibliography.

Physics. See Electronics Option.

Mechanics (strength of materials). Stress and strain. Tension and compression. Shear. Torsion. Bending, simple and unsymmetrical; moment and shear force diagrams; shear stresses in bending, shear centre; composite beams. Deflection of beams. Continuous beams. Beams in the plastic range. Buckling. General state of stress and strain. Compound stresses. Energy methods, theorems of Castigliano, Maxwell, Mohr; applications to determinate and indeterminate structures. Strength theories. Impact stresses. Principal elements of experimental stress analysis. Curved beams.

Thermodynamics (special course). Basic definitions. System, equilibrium, properties, thermodynamic process, cycles, work.

Zeroth Law. Zeroth law, temperature. First law, internal energy, separable energies, heat, cycle, open system, enthalpy. Second law, Carnot cycle, enthropy, maximum available work, system-surrounding equilibrium, the phase rule. Substance. Ideal gas, van-der-Waals gas, real gas, vapours, diagrams and tables. Processes. Work and heat computations. Technical systems. Compressors. Gas cycles. Lenoir, Otto, Diesel, gas turbines, regeneration, jet engines. Vapor cycles. Heat and power systems. Refrigeration. Refrigerants, cycles. Mixtures. Ideal gases mixtures, combustion, gas-vapor mixtures, humid air, air conditioning. Flow. One dimensional steady gas flow, nozzles. Heat transfer. Conduction. Convention and radiation - elements. Overall coefficient of heat transfer, heat exchangers.

Mechanical Technology(special course).
The Definition of Technology. Theory of materials.
Fundamentals - chemical and physical; specifications.
Testing of materials - including laboratory exercises.
Metallography: Crystallization; molecular and crystalline structure. Phase diagrams of pure metals and binary and ternary alloys. Oxidation, and corrosion problems (including laboratory exercises).
Metallography: fundamentals; production of iron and steel, iron-carbon diagrams. Heat treatment of steel. Production of copper and copper base alloys. Production of aluminium and its alloys. Heat treatment of aluminium alloys. Production of important non-ferrous metals such as chrome, nickel, lead, tin, zinc, tungsten, and their alloys. Alloyed steels, spark testing (with demonstrations, visits, and laboratory exercises).
Classification of metals - according to standards of the big industrial countries. Non-metallic materials - important in mechanical engineering: wood, leather, rubber, plastic, oil. Selected material important in other technical fields, such as semi-conductors; insulating materials; building materials.
Workshop Technology and Processes. Metal Workshop: work bench, tools and measuring instruments. Casting: basic operations. Foundry equipment. General metallurgical means. Cast iron, cast steels, malleable casting and their properties. Casting of non-ferrous metals. Special processes. (Casting exercises, and visits to foundries). Design of cast parts according to the casting processes (including exercises). Rolling and Forging: Fundamentals of plastic cold working; rolling and drawing machines.
Rolling: Production of sheet metal, profiles, wires, seamless pipes (including visits). Effect of rolling on steel and non-ferrous metals. Forging: forge equipment; mechanical hammers and presses; heating and cooling means (including visits). Hand-forging: planning stages of work. Calculation of steel, fuel and air requirements (including exercises). Die-forging: planning stages of work and

