A report presented at the 29th Annual Convention of the American Institute of Electrical Engineers, Boston, Mass., June 27, 1912.

INDUSTRIAL EDUCATION

PRELIMINARY REPORT BY THE EDUCATIONAL COMMITTEE

I. INTRODUCTION

The Institute Committee on Education was reorganized last November as it was impossible for the original chairman to serve. At the meeting held at that time, it was decided to study the status of vocational education, that subject being at the present moment of paramount interest to the industrial interests of the country. The time available has been so short that it is impossible to present more than a preliminary report of progress, but this may possibly be of sufficient interest and value to warrant future committees of the Institute in continuing the work.

In laying out the plan of procedure of the Committee, no specific effort was made strictly to confine the study to educational conditions as applied to the electrical industries. This attitude was taken because it was believed that the proper establishment of vocational education for *all* children who cannot advance beyond the rank of hand workers is essential to the highest success of the country as a whole in its industrial and commercial functions, and, as a result, to the success of the electrical, or any other particular branch of the industries.

It is believed by the committee, since the Institute contains a large and intelligent membership widely distributed over the entire United States, that much good may be accomplished by gathering data together in the TRANSACTIONS for ready reference which will aid the individual members to effectively influence the development of this most valuable kind of education in their respective commonwealths and communities.

Probably there is no more important problem to be solved by

the industrial communities of this country today than the proper preparation of the new generation for efficient, skilful, intelligent, and loyal labor. It is now quite generally known that we have fallen behind Germany, Austria, France, and some other European nations in this regard. To a certain extent, this is indicated by the fact that many of our exports carry from three to fifteen per cent of labor cost, while a large part of the exports of the countries named carry from forty to eighty per cent of such cost. Indeed, we have occasionally exported large quantities of comparatively crude and unmanufactured products to Europe to have them improved and refined to many times their original export value and then have brought them back to this country for our consumption. These conditions must exist to some extent always, but the balance against us is so excessive that it behooves us to take it into consideration.

In regard to the effect of applied education, Mr. H. E. Miles, chairman of the National Manufacturers Association's Educational Committee, makes this statement in a recent report: "By industrial education it now devolves upon us in very important respects to shape the lives of the children of today and thereby to make the men and women of tomorrow. Each year 2,500,000 children graduate from or leave our elementary schools proud and confident in having accomplished the first great task of their lives in successfully finishing the eight years' course with credit. But this same vast army of 2,500,000 little ones, most of them only 14 years of age, leave the schools soon to be discouraged, to prove unsuccessful, aimless; most of them have gotten no further than the sixth grade, having learned little else than the three R's, not educated in any sense, but only possessed of the rudiments whereby real education may be acquired. They then, in a way, learn in school only how to fail. These are the children who come into the industries, and deserve or require industrial or trade education."

This injurious condition, as set forth by Mr. Miles, is to be found to a more or less serious extent in almost every manufacturing community in the United States and also to some degree in the rural communities. The difficulty has been largely relieved in Germany by the development of her magnificent system of trade and "continuation schools." In this system, after a boy has reached the age of fourteen, he has the opportunity to continue in schools which are particularly adapted by the character of their teaching and organization to aid him in

making himself a skilful and intelligent workman. A compulsory attendance law makes it necessary for most of the boys, whether working or otherwise, to attend these continuation schools at least one-half a day each week until sixteen years of age. The expense of the schools is little greater than that required for maintaining the ordinary types of public school curricula with which we are familiar in this country. Though trades are taught—as many as two score in one of the cities of Germany—the cost of equipments required is comparatively small; only sufficient apparatus is used to teach the fundamental movements of the processes called for by a particular trade. Because of the large number of pupils who are employed in labor and attend for part time only, these foreign schools cost per pupil, per year, a small fraction of the amount expended per pupil in our best full time trade and industrial schools.

It is considered by well qualified industrialists who have studied the question, that many classes of workmen of continental Europe are more skilful and accurate than similar classes of American workmen, even after due allowance is made for the American's native resourcefulness, energy, and ability. Therefore, if the truth of this statement is conceded, active means should evidently be adopted for the development of educational methods which will cause our manual workers of the future to reach a higher stage of efficiency. This is particularly so since our country must, perforce—as its population grows and natural resources relatively decrease—in order to maintain its prosperity, wealth, and the happiness of its people, put forth increasingly greater efforts to maintain its share of the world's trade.

With the exception of a comparatively few successful experiments with continuation and free vocational schools such as are to be seen here and there scattered over the country, as yet comparatively little has been either attempted or accomplished in the United States in the form of publicly supported training of the character demanded; and a beginning only has been made in the establishment of industrial schools supported by private benevolence, or by industrial corporations for preparing workers for the ranks of their own employees. The number of pupils enrolled in such schools, the number of teachers employed, and the buildings and equipments in use are small compared with those in some of the European nations. Statisticians estimate that only from ten to twenty per cent of the children of this country of the age

of sixteen, whom necessity drives from school to work, are so situated that they can learn a trade. The remainder work at casual employment or in such places as fail to develop their full usefulness to their communities. This condition of inefficiency is apt to remain with them throughout life to their detriment, and to a considerable degree the character of our export trade undoubtedly is influenced thereby.

It seems probable that this country could, without heavy burden beyond that incurred in maintaining the present more or less inflexible public school system, so modify the pedagogical methods in use as to make it possible for the great majority of sound children to take positions in the world of labor where they could be classed as skilled. Such training of the mass of the people should lead to increased sense of responsibility, good spirit, orderliness, and efficiency and should go far toward removing much of the unrest and dissatisfaction rapidly becoming prevalent.

On account of the limited time at the committee's disposal, it was decided to study certain schools in the New England and Middle States—the thought being that if the work is continued by future committees, a further study can be made of the conditions in other parts of the country. Even in the districts chosen it was found wise to confine attention to but a few of the most typical schools and to neglect many institutions of great merit. The work of gathering data was divided among the membership of the committee somewhat as follows: Professor H. H. Norris of Cornell University undertook the burden of reporting upon certain schools to be found in New England and New York; adding thereto, with some assistance from the Chairman, descriptions of various schools maintained by the railroad systems of the country. Professor Samuel Sheldon of the Brooklyn Polytechnic Institute was assigned certain typical schools in New York City.

Insomuch as vocational education, to serve the entire population of the country, eventually must be supported largely from the public purse, and insomuch as many of the commonwealths of the Union are now endeavoring to inaugurate such work by the enactment of special legislation relating to the subject, a special section of the committee's report is devoted to a study of the laws already in existence. Dr. W. I. Slichter of Columbia University was assigned the duty of making an investigation of this subject and preparing a brief report thereupon.

It is hoped that the short descriptions of the few schools that are named hereafter and, also, the brief discussion of laws which seem to be suitable for the establishment of effective vocational educational systems may be of service to members of the Institute, who have not already given the subject special study, in aiding them to direct the development of this important phase of education in their own commonwealths. The committee, of course, does not pretend that its findings are complete, but the data given may prove useful by indicating the direction in which the development is tending.

Before proceeding with the more detailed discussion, it seems well to point out here certain salient classifications and facts concerning industrial schools. They may be divided properly into three general classes, namely:

1. Those maintained at public expense and open to all children of their respective districts.

2. Those maintained through private benevolences and also open largely to children of their districts.

3. Those maintained by corporations for preparing skilled employees for their own purposes.

These schools, without including those that are giving instruction in drawing, manual arts, etc., for purposes of general training rather than for direct vocational preparation, are frequently divided into two types, namely:

a. Full time schools.

b. Continuation schools.

In the former, the youth attends the school continuously until he has been prepared so far as possible, both mentally and manually, for the particular trade or vocation which he proposes to enter. The continuation schools are those to which pupils, already at work, give only part time—such as evenings, or a day or part of a day each week. The third general division named above consists of continuation schools, while the first and second divisions include both types, or a combination of the two.

