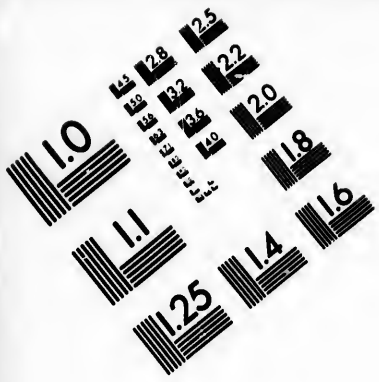

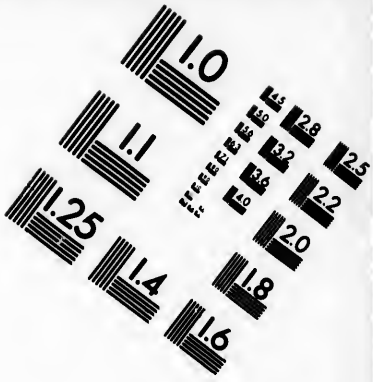

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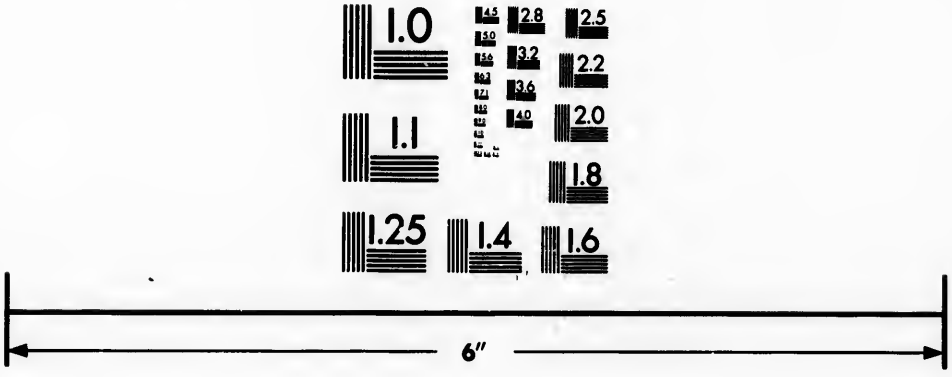

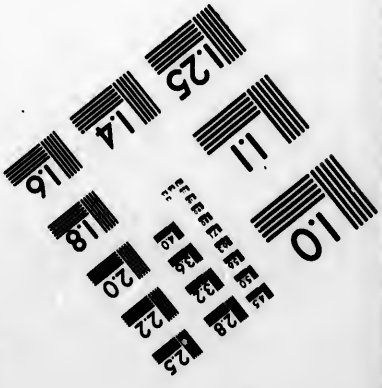

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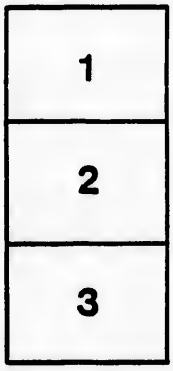

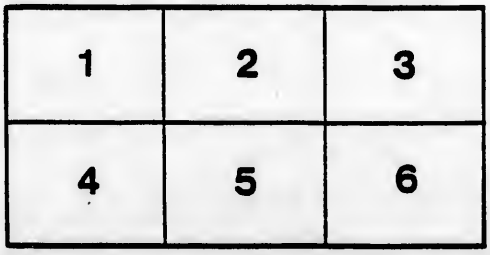

REPORT . . .
ON

TECHNICAL EDUCATION

BY

BERNARD McEVOY

ISSUED BY ORDER OF THE
DEPARTMENT OF EDUCATION FOR ONTARIO
1900

TORONTO:
GEORGE N. MORANG & COMPANY, LIMITED
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PREFACE

In the following pages an endeavour is made to set down in order some of the essential facts with regard to Technical Education, taking Toronto as a typical centre of population and work. In seeking to draw some lessons from the very numerous and extensive institutions in the United States which are devoted to Technical teaching, it was impossible to do more than select a few examples from a field which is surprising both for its extent and for the activity of its operations in educating those who are to deal, in future, with the material resources of that country. The information given is the result of observations made, at the instance of the Education Department for Ontario, in November, 1899.

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Report on Technical Education

By BERNARD McEVOY

(1.)—The great diversity of the trades carried on in Toronto is a feature with regard to the problem of technical education that demands some attention. The first thing in attempting to evolve a general plan for teaching workers such things as will help them in their daily tasks would seem to be to ascertain the sort of work they are likely to be engaged in. Speaking broadly, technical schools are for the purpose of giving instruction in:—

a. The principles of science and art applicable to industries.

b. The application of special branches of science or art to specific industries and employments.

c. The use of typical tools, and such simple machines as embody the foundation principles of machinery in general.

d. The principles and methods of commercial distribution, and such transactions as are connected therewith.

e. The household branches of cooking, needlework and domestic management.

(2.)—The principal branches of industry which we have to consider in Toronto are as follows:

Group 1.—*Building:*—Brick-making, stone-cutting, brick-setting, carpentry, iron girder and pillar making, hoisting, forging, plastering, modelling, stone-carving, wood-carving, painting, decorating, glazing.

Group 2.—*Metal-working:*—Moulding, iron and brass founding, sheet metal working, wire-working, tin-plate working, bridge making, boiler making, plumbing, forging, japanning, grinding, polishing, enamelling, silver and silver-plate working, goldsmith's and jewellery work, gilding, electro-plating, engraving, enamelling (gold and silver), chasing.

Group 3.—*Machine Construction:*—Pattern-making, die sinking and tool making, electrical engineering, ship building, agricultural machine making, carriage and waggon making, planing, fitting, turning, bicycle making, engine and machine building, engine driving.

Group 4.—*Earth Trades:*—Mining, agriculture, horticulture, road-making.

Group 5.—*Printing:*—Type-setting, pressing, lithography and engraving, type-founding, book-binding.

GROUP 6.—*Chemico-Vitreous Trades:*—Glass making, soap and chemicals making, pottery, dyeing.

GROUP 7.—*Human Requisites:*—Carpet weaving, garment making, hat making, millinery, furniture and cabinet making, flour making, baking, boot and shoe making, rubber working, food making.

GROUP 8.—*Commercial Distribution:*—Clerking, railroading, book-keeping, telegraphy, warehousing, packing and shipping.

GROUP 9.—*Household:*—Cooking, sewing, dressmaking, domestic management, household decoration.

(3.)—The courses of instruction necessary to meet the requirements of these trades and callings are as follows:—

SCIENTIFIC—THEORETICAL.

1. *Mathematics:*—Arithmetic, algebra, plane and solid geometry.
2. Theoretical mechanics and dynamics.
3. Sound, light, and heat.
4. Magnetism and electricity.
5. Chemistry, inorganic and organic.

SCIENTIFIC—APPLIED.

1. Chemical laboratory practice.
2. Machine construction and drawing.
3. Building construction and drawing.
4. Naval architecture.
5. Steam.
6. Electrical engineering.
7. Metallurgy.
8. Carpentry, workshop practice.
9. Metal working, workshop practice.

ARTISTIC.

1. Freehand outline drawing from the "round" or solid forms.
2. Perspective.
3. Shading from the round or solid forms.
4. Drawing the human figure or animal forms from the "round" or from nature.

5. Anatomical studies of the human figure or animal forms.

6. Drawing flowers, foliage and objects of natural history from nature.

7. Painting ornament from the cast.

8. Painting the human figure or animals in monochrome from casts.

9. Painting flowers, drapery and groups of still life as compositions in colour.

10. Modelling ornament.

11. Modelling the human figure.

12. Elementary design, and the conventional treatment of natural objects.

COMMERCIAL.

1. Business customs, invoices, commercial paper, bills of lading and manifests.

2. Book-keeping, principles and practice of single and double entry.

3. Correspondence, arrangement and style of business letters.

4. Commercial Geography, physical and mathematical geography in their relations to business.

5. Banking and Finance, outlines of the history of banking and of the Canadian banking system, savings banks, trust and financial companies.

6. Mechanism of commerce, boards of trade, stock and produce exchanges, transportation, warehousing, importing and exporting, duties, exchange, mercantile agencies.

7. Commercial Law. Elementary principles of contracts and negotiable paper, and the leading principles which regulate the relations of the business man, principal and agent, carriers, commission merchants, partnerships, joint-stock companies.

8. The French and German languages.

HOUSEHOLD SCIENCE AND ARTS.

1. Household economics, cookery, food values.

2. Sewing, dressmaking, millinery.

3. The decoration and furnishing of the home.

GENERAL OBSERVATIONS.

(4.) *Age of Pupils.*—The result of my inquiries among directors of technical schools in the United States and in Great Britain is that the age of sixteen should be regarded as the minimum for pupils undertaking special technical studies with a view to their commercial utility. Sir Andrew Noble in a recent address at the City and Guild's Central Technical College, London, said: "In my judgment, the age at which a boy should seriously begin any special studies

with a view to fit him technically for the profession he may have decided to follow, should not be earlier than seventeen or eighteen."