design of dies. Die production. Special processes and equipment. Forging of non-ferrous metals. Welding: Metallurgical fundamentals. Survey of welding methods and considerations for selection of method. Hammer-welding. Oxy-acetylene welding: gas cylinders. Acetylene generators. Special safety measures. The burners for welding and melting. Techniques for oxy-acetylene welding (with demonstrations and exercises). Electric arc-welding: Equipment, safety measures, electric arc-welding techniques (with demonstrations and exercises). Welding with gas shield and other special methods. "Thermit" welding etc. Design of welded parts as a function of welding process; welded parts as subsidiaries to cast parts (with design exercises). Welding as an easy means. Brazing and Soldering: Equipment, materials, usual and special methods. Rivetting: methods and equipment. Special methods (in aircraft construction).
Sheet metal working: shears, punches, dies. Mechanical principles. Design of processes and installations. Efficiency calculation. Presses. Safety measures (including visits, demonstrations and exercises). Chipping: chipping theories. Cutting speed, stopping time. Lubrication and cooling of materials in chipping tools; their shapes. Machine tools, special conditions in comparison with other machines (accuracy, vibration resistance, usefulness, safety). Automation and other modern developments. Turning: structure of a lathe. Taper-turning and screw-cutting (including exercises in calculations). Form-turning and other special methods. Semi-automatic lathes. Design of parts for turning (including exercises). Drilling and Planning (including design exercises).
Milling: special conditions in milling. Types of milling. Production of milling machines. Dividing heads. Production methods for gear-cutting. Design of milled parts. Grinding: grinding materials their production, testing, selection, speeds of wheels and work. Safety measures. Various kinds of grinding machines. Modern methods of metal working. Industrial Theory: The workshop and its layout, industrial hygiene and safety. Mass production, specifications, clearance and tolerance methods according to I.S.A. Additional design exercises with determination of production processes. Time study, work and efficiency study. Principles of Labour Laws.

Machine Design Topics. Determination of function of installation. Analysis of existing solutions. Search for improved solutions. Developing of solution. The details, and the importance of designing them accurately. Use of ready-made parts and parts according to specification. Production of a series from a sample, plant specifications, size-grading. Design. Testing force distribution, temperature, stability, rigidity, elasticity, strains, strength, weight, choice of materials. Assembly and its effect on design. Lubrication. Frequency, length of life, simplicity of replacement. Design aesthetics, shape, colour, etc.
Exercises: developing jigs and fixtures, function, connection with machine, easy maintenance of device, possibility of increasing output by means of minor modifications.

Introduction to Electrical Engineering. D.C. Circuits. Kirchhoff's laws. Network simplification. A.C. Currents and Voltages. RMS values phasor representation. Power and energy. Complex algebra notation. Simple transients. 3 phase circuits. Power measurement. Magnetic Circuits. Effect of electric current. Definition of H and B. Calculation of magnetic circuits. Law of electromagnetic induction. The transformer. Ideal transformer. Eqhivalent circuit of transformers, 3 phase transformers, construction and connections. The Induction Motor. Rotating magnetic fields. Equivalent circuit of motor. Classification of motors. Starting devices, protection. Description of a single motor. Synchronous Machines. General description. Concept of synchronous impedence. Analysis of motor performance. D.C. Machines. Commutator action, back EMF. Shunt, series and compound connections. Motor and generator performance.

Measuring Instruments. D.C. moving coil instruments. Moving iron and dynamometer type instruments. Wattmeters. Fundamentals of electronic circuits. Construction and performance of vacuum tubes. Rectifiers. The vacuum tube as amplifier.

Machine Parts (special course). Materials for the construction of machinery. Stresses in machine parts, fatigue and concentrated stresses. Allowable stresses. Fastening and joining of machine parts. Screws, bolts, threads, screw connections, deformation. Flexible bolts. Riveting in steel and non-ferrous metals. Blind rivets. Welding, arc-welding as construction process for machine parts, stresses and strength calculation. Resistance welding. Adhesive and adhesive-bonded joints of metals and plastics. Brazing and soldering. Pins and clamps.

Mechanical Engineering Subjects - Summer Term.

Workshop practice (in modern workshop). The work will be carried out under the guidance of instructors and the students must present a report according to the instructions of the Department.

THIRD YEAR

Methodology I, II - See Electronics Option.

Fluid mechanics and hydraulic machines (special course).