It may be safely stated that the continuation school in which the pupil, already regularly employed, gives a part of the working hours each week to school work, shows distinct and positive signs of being best suited to the conditions facing the great majority of young men.

These schools, whether maintained at public expense or by industrial corporations, should aim to develop the mental judg-

ment and physical skill required for promoting the industries in the localities in which they are situated. This means very close correlation between the school work and the shop work in which the youth is engaged, and as a result demands efficient co-operation between the school and shop staffs.

Continuation schools need not be materially more expensive than the common schools, as the practical applied part of the training can be obtained to a large extent during the portion of the time the pupils are at work.

Experience with laws relating to the organization of industrial schools (continuation and full time), carried on at public expense, seems to indicate that certain more or less well defined conditions of organization are desirable. Some of these, which appear to be of especial importance, are presented below for consideration:

1. Young men who leave the common schools at fourteen years of age should be required ordinarily to spend at least two years thereafter in either a continuation or full time vocational school. Those leaving at fifteen should give at least one year to work of the same kind.

2. Opportunity should be given all residents of the community over sixteen years of age to enroll in the continuation school upon the payment of a small tuition fee, especially those persons between the ages of sixteen and twenty-five.

3. Each commonwealth should have a commission composed of representatives of the industries, with power to direct its industrial school work, under the condition that its actions are subject to the approval of the regular state board of education.

4. Local communities should have commissions selected from the personnel of the local industries, with power to direct the work of the local industrial schools, but subject in their actions to the approval of the local school boards.

5. The commissions named above need not interfere with the regular public school organization of the state, but should be correlated therewith.

6. In order to encourage the establishment of vocational schools, and to give a proper central authority over the school officials of local communities, the state should give material financial aid to those institutions which comply with its regulations and are approved by its commission on industrial education.

Lack of state and local boards, whose membership is selected from the officials and ranks of the industries, having sufficient

power to enforce the adoption of their methods, must result, as a rule, in industrial schools failing to give the full possible measure of usefulness. The modern school teacher usually knows his particular business; but this does not include, in general, the direct preparation of his pupils for industrial pursuits, nor can he have the opportunity to learn the requirements essential to giving such preparation except through close contact with, and the active cooperation of, the industrialists who are to absorb his pupils into their ranks of labor.

The term vocational education is used in this report to cover any kind of education that leads to a vocation; industrial education is included in this and refers to the bulk of the manual vocations other than agriculture and the domestic arts (see hereafter).

II. PROVISION BY LAW FOR VOCATIONAL TRAINING IN THE UNITED STATES

A survey of the educational enactments of the various states shows that 24 states have active provisions for vocational training, six have permissive provisions and fifteen have no provision at all. In twenty of the states vocational schools are in practical operation.

Massachusetts, Wisconsin, New York and Maine seem to have given the subject the most careful consideration and special commissions to study the subject have rendered elaborate reports on the subject. The State of Massachusetts seems to be not only the pioneer but the leader in this branch of education and while other states may have studied the subject and made provisions for the training yet Massachusetts is the only state in which elaborate provisions are in extensive operation. As the term vocational training is used in a very broad sense and includes any training intended to prepare the scholar to become economically productive, it is desirable to distinguish between the various forms of training to be discussed. The amended acts of the State of Massachusetts carefully define the various forms of education as follows:

1. "Vocational education" shall mean any education the controlling purpose of which is to fit for profitable employment.

2. "Industrial education" shall mean that form of vocational education which fits for the trades, crafts, and manufacturing

pursuits, including the occupations of girls and women carried on in workshops.

3. "Agricultural education" shall mean that form of vocational education which fits for the occupations connected with the tillage of the soil, the care of domestic animals, forestry and other wage-earning or productive work on the farm.

4. "Household arts education" shall mean that form of vocational education which fits for occupations connected with the household.

5. "Independent industrial, agricultural, or household arts school" shall mean an organization of courses, pupils and teachers, under a distinctive management, approved by the board of education, designed to give either industrial, agricultural or household arts education as herein defined.

6. "Evening class" in an industrial, agricultural, or household arts school shall mean a class giving such training as can be taken by persons employed during the working day, and which, in order to be called vocational, must in its instruction deal with the subject-matter of the day employment, and be so carried on as to relate to the day employment.

7. "Part-time, or continuation, class" in an industrial, agricultural, or household arts school shall mean a vocational class for persons giving a part of their working time to profitable employment, and receiving in the part-time school, instruction complementary to the practical work carried on in such employment. To give "a part of their working time" such persons must give a part of each day, week, or longer period to such part-time class during the period in which it is in session.

8. "Independent agricultural school" shall mean either an organization of courses, pupils and teachers, under a distinctive management, designed to give agricultural education, as hereinafter provided for, or a separate agricultural department, offering in a high school, as elective work, training in the principles and practise of agriculture to an extent and of a character approved by the board of education as vocational.

9. "Independent household arts school" shall mean a vocational school designed to develop on a vocational basis the capacity for household work such as cooking, household service, and other occupations in the household.

Practically all states offer vocational education in the state normal and training schools for teachers, and work of a collegiate

grade in the state land grant colleges established under the Morrill act. In a majority of the states there is permissive legislation relative to the introduction of manual training, including drawing, in the elementary schools. In many states instruction in these branches is required in all towns having above a certain specified population. In twenty-four states legal provision has already been made for the encouragement or support of industrial education beyond the general provision for the manual training in elementary schools. The following gives an outline, according to such information as was obtainable, of the provisions in those states having such provisions:

Alabama—Provides for the establishment and maintenance of a branch agricultural experiment station in each congressional district. The annual appropriation for each school is $4500.

Arkansas—Has four state public schools of agriculture, appropriating annually $160,000 for their support.

California—Permits but does not provide for.

Connecticut—Aids in the support of two schools giving instruction in the principles and practise of trades. Total amount is $50,000 for both schools.

Georgia—Aids district agricultural high schools to the limit each of $2000.

Illinois—No special provision, local option.

Indiana—Authorizes industrial and manual training in cities of more than 100,000 and confers power to raise money by taxes.

Iowa—Has no law but aid is given for manual training.

Kansas—Authorizes local boards to levy tax of one half mill for the equipment of industrial training schools or departments. State aids such schools to the limit of $250 annually.

Kentucky—Does not provide but the cities do.

Maine—Provides for and aids to the extent of two-thirds the salaries of the instructors, subject to the approval of state superintendent. Has a commission which has made valuable recommendations.

Maryland—Gives state aid to county manual training schools or departments, limit $1500 each. Also aids high schools having commercial courses.

Massachusetts—Has a deputy commissioner of education whose duty it is to encourage and supervise forms of vocational education supported by the state. Grants permission to towns and cities to provide independent vocational schools and to provide evening and part time courses for persons already employed. Permits two or more cities to join for the purpose of maintaining vocational courses or schools; aids to the extent of one-half the net expense of such schools, provided the school has been approved by the state authorities.

Michigan—Authorizes and aids county schools of agriculture and domestic economy to the extent of $\frac{2}{3}$ of the cost if approved by state authorities.

Minnesota—Gives state aid to departments of agriculture, manual training, and domestic science in state high, graded, and consolidated schools if approved by state board. Maximum limit of $2500 to any school.

Nebraska—Does not provide but the cities do.

New Jersey—Contributes half the cost of maintainance and authorizes the locality to levy a tax for the remainder; maximum limit of aid is $10,000.

New York—Authorizes local board to establish such schools and gives aid to the extent of $500. Has a state director of trade schools.

North Dakota—Authorizes and aids such schools.

Ohio—Provides for manual training but the cities do most.

Oregon—Provides for courses in any high school under supervision of state board.

Pennsylvania—Requires that manual training courses shall be provided and aids, by direct appropriation, established vocational schools. Has three deputy state superintendents of education in charge of work.

Texas—Gives aid to the extent of half the cost of maintaining courses in agriculture, domestic economy, and manual training subject to the approval of state board. Maximum limit $500. Aid is not permanent.