(5.) *Fees or Entrance Examinations.*—I found that most technical instructors and directors in the United States are of opinion, that it is desirable that a fee should be paid by pupils attending technical schools. Dr. James MacAlister, President of the Drexel Institute, Philadelphia, was very decided on this point. He said that he had tried the system of free instruction and found that its tendency was to crowd the classes, especially at the commencement of courses, with those who had no serious purpose of making the best of the privileges at their disposal. The fee might be merely nominal but he had found that it acted as a guarantee of sustained endeavour on the part of the candidate for instruction.

An alternative plan is to institute an entrance examination such as may be readily passed by any person of reasonable capacity, earnestly desiring to avail himself of the privileges of the school, but which would have a deterring effect on those who would otherwise overload the classes to the disadvantage of more capable and eligible pupils. There seems to be no reason for impeding the efficient work of the teacher and lowering the grade of the school by the presence of those whose needs and capacities would be better met by the resources of the ordinary night-school. The failure to recognize that the technical school, properly considered, can deal advantageously with only a percentage of the operative population, must lead to disappointment. While the percentage may be relatively large, it seems desirable to keep within the bounds of it as far as those bounds can be ascertained.

(6.) *The Teaching of Theory.*—The office of the Technical School is mainly and primarily the teaching of theory. In some departments it is true that practice might seem to be its aim—as for instance in the teaching of mechanical drawing, in the workshop-training, in the art department, and in that of household science. Even here, however, handiwork comes in chiefly as experimental theory-teaching, and as a means of impressing upon the mind of the pupil the lessons in theory that he has received. In this respect the technical school is the antipodes of the trade-school, in which the main object is craftsmanship. The technical school teaches theory with a little practice, the trade school teaches practice and a *soupçon* of theory. It seems highly desirable that this basic principle of the technical school should receive due consideration. The school is instituted mainly for the benefit of those who are engaged in the operations of the workshop, the warehouse, and the office, where the greater part of their time is taken up in practice. But their progress is barred by ignorance of the laws that underlie their operations. Moreover it is well to bear in mind the educative influence of theory. "Those technical schools," says Dr. Walker, late president of the Massachusetts Institute of Technology, "will best accomplish their purposes of usefulness, alike to their students and the State, which make more of the sciences than the arts, more of principles than of their applications, and which offer to their pupils in addition to the studies which will make them exact and strong, some of the studies and exercises which will help to render them at the same time broad and kind."

(7.) *The Technical School Museum.*—Technical education in the United States received a powerful impulse from the exhibit made at the Philadelphia Centennial Exhibition, of specimens of work from the Moscow Technical School. That exhibit may be said to have been the seed from which much of the present work in this direction has grown. It taught among other things, the utility of making technical pupils familiar with products and specimens of manufacture from other places, and in most of the institutions for technical education in the

United States the museum takes a deservedly important place. Pupils thus obtain information not only about all sorts of substances and products but of the way in which they are manufactured. For instance they can observe, in the museum cases, not only the various iron ores and chemical combinations of iron, but in their proper place are shown manufactured articles of iron in various stages, and those typical forgings which are the alphabet of ironwork. No technical school can be considered at all complete without its museum, and the effort should be to make this as complete as possible. Specimens of the best manufactures of foreign countries should be obtained, while in the artistic department a selection of reproductions of some of the best works is an absolute necessity.

(8). *The Principal Makes the School.*—This may seem to be a truism scarcely worth entering in this report, but nothing is more observable than that the American managers of technical institutes have for the most part spared no pains in selecting capable heads. No consideration but that of fitness appears to have entered into their choosing. Having selected their man he is made responsible for the entire conduct of the school and is for the most part regarded as the supreme autocrat. I had considerable conversation on this point with a prominent Philadelphia educationist and he told me that he had never recommended the appointment of an instructor which had not received the ratification of his board. In like manner he placed the full responsibility of the various departments on his staff instructors, and while he demanded that their classes should be effective he did not interfere in details. The respective instructors plan their courses and arrange their time-tables. Only in case of the end in view not being attained does the principal interfere. There is no such thing as argument by the board of directors as to whether this or that instructor is to be employed or dismissed. If a class fails in effectiveness its instructor receives his *congé* with the certainty of a law of nature and without any unseemly wrangling by "friends on the board." It is manifest that only exceptional men can be entrusted with such complete powers of recommendation and supervision, and it is instructive to find that in a country in which a susceptibility to the questionable advantages of what is called "pull" is not unknown, there is a department from which it is entirely absent. One reason for this seems to be that a very large proportion of the funds for founding technical institutions has been contributed by business men who have been naturally desirous that business principles should prevail in the administration of the organizations they have subsidized.

At the same time it may be remarked that in the typical case of the Drexel Institute, the staff instructors form a consultative council, which the President from time to time calls to his assistance in deciding on any important question of administration.

TECHNICAL EDUCATIONAL INSTITUTIONS IN THE UNITED STATES.

The establishments for technical training in the United States may be divided into those which teach practice chiefly, and science and art only as they are concerned with the operations of industry; and those, on the other hand, which in a more liberal way teach scientific theory, using practice only as the exemplification of theory. The first appear to be directed to the training of skilled workmen who shall have some rudimentary knowledge of the scientific principles that underlie their work. The second turn out fully equipped captains

of labour—engineers, architects, chemists, managers, foremen, etc., who in the measure of their natural capacity are able to control the largest operations.

The Industrial Institute at Springfield, Mass.—

This is almost exclusively a trade school. New England being largely devoted to manufacturing, there is always a demand for skilled workmen, and it is the supply of this demand that the Industrial Institute takes as its field. This school has diverged more widely from the course of other schools following in the same line of work, by making the work on which the students are employed in learning a trade commercial, the products being sold, or the work being done in open competition with shops in the same line of business. It is a day school, charging $100 per year for tuition. It is a private corporation, receives no State or Municipal aid, and the experiment is being tried of making the receipts from tuition, sale of articles, and work done to order, pay for the cost of tuition. It is operated as a business enterprise and its graduates are said to be in good demand. The courses of instruction embrace kindergarten work, elementary engineering and normal instruction, and the following trades: machine construction, pattern-making, printing, plumbing, blacksmithing, bricklaying, plastering, carpentry and joinery. An opportunity is given the student to learn the trade he may choose in all its branches.

The Rhode Island School of Design, Providence, R.I.—

Provides instruction to artisans in drawing, painting, modelling and designing, that the principles of art may be applied to trade and manufacture. It has a large art gallery, owns some works of art and has loan exhibitions from time to time. The Art Gallery is open free to the public. Instruction is given both day and evening and a tuition fee is charged. It is supported mainly by private subscriptions, the city and State contributing but a small amount. The manufacturers of Rhode Island found it difficult to obtain native designers, and this school is intended to supply the demand.

The School of Industrial Art, Philadelphia—

Represents the most important effort made in America to teach art and science in direct application to the actual needs of an industry. It has a most spacious and advantageous location, probably exceeding in these particulars any industrial art school in America. The munificent gift of $100,000 by Mr. W. Weightman, and a public subscription of like amount in 1893, enabled it to acquire the magnificent property it now occupies at the corner of Broad and Pine streets. The course of study includes instruction in the manufacture of cotton, woollen and silk fabrics. It covers three years of work in fabric structure, fabric analysis and calculations, colour harmony and principles of figured design, mechanical drawing, chemistry of dyeing, carding, spinning and weaving. Its equipment comprises the latest machinery for wool-carding and spinning, worsted drawing and spinning, cotton-carding and spinning, hand and power weaving, jacquard card-cutting, etc. It has also well appointed dyeing and finishing departments, so that students can carry their product through all the necessary processes to the finished manufacture.

The "Regular Course" of instruction enables the student to enter on any branch of manufacture in cotton, wool, worsted or silk. Three years are required to complete this course, and the subjects of study include :—

First Year.—Weave formation—analysis and structure of fabrics—colour harmony—freehand drawing and principles of figured design—mechanical drawing—jacquard design—warp preparation and weaving—chemistry—carding and spinning—miscellaneous lectures.

Second Year.—Weave formation—analysis and structure of fabrics—colour harmony—jacquard sketching and design—wool and worsted spinning—machine drawing—warp preparation and weaving—chemistry—dyeing—wool and worsted cloth finishing—miscellaneous lectures.

Third Year.—Weave formation—analysis and structure of fabrics—colour harmony—jacquard sketching and design—wool, cotton and worsted spinning—machine drawing—warp preparation and weaving—chemistry—dyeing—wool and worsted cloth finishing—miscellaneous lectures.

The foregoing "Regular Course" affords one of the best examples of those I saw in the United States in which the attempt is made to apply science and art teaching directly to the purposes of a special industry. It is the development of fifteen years of active, thoughtful work in textile education, and it must be allowed that, within its limits, it tends to overcome for the individual the narrowness of knowledge which is apt to result from division of labour and specialization in industry.

It is required that pupils undertaking it should be possessed of considerable proficiency in free-hand drawing, that they should be well versed in the common English branches, and that they pass an examination in arithmetic. The fee for the "Regular Course" is $150 for the year of thirty-six weeks.