Gas Dynamics. The continuum model - methematical introduction (deratives of integral, Gauss', Green's and Stoke's theorems, transformation of coordinates). The continuity equation - stream functions. The general momentum equation. Ideal fluids. Euler equation, the weak and strong Bernoulli equations, barotropic fluid, Kelvin and Helmholtz theorems, potentional flow, two-dimensional flow, introduction to thin airfoil theory. Viscuous fluids. Deformation analysis, the stress tensor, stress to strain rate relations, Navier-Stokes equations. Gas flow. One-dimensional steady flow, Crocco theorem, sonic speed flow in nozzles, pipe flow with friction (Fanno lines) and heat transfer (Rayleigh lines), normal and oblique shock waves, wedge flow, weak oblique shocks, compression and expansion by turning, Prandtl-Meyer angle, the supersonic wing, acoustic equations, circular cone flow, the complete velocity potential equations. Remarks on measuring instruments. Pressure, velocity, temperature.

Turbo machines. Turbo-pumps and turbo-compressors. The one-dimensional and two-dimensional theory of flow in impeller channels. The differential equation of the relative velocity distribution. Calculation of dimensions. Design of radial impeller blades. Losses, axial thrust and cavitation. Characteristic curves. Installation. Deep-well pump. Steam Turbines. Fundamental principles. Azial and radial turbines. General Theory. Peripherical efficiency. Losses. Calculation of main dimensions of impact and reaction turbines. Gas Turbines and Jet- Propulsion. The gas-turbine power plant. Open, closed and semi-closed cycles. Performance characteristics of the various cycles. Typical power plants. Thermal jet engine. Water Turbines. Impact, reaction and propeller turbines.

Machine Dynamics. Kinematics of mechanisms. Legrange's equations. Cams. Differentials. Integrators, differentiators and computing elements. Crank and piston mechanisms. Planetary motion. Variable mass. Governors. Friction. Self-locking mechanisms, optimum spring design. Mechanical vibrations, simple systems, several and infinite degrees of freedom. Forced vibration with damping.

Machine parts (special course). Transmissions - the shaft, the wheel and its connections (keys, splines, shrinkage fit). Gears. Spur and internal gears, helical and spiral gears. Work gears. Chain drives, friction drives. Clutches and couplings. Bearings - rolling bearings, sliding bearings. Hydrodynamic and hydrostatic bearings. Springs (metallic and non-metallic) and spring design. Crankshafts. Pipes and pipelines. Design of machine tools. Theoretical and analytical analysis of gear boxes (stepped), beds and spindles. Movements in machine tools: main movements, feeds. Stepless drive: mechanical, hydraulic, electrical. Mechanisms in automatic machine tools. Numerical control. Hydraulic circuits and copying systems. Processes. Electro-grinding. Chemical milling. Electro-erosion. Ultra-sonics. Lasers. High-energy rate forming. Processing of plastics and wood.

Metrology. Introduction (principles of work emthods). Master gauge. Accuracy of measurement. Measuring instruments. Treatment of results. Tolerances. Gauges (structure, dimensional additions, length of life). Special applications (screws, gears).

Electronics (See Introduction to Electrical Engineering).

Control Theory. Automatic Control. Closed loop systems and concept of feedbacks. Examples of feedback systems. Static and dynamic response. Different modes of control action (on-off, proportional, integral, derivative). Adjustment of controllers. Controller construction (pneumatic, electric, hydraulic). Control valves. Multi-loop control systems. Transfer functions. Frequency response. Nyquist and Bode diagrams. Stability and the Nyquist criterion. Use of electronic analogue computers to solve problems in automatic control. Measurement and calculation of dynamic response.

Summer Term

Lectures and Projects in Mechanical Engineering Subjects.

Power and Heat Plants. Energy demand and plant rating. Demand per capita, laws of demand rise, selection of plant site and unit size. Steam power: Choice of steam conditions, equipment and auxiliaries, layout of condensing turbine plant, water-cooled and air-cooled condensers, power and heat industry, heat balances, building layout. Diesel power: Selection of engine type, use of heavy fuel oil, heat balance and waste heat utilisation, station layout.
Gas turbine plant: Interconnection of steam turbine and gas turbine systems, plant layout. Common problems of thermal plants: Comparison of steam, diesel and gas turbine plants; cooling water supply incl. cooling towers, fuel transportation and storage, piping systems. Power plant economics: Construction costs, cost per kWh.