Utah—Permits vocational courses to be prescribed in existing schools.

Vermont—Aids schools with approved manual training courses to the extent of $250 per year.

Virginia—Provides by law and has ten schools in operation.

Wisconsin—Has a State Board of Industrial Education and a Commission to encourage Industrial Education; aids county schools having industrial courses which are approved by state.

Thus in the majority of cases, heretofore, the vocational training has been almost altogether in the form of agriculture or home-making and with manual training as an addition or incidental to existing courses in high and secondary schools. The problem, therefore, of true *industrial* education is comparatively new and has been met in only a few states such as Massachusetts, Pennsylvania, Maine, New York, Indiana, and Wisconsin. In order to study the subject and learn the best methods of accomplishing the desired object we need therefore only consult the records of the results in these States.

An especially appointed commission in Maine has made a very careful study of the subject and placed the results of its

conclusions in a valuable report. This report is dated 1910. The records do not show that the conclusions of this commission have been carried out to the extent of perfecting an operating system.

While there are a great many institutions of vocational training in New York State they appear to be not as fully correlated as those in Massachusetts and Wisconsin and the initiative appears to be in the cities and localities themselves. The state board is ready and prepared to give advice but does not have the control that is provided for in Massachusetts and Wisconsin.

In the opinion of this committee the feature of the Massachusetts and Wisconsin laws which causes them to excel is the provision that a vocational school, to receive state aid, must receive the state's approval of many of its important features, such as courses, teachers, buildings, methods, time, and accounts. This clause is used as an inducement to encourage the local boards to consult with the proper representative of the state board from the beginning of the organization of the school, rather than to await the exact period when money is requested of the state. The state board includes an assistant superintendent who has made a special study of the subject of vocational training, and, members of the board, private citizens representing the points of view of employers and employees. The new Pennsylvania laws bearing upon this subject are also much similar in effect.

To crystallize and collect the best ideas on the subject of legislation and provisions for vocational training it is deemed sufficient to pick out the best points of the methods of Massachusetts and Wisconsin as representative of good practise.

Outline of a Scheme for Industrial Education Based Largely on the Laws of Massachusetts and Wisconsin

Either a state board of industrial education containing representatives of both employers and employees and independent of the usual state board should be appointed, or an advisory board of similar character should work with the regular board of education.

The state superintendent of education or, in case the duties are sufficient to warrant the appointment, an assistant for industrial education should be authorized to approve, with the board, the courses of study and to certify that the work of the various

schools is satisfactory. The industrial assistant should be authorized to attend industrial conventions and make investigations outside the state as well as within.

The board of education should have control over all state aid given, and aid should only be extended to those schools that have received the approval of the board and superintendent or assistant. The industrial board of education should be authorized to investigate and aid in the introduction of vocational education and to initiate and superintend the establishment and maintenance of the schools. Three classes of independent schools should be recognized, such as industrial, agricultural, and household arts, and each of these schools should have day instruction, part-time, and evening classes. Attendance upon such day or part-time classes should be restricted to those between fourteen and twenty-five years of age and should be compulsory for those between fourteen and sixteen. Attendance at evening classes should be restricted to those over seventeen. The local board of education should be authorized to establish and maintain independent vocational schools; and in the establishment of such schools should call in the advice of the state superintendent and after adopting a plan of organization and administration submit this plan for approval to the state board. It is desirable that local and district boards of trustees appoint an advisory committee composed of members representing local trades, industries, and occupations. The state should reimburse the local district to the extent of one-half the net expenses of the school, provided the form of organization, control, location, equipment, courses of study, qualification of teachers, methods of instruction, conditions of admission, employment of pupils, and expenditures of money are in accordance with the approved methods of the state board.

The community should provide the buildings and equipment and sufficient money for the operation of the schools and after a year's operation the state should reimburse the community the amount stipulated. In order that this amount may be easily determined uniform methods of accounting in the schools should be required.

Each locality should endeavor to make its courses meet its local needs and, if possible, should endeavor to secure cooperation between the schools and the local industries so that the school shall prepare the students to be successful in those in-

dustries, and, if possible, so that the local industries shall supply the opportunity for practical work. To this end it is desirable that, either on the local board or the local advisory board, persons interested in the local industries be represented.

It is desirable that a reasonable tuition fee be charged in order to discourage from attending those persons who have no serious purpose.

It is desirable that all children from fourteen to sixteen years of age be compelled to attend these classes at least one day per week or the equivalent thereof and that their working hours, if employed, should be such that this attendance would not be an unreasonable burden.

Provision should be made that illiterate minors over seventeen years of age should be required to attend the evening schools.

The training given should be designed to encourage the children of the locality to enter the local industries and to fit them to become expert workmen in those industries; thus the children would be kept at home, would be assured useful and successful careers and the local industries would be kept in the hands of natives of the community.

Laws of Massachusetts on State-Aided Vocational Schools

State Administration and Supervision

Section 2. The board of education is hereby authorized and directed to investigate and to aid in the introduction of industrial, agricultural, and household arts education; to initiate and superintend the establishment and maintenance of schools for the aforesaid forms of education; and to supervise and approve such schools, as hereinafter provided. The board of education shall make a report annually to the general court, describing the condition and progress of industrial, agricultural, and household arts education during the year, and making such recommendations as the board may deem advisable.

TYPES OF SCHOOLS

Section 3. In order that instruction in the principles and the practise of the arts may go on together, independent industrial, agricultural and household arts schools may offer instruction in day, part-time, and evening classes. Attendance upon such day or part-time classes shall be restricted to those over fourteen and under twenty-five years of age; and upon such evening classes to those over seventeen years of age.

LOCAL ADMINISTRATION AND CONTROL

Section 4. Any city or town may, through its school committee or through a board of trustees elected by the city or town to serve for a period of not more than five years and to be known as the local board of trustees for vocational education, establish and maintain independent industrial, agricultural, and household arts schools.

Section 5. 1. Districts composed of cities or towns, or of cities and towns, may, through a board of trustees to be known as the district board of trustees for vocational education, establish and maintain independent industrial, agricultural, or household arts schools. Such district board of trustees may consist of the chairman and two other members of the school committee of each of such cities and towns, to be appointed for the purpose by each of the respective school committees thereof; or any such city or town may elect three residents thereof to serve as its representatives on such district board of trustees.

2. Such a district board of trustees for vocational education may adopt for a period of one year or more a plan of organization, administration and support for the said schools, and the plan, if approved by the board of education, shall constitute a binding contract between the cities or towns which are, through the action of their respective representatives on the district board of trustees, made parties thereto, and shall not be altered or annulled except by vote of two thirds of the board, and the consent of the state board of education to such alteration or annulment.

Section 6. Local and district boards of trustees for vocational education, administering approved industrial, agricultural, or household arts schools, shall, under a scheme to be approved by the board of education, appoint an advisory committee composed of members representing local trades, industries, and occupations. It shall be the duty of the advisory committee to counsel with and advise the local or district board of trustees and other school officials having the management and supervision of such schools.

REIMBURSEMENT

Section 8. Independent industrial, agricultural, and household arts schools shall, so long as they are approved by the board of education as to organization, control, location, equipment, courses of study, qualifications of teachers, methods of instruction, conditions of admission, employment of pupils, and expenditures

of money, constitute approved local or district independent vocational schools. Cities and towns maintaining such approved local or district independent vocational schools shall receive reimbursement as provided in sections nine and ten of this act.

Section 9. 1. The commonwealth, in order to aid in the maintenance of approved local or district independent industrial and household arts schools, and of independent agricultural schools consisting of other than agricultural departments in high schools, shall, as provided in this act, pay annually from the treasury to cities and towns maintaining such schools an amount equal to one half the sum to be known as the net maintenance sum. Such net maintenance sum shall consist of the total sum raised by local taxation and expended for the maintenance of such a school, less the amount, for the same period, of tuition claims, paid or unpaid, and receipts from the work of pupils or the sale of products.