The school attracts a remarkably good grade of pupils, active, intelligent, earnest young men from eighteen to twenty-five years old, who work in the school as they would in business, from 9 a.m. until 12 o'clock, and from 1 p.m. until 4 p.m., every week-day, except Saturday, when the session is from 9 a.m. until 12.

The object of the school, no doubt, is to turn out cloth manufacturers, and accordingly much time is taken up with weave-formation and analysis, the analysis and structure of fabrics, etc. But in the "Colour Harmony" class, one sees that the institution takes no narrow view of what a cloth manufacturer should know. Here are taught the theory of colour, the drawing of diagrams showing primary, secondary, and tertiary colours and their relation to each other, the mixing and grinding of pigments, colour matching from yarns and printed fabrics, harmonies of analogy, self-colour and analogous colour, etc. This is in the first year. In connection with this branch of study, the Principal gives a course of illustrated lectures on the derivation and history of ornamental forms, principles of design, conventionalization and the theory of colour. In the same year we find the textile pupil undertaking a course of mechanical drawing which includes elementary geometrical problems, orthographic projections, cycloidal and involute curves and their adaptation to toothed gearing, the construction of cams for producing weaves and for other motions used in textile machinery. These lessons occupy a period of two hours per week for twelve weeks of the school year.

Again, the pupil learns chemistry both in the lecture-room and in the experimental work of the laboratory. He takes up in the first year general inorganic chemistry, including the general properties of matter—simple and compound bodies—laws of chemical combination—elements, atoms and molecules—the atomic theory—chemical calculations—preparation, classification and chemical behaviour of the chief elements and their compounds, comprising the

non-metals and metals, with special reference to those of commercial importance. In the Second Year he takes up qualitative and in the Third quantitative analysis.

Proceeding still with the textile work of this school, we find that it has also a "Cotton Course," a "Wool and Worsted Course," a "Silk Course" and a "Chemistry and Dyeing Course," each of which takes two years. There is also an "Ingrain Carpet Course" of one year. For each of these courses the fee is $150, for the year of thirty-six weeks with the exception of the "Ingrain Carpet Course" which is $75.

Besides the day classes there is an evening school, the aim of which is to cover in a general way what is given in the day classes. The evening classes are held from 7.30 to 9.30 on Mondays, Wednesdays and Fridays, and the fee for any one of the courses is $15. The shortness of the time, however, renders it impossible to treat exhaustively any particular branch, and it is expected that the instruction given in the class will be supplemented by a considerable amount of home study.

In addition to the Textile side of this valuable institution, the following schools are in operation there :—

School of Drawing.
School of Applied Design.
School of Normal Instruction.
School of Woodwork and Carving.
School of Decorative Painting.
School of Illustration.
School of Decorative Sculpture.
School of Architectural Design.
School of Modern Languages.

The annual enrollment in these departments as a whole now amounts to about 900.

In the Art schools and Language classes the fees are $60 per year, or $10 per month for the day classes, and for the evening classes $12 per year, or $2.50 per month. The Life class is $3 per month. The art instruction in all these classes is of a high order. In this, and in other American schools, I noticed that considerable attention is devoted to drawing from plants, flowers and other natural objects. Among other specialties a weekly sketch-class, using the costumed model, makes good and constant use of the large collection of historical costumes belonging to the school. The school buildings enclose a large open courtyard, which is used as a flower garden—the walls being covered with vines; this offers exceptional facilities for out-of-door study, and when the weather permits it is used by the sketch class.

I have given considerable space to this Philadelphia institution, because I consider that it represents a very high type of a special form of educational endeavour. It has the advantage of being under the guidance of a Principal, Mr. L. W. Miller, who is a man of great strength of character, large attainments, and very decided views as to what he wants to do. The following remarks, which are extracted from an address he gave before the Art Club of Philadelphia, on "The Claims of Industrial Art in Modern Education," set forth in a lively manner the aims that are pursued at this school:

"The ground on which industrial education is usually advocated (quite apart, of course, from the question of its value as a part of general education with which it is no part of my present purpose to deal), is something like this. The apprentice system has died, or is dying

out. Our industries suffer from the want of the skill and experience in all branches of the different trades which the apprenticeship system supplied, for which state of things the division of labour, due partly to the perfection of machinery, and partly to better economical organization, and the spread of trade unionism, are about equally to blame. The remedy being the provision of organized instruction in the elements of all the trades, in the hope that this will fill the place left vacant by the apprenticeship system that is gone, and shall be by its philanthropic and educational character secure from the assaults of the wicked trade unions.

"Now, without going very deeply into the discussion which these statements invite, I ask my audience to note that they fail to touch the real root of the matter. In the first place the apprenticeship system (so far as it is really gone) did not pass away a moment before its time. We need waste no sympathy over it, nor fling away any regrets after it. Master and man alike are better off without it, and in the second place we have done, and have so far shown a disposition to do, next to nothing to fill its place.

"This is not quite the right way to put it, because it is not so much its place that we have to fill as the work to do which it failed to accomplish, or which at any rate it could not have accomplished under the changed conditions which have come over the industries, themselves, or as the increasing demands which advancing standards imply are made, upon the workman.

"The need of the hour in America, if our industries are to prosper, is organized and thorough instruction—not in the elements of all trades, but in the trades themselves, carried as far as it is possible to carry it, and in art as applied to the trades.

"I am sorry to say that in most of the discussion which the subject has hitherto received, neither of these seem to have been accorded anything like the prominence which they deserve. In a vague and general kind of way, it is true, the feeling has often been expressed that our industries were deficient in design, and more or less earnest efforts have been made to supply this deficiency by the establishment of schools of design, in which very good work has often been done no doubt, but it has been for the most part either of so general, not to say elementary a character, and with its efforts so diffused over the whole field of art study, that its industrial purpose is hardly apparent, or it has been so purely technical, so much occupied with teaching the mere methods of the designer, as to deserve no recognition as art instruction at all.

"On the other hand, such efforts as have been made to furnish instruction in craftmanship pure and simple have curiously enough, been dominated by a determination which has been reiterated so often, and in so many quarters, that there can be no doubt of the deep-seatedness of the error for which it undoubtedly stands, that the trades themselves shall not be taught, only smatterings and beginnings, only rudiments and fundamentals, only the use of simple and primitive tools, and the application of the most general principles and processes.

"The need of the hour is for trade schools that shall carry their pupils far in the trades themselves, that shall instruct them in doing as well as it can be done, the work which the trades represent. The industries do not need beginners who are willing to learn, and have been started in the way of learning, but masters of their craft, trained as only modern scientific methods can train them in a knowledge of approved methods and the reasons for their approval—men trained to a high degree of skill under the eye and the example of those who have gone farthest in these crafts already, and saturated with the influence of the best productions of the ages which are gone.

"It is all nonsense to say, as I have heard it said lately, that trade schools are not practicable, and have not succeeded where they have been fairly tried. Europe depends upon them to-day for leadership in their skilled industries, as we depend upon the sun for light and upon the earth for food.

"Go with me into almost any district with which a special industry is identified, and I will take you to the trade school in which that industry is thoroughly and practically taught. Look at the schools for wood-carving in the Tyrol, for watch-making in Switzerland, for furniture and cabinet work, and jewelry, and mosaic, and pottery, in Paris, for the silk industry at Lyons, for other classes of textile manufacture in Germany, and so on through a list which I need not extend.

"Such schools are not elementary institutions for familiarizing the pupils with the tools used in these industries, they are true conservatories of the crafts which they represent, and bear to them the same relation that our schools of law and medicine and engineering do to these professions. It is for similar schools that the industries are starving in America to-day."

In the utilization of the museum as an instructive auxiliary, the Philadelphia School of Industrial Art is pre-eminent. The institution owes its origin to the increased interest in art and manufactures awakened by the Centennial Exhibition of 1876. Pending the incorporation of the institution, the sum of $25,000, was subscribed with which to make purchases at the Exhibition, and in

several instances the institution was the recipient of valuable gifts from individual exhibitors. The British Government presented it with the major part of the magnificent collection of the products and manufacture of British India, shown at the Exhibition. Around the nucleus thus formed the museum has grown by purchase, gift and bequest to its present proportions, numbering upwards of ten thousand objects. It is open free to the public, and is visited by 400,000 persons annually.

The average salary of instructors is $100 per month.

The Spring Garden Institute, Philadelphia—

This institution is somewhat on the same lines as the preceding, but it is of smaller dimensions, does not touch textile manufactures, and concerns itself chiefly with art-teaching, mechanical engineering and applied electricity.

It has night classes in mechanical drawing, freehand drawing from object, cast and life, designing, architectural drawing, mechanical handiwork, applied electricity; and day classes in freehand drawing from object, cast and life, designing, oil and water-colour painting, china painting, mechanical drawing, mechanical handiwork, applied electricity.