Refrigeration. Refrigeration. Thermodynamic basis. Refrigerants. Cooling load estimates. Components of the refrigeration plant. Controls. Air conditioning - physiological basis, humidity control. Ventilation and air distribution. Industrial ventilation. Heat pump. Heating: Load estimates. Heat production and distribution systems. Special problems - high pressure water heating, radiant panels. Allied subjects: Thermo-electric cooling (Peltier). Gas liquefaction. Theory of binary mixture and absorption refrigeration.

Production Technology. Manufacturing processes. Chip removal. The accuracy. Establishing the type and dimensions of raw material. Adequate material (allowance) for different machining operations. Machining conditions (technological and economic considerations). Selection of adequate equipment (processes, machine tools, cutting tools, etc.), tool design. Functional-dimensional analysis of workpiece as basis for various jig and fixture design. Production time table, establishing machining, idle-times etc. Production line planning. Sheet metal working. Design and calculations of various types of punches and dies. Bending, drawing etc. Material utilization. Design problems in sheet metal working. Forging. Processes, tools, jigs, workpiece design. The technology of the processes. Inspection. Inspection methods, tools and fixtures for dimensional control. Special requirements. Assembly Operation. Organization and design of assembly lines. Special production processes. General information on latest development.

Automatic Control. The same course continued from the third year.

APPENDIX C. A Syllabus of Professional Education Course Work for an Undergraduate Program of Technical Education - As recommended by Dr. Maurice Roney, Oklahoma State University.

This is a preferred sequence of subject matter to be covered in a series of four courses. It is assumed that the student entering the Technical Education program at this stage has completed two years of technical training in an established technical institute program. It is further assumed that the student is interested in entering the teaching profession, either at the completion of the degree program or after an appropriate period of industrial experience.

The four courses outlined in this syllabus cover a two year period of study during which time the prospective teacher takes advanced technical courses in engineering and science along with a program of humanities, social sciences, and behavioral sciences leading to a B.Sc. degree in Technical Education. In addition to the four courses included in this syllabus, a program of practice teaching is recommended for those persons who wish to qualify for teaching positions immediately upon graduation.

Course No.1 -- 3 Credit Hours
Introduction to Technical Education

I. Industrial Occupations. An identification of the range of industrial occupations for which formal education and training is normally required. Particular attention is given to the technician's occupations in the broad spectrum of skilled trades and crafts - technical workers - engineers and scientists. Special attention is given to the occupational and educational criteria that have been developed to describe occupations requiring two years of engineering-related post-high school education.

II. Technological Education Services. An identification of the organized educational programs that prepare persons for industrial occupations ranging from short intensive skill training courses to professional degree programs in engineering and scientific fields. Attention is given to the objectives, content, and organization of programs; student ability requirements at the various levels of instruction; and the current status and general trends in programs of industrial education and training.

III. The Historical Development of Technical Education. The evolution of the technical institute concept as a part of engineering education from the early polytechnic institutes to the contemporary engineering technology programs accredited by ECPD. The historical aspects of industrial arts and vocational education leading up to and including current developments in technical education under the provisions of National Defense Education Act of 1958 and the Vocational Education Act of 1963.

IV. Contemporary Technical Education Services. An analysis of educational institutions and programs in the field of technical education. Institutional forms, program offerings, and enrollments; their geographical distribution; problems of promotion, operation, and finance; and current trends in the expansion of services in this field.

V. The Preparation of Teachers for Technical Education. The basic requirements for teachers in technical programs with special attention to teachers of specialized technical subject matter. Requirements for technical competence, industrial experience, and pedagogy. Current and projected employment opportunities in the field of technical education.