2. Cities and towns maintaining approved local or district independent agricultural schools consisting only of agricultural departments in high schools shall be reimbursed by the commonwealth, as provided in this act, only to the extent of two thirds of the salary paid to the instructors in such agricultural departments: provided, that the total amount of money expended by the commonwealth in the reimbursement of such cities and towns for the salaries of such instructors for any given year shall not exceed ten thousand dollars.

3. Cities and towns that have paid claims for tuition in approved local or district independent vocational schools shall be reimbursed by the commonwealth, as provided in this act, to the extent of one half the sums expended by such cities and towns in payment of such claims.

Section 10. On or before the first Wednesday of January of each year the board of education shall present to the general court a statement of the amount expended previous to the preceding first day of December by cities and towns in the maintenance of approved local or district independent vocational schools, or in payment of claims for tuition in such schools, for which such cities and towns should receive reimbursement, as provided in this act. On the basis of such a statement the general court may make an appropriation for the reimbursement of such cities and towns up to such first day of December.

III. DESCRIPTION OF A FEW TYPICAL VOCATIONAL AND INDUSTRIAL SCHOOLS

The few schools hereafter described were selected for the dual reason that they illustrate types and because information concerning them was readily available to the committee. There are numbers of other schools which would have served the purpose equally well and which are fully as efficient.

A. Certain Schools in New York City

Pratt Institute. This Brooklyn private school, founded by Charles M. Pratt in 1887 and now under the control of his six sons, is adequately endowed and gives day and evening instruction to over four thousand students. There are at present five divisions of instruction. Among these is the "School of Science and Technology" which offers thorough practical courses planned to meet the needs of four different classes of students:

"First. Day Industrial Courses in Mechanics, Electricity, and Chemistry, for young men who cannot afford the time and expense required for four-year college or engineering courses, but who are nevertheless ambitious to fill positions above the grade of skilled mechanics in manufacturing and industrial plants.

"Second. Day Trade Courses in Machine Work, Carpentry and Building, and Tanning, for those who wish practical and theoretical instruction in these trades.

"Third. Evening Technical Courses for those employed during the day in mechanical, electrical, and chemical industries and related occupations.

"Fourth. Evening Trade Courses for apprentices and journeymen.

"The courses offered are as follows:

Day Industrial Courses	
Steam and Machine Design	A two-year course
Applied Electricity	A two-year course
Applied Chemistry	A two-year course
Applied Leather Chemistry	A one-year course
Day Trade Courses	
Machine Construction	A one-year course
Carpentry and Building	A one-year course
Tanning	A one-year course

Evening Technical Courses

Technical Chemistry
- General Chemistry
- Qualitative Analysis
- Quantitative Analysis
- Organic Chemistry

Mechanical Drawing and Machine Design
- Mechanical Drawing
- Machine Design
- Mechanism

Industrial Electricity
- Electricity and Mechanics
- Electrical Machinery
- Electrical Design

Practical Electricity
Practical Mathematics
Steam and the Steam Engine
Strength of Materials

Evening Trade Classes

Machine-Work
Tool-Making
Carpentry and Building
Pattern-Making
Sheet-Metal Work
Plumbing
Advanced Wood-Working for Teachers"

Requirements for admission to these courses are based largely upon the personality of the applicant rather than upon his prior scholastic achievements. A moderate honorarium is charged for each course.

The purpose of the school is to reach and help all classes of practical workers, both artists and artisans, and to give every student practical skill along some line of work. As a rule the instruction is intended to be more theoretical and less practical than that usually given in trade schools, whereas it is more practical and less theoretical than that usually given in engineering schools and colleges. This type of instruction is a unique feature of the Institute's work and its conception was inspired by the personal experiences of its founder, who was a self-made man of unusual breadth and power, and who started life as a machinist. In this connection there appear the following statements in a report by Samuel S. Edmands from the Department of Science and Technology:

"The trained workers in the electrical and mechanical fields are, in a general way, divided into three different classes, the first and highest comprising the comparatively few men of superior ability and attainments who originate and direct operations requiring the services of many. In this class we find the engineering experts, designing and consulting engineers, and many others who bear the prime responsibility for the successful operation of industrial and engineering enterprises. The third

Experience in trade taught	Cabinet making	Pattern making	Carpentry and joinery	Plumbing	Blacksmithing	Machine shop practise	Steam engineering	Physics and elect. engineering	Advanced elect. engineering	Elect. wiring and installation	Chemistry	Free-hand drawing	Mech. drawing	Architectural drawing	Total
None	15	37	53	11	53	6	21	144	9	36	43	57	117	81	683
Less than one year	2	5	6	6	0	3	15	0	6	15	6	16	12	17	109
One to two years	2	7	1	18	2	3	6	1	10	14	15	12	6	23	120
Two to three years	2	1	2	22	1	9	6	1	12	6	13	5	2	10	92
Over three years	3	1	0	45	0	16	4	3	9	4	10	6	0	2	103
Aim in taking trade course															
To improve knowledge of trade	7	14	9	91	1	31	21	11	28	40	40	31	50	52	426
To learn trade	9	28	50	5	8	3	21	47	15	30	31	55	87	78	467
To gain general information	8	9	3	6	47	3	10	91	3	5	16	10	0	3	214
Number of students admitted to different trade classes	24	51	62	102	56	37	52	149	46	75	87	96	137	133	1107
Average number of night students remaining in each class after reg	58	48	36	45	34	71	33	44	71	65	60	46	51	57	50
Number of pupils who have obtained any industrial benefit as shown by advancement in position or wages	4	7	2	35*	14	2	0	2	6	21	6	12	4	21	136

*Increase of wages is governed principally by unions. All of present students declare they have been greatly benefited in theory and practise.

and last class is composed of the skilled laborers and trained mechanics. Between the highest and lowest class there is a constantly widening field, the workers in which constitute the second class and occupy positions secondary and subordinate to the members of the first class, but nevertheless of great importance. They are the assistants to the engineers, the supervisors of skilled labor, or the specialists performing operations requiring a degree of knowledge and training in excess of that possessed by those in the third class. The commercial demand for technically trained workers of this second or intermediate grade is keen, and it is to afford a means for them to obtain the training that they need that the two-year technical courses in the Institute are primarily intended."

During 1910 the National Association of Tanners, desiring to affiliate with some educational institution in the formation of a tanning school, found that the Pratt Institute was prepared to train young men for its employ in the manner desired.

The formal report of the Tanning School Committee of this association contains an outline of the equipment and courses of instruction proposed by Pratt Institute. Its study is recommended to those interested in the formation of effective industrial curricula.

Public Schools. There are three public high schools in New York City which offer opportunities for instruction in vocational subjects, Stuyvesant, at 245 E. 15th St., Manhattan, for boys and men, Manual Training, on 7th Ave., Brooklyn, for boys and girls, and Bryant, on Wilbur Ave., Long Island City, for boys and girls. The courses of study, which are directed towards the technical industries, are similar to the ordinary high school courses, except that biology and history are omitted and manual training is given throughout four years.

Applied Mechanics, Steam, and Electricity forms a special course at Stuyvesant which is given to fourth-year students and is open only to students of exceptional ability. It is designed to prepare its graduates for giving efficient service immediately after leaving the school. The physical equipment of all these schools is adequate for the purpose and the laboratories are better equipped with apparatus than many engineering colleges, as will be evident after an inspection of the accompanying illustrations of the engine room at Stuyvesant. Though such extensive facilities as shown in the illustration are desirable it should be distinctly understood that much excellent and practical industrial instruc-

tion can be given with simple and quite inexpensive equipments. No community, therefore, need be deterred from entering upon this kind of educational work because of the burden of the primary plant cost.

The day instruction at this school is duplicated in the evening with some modifications, attending students being of the same general class as the day students but being commonly from 8 to 10 years older. The evening instruction has for its motive increased earning capacity of the student. Besides preparing some evening students for entrance to college, others are fitted for positions in the trades. The effectiveness and characteristics of this work may be judged from the data contained in the foregoing table, which is based upon information supplied by the students and which refers to the academic year 1910--11.