This school has an endowment fund of $158,000. The story of its evolution is exceedingly interesting and instructive. In 1850 was formed the "Young Man's Institute" in Philadelphia, the sum of $30,000 being raised among generous citizens "to encourage and foster among the young men of our labouring population the spirit of self-improvement by the establishment of libraries, reading-rooms, lectures, etc." It was the intention of the contributors to give assistance in the foundation of local institutes which should be distinct organizations and as far as possible, self-reliant and self-sustaining. The efforts of the Young Man's Institute were confined to these purposes, and it has remained a corporation with no lands or buildings, but with the record of having afforded effective aid to the cause of public education.

One of the first institutions helped by it was the Spring Garden Free Reading Room, which had life in it, and the managers of which were anxious to develop it into a teaching organization for young men. These managers procured the gift of a building lot and $3,000 in subscriptions, and borrowed $5,000 from the Young Man's Institute. This was in 1851. The work of the institute was carried on with varying degrees of success, but by 1876 it had somewhat fallen into decay. A revival came to it through the Centennial Exhibition of 1876, which has been before alluded to in this Report as a fountain of much energy in the cause of technical education, and from this time onward its course has been increasingly successful, several "windfalls" in the way of bequests and generous donations having smoothed the path of the managers and enabled them to lay by the endowment fund which has already been mentioned. Among those who took an active part in its revivification were the managers of the adjacent Baldwin locomotive works, who not only gave $15,000 towards the endowment fund, but subscribe $1,000 annually towards the expenses. The school is governed by a Board, of which Mr. Addison B. Burk, Editor of the *Philadelphia Ledger*, is the chairman, and receives no subsidy either from the city or the State. It has in its classes about 550 pupils, its premises are particularly well adapted to the work done, and are worthy of inspection by any building committee or architect desirous of erecting a building for a similar institution. It possesses a fine steam electric plant and well equipped mechanical workshops both for wood and iron.

The instruction given at the Spring Garden Institute may be placed under three heads—art, mechanical handiwork, and applied electricity. Its tendency

is towards what may be called direct technical teaching, and it lays considerable stress on workshop practice. Thus the mechanical pupils work eight hours per day as they would in a factory, and are therefore able to acquire a considerable amount of efficiency in craftsmanship.

The courses of instruction in both the day and evening classes are arranged for three years. With regard to the Art Course I will only observe that it seemed to me very intelligently graduated and effective. The school has the advantage of a very complete equipment of casts, etc., and is under the care of a very able Principal, in the person of Prof. W. A. Porter, a graduate of the South Kensington Museum.

The other courses which demand mention in this report are those of architectural drawing, in which I observed several women students, mechanical drawing, very successfully conducted by Mr. Wm. H. Miller, and the course in electricity.

The Architectural Course aims to be practical in so teaching principles that pupils may be able to understand such drawings as they will be likely to use in their trades or be required to make, and that they may also learn to be skilled draughtsmen, and develop whatever talent they possess for original design.

The Mechanical Drawing Course is as follows:—

First Year.—(1) Definitions of all geometrical terms likely to occur in mechanics.

(2) Construction problems in plane geometry, viz; all problems likely to be of practical use in laying out work.

(3) Orthographic Projection—first lines only, then surfaces, then solids, giving three tilts, with development of surfaces and making paper models of same.

(4) Drawing of simple mechanical forms from sketches which only show two views, and requiring pupils to develop *third* view for themselves.

(5) Making original sketches from some detail of machinery, and making working drawing of same. Drawing of helix and screws.

(6) (For examination First Year). A complete drawing of some detail of machinery from original sketches. This drawing is figured, lettered and coloured in the sections.

Second Year.—Designing of cams.

Gearing—cycloidal and involute through bevel wheels.

Motion Curves.

Valve motion and the travel scale.

Drawing of machinery from original sketches.

Third Year.—All drawing from original sketches, and reviewing earlier work where necessary to *individual* pupil. General and detail drawings complete.

There is absolutely no copying of other drawings.

Practical Electricity :—

The evening course of lectures in practical electricity is as follows:

ELEMENTARY CLASS.

Thursday Evenings, at 8 p.m.

Each lecture is thoroughly illustrated, experimentally, graphically and pictorially and is supplemented by a night of individual work in the electrical laboratory with a complete set of students' electrical instruments.

LECTURES.

I. Phenomena and Properties of Electrostatics.
II. Electrostatics (concluded).
III. Phenomena and Properties of Magnetism.
IV. Magnetism (concluded).
V. The Elements of Voltaic Electricity.
VI. Voltaic Electricity (concluded).
VII. Properties of the Electric Current.
VIII. Magnitude of the Properties as a Means of Current Measurement.
IX. The Property of Electrical Resistance.
X. Laws Governing the Electric Circuit.
XI. Practical Applications of Laws of Electric Circuits.
XII. Electromagnetism (Electric-Magnetism).
XIII. Galvanometers, their Construction and Use.
XIV. Measurement of Current Strength (Ampere-meters).
XV. Electrical Work and Power.
XVI. Measurement of Electrical Pressure (Voltmeters).
XVII. Measurement of Electrical Resistance (Ohmmeters).
XVIII. Electrodynamics and Measurement of Electrical Power (Wattmeters).
XIX. Phenomena and Elements of Electromagnetic Induction.
XX. Dynamo Electric Machines (their Principles, Construction and Operation).
XXI. Dynamos (concluded).
XXII. Electric Motors and Power Transmission.
XXIII. Modern Applications of Electricity.
XXIV. Alternating Current Induction Phenomena.

Second Year, Night Class.—

This course includes a more detailed study of the subjects practically considered in First Year work, and the applications of the principles thus

mastered to commercial electrical apparatus and systems of lighting and power transmission. The laboratory work includes the operation and testing of dynamos, motors, arc lamps, etc., with particular attention to the development of faults in apparatus, and their remedies.

The instructor's text-book is supplemented by Morrow & Reid's "Arithmetic of Electricity and Magnetism."

Third Year, Night Class.—

The work of this class is entirely of an experimental character. A number of specially prepared exercises in electrical measurements and testing have been organized, with a view of giving the student a clearer knowledge of the subject, this being possible by reason of his two years' previous experience with the subject. The class works together as a whole, each set of students on a different exercise, however, the order being rotated from test to test, night after night. Text-books previously used by the student are further supplemented by Ayrton's "Practical Electricity."

Students are eligible to this class who have taken the regular two-year Institute course in electricity.

In the Electrical Department there is a chief instructor who receives a salary of $1,800, and two assistants who receive $1,000 per annum each.

The fees payable at this Institute are as follows:

ART DEPARTMENT.

Night Classes.—Two nights per week from 7.30 to 9.30 p.m. Term begins October 2nd and ends April 7th.

Mechanical Drawing	$5.00 per term.
Freehand Drawing	" "
Designing	" "
Architectural Drawing	" "
Life Class	" "
Geometry and Perspective	Free.

Pupils are admitted to the Life and Designing Classes only after receiving certificates in freehand drawing.

Day Classes.—Five days per week, from 9 a.m. to 2 p.m.

Term begins September 18th and ends June 15th.

Freehand and mechanical drawing, painting, etc., two terms, twenty weeks each, $20 per term.

No deduction in fees is made for pupils who take a less number of lessons than the number to which they are entitled.

MECHANICAL DEPARTMENT.

Night Classes.—Two nights per week, from 7.30 to 9.30 p.m. Term begins October 2nd, and ends April 7th.

Shop work (wood or metal), $5 per term.

Day Classes.—Six days per week, from 8 a.m. to 5 p.m., except Saturday, 8 a.m. to 12 noon. Term begins October 2nd.

Three terms, 12 weeks each, $20 per term, first year; $25 per term, second and third years.

A summer term of 12 weeks, not included in the regular course, begins June 18th.

Night Classes.—Two nights per week, from 8 to 9.30 p.m. Term begins October 2nd.

Primary class, $10; advanced class, 2nd year, $15; advanced class, 3rd year one night per week, $10. Pupils are admitted to the advanced class who have received certificates in the primary class, or who can pass a satisfactory examination.

Day Classes.—Two periods per week, $5 per term.

The Franklin Institute, Philadelphia—

Founded in 1824, the Franklin Institute which has been called a "democratic learned society" is known throughout the scientific world, to which it has rendered, and still renders, important service. It is mentioned in this report on account of the following schools which are conducted under its auspices, viz:—

(1.) SCHOOL OF ELEMENTARY MATHEMATICS.—The purpose of this school is to place within reach of the many ambitious young men engaged in industrial pursuits, who wish to improve their opportunities of studying technical subjects in their limited leisure, a means of overcoming the one great obstacle to their advancement, viz.: an insufficient knowledge of mathematics.

Course of Instruction.—Winter term, September 18th, to January 5th.

Spring term, January 8th, to April 20th. The duration of a term is fifteen weeks of four class hours each. Classes are in session Monday and Friday evenings, from 7.15 to 9.15 o'clock. Tuition fee $5 per term. The course is divided as follows:

CLASS A.—Algebra: Fundamental rules, algebraic theorems, fractions, factoring, simple equations.

CLASS B.—Algebra: Involution and evolution, theory of exponents, radicals, quadratic equations, proportion and progressions.
Plane Geometry: Book I.