### Course No.2 -- 3 Credit Hours
### Instructional Planning and Teaching Practices

I. The Profession of Teaching. An introduction to the role of the technical teacher as a member of the educational community. An identification of controversial issues in education and their implications for technical education. A discussion of the purposes and services of professional and technical organizations and their value to members of the teaching profession. Technical education as a professional field.

II. The Personal Nature of Teachers. An identification of the personal and social qualities generally considered to be necessary for success as a teacher. Particular attention is given to the relationship between techniques of instruction and subject matter competence. The importance of developing and maintaining good personal relationships, with students, staff, parents and graduates.

III. The Nature of the Learning Process and its Relationship to the Teaching Process. The student as an individual and the ways in which he learns. The influence of individual differences and motivational factors on the learning process. The unique requirements of technical education for an integrated instruction in mathematics, science and technical subjects.

IV. The Elements of Lesson Planning. Relating instructional material to the learning process in order to provide an effective learning experience. Analyzing and organizing subject matter material according to the steps of the learning process.

V. Methods of Teaching. A study of several techniques of teaching; the strengths, limitations and appropriate uses of each technique. The proper use and importance of teaching aids, audio visual aids, written reports and laboratory exercises in teaching technical material.

VI. Breakdown of Course Content into Instructional Units. Detail planning of the lessons within each instructional unit. Selecting the proper teaching technique for each lesson and each step within the lesson. Developing and using instructional material. Coordination of classroom and laboratory instruction.

VII. Evaluation in Education. The place of evaluation in education. A discussion of types of evaluation and their uses. The relationship between tests and evaluation. The use of teacher-made tests in teaching. Techniques of test construction.

VIII. Student Presentations. Student practice in making class presentations with critical evaluation by the instructor and class.

Course No.3 -- 2 Credit Hours
Analysis Techniques in Technical Education

I. Determining Needs for Educational Services. Techniques of making occupational surveys for determining training needs. Preliminary planning, implementation of survey plans, and the reporting of survey findings, relating of survey findings to local, state and national needs.

II. Analysis of Industrial Occupations. Systems of industrial job classification. Job descriptions. Job analysis. Job cluster concept. Analysis of technical occupations using job cluster techniques.

III. Educational Content Analysis. Analytical techniques used in examining occupations for teachable content. Methods of analyzing existing educational programs for appropriate services. The use of advisory services and resource personnel.

IV. Applications of Occupational Analyses. Practice in using analysis techniques to identify skills and knowledge requirements for the skilled trade, technical specialist and engineering technician occupations.

V. Development of Training Program Materials Using Analysis Techniques. Student practice using occupational analysis data in the development of technical course materials. Techniques of correlating classroom theory and laboratory experiences in technical coursework.

## Course No.4 -- 3 Credit Hours
## Program Planning in Technical Education

I. The Essentials of Long Range Educational Planning. Philosophy, objectives, programs, organization, staffing, facilities, finances.

II. Information Sources for Educational Planning. Use of surveys and studies to justify the establishment of new programs or the modification of existing programs. Using information from existing institutions and programs in the planning process. Making school population studies to determine the potential demand for technical education services.

III. Use of Advisory Services. How to establish and use the services of Industrial Advisory Committees to provide support for the technical education program. Using curriculum advisory committees and special consultants to plan curricula and programs.

IV. Planning the Curriculum. Determining the relative emphasis placed on specialized technical courses, mathematics and science, auxiliary technical courses and general education courses in a technical curriculum. Planning of the subject matter in the instructional program with the necessary balance between classroom and laboratory instruction. Special requirements for mathematics and science instruction in the technical curriculum.

V. Instructional Facilities. A comparative study of laboratory facilities designed for technical study and shop facilities used for skill training with reference to equipment selection and the efficient use of laboratories in the instructional program.

VI. Staffing the Technical Program. Selection criteria for teachers of specialized technical courses. Recruitment, in-service training and supervision of technical teachers. Desirable qualifications for teachers of mathematics, science, and general education subjects.

