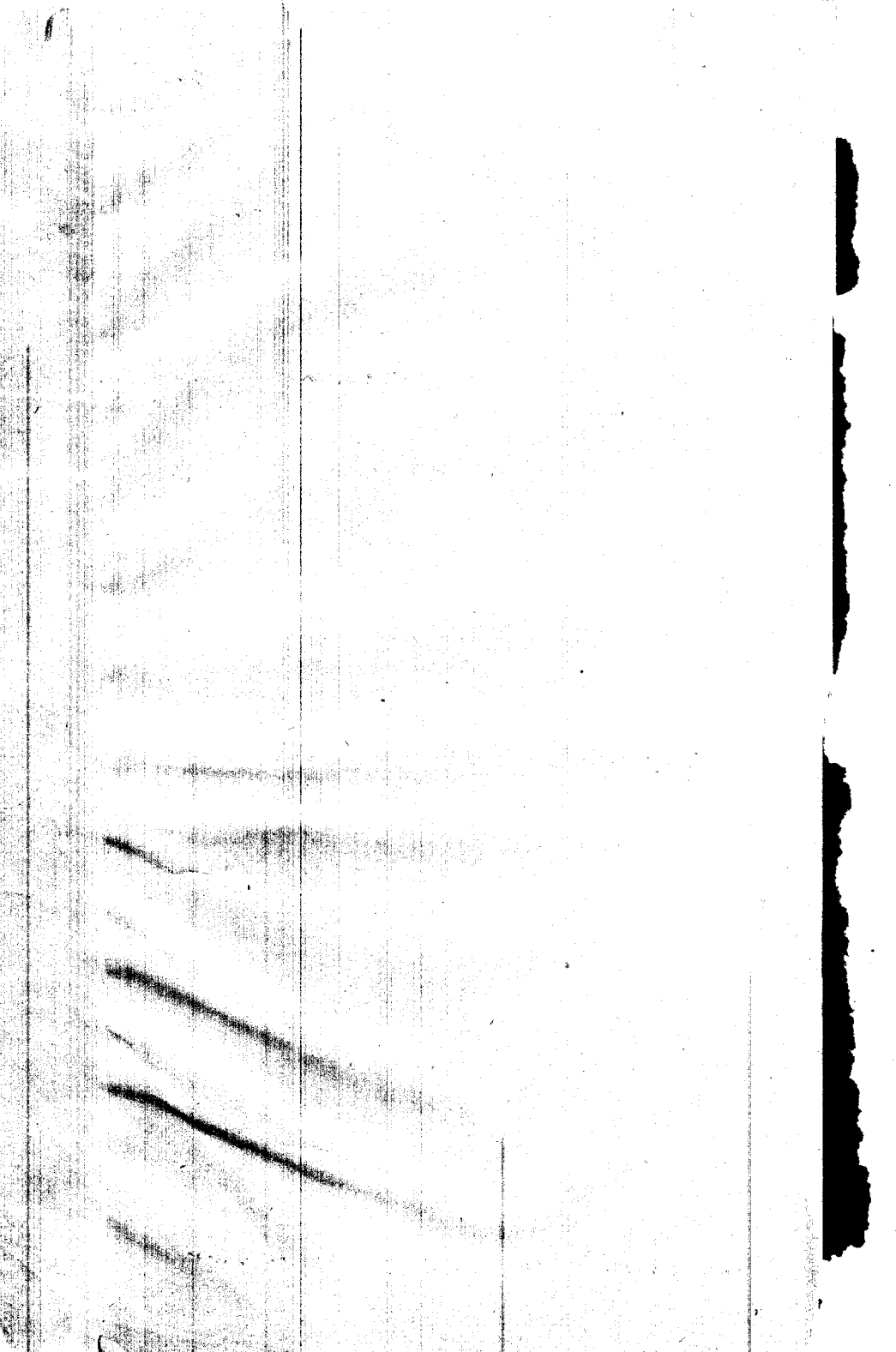


146 Sketches
Aug. 1877

Rensselaer Polytechnic Institute.