CLASS C.—Plane Geometry: Books II., III. and IV.
Plane Trigonometry: Measurement of angles, trigonometric ratios, algebraic signs, angles with given trigonometric ratios, trigonometric ratios of two angles.

CLASS D.—Plane Geometry: Book V.
Plane Trigonometry.
Logarithms: Use of mathematical tables, relation between sides and angles of a triangle, solution of triangles.

While, at the outset, the instruction is of an elementary character, it is necessary for the student to possess a fair working knowledge of arithmetic. Familiarity with the four fundamental rules, fractions and decimals, is sufficient preparation.

(2.) THE DRAWING SCHOOL is divided into the following classes:

Junior Mechanical Class.—In which drawing tools and their proper manipulation, lines, surfaces, and single solids with plane surfaces are treated.

Intermediate Mechanical Class.—In which solids with curved surfaces, the intersections of solids and the development of their surfaces are treated.

Senior Mechanical Class.—In which the methods, technicalities, and style of draughting and designing engineering work are treated.

Architectural Class.—In which designs, plans, elevations and details of buildings and of interior and ornamental work are treated.

Free-hand Class.—In which free-hand drawing with pencil, pen and crayon from the flat and from cast is treated.

The full course comprises four terms, at the end of which certificates are awarded to such students as have shown sufficient attention, industry, and progress. The tuition fee is $5.00 per term of fifteen weeks. The class-rooms are open on Tuesday and Thursday evenings at 7 p.m. Instruction commences at 7.15 and ends at 9.15. School tickets admit to the Institute lectures on Friday evenings.

The winter term begins September 19th, and ends January 4th. The spring term begins January 9th, and ends April 19th.

(3.) THE NIGHT SCHOOL OF NAVAL ARCHITECTURE:

Course of Instruction: The course of instruction in Naval architecture embraces:

Theoretical naval architecture; ship construction and design.

THEORETICAL NAVAL ARCHITECTURE

is treated as follows:—

(1) The several rules for the determination of plane areas with proofs and methods of combinations of same.

(2) Application of the rules to finding volumes to the different water lines, etc.

(3) Displacement sheet and use of planimeter.

(4) Curves of displacement. Tons per inch. Areas of midship section and their co-efficients.

(5) The centres of gravity of plane areas and their properties.

(6) The centre of buoyancy, vertically and longitudinally, for change in draft and loci.

(7) The transverse and longitudinal metacentres and their loci, with trim, centres of effort, and pressure.

(8) Tonnage, freeboard and surplus buoyancy.

(9) The different methods of approximating to the surface of a vessel.

(10) Statical and dynamical stability and curves for same for particular vessels and under peculiar conditions.

(11) Mechanical methods for determining stability at various angles of inclination, including the use of integrator.

(12) Curves of buoyancy, loads, shearing force and bending moments of different classes of vessels floating in still water.

(13) The inclining experiment.

(14) Matrial, stress and strain, tests of.

(15) Riveted joints, comparing strength of different arrangements.

(16) Investigation of the formula $\frac{PM}{YI}$

(17) Resistance, different theories of, at surface and deeply submerged; law of comparisons and diagram of ship from that of model; tank experiments.

(18) Waves, species of, made by a ship in motion.

(19) Propulsion, the different ways IHP is expended, curves of IHP, slip and thrust.

(20) Speed trials and their analysis.

(21) Stress on upper edge of sheer strake when vessel is inclined, and on the structure of the hull for different conditions of lading.

(22) Particular calculations, such as required for launching diagrams, sizes of rudder-head, tillers, davits, estimating weights and costs.

SHIP CONSTRUCTION AND DESIGN

is treated as follows:—

(1) The practical work in drawing room, which consists in tracing detail drawings, etc., so that the student shall become familiar with technical terms and the use of the different drawing instruments, then deriving and plotting the several curves as enumerated in theoretical naval architecture, and comparing the scantlings of a given steel steamer with the different insurance societies' rules.

(2) Preparing a "sheer draft," using the different "fairing up" processes.

(3) The "work in mould loft," making moulds, scrive board and models.

(4) The different methods of preparation and assembly of the various parts of a ship in proper order, preparing slip, laying blocks and ordering materials.

(5) Different methods of bending and setting frames, reserve frames, floors and beams, laying and fitting different kinds of keels and keelsons.

(6) The stem, stern, frame and rudder forgings.

(7) Examining the different kinds of double bottoms, bulkheads, stringers, ties, pillaring, engine seats, tunnels and tools, deck plating, bunkers and uptakes, hatches, erections (such as deck houses, bridges, etc.,) wood decks, ceiling, painting and cementing.

(8) Description of the building of different and particular kinds of vessels, both for mercantile and naval marine, such as floating docks and derricks, caissons, bulk oil steamers, launches, torpedo boats, cruisers of different types, armourclads, etc.

(9) Masting and rigging, steering gear, anchors and cables, pumping, flooding, draining and ventilating arrangements, electric lighting, voice tubes and telegraphs, boats, rafts and life-saving appliances and numerous other details of equipment.

It is in contemplation to extend the scope of the school to include instruction in MARINE ENGINEERING, as soon as circumstances will warrant.

The Master Builders' Mechanical Trade School, Philadelphia—

I inspected this institution, which is a fair sample of the Trade School, *i.e.* that in which the teaching of theory is reduced to the minimum, and the principal attention devoted to craftsmanship. But the school is at present in a

state of quiescence, the Governor of the State of Pennsylvannia having vetoed the grant of $3,500 per annum, hitherto given, and which enabled it to meet the deficit arising from the insufficiency of the fees paid by pupils to pay the expenses of the school. Instruction is given in the following trades:—Carpentry, bricklaying, plastering, stone-cutting, blacksmithing, painting and plumbing. The classes are held in the evening, and the entire course is planned for nine months' duration. The instruction is said to be "both manual and scientific." A trade is taught in all its branches by skilled mechanics, and the reason why one method is right and another which seems to produce the same result, is wrong, is carefully explained. Progress at a Trade School is necessarily rapid. It is constantly sought to ascertain not only what the pupil knows, but in what he is deficient. Such a system can rarely be pursued in a workshop, where each employee is necessarily employed upon the work he can do best. The classes are intended for young men between sixteen and twenty-one years old, and the charge for the entire course of nine months in each trade is $27, which is payable when the name is entered for admission. No additional charge is made for tools or material. I saw a small house which had been erected by pupils of the school as part of their lessons. It was about a quarter "life-size," and exhibited good workmanship. Specimens of iron-work and plumbing done by the pupils were also on view. The former were replicas for the most part of the examples of blacksmithing contributed by the Moscow Technical School to the Philadelphia Centennial Exhibition of 1876, copies of which I saw with recurring evidence of their instructiveness in various schools. The classes are held from 7.30 to 9.30 p.m.

The Drexel Institute, Philadelphia—

The Drexel Institute, is a most complete organization for industrial education, and it bears evidences of thoughtful planning throughout its spacious accommodation. It is said to have been modelled to some extent on the Pratt Institute, of Brooklyn, N.Y., and as the latter is some years its senior, being founded in 1887, while the Drexel began in 1891, it is probable that the experience already obtained at the Pratt Institute was utilized. Both institutions are the result of princely gifts on the part of citizens. The Pratt Institute has an endowment fund of $3,500,000, while the donations of the late Anthony Drexel to the institute that bears his name, amounted to $3,000,000.

The Drexel Institute was built and developed under the supervision of its present President, James McAllister, L.L.D., who formerly occupied the position of Superintendent of Education in Philadelphia. To his administrative ability, the institution no doubt owes much of its success. Its chief object is "the extension and improvement of industrial education as a means of opening better and wider avenues of employment to young men and women. In accordance with the founders desire, however, the plan of organization has been made comprehensive, providing liberal means of culture for the masses by means of evening classes, free lectures and concerts, the library and the museum. The building in which the organization is housed is exceedingly complete and symmetrical. It has a great central court sixty-five feet square, the entire height of the building, around which are the class-rooms in three stories and opening off broad galleries. It has an auditorium capable of seating 1,500 persons and containing one of the finest organs in the country, while the lecture-hall opening off the central court has chairs for 300 students, and is equipped with every appliance necessary for scientific experiments. Among its accessories is a large gymnasium with bath-rooms. In the basement are the very extensive, steam mechanical and electrical plants that almost give the

visitor the impression that he is in the premises of a large manufactory. In the scores of class rooms from 1,200 to 1,300 students are instructed. The building and its equipment cost a million dollars. The average amount paid by the students for the day courses is $50 to $80 per session of six months, while for the evening courses about $5 per session is paid. Staff instructors receive $2,800 per annum, assistants from $600 to 1,200. There are free scholarships for deserving students, and the institute is open to both sexes on equal terms. Systematic courses are organized for the benefit of the evening students, and certificates are granted to those who finish these courses and pass the required examinations. The Institute also carries on a large and important work through the means of the free public lectures and concerts which are given during the winter months. These lectures aim to furnish opportunities for general culture to the public at large. During last year the attendance at the lectures and concerts was more than 36,000.

DEPARTMENTS.

The Institute is organized in the following Departments:—

I.—DEPARTMENT OF FINE AND APPLIED ART

School of Illustration.