VII. Student Services. Recruitment and selection of students. Maintaining adequate student records. Promoting a program of extra-curricular activities. Placement and follow up.

VIII. Public Relations. Use of news media. News writing. Working with professional and civic groups in the community.

IX. Program Evaluation. Evaluation systems and techniques. Accreditation procedures and standards.

X. Legal Aspects. The legal requirements for program operation under state and federal regulations. Reporting procedures.

## APPENDIX D - People and Institutions Visited by Dr. Perlberg During September-October 1965.*

Department of Health, Education and Welfare - U.S. Office of Education: Dr. Sam Halperin, Dr. Duane M. Nielsen, Mr. Robert Knoebel, Miss Gertrude Broderick, Mr. Robert Hochstein, Dr. Charles Hauch, Dr. Herbert S. Conrad, Mr. Ralph C.M. Flynt, Dr. Richard Suchman, Dr. David Bushnell, Dr. Francis A.J. Janni and Dr. Harold A. Haswell.

AIR - American Institute for Research: Dr. Edwin A. Fleishman.

Basic Systems Inc.: Mr. David Padwa (President), Dr. Francis Mechner.

Center for Advanced Study in the Behavioral Sciences: Dr. R. Tylor.

University of Chicago: Prof. B. Bloom.

City University of New York: Prof. Harry Rivlin, Dean, Division of Teacher Education.

Colorado State University: Dr. Douglas Sjogren, and members of the faculty.

Harvard University: Prof. Neal Mitchell.

Hunter College: Prof. Herbert Schueler, and members of the faculty.

University of Illinois: Dean, College of Education, Prof. Rupert Evans, Prof. R. Karnes, Prof. J. Dobrovolny, Dr. Donald L. Bitzer, Prof. L. Stolurow, Dr. Jack Stern.

Massachusetts Institute of Technology: Dr. Paul Marsh.

NEA - National Educational Association: (Dept. of Audio-Visual Instruction) Dr. Anna L. Hyer.

National Science Foundation: Mr. Michael P. Gaus.

New York Institute of Technology: Mr. Sheldon Littwin.

North Carolina State University: Prof. Joseph Nerden, and members of the faculty.

Pennsylvania State University: Prof. G. Brandon, and members of the faculty.

University of Pennsylvania: Prof. H. Halleck Singer, and members of the faculty.

Rensselaer Polytechnic Institute: Dr. R.W. Schmeltzer, and members of the faculty.

Science Research Associates Inc: Dr. Dean Laux, Mr. Ivor Balyeat, Mr. Theodore Nelson.

Stanford University: Prof. H. Thomas James, and members of the faculty.

Utah State University: Prof. John R. Wood, Dr. Carl Bartel, Dr. Boyer Jervis.

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* During his stay in the United States, 1966-68, Dr. Perlberg had the opportunity to meet an additional number of leading figures in the field during his visits at the U.S. Office of Education, research centers, universities and conventions.

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Preparation of Teachers for Vocational-Technical Schools in Israel
Final Report

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ABSTRACT. The purposes of this study were: (a) to prepare a program of studies for the preparation of teachers for the sciences and engineering-related subjects in vocational-technical schools and in technical junior colleges. (b) to recommend ways and means to overcome the general problems involved in developing vocational-technical teacher education programs in Israel.

An analysis of the pertinent problems of this area in Israel and a survey of international literature and study visits in selected countries, lead to the identification and analysis of problems, programs and innovations in vocational-technical teacher education in selected countries. A program of studies for the preparation of teachers for the engineering-related subjects in electronics and mechanical engineering was submitted by two curriculum committees.

Recommendations made include: the necessity to raise the status and image of vocational-technical education; problems of recruitment and selection procedures; specific problems of the Teacher-Training Department of the Technion-Israel Institute of Technology such as curriculum structure, relations with other institutions methods of teaching. It is also recommended that further, more thorough research be conducted in this area.