B. A Few Schools Situated in the Middle and New England States.

The Privately Endowed Industrial School. As an example of the recent development in privately endowed trade schools, Wentworth Institute, of Boston, Mass., may be considered as representative of modern ideas. The Institute is designed to be a high-grade trade school, that is, one which places a rational scientific foundation under the direct preparation for mechanical trades and industry. The Director states that the aim is to develop artisans and skilled mechanics, and also to train men who wish to become inspectors, shop foremen, master mechanics, and superintendents in industry.

As a school of this kind attracts young men of all kinds of preparation, the courses have to be adapted to various needs. There are, therefore, short one-year day courses for beginners and others with little practical experience, two-year day courses for those with some experience who wish to train themselves for positions of foremanship grade, and also evening courses where men employed in mechanical occupations during the day may either increase their skill and practical knowledge of their trade or study such supplementary subjects as will help them to advance to more responsible positions. While the school has been in operation but a few months, those in charge of it have had long experience in somewhat similar schools, so that the plans and methods of instruction may be considered in no way experimental. The following facts dealing with the organization of the school and the results thus far accomplished will, therefore, be of interest.

Trades Taught. After a study of the probable demand for instruction the faculty of the Institute selected the following trades for the day courses. In the building trades—carpentry, plumbing, and electric wiring; in the manufacturing trades—machine work, foundry practise, and pattern-making; also, electrical construction for those who wish to become foremen in electrical industries, and machine construction for those who wish to become foremen in mechanical industries. While in the case of foundry practise, especially, great doubt was felt as to whether American boys could be made to see its scope, the possibilities of future development in the industry made this trade of importance. The class in foundry practise has proved one of the most successful of the day courses.

For boys employed during the day, evening classes are provided. For those who wish to perfect themselves in mechanical skill and practical knowledge of their trade, courses are offered in carpentry, pattern-making, machine work, tool-making, foundry practise, electric wiring, and plumbing; and for those who wish to supplement their knowledge and prepare themselves for more responsible positions, there are courses in practical mathematics, mechanical drawing, machine design, practical mechanics, strength and properties of materials, the steam engine and the operation of power plants, applied electricity, and electrical machinery.

Selection of Students. Although the buildings and equipment of the Institute were hardly completed in September, 1911, more than three times as many applicants as could be accommodated appeared. In selecting from this large number, personal interview and oral questioning were the only practicable means. All academic standpoints of scholarship and skilled attainments were discarded and the attempt was made to measure the applicant's forcefulness, seriousness of purpose, and adaptability to the trade selected. In this way an earnest body of students was picked out.

Selection of Teachers. Of the 18 men who constitute the day school faculty, eight have charge of shop instruction. Six of the eight have special qualifications for this work, having occupied responsible industrial positions. The other teachers are school and college trained and they have had wide experience in industrial work. As the success of an institution like this depends largely on the teachers every effort has been made to get those properly equipped for this work.

Typical Curriculum. Following is a typical curriculum which shows clearly the scope of the work of this institution:

A typical curriculum for a one-year course is as follows:

	Hours per week		
	Fall term	Winter term	Spring term
Shop practise in machine-tool work, machine construction, bench work and tool-making, principles and practise of forging, tempering steel, foundry practise and pattern-making	20	20	20
Mechanical drafting and blue print reading	6	6	6
Practical mechanics, materials of construction, and power transmission, etc., (recitations and laboratory practise)	9	9	9
Practical mathematics, machine shop computations	5	5	5

A typical curriculum for two-year courses is as follows:

FIRST YEAR

	Hours per week		
	Fall term	Winter term	Spring term
Practical Mechanics:			
Recitations	5	5	5
Laboratory practise	8	8	
Electrical Motors and Appliances:			
Principles of construction and operation, Recitations			5
Laboratory			8
Mechanical Drafting:			
Shop drawing and machine details	8	8	8
Practical Mathematics:			
Shop computations and use of formulas	5	5	5
Shop Practise:			
Moulding and foundry work	8	4	
Pattern making		4	8
Forging and tempering	6		
Machine tool work		6	6

SECOND YEAR

	Hours per week		
	Fall term	Winter term	Spring term
Applied Mechanics: Mechanism of machinery, materials of construction, transmission of power, plant care and operation, etc.			
Recitations	5	5	5
Laboratory	8	8	8
Machine Sketching: Tool and jig design	6	6	6
Advanced Practical Mathematics, including useful applications of algebra, geometry, and trigonometry	5	5	5
Advanced Shop Practise: Machine construction	10	4	4
Tool making		6	6
Optional			
Advanced jig and tool making	6	6	6
or			
Advanced machine construction	6	6	6

NOTE: In the two-year courses a considerable portion of the laboratory work is actual construction and for that reason the time spent in shop practise is somewhat reduced.

Vocational Instruction under the Direction of the New York State Department of Education. In 1908 a law was passed by the legislature of New York State (already referred to in Section II) providing for vocational and trade instruction in public schools. To put this law into effect the New York State Education Department organized a separate division of trade schools under the supervision of a chief. This division endeavors to keep in touch with the various labor organizations and with the manufacturers with a view to the promotion of education of such a nature that the young people of the state will be fitted to take up employment in the industries with the greatest possible efficiency.

The Department of Education recognizes two divisions of this field: (1) There are young people from 12 to 16 who need industrial education of a preliminary character. At this age young people are of little value in the industries, but they are of an age suitable for the acquirement of the fundamental principles of industry. Assuming that the ordinary school subjects of reading, spelling, writing, arithmetic, etc., have been fairly well mastered, the applications of these fundamental studies to

shop work, shop accounts, business subjects, etc., may be profitably emphasized. It is not the aim in this part of the work to teach trades, but by means of manual training, drawing and other practical studies, the elements of all trades are taught.

Under the law of 1908 a number of vocational high schools have been organized, including a school at Albany near the headquarters of the State Department of Education. The Albany school is considered typical, and will be treated in more detail later.

(2) The second division of industrial training recognized by the Board of Education is instruction in the trades. New York State contains a large number of groups of industrial workers engaged in printing, textile industries, shoe manufacture, ready-made clothing manufacture, manufacture of electrical apparatus, iron working, paper manufacture, etc. These groups need recruits especially prepared for their specialties. In addition to the general preparation given by the vocational high school, which is supposed to prepare the way for all trades and business activities, there are many special subjects which should be studied in order to make intelligent workers in, say, the printing business, shoe manufacture, or electrical machinery manufacture.

The State Department of Education has made a real beginning in the first division of its field mentioned above. State aid is given to schools which qualify under the law. In the 8th annual report of the Department, Mr. A. D. Dean, Chief of the Division of Vocational Schools, states as follows:

" *The Intermediate Industrial School.* The plan as now operating provides that five-twelfths of the school program shall be given over to the shop, laboratory and drawing instruction and that the remaining seven-twelfths be devoted to " book studies," which practically amounts to saying that the pupils shall for the remainder of the time take the regular elementary school studies corresponding to the seventh and eighth grades. These studies are related to the industrial studies as far as is possible. Both boys and girls have similar work in English and history. The arithmetic course for boys differs from that for girls. The geography is viewed as an outgrowth of the life-long problem of providing food, clothing, and shelter. The physiology is studied from the view-point of hygiene and sanitation rather than the structural only. The shop, laboratory, and drawing work differs with the sex considered.

Vocational Courses in the High School. The Education Department proposes a plan by which an average high school now teaching college preparatory, commercial, industrial, and home-making subjects can economically and effectively develop courses of instruction which shall have a well-blended liberal and vocational training. Instead of these schools offering commercial, industrial, and home-making subjects it is arranged so that they offer well-defined courses for pupils who seek different destinations. A certain amount of the work is common to all these courses and consists of the prescribed studies which are deemed essential to a sound and symmetrical education and which, under normal conditions, should be prescribed for all pupils in a secondary school. These prescribed studies are English for four years, English history with civics, algebra, plane geometry, biology, and physics. Another division consists of such elective subjects as may be necessary for pupils seeking different destinations.