School of Drawing, Painting and Modelling,

Course in Design and Decoration. Three years.

Course in Architectural Drawing. Two years.

II.—DEPARTMENT OF MECHANIC ARTS.

Three years' systematic course in mathematics, mechanical drawing, free-hand drawing, science, English language and literature, history, civics, shop-work in wood and iron, applied electricity.

III.—DEPARTMENT OF SCIENCE AND TECHNOLOGY.

Course in Electrical Engineering. Two years.

Course in Machine Construction. Two years.

Course in Mechanical Drawing. Two years.

Special Courses in Mathematics, Physics, Chemistry.

IV.—DEPARTMENT OF COMMERCE AND FINANCE.

General Course in Commerce and Finance. Two years.

Commercial Course for Teachers. One year.

Office Courses in Bookkeeping, Stenography, Secretary Work. One year each.

V.—DEPARTMENT OF DOMESTIC SCIENCE AND ARTS.

Junior Course in Domestic Science and Arts. Two years.

Advanced Elective Courses in Domestic Science and Arts.

Special Courses in Household Economy and Cookery.

Normal Course in Domestic Science. Two years.

Normal Course in Domestic Arts. Two years.

Courses in Dressmaking.

Courses in Millinery.

VI.—NORMAL DEPARTMENT FOR THE TRAINING OF SPECIAL TEACHERS.

Manual Training, Commercial Instruction, Domestic Science (Cookery and Household Economics), Domestic Art (Sewing, Dressmaking and Millinery).

VII.—DEPARTMENT OF PHYSICAL TRAINING.

Special Courses for young men and young women.

VIII.—DEPARTMENT OF EVENING CLASSES.

Courses in all the Departments of the Institute.

IX.—FREE EVENING CLASSES IN CHORAL MUSIC.

X.—DEPARTMENT OF FREE PUBLIC LECTURES AND CONCERTS.

Courses of Lectures in Art, Science and Technology.

Organ Recitals and Concerts during the winter months.

XI.—LIBRARY DEPARTMENT.

The Library contains twenty-four thousand volumes. Open free to the public daily, except Sunday.

School for the Training of Librarians, in connection with the Library.

XII.—MUSEUM DEPARTMENT.

The Museum, containing valuable and important collections of textiles, wood-carvings, metal work, ceramics, casts, paintings, drawings, prints, etc., is open free to the public daily, except Sunday.

While some of the courses are specially designed for either young men or young women and are quite distinct in their arrangement and management, all the general courses are open to both sexes, on the same terms and conditions.

The academic year is divided into two terms, beginning in September and February, respectively.

The evening classes begin October 1st and close March 31st.

The Department of Evening Classes is most interesting and instructive, and the sight of the spacious, well-lighted and particularly clean class rooms, filled with earnest and intelligent students is an inspiration. All the resources in the Institute in the way of teaching, laboratories and appliances of every kind are brought to bear upon the Evening Classes. The session is for six months, beginning October 1st and continuing until April 1st. Some of the Courses are as follows:—

ART COURSE.

I. Free-hand drawing—Monday and Wednesday. Fee $3.

II. Drawing from the Antique—Tuesday and Thursday. Fee $3.

III. Clay Modelling, Elementary and Life Classes —Monday and Wednesday. Fee $3.

IV. Life Class—for men—Tuesday, Thursday and Friday. For women—Monday and Wednesday from 7 to 10 p.m. Fee $6.

ARCHITECTURAL COURSES.

I. Course in Architectural Drawing—Tuesday and Thursday. The full course occupies two sessions (years). Fees First Year $4. Second Year $5.

II. Course in Architectural Design—Tuesday and Thursday. Fee $5.

III. Course in building construction—two years.

First Year Class.—Wednesday evening, at 7.30. Lectures on the strength of building materials, investigation and calculation of the strength of tension members, compression members, beams, plate-girders, foundations, etc. Graphic analysis of the stresses in the ordinary forms of roof-trusses. Calculation of the weights of materials and of the usual loads upon floors, roofs, etc.

Second Year Class.—Saturday afternoon, 2 to 5. Lectures on the design of structural parts and the best and most economical forms of construction. Advanced calculation. Design and detail of complete construction. Specifications.

Drawing and Testing Class.—Monday evening, at 7.30. For both the first year and the second year class. Drawing of details of foundations, columns, roof-trusses, joints in wood and steel construction, timber work, riveted steel work, pin-connected work, and all kinds of structural detail. Testing of strength of stone, brick and cement; also tension, compression, and transverse tests of steel and timber, and of the various combinations used in building construction.

Equipment.—The Institute is equipped with all appliances for making these tests in the latest and most approved manner, including a 200,000 pound Olsen Automatic and Autographic machine and a Standard Cement Tester.

Certificate.—In order to obtain a graduate certificate, a student must complete the full course of two years and must prepare, as a thesis, the design and detail of a satisfactory piece of construction.

Requirements for Admission.—For admission to the first year class, a knowledge of elementary mathematics (algebra and plane geometry) and mechanical drawing is required; to the second year class, a knowledge of the subjects embraced in the first year class.

Fees.—Elementary Class, $5; advanced class, $6.

IV. Course in house construction—two years.

First Year.—The drawing of plans and elevations and various woodworking details.

Second Year.—Continuation of the work in detail drawing and the study of specifications.

Lectures on plumbing, heating, and lighting are given in connection with the work on specifications.

Examinations are held in the middle and at the end of each session.

Fees.—First year, $4; second year, $5.

SCIENCE COURSES.

MATHEMATICS.

I. *Beginners course in Algebra and Geometry.*—Tuesday and Thursday. Fee, $3. A knowledge of arithmetic is required for admission to this class.

II. *Advanced Algebra and Geometry.*—Monday and Wednesday. Fee, $3.

III. *Plane Trigonometry.*—Wednesday. Fee, $3.

IV. *Analytical Geometry.*—Thursday. Fee, $3.

V. *Calculus.*—Tuesday. Fee, $3.

MECHANICAL DRAWING.

Orthographic projection; intersections; developments and their applications to machine construction, etc. Monday and Wednesday; Tuesday and Thursday. Fee, $3.

CHEMISTRY.

I. *General Chemistry.*—Lectures and laboratory work. Tuesday and Wednesday. Fee, $5.

II. *Elements of Qualitative Analysis.*—Laboratory work. Tuesday and Wednesday. Fee, $5.

III. *Elements of Quantitative Analysis.*—Laboratory work. Tuesday and Wednesday. Fee, $5.

IV. *Advanced Quantitative Analysis.*—Laboratory work. Tuesday and Wednesday. Fee, $5.

V. *Technical Analysis.*—Tuesday and Wednesday. Fee, $5.

This course is designed for advanced students who desire to fit themselves for dealing with the practical problems of engineering chemistry. The course embraces the following subjects:—

Fuel.—Proximate analysis of coal; moisture, volatile matter, coke, ash and sulphur. Specific gravity and calorific value.

Gas.—Determinations of carbon di-oxide, oxygen, carbon monoxide, hydrogen and nitrogen, employing the Elliot, Fisher-Orsat, and Hempel forms of apparatus.

Water.—Total solid matter, temporary and permanent hardness, chlorides sulphates, nitrates, also silica, iron, oxide, alumina, lime, magnesia potash, and soda.

Lubricating Oil.—Specific gravity, viscosity, cold test, flashing point, loss in weight on exposure to elevated temperatures, tendency to oxidize and gum, percentage of mineral and of fatty oil, free fatty acid, free mineral acid, suspended matters, rosin oil.

A deposit of $3, as security against breakage, is required of students in the chemistry classes. This is returned at the close of the session, less the cost of the apparatus destroyed.

PHYSICS.

I. *Laboratory Course.*—Tuesday and Thursday. Fee, $5.

II. *Special Course for Advanced Students.*—Lectures and laboratory work. Tuesday and Thursday. Fee, $5.

A deposit of $3, as security against breakage of apparatus, is required of students in physics. This is returned at the close of the session, less the cost of the apparatus injured.

APPLIED ELECTRICITY.

Evening classes in Applied Electricity, are provided for those unable to avail themselves of the day classes. The instruction and training are of the most practical character. In the Second Course, such scientific and technical work is taken up as can be accompiished with the amount of mathematical knowledge required for admission.

There are two courses, as follows:—

First Course.—A course of one year, embracing the simple theory of the electric circuit and its commercial application in lighting and power distribution, etc., with laboratory work in testing. Class-room work, Thursday, laboratory work, Tuesday or Friday. Fee, $5.

This course is intended for men who have not the time to devote to the study of physics and mathematics, and is designed to prepare them for operating electric plants.

An examination in arithmetic and the simpler algebraic forms must be passed for admission to this course.

Second Course.—A systematic course of two years, embracing lectures on the theory and practical application of continuous and alternating currents. The electrical measurements and tests used in general engineering work are made in the laboratories. First Year Class, Tuesday and Thursday; Second Year Class, Tuesday and Friday. Fee, $6.

Students not having a knowledge of plane trigonometry, must attend the class in that subject during the first year, as a part of the preparation for the second year's work.