The " industrial and agricultural purpose " courses have intensive courses in the agricultural and manual arts and drawing. The " home-making purpose " course is rounded out with strong courses in domestic science and art, household decoration, sanitation, and personal hygiene. It cannot be emphasized too often that a vocational course does not consist merely of vocational subjects thrown at random into a high school system. The vocational purpose must be satisfied by a definite course.

The law states clearly certain conditions which a vocational school must meet in order to be considered as entitled to special State aid. (1) It must be independently organized— not necessarily a separate building but most assuredly established with a distinct vocational purpose in mind; (2) it must have an enrolment of at least 25; (3) it must employ the full time of a teacher and (4) it must have a course of study meeting the approval of the Commissioner of Education. The first three conditions admit of no changes and are to be enforced in all places without variation from the word of the law. The fourth condition allows for considerable latitude and discretion. The course of study is not defined by the law; it may vary in different localities and connect with the different local industries, which vary in different parts of a great State. The course of study in agriculture and related subjects may emphasize dairying in St. Lawrence county, and fruit growing in Ontario county. An industrial course may concern itself with the shoe industry of Rochester or the knitting mills of Utica; it may omit mechanical drawing in

Gloversville and emphasize it in Schenectady. The vocational training may be of rather the general industrial nature in Albany or have its specific trade aspects in Lackawanna. The only points that need to be considered in the establishment of such a school course in a high school system are: (1) Is it established to meet the vocational purposes in education? (2) Does it meet the requirements of the law?

The New York Department has ruled that five-twelfths of the weekly program of a vocational school department must be given over to the vocational studies chosen for the elective group. This particular ratio was settled upon after considering two propositions: (1) The present requirements for an academic diploma call for 41 counts in certain studies, primarily liberal. These counts closely approximate seven-twelfths of the total number, 72, required for a diploma. (2) Vocational training of high-school grade demands a certain amount of liberal training. Preparation for a vocation should have academic recognition through a diploma if the work is of high school grade. The placing of the ratio five-twelfths vocational to seven-twelfths liberal will satisfy the time elements of both divisions of the course of study. Consequently the pupils in the vocational school course have the same liberalizing studies, or their equivalent, as do pupils in other courses. They take the same department examinations in English, history, algebra, geometry, and biology when they follow the same syllabus as other pupils. When the school offers, as it should, special and practical courses in mathematics and science beyond, or in place of, those just mentioned, the work is inspected and if the definite outlines submitted to the Department are satisfactory, if the teacher is trained for his work, and if it is seen that he can make direct and useful applications of the abstract to the concrete shop, laboratory, or field work of the home and the school, then the Department grants credits without examination. No examinations are given in the vocational subjects proper.

There are now 35 industrial and trade schools, employing 145 teachers. These schools have a day enrolment of 3370 pupils and an evening enrolment of 2933 pupils, or a total enrolment of 6303 pupils. There are 527 other pupils using the equipment, but not enrolled in these schools.

The Albany Vocational School is one of the most advanced of these institutions. It was organized soon after the law of 1908 went into effect. It started with one hundred pupils

selected from a large number of applicants prepared in the lower schools. The equipment of the school does not differ materially from that of manual training high schools, but very much greater prominence is given to the manual part of the course. This equipment comprises a wood shop with the necessary benches, bench tools, saw bench, band saw, speed lathes, and accessories, all electrically driven. A home-making department uses cooking tables, gas stoves, and other necessities of the home, for instruction in domestic arts.

Book-work is not neglected, but it has a practical aspect. For example, in the study of algebra the formulas are stated in terms of the workshop and complicated equations are solved graphically. The formulas studied deal with such applications as electricity, mechanics, and engine practise. In mensuration, areas are studied by reducing plane figures to equivalent triangles, by counting squares when figures are drawn on squared paper, by weighing similarly shaped areas cut from cardboard, sheet lead, or iron. In scientific subjects like physics everyday applications are studied. Among these may be mentioned the radiation from water supply pipes, practical use of exhaust steam, steam boilers, and heating and ventilating.

Industrial work in this school is not confined to boys, but the needs of girls are carefully considered. The work for girls comprises housekeeping, sewing and design. The fundamental scientific principles underlying the household arts are taken up. Girls are taught to use their hands as well as their heads.

While the Albany school has been in operation but a short time, it has apparently demonstrated the soundness of the principles upon which it is founded.

C. Typical Electrical Operating Corporation Schools

New York Telephone Company. This company gives five courses of instruction to its employees, maintaining continuously (1) a school for operators, and (2) a school for instrument inspectors and installers; and offering periodically, as occasion may demand, (3) a course for cable splicers and wiremen, (4) a course for salesmen and employees of the Commercial Department, and (5) a course for college men employed in various capacities in the Plant, Traffic, and Engineering Departments.

The first three courses are directed towards the instruction of the employees in the performance of the specific duties for which they are employed. The other courses are directed toward

extending the information of the employees so as to give them a perspective view of the policies and many correlated activities of the company.

The instruction in the operators' school consists of a series of lectures, each followed by practise at a special school switchboard of standard construction. The course lasts for four weeks; the first week is devoted to simple calls from one direct line to another; the second is devoted to more complicated calls, such as emergency, party line, official, and telegram calls, and those involving an understanding of the meanings of switchboard markings; the third is devoted to calls from automatic pay stations, to busy or unanswered calls and to trouble reports; and the fourth week is devoted to a review.

The instruction in the school for inspectors and installers comprises lectures, work with standard apparatus that has been specially modified for the introduction of troubles, and work as helpers in the field. There are six grades of instruction differentiated from each other by the greater or less complexity of the involved apparatus or circuits. Not all of the employees in this line are required to take all grades.

The course for salesmen and employees of the Commercial Department consists of lectures and observations. It is directed so as to give information concerning the organization of the company, its territory, the correlation of its departments, central office operation and traffic troubles, accounting, ledger routine, adjustments, advertising, rates, contracts, renewals, office practise, orders, collections, canvassing, and salesmanship.

College men are usually employed for engineering positions, for construction work, or as central office managers. Instruction is given to them through informal talks and through observation. They are required to make written reports upon their observations. They are also questioned so as to determine their understanding concerning the work. The following schedule, indicating the nature of the course which is taken by those who enter the Engineering Department, has been obtained through the courtesy of Mr. H. C. Carpenter:

NEW YORK TELEPHONE COMPANY

INSTRUCTION COURSE

Operating— 3 weeks

a. Course in the Operators' School, 2 weeks; the afternoon being spent in listening in for about 1 week at the "A" board and for 1 week at the "B" board at the Spring office.

b. Listening in at various toll board positions, information desks, and " A " and " B " boards at other offices, 1 week.

Maintenance of Common Battery Central Offices— 2 weeks

To gain a general knowledge of the wire chief's work and of the functions of the various pieces of apparatus.

Instrument Installation and Inspection— 2 weeks

To include a special course for one week in the Instrument Installer's School in New York and a week on installation and inspection work, including private branch exchange installations.

Pole Line Construction— 3 weeks

Placing new and replacing existing poles, crossarms and other fixtures, highway and interior block.

Making transpositions, including phantom circuit transpositions.

Stringing wire and removing dead wire.

Placing and splicing aerial cables and terminals.

Joint construction with electric light and power lines.

Protection against high-tension lines.

Loop Construction— $\frac{1}{2}$ week

Special attention is given to the methods of distributing from crossarms, iron brackets, and from joint lines with an electric light company; distribution through trees.

Subway and Subsidiary Work— 1 week

To include, if possible, both light and heavy subway construction in city and country, special attention being given to the arrangement of manholes, duct formation, and the kinds of material used. (If no heavy subway construction in congested streets is under way while the student is taking the course, a day or two of this time may be spent with the Empire City Subway Company.)

Placing and Splicing Cable— 3 weeks

Placing cables in subways and subsidiaries.

Removing cables from subways.

Placing interior block cables.

Placing house cables.

Placing submarine cables.

Straight splicing.

Potheads of both okonite and switchboard cable (when made on the job).

Test of splicing, including throw and tap work, special attention being given to the methods of testing working and dead cables.

Block splicing.

Wiring Work— 1 week

Half tap.

Block rewiring and reconcentration.

Cutting in potheads in central offices and in buildings.

Galvanometer Work— ½ week

To gain a general knowledge of the tests made, and also the method of locating faults.

Outside Trouble Hunting— ½ week

To gain a general knowledge of the kind of troubles met with, and the methods of locating and clearing them.

Plant Engineering and General Office Work— 5 weeks

This is to gain a general knowledge of the work of the plant engineer, of the methods of accounting, and of the organization of the Plant and other departments. It is suggested that these five weeks be spent about as follows:

1 week in learning the nature of the plant engineer's work, the preparation of spider maps, character maps, and getting familiar with joint use agreements and division instructions.

1½ weeks working with an assistant to one of the district engineers on such jobs as may be under consideration, if possible letting the student do some small job himself so that he may become familiar with the methods of planning relief and reaching new territory.

1 week on block work—spending about a third of the time in inspecting block work, which should include both short pole line construction and fence runs so as to become familiar with the general layout of interior block cable. The remainder of the time may be spent with the block engineer in making new blocks and relief of existing blocks, in estimating the cost of the work, and finally in the making out the necessary permits for the Wayleaves Department.

½ week in learning how to overcome inductive disturbances on telephone lines, in studying exposures and methods of cutting in transpositions on ordinary circuits and for phantoms.

1 week with the Accounting Department—learning how the material is ordered from the storerooms and from the manufacturing company, and the accounting of the material and labor under estimates; also learning how records of the Plant Department are kept, such as attachments to foreign poles, card records, statistics, and records of trunks.

Traffic Department— 2½ weeks

Work of the traffic engineer.

Rainy Weather.

During rainy weather, the student goes to one or more repair shops to become familiar with the work done in them and to see the making up of cable forms, cable head boxes, repairing apparatus; also to gain a knowledge of the stock rooms and the methods of issuing and crediting material recovered.

New York Edison Company. Under the auspices of the Association of Employees of the New York Edison Company, there is offered free to any employee of the company a theoretical and

practical course in electricity extending over three years and including fifteen two-hour weekly exercises each year. The upper portion of one of the company's substation buildings contains a fine auditorium, a well equipped laboratory, and a carefully selected and growing reference library. Members of the test department give instruction during every evening and on one afternoon during fifteen weeks of the year, commencing about the middle of November. There has been prepared a separate printed and illustrated instruction sheet for each exercise, the nature of which can be inferred from the titles given in the following table furnished by Mr. H. G. Stott.

COURSE 1

1. Uses and Properties of Electric Currents.
2. Measuring and Controlling Electric Currents.
3. Connections and Types of Circuits.
4. Magnetic Fields and Magnets.
5. Conductors and Resistors.
6. Voltmeter Adjustments and Calibration.
7. Ammeters and Shunts.
8. Measurements of Power and Electric Energy.
9. Magnetic Properties of Iron.
10. Generators.
11. Motors.
12. Storage Batteries.
13. Characteristics and Testing of Insulation.
14. Lamps and Photometry.
15. Alternating Currents.

COURSE 2

1. The Magnetic Circuit.
2. Direct-Current Armatures.
3. Separately Excited Generators.
4. Shunt Generators.
5. Shunt Generators (concluded).
6. Compound Generators.
7. Shunt Motors.
8. Shunt Motors (concluded).
9. Prony Brake Tests on Shunt Motors.
10. Prony Brake Tests on Series Motors.
11. Motor-Generator Heating Test.
12. Armature Reactions.

13. Shop Tests on Motors.
14. Boosters.
15. Balances.

COURSE 3

1. Alternators.
2. Characteristics of Alternating-Current Circuits.
3. Phase Measurements and Vector Diagrams.
4. Principles of the Transformer.
5. Constant Potential Transformers.
6. Instrument Transformers.
7. Polyphase Circuits.
8. Induction Motor Principles.
9. Induction Motor Operating Characteristics.
10. Induction Regulators.
11. Polyphase Transformations.
12. Alternators in Parallel.
13. Synchronous Motors.
14. Converters.
15. Wave Forms.

Of some 4500 employees, the initial enrolments for 1910-1911 in these three courses were respectively 60, 180, and 60. Of those there were respectively 5, 9, and 5 who attended every exercise and prepared the corresponding reports. The average weekly attendance was initially 100 and dropped to 70 at the conclusion of the season. Decrease in attendance after the novelty had worn off also characterized a course of free lectures by electrical specialists, given previously in connection with the educational work of this company. To prevent falling off in attendance, one department of this company is at present compelling attendance on the time of the company.

D. DATA CONCERNING RAILROAD CORPORATION SCHOOLS.

New York Central Lines Apprentice School System. As the New York Central plan has been worked out in great detail and as it comprises most of the features found satisfactory in other systems it may be considered as typical of the best practise in its line. Six years ago the New York Central lines put into operation at the larger shops a school system for the benefit of shop apprentices, in various trades. The purposes of these schools are:

1. To improve the quality of mechanical skill available in shop work.

2. To make apprenticeship attractive to intelligent boys.

3. To make it possible for the right kind of boys to rise from the ranks to positions as foremen and master mechanics.

School work is done in regular shop time under pay, and in the morning when the boys are at their best. The work is done under drawing and shop instructors appointed from the local shops, these instructors being under the direction of the officers of the company in charge of the local shop operations. The whole work is under the supervision of a superintendent of apprentices who in turn reports directly to the general superintendent of motive power.

The boys who apply for apprenticeships in the shops of the company are of various grades of education, some having practically no schooling, while others are high school graduates. The instruction is therefore somewhat varied in character, but is mainly of two general types: drawing and numerical calculations, and shop work. The drawing instruction is given in the rooms or small buildings especially devoted to this work. These rooms are fitted up in a simple style with drafting tables, blackboards, cabinets for storing boards and supplies, models, etc. The courses, which are laid out for all shops by the superintendent of apprentices, are of a nature to appeal to apprentice boys.

The objects which he is expected to draw are the familiar things with which he works in the shops. Small locomotive parts, parts of shop tools, wrenches, nuts, etc., form the drawing exercises. Very simple subjects are assigned at the start, leading up to rather complicated ones toward the close of the four-year course. The work includes tracing so that the student finally leaves his work as if for use in actual construction. In many cases the apprentices actually prepare drawings for foremen, supplementing the work of the regular draftsmen.

The drafting room periods afford an opportunity also for testing the ability of the students to think for themselves. A large number of problems are assigned for home work, these problems being all of a simple and practical character. Solutions to the problems are handed in from time to time, and by means of blackboard exercises the real ability of the pupils in solving problems is tested.

Most of the time of the apprentices is put in at actual shop work under the direction of the shop instructor. This instructor is a practical mechanic who is familiar with all branches of shop work. His duty is to see that the pupil is taught thoroughly

all branches of the selected trade. The instructor shifts the pupil from one line of work to another, giving him sufficient time to obtain a thorough mastery of each part. For example, if a boy elects to learn the trade of machinist, which requires four years, his time will be divided up roughly as follows: helping in shop, 0-3 months; bench work, 6-12 months; light tool work, 3-6 months; heavy tool work, 3-12 months; in air brake department, tool room or brass tool, 3-6 months; in erecting shop, 16-24 months. The instructor shows the apprentice how to perform each operation assigned to him and sees that the work is done thoroughly. He thus relieves the foreman of the necessity of instructing apprentices, and as he is a specialist in this line, the work is much better done than formerly. It is understood that while the shop course is going on the apprentice is also working in the drafting room, as explained earlier.