The Second Course is intended for those who have had some scientific training and are engaged in, or desirous of preparing themselves for the higher grades of electrical work.

The practical work of the students is carried on in the electrical laboratories which are equipped with an extensive plant of engines, dynamos, testing apparatus, etc.

For admission, applicants must have knowledge of laboratory physics, elementary algebra, and plane geometry.

Students entering either the First or the Second Course, are required to make a deposit of $5, as security against injury to apparatus. This is returned at the close of the session, less the cost of the apparatus injured or destroyed.

Extensive as are the machinery, plant, and workshops of the Drexel Institute, machinery which is as massive and impressive as that of many a large manufactory, plant that includes most complete electrical installations, and workshops that are full of active young workmen, so that the ring of the anvil, the impact of the chipping hammer, and the sound of plane and saw are heard, it is evident that the aim of the place is to teach craftsmanship, only so far as it

illustrates and emphasizes the lessons of the class-room. It seems to the observer that the product of that part of the Institute which has been described in the previous pages, is a body of young men who are fitted to take prominent positions in the mechanical, building and commercial world, a world which will not only have at command the latest discoveries of science, but will be beautified by the gracious ministry of art.

The Pratt Institute, Brooklyn—

This institution has been called by a technical specialist " the most pretentious undertaking in the line of industrial education." Its object is " to promote manual and industrial education as well as cultivation in literature, science and art, to inculcate habits of industry and thrift, and to foster all that makes for right living and good citizenship." The work of the Institute is carried on along the following lines, viz: educational, normal, technical, and special. Its equipment is of the best. Larger than the Drexel, it is housed in a building that is neither so artistically beautiful nor so symmetrically arranged as the latter institution. It has day and evening classes, the charges for tuition being very moderate. The income from tuition fees does not pay one-third of the expenses of running the school. Its endowment of $3,500,000 has already been mentioned, and it is able to offer advantages in its lines of work that no other institution on this continent has yet surpassed. It has furnished numerous instructors for schools all over the United States. It is an excellent example of what can be done through private benefactions, the management of the trust having been very judiciously administered by the children of the founder. It has the large number of about 2,500 students, and makes a specialty of domestic art and science. For the purposes of this report the latter branch, and also its department of evening classes are of salient interest.

From the very comprehensive list in the catalogue, the following courses are selected:

SEWING.—Two lessons a week; four grades of three months each.

First Grade....Hand sewing, mending. Study of materials and colour.

Second Grade..Machine sewing, draughting, fitting, making undorgarments.

Third Grade...Draughting, cutting, fitting, making unlined dresses.

Fourth Grade..Advanced machine and hand sewing, draughting and making children's dresses.

DRESSMAKING.—Two lessons a week; five grades of three months each.

First Grade....Draughting skirts and waists. Exercises with practice material in fitting and designing, and in making dress trimmings and finishings. Study of colour, form, line and texture.

Second Grade..Draughting and making walking skirt. Cutting, fitting, and making lined waist. Study of the contour and poise of the body.

Third Grade...Matching stripes and plaids, draughting and making princesse gown. Practice in designing; study of artistic principles.

Fourth Grade..Draughting, cutting, and making jacket. Draughting child's dress and coat. Study of woollen textiles.

Fifth Grade....Draughting and making evening gown. Practice in designing gowns for home and evening wear.

Drawing, water colour, elementary design..Practice in the use of the pencil and of water colour. Appearance of objects, bows, gowns, and drapery. Outline and proportion of the human form. Study of historic costume; designing of gowns.

MILLINERY.—Two lessons a week; four grades of three months each.

First Grade....Facing and finishing hat brims; making bows; trimming hats; study of form, line, colour, and texture.

Second Grade..Designing, draughting, and making frames. Making and trimming covered hats and bonnets.

Third and Fourth Grades..WINTER SEASON.—Making velvet hats and bonnets, toques and evening bonnets.

SPRING SEASON.—Making wire frames and straw hats, lace and shirred hats and bonnets, children's hats.

Drawing, water colour, elementary design..Practice in the use of the pencil and of water colour. Appearance of objects, drapery, bows, hats. Outline and proportion of the head. Study of historic costume, designing of hats.

COURSES IN DOMESTIC SCIENCE.—Special courses are offered for students who can give but a few hours a week to the work. These may be taken separately or in the following groups;

Group I.—One Year; three hours a week—Bacteriology; dietetics; emergencies, home nursing and hygiene; invalid cookery; house sanitation; public hygiene.

Group II.—One Year; four hours a week—Bacteriology, dietetics, plain cookery, fancy cookery, invalid cookery.

Group III.—One Year; one hour a week—(*a*) Evolution of the house: architecture, interior decoration, furnishing.

(*b*) House sanitation: situation of the house, surroundings, cellar, removal of wastes, plumbing and care, substitutes for water carriage, water supply, ventilation, heating, lighting, sanitary furnishing and general care of the house.

(*c*) Household economy: the arrangement of work and furnishings. The care, in detail, of every part of the house. House cleaning. Household accounts. Mistress and maid. Household amenities.

Worcester Polytechnic Institute, Mass.—

This institution is a college of engineering, and it defines engineering as "the utilization of the forces of nature in the service and for the benefit of man, as illustrated in the construction and use of machinery, the erection and maintenance of structures, and the discovery, decomposition and recomposition of the component parts of material things, and other functions ordinarily included under the still somewhat general terms mechanical, civil, chemical and electrical engineering."

The Worcester Institute was one of the first in the United States field. It was the offspring of private beneficence, and while its scope is not so comprehensive as those of some other institutions, it holds a rank second to none in its special area of endeavour. It was the first institution in the United States to establish workshops as an adjunct to the training of the mechanical engineer. But it holds that mere manual skill is not an essential element in the make-up of the engineer, belonging, rather, to the artisan and the artist. Its courses are planned so as to supply in as large a measure as possible the benefits of a liberal education. In some of these so-called liberal branches, the students progress much farther than in the average college, for these subjects are considered to be at the very foundation of professional as well as of liberal training. They are common to all courses, and comprise mathematics, modern languages and English, political science and economics, physics and elementary mechanics, chemistry and drawing.

Applicants for admission are supposed to have taken a full High-School Course. The entrance examination is in the following subjects:

English Grammar and Composition, Algebra, Plane Geometry, Solid Geometry, English with French or German.

The entrance examination is intended to satisfy the faculty that each candidate gives reasonable promise of success in the studies of the Institute.

The fees for tuition are $160 per year. It is stated in the catalogue that the entire expenses for tuition, board, and incidentals need not exceed $400 a year.

Scholarships are given to a limited number of students, and forty scholarships to residents of the Commonwealth of Massachusetts. The Institute is enpowered by the Legislature to confer degrees. The Institute has extensive class and lecture-rooms, workshops and grounds. It is a very complete organization with definite aims scrupulously fulfilled.

The Massachusetts Institute of Technology, Boston—

The immense area and scope of this institution forbid more than limited mention in this report. I spent the whole of one day in seeing part of it. I could, profitably, have spent a week. It has a Faculty, comprising President and fifty-four Professors, and it employs a grand total of 136 instructors.

The fundamental elements in the curriculum of the school are mathematics, chemistry and physics.

Instruction in technical methods is subordinated to the acquisition of principles.

The Institute offers thirteen distinct courses, each of four years' duration, as follows:

I. Civil Engineering.

II. Mechanical Engineering.

III. Mining Engineering and Metallurgy.

IV. Architecture.

V. Chemistry.

VI. Electrical Engineering.

VII. Biology.

VIII. Physics.

IX. General Studies.

X. Chemical Engineering.

XI. Sanitary Engineering.

XII. Geology.

XIII. Naval Architecture.

The tuition fee for regular students is $200 per year, payable in advance. There are forty free State scholarships in consideration of aid received from the Commonwealth in addition to a number founded by private individuals.

The Institute grants degrees.

Under the auspices of the *Lowell Institute* which is also conducted by the management of this institution, a number of courses—twelve lectures each—of free scientific lectures in advanced subjects is given each year by competent professors. Candidates for attending these courses must have attained the age of eighteen years, and must satisfy the instructors as to their previous preparatory education.

Connected with the Institute is also the *Lowell School of Practical Design*, the instruction in which is free. To teach drawing is not among the objects of this school. A considerable degree of skill in free hand drawing from nature and in the use of the brush is positively required for entrance. The course of study is as follows:

Students are taught the art of making patterns for prints, ginghams, delaines, silks, laces, paper-hangings, carpets, oil-cloths, etc. The course is of three years' duration, and embraces:

1. Technical manipulations; 2. Copying and variations of designs; 3. Original designs or composition of patterns; 4. The making of working drawings, and finishing of designs.

Instruction is given personally to each student over his work. Students supply their own instruments and materials, the cost of which is about $5 per year.

The hours of instruction are from 9 a.m. until 12, and from 1 to 3.30 p.m.