The instruction of apprentices is very similar to the best type of school work of any kind, as will be evident from the description given. The primary function of the course, as should be that of the courses of all schools, is to teach the apprentice to apply skill and knowledge efficiently in his vocation. Mental development is, of course a vital necessity; but this mental development comes as a result of the continual exercise of the constructive and reasoning faculties. Practically no text-books are used in the course. Lectures, examinations, and recitations, as used in school, have little place.

The results of the system have been highly gratifying to the company, and although the experiment has been in operation but a few years, the benefits have been evident in an increase in shop output, a reduction in the amount of spoiled work, and increased desire on the part of the boys to prepare themselves for trades (including even some trades which a few years ago did not attract boys at all) and a general improvement of the spirit in the shops. The shop instructors meet from time to time to discuss their problems, and as they work through a central organization, their efforts are marked by unity of plan and purpose.

The Pennsylvania Railroad Apprentice School. An instance of a continuation school, doing a large amount of good in its community, is the one maintained by the Pennsylvania Railroad Company in Altoona, Pa., which was inaugurated under the direction of General Superintendent George W. Creighton and his staff, of the company, and the Chairman of the Committee making this report, representing The Pennsylvania State Col-

lege. (The latter institution holds an advisory position in the organization of the school and receives full weekly reports from the head instructor.) In this school something over 250 apprentices spend one-half a day a week in a specially prepared building, which, with its equipments, was comparatively inexpensive. Three instructors are required. The curriculum consists largely of practical drawing, English, natural science, and mathematics. The weekly time spent by each apprentice in the school is divided into two periods scheduled for different days.

The English is taught in a manner best adapted, in the opinion of the instructors, to improve the pupils' ability readily to understand shop or similar orders and to make verbal or written reports in clear language. The natural science studies take up elementary functions having to do with features of combustion in the firing of boilers, the simple principles underlying machine mechanisms, the qualities and characteristics of materials used in machine construction, and similar practical information which should add to the intelligent performance of the workman's duties. The mathematics taught is a study of the fundamental principles of arithmetic, algebra, geometry, etc., as they apply to the ordinary simple mental or written computations which are demanded of the skilled mechanic in the course of his labor. The drawing is of a practical sort, such as to give the mechanic keener appreciation of working drawings required in construction, and to enable the management to select men of suitable caliber for their drafting rooms as needed. The instruction in English and natural science, of the nature indicated, seemed at the outset of the work to be desirable; and the experience thus far obtained indicates its material value in improving the quickness and intelligence of the young men pursuing the work.

While in the shops the apprentices are under the supervision of the foremen, who in turn are in close touch with the school instructors. The use of the foremen, instead of the special shop instructors employed in some other corporation schools, has much to commend it. The foreman of sufficient intelligence to carry on the industrial operations of his department should have ability, if he is the proper man for his place, to direct the apprentices to proper advantage. Further, adding this special supervision and instructional function to the responsibilities of the foreman seems rather to add to his effectiveness and interest in his work than otherwise. And still further, by using the foreman the

schools are tied up more closely and correlated to better advantage with the industrial organization as a whole than is otherwise possible. The apprentice courses are four years in length. During this time the young men are given a well rounded and broad shop training. They attend the school classes regularly during the first three years.

The school instructors and foremen are required to submit exhaustive weekly, monthly, semi-annual, and annual reports to the organization management. These reports have apparently proved of value in enabling the management to weed out apprentices who are unworthy and to place into line of promotion young men who are of noteworthy merit. This latter function is in itself of sufficient worth to warrant the expense of the school.

The success of the school, though in operation but slightly over two years, has been marked; and the pupils themselves have been enthusiastic over this work. Those completing the course have, in many cases, petitioned to be allowed to continue further. That the management believes the expense of the school to be warranted by the results, is indicated by the fact that it has recently extended the system to other divisions of the railroad.

Tabulation of Data Concerning Instruction by Certain Steam Railroads. A number of important railroads have well-organized systems of instruction of apprentices. Mr. J. W. L. Hale, Head Instructor in the Pennsylvania Railroad Apprentice School, just referred to, recently made a careful study of the instructional work of a number of systems. His findings are summarized in the following tables:

1. EXTENT OF INDUSTRIAL EDUCATIONAL WORK.

Name of road	Where applied	How applied	No. of points where instruction is provided	Headquarters for the Educational Department
Atchison, Topeka & Santa Fe Ry.	To apprentices in the Mechanical Dep't. over the entire system.	Through an organized apprenticeship system extending over entire railway and providing both shop and school instruction.	29 (2–31–11)	Topeka, Kansas.
Canadian Pacific Railway.	To apprentices in the Mechanical Dep't. at the Montreal, Toronto and Winnipeg shops.	Through apprenticeship operated independently at the several shops and providing both school and shop instruction.	3	No central organization for the apprentice work of the system. Each shop operated independently as regards apprentice training.
Delaware & Hudson Company.	To apprentices in the Mechanical Dep't. over entire system.	Through an organized apprenticeship system providing both shop and school instruction.	3	Green Island (Albany, N. Y.).
Erie Railroad.	To apprentices in the Mechanical Dep't.	Through an organized apprenticeship system providing both shop and school instruction.	5	Meadville, Penn.
Grand Trunk Ry.	To apprentices in the Mechanical Dep't.	Through an organized apprentice system providing compulsory evening school instruction and a system of examination for promotion in the shops.	7	Montreal, Quebec.
N. Y. Central Lines.	Same as above.	Through an organized apprentice system providing both shop and school instruction.	12	Grand Central Terminal, New York City.
Union Pacific R. R. Company.	Open to all employees of the railroad. Evening apprentice school at Omaha, Neb.	Through correspondence courses conducted by an Educational Bureau of Information. Apprentice evening school at Omaha.	Reaches all employees who voluntarily apply for instruction.	Omaha, Nebraska.

2. ORGANIZATION EMPLOYED.

Name of Road	Higher Officer in Charge	Officer in Direct Charge	Assistant Officer in Direct Charge	Officer in Charge at Local Shops	Instructors at the Local Shops
Atchinson, Topeka & Santa Fe.	General Supt. Motive Power.	Supervisor of Apprentices.	School Instructor at Topeka, Kansas.	Master Mechanic or Superintendent of Shops.	School and Shop.
Canadian Pacific Ry.	Superintendent Motive Power.	Senior School Instructor.	———	Local Shop Head.	School and Shop.
Delaware & Hudson Company.	Superintendent Motive Power at Albany.	General Efficiency Engineer.	Traveling School Instructor.	Local Shop Head.	School and Shop.
Erie R. R. Company.	General Mechanical Superintendent.	Shop Specialist or Supervisor.	Assistant Supervisor.	Local Shop Head.	School and Shop.
Grand Trunk Railway System.	Superintendent Motive Power.	Chief Draughtsman at Montreal.	———	Local Shop Head	School
New York Central Lines.	General Superintendent Motive Power.	Superintendent of Apprentices.	Asst. Supt. of Apprentices.	Master Mechanic or Local Shop Head.	School and Shop.
Union Pacific R. R. Company.	Vice-President.	Chief of Educational Bureau.	Asst. Chief of Educational Bureau.	———	Apprentice evening school instructor at Omaha only.

4. NUMBER OF INSTRUCTORS AND PUPILS

Name of road	No. of points reached	Total No. of apprs. instructed on system	Total No. of instructors
A. T. & Santa Fe Railway.....	29	645	40
Canadian Pacific Ry.....	3	353 of whom 223 are at Montreal.	School 5 Shop 6
D. & H. Co.....	3	95	School 2 Shop
Erie R. R. Co,.....	5	253	School 3 Shop 3 (?)
Grand Trunk Ry. System.....	7	329	——
N. Y. Central Lines.....	12	690	School 12 Shop 12
Union Pacific.....	2700 from all branches of service. Approx. 175 apprentices included on entire system not all taking course		——