The buildings of the Massachusetts Institute of Technology are probably more extensive than any in the world devoted to technical education, and the comprehensiveness of the various laboratories and workshops is such as to afford the best opportunities of practical study in the sciences undertaken. As examples, the metallurgical department has facilities for the reduction of ore in considerable quantities, while in the testing and hydraulic departments the appliances and machinery are on the most liberal scale.

The Institute is largely assisted by the State of Massachusetts. After successive subsidies of land, in April, 1863, an additional Act allotted to the Institute one-third of the interest received by the State from the United States Land Grant to Support Colleges of Agriculture and the Mechanic Arts, under the condition that instruction in military tactics should be provided, and that the Governor, the Chief Justice of the Supreme Court, and the Secretary of the State Board of Education should be each a member *ex-officio* of the government of the Institute.

Stevens' Institute of Technology, Hoboken, N.Y.—

This extensive institution is a school of engineering and mechanics in which instruction of college grade is given in the various branches of science. It was founded in 1867 under the provisions of the will of the late E. A. Stevens, who bequeathed a block of land, $150,000 as a building fund and $500,000 as an endowment fund. The present president, Henry Morton, Ph. D., Sc. D., L.L.D., has also contributed to it about $67,000 and Mrs. Stevens, $30,000.

Students in the State of New Jersey pay $150 per year. Students coming across the river each day from New York pay $75 extra. The courses are of four years' duration and comprise a very systematic and complete education in mechanical engineering. The workshop equipment is in every way considerable, and the laboratories are extensive and well provided with apparatus.

Cooper Union, N.Y.—

The Cooper Union for the advancement of Science and Art is an important organization which presents many lessons to the observer in search of knowledge

of technical education. It has an endowment fund consisting of benefactions of the late Peter Cooper (who founded the institution 40 years ago), which brings in an income of about $60,000 per annum and the classes and lectures are free. The operations of Cooper Union are carried on in a building which with its furniture and apparatus are valued at more than a million dollars, and it gives instruction to upwards of 3,000 students. The arrangements for the free night school of science are as follows:

The term begins on the 1st of October and ends about the middle of April. The classes are in session every evening, except Saturday, from 7.30 to 9.30. The instruction in this department is for both men and women. Applicants must be at least fifteen years of age. Application for admission must be made between June 15th and December 31st.

The regular course of study embraces the following subjects:

Class E.—First year: Algebra, geometry, natural philosophy and elementary chemistry.

Class D.—Second year: Algebra, geometry, elementary chemistry and geology.

Class C.—Third year: Trigonometry, descriptive geometry, analytical geometry, mechanics and electrical measurments.

Class B.—Fourth year: Analytical geometry, differential and integral calculus and mechanical drawing.

Class A.—Fifth year: Applied mechanics, advanced physics and analytical chemistry.

Applicants for the first year class are required to pass an examination in algebra through simple equations, and through the first book of geometry.

Students who complete the full course receive the degree of Bachelor of Science. The subjects of the first two years may be passed upon examination, but it is required of a graduate that he shall have attended each and all of the classes of the last three years.

Applicants may select any single subject in the course for which they are prepared, and omit all others, if they desire.

There is a special course in qualitative and quantitative chemistry, extending through three terms. The instruction is free, but there is a charge of $10 for chemicals used, and a deposit of $5 must be made to cover the cost of possible breakage.

The following is the programme of studies:

CLASS B.

Monday,	7.30	Mech. Drawing.
"	8.30	" "
Tuesday,	7.30	Calculus.
"	8.30	"
Wednesday,	7.30	
"	8.30	Anal. Geometry.
Thursday,	7.30	Mech. Drawing.
"	8.30	Calculus.
Friday,	7.30	Anal. Geometry.
"	8.30	" "

CLASS C.

Monday,	7.30	Descrip. Geometry.
"	8.30	Trigonometry.
Tuesday,	7.30	Descrip. Geometry.
"	8.30	Trigonometry.
Wednesday,	7.30	Anal. Geometry.
"	8.30	Trig. or Mechanics.
Thursday,	7.30	Anal. Geometry.
"	8.30	Elec. Measurements.
Friday,	7.30	Descrip. Geometry.
"	8.30	

CLASS D.

Monday,	7.30, Sec. 1, Sec. 3	Geometry.
	Sec. 4	Physics.
"	8.30	Algebra.
Tuesday,	7.30, Sec. 2, Sec. 5	Geometry.
	Sec. 1, Sec. 6	Physics.
"	8.30	Algebra.
Wednesday,	7.30, Sec. 4, Sec. 6	Geometry
	Sec. 3	Physics.
"	8.30, (Lecture)	"
Thursday,	7.30, Sec. 2, Sec. 3	Geometry.
	Sec. 5	Physics.
"	8.30, (Lecture)	Chemistry.
Friday,	7.30	Algebra.
"	8.30, Sec. 1, Sec. 4, Sec. 5, Sec. 6	Geometry.
	Sec. 2	Physics.

CLASS E.

Monday,	7.30	Algebra.
"	8.30	Chemistry.
Tuesday,	7.30	Geometry.
"	8.30	Chemistry.
Wednesday,	7.30	Algebra.
"	8.30	
Thursday,	7.30	Geometry.
"	8.30	Algebra.
Friday,	7.30	
"	8.30	Geometry.

LECTURES.

The following subjects are presented in the form of lectures to the scientific students: Elementary chemistry, natural philosophy, geology and electrical measurements.

The programme for each week from October 1st to March 1st, is as follows:

Monday,	8.30	Chemistry (1st year).
Tuesday,	8.30	" "
Wednesday,	8.30	Nat. Philosophy.
Thursday,	8.30	Electrical Measurements.
"	8.30	Chemistry (2nd year).
Friday,	8.30	Geology, January till March.

There is also a free night school of Art, which is carried on along the ordinary lines. Cooper Union also makes a specialty of free public lectures on a great variety of interesting and instructive subjects.

Rochester Mechanics' Institute—

Gives instruction to upwards of 600 pupils in "Industrial and Fine Arts," in "Domestic Science" and in "Manual Training." It has a three years course for day pupils, known as the "Mechanic Arts Course," including instruction in English, mathematics, physics, freehand and mechanical drawing and manual training in wood and iron. A grammar school training or its equivalent is required for entrance to this course. The managers say in their circular that the aim of this course outside of the educational features is "to prepare the pupil for practical work, that is to fit him to be of practical value to his employer from the start, and enable him to solve all ordinary problems that may come up in any manufacturing or business establishment. Although not designed especially for a college or technical preparatory course it would be of great help to students desiring such preparation, and includes all necessary preparatory work with the exception of French or German."

The following are the day courses:—

Mechanic Arts Course.—Three years, five days a week. Instruction in English, mathematics, physics, freehand drawing, mechanical drawing, manual training in wood, including joinery, wood-turning, pattern-making and moulding, manual training in iron, including forging, vice work, machine work and construction.

Mechanical Course.—Three years, five days a week. Instruction in freehand drawing, mathematics, mechanical drawing.

Design Course.—Three years, five days a week. Instruction in freehand drawing, mechanical drawing, designing and clay modeling.

Manual Training Course.—Three years, five days a week. Instruction in freehand and mechanical drawing, mathematics, joinery, wood-turning, pattern-making and moulding, forging, bench work in iron, machine work and construction.

Art Course.—Three years, five days a week. Instruction in freehand drawing, composition, painting in oil and water colours and history of art.

Normal Course.—Three years, five days a week. Including instruction in freehand drawing, three years; mechanical drawing, one year; designing, one year; composition, three years; teachers class, one year; painting in oil and water colours, two years; clay modeling, one year; history of art, history of education.

The fee for any of the day courses is $75 per year. The day classes are divided into two terms of four months each.

EVENING CLASSES.

The diploma of the Institute is given to pupils who successfully complete any of the following evening courses:

Mechanical Course.—Five years, two evenings a week. Instruction in freehand drawing, mathematics and mechanical drawing, machine design.

Design Course.—Five years, two evenings a week. Instruction in freehand drawing, mechanical drawing, designing and clay modeling.

Architectural Course.—Five years, two evenings a week. Instruction in freehand drawing, mathematics, designing and architectural drawing.

Manual Training Course.—Five years, two evenings a week. Instruction in freehand and mechanical drawing, mathemetics, joinery, wood-turning, pattern-making and moulding, forging, bench work in iron, machine work and construction.

If pupils will devote three or four evenings a week, the above courses may be completed in three years.

CERTIFICATES.

A certificate of the Institute is given to pupils who complete and pass examinations in any of the following classes: Mechanical, architectural, freehand, design, and pen and ink drawing, life drawing, oil and water colour painting, lettering, history of art, teachers' class, clay modeling, mathematics, electricity, and manual training.

The practice sheets are examined and recorded by the teachers and returned to the pupils.

Certificate sheets, when completed, are passed in, examined, initialed, stamped and recorded. When the set is completed, and the examinations are passed satisfactorily, a certificate is given to the student, together with his set of drawings. The student is then qualified to enter the next higher class. One sheet of drawing may be selected from each set of works and kept as school property.

These classes are held each year during one term of seven months—two lessons per week. Fees about $15 per year.

The classes in domestic science are modelled after those of the Drexel Institute.

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