THE
Rensselaer Polytechnic Institute.

*Its Reorganization in 1849-50; Its Condition at the Present Time; Its
Plans and Hopes for the Future:*

BY THE
DIRECTOR OF THE INSTITUTE.

ALSO,
THE STATEMENT OF A COMMITTEE

APPOINTED BY AND OF THE TRUSTEES OF THE INSTITUTE, FOR THE PRE-
SENTATION OF ITS VARIOUS INTERESTS TO THE CITIZENS OF TROY.

TROY, N. Y.:
D. H. JONES & CO., PRINTERS, 216 RIVER STREET.
1855.

INTRODUCTORY NOTE.

The following explanatory sketch of the Institute and its system, has been prepared at the request of the Committee whose statement follows, with the hope that it may contribute to the diffusion of more accurate knowledge than, it is to be feared, now prevails in our own community, with respect either to the real objects of the Institute or its plans of future development. It is deemed proper to remark that the mere notice which is here introduced, of some of the more prominent Polytechnic Institutions of Europe, has seemed to be *the very least* that could be said on this point in order—as was the object of their introduction in this paper—to aid the formation of an intelligent judgment of the characteristics as well as utilities of that class of educational institutions in which the Institute finds its place.

Troy, December, 1855.

THE Rensselaer Polytechnic Institute.

It is scarcely to be doubted that, in respect to the RENSSELAER POLYTECHNIC INSTITUTE, there is considerable misapprehension, not to say ignorance, more or less prevalent with regard to its position, objects, and other characteristics, as an educational establishment. And, yet, this is not so remarkable when it is understood as it properly should be, that some of the most material changes, in what may be called the *characteristics* of such an institution, have been effected in this within a period of less than six years past. To explain the nature of these changes, the considerations which conducted to them, the consequences which have resulted from them, and the present aims and hopes of the Institute management, will be the main objects of this paper.

RE-ORGANIZATION OF THE INSTITUTE.

2
1824
Prior to the year 1850, the Rensselaer Institute was announced, and generally understood to be an institution for "Instruction in *Mathematics, Physics, Chemistry, Geology, and Natural History*, with their Applications to CIVIL ENGINEERING, the ARTS, MANUFACTURES, and AGRICULTURE." These, indeed, were substantially the objects of the institution, as originally established in 1825, by its Founder, STEPHEN VAN RENSSELAER; and, with unimportant deviations in the style of declaration or details of execution, these continued to be the declared objects of the Institute, through the intervening period of a quarter of a century, up to the date mentioned at the opening of this paragraph. At this time, the present Direction of the Institute, after an experience of nearly three years with its plans and workings, had reached the conclusion that, notwithstanding the acknowledged usefulness of the institution upon its then existing basis,

it nevertheless did, and must continue to fail to realize those better results, which, as an educational establishment, it might, and, indeed, ought to be capable of, were it not for certain radical defects in fundamental features of its organization. These were believed to be, first, in the recognition of educational objects which were not only too *comprehensive in reach*, but liable to be *too vaguely and indefinitely worked out*, to admit of that completeness of treatment or that balancing of parts, so essential to anything like satisfactory results; and, secondly, as if to render more unmitigated the evils noted under the first head, in the *short time, allowed to be sufficient*, for the preparation of candidates for the scholastic or professional degrees conferred by the Institute Board.

The Managers of the Institute, therefore, resolved, that *their field should be narrowed and more thoroughly cultivated*; that, indeed, their educational objects should be restricted to matters immediately cognate to ARCHITECTURE and ENGINEERING; that, moreover, for a somewhat irregular and for the most part optional course, requiring but a single year for its accomplishment, they would substitute a carefully considered Curriculum, which should require at the least three full years of systematic and thorough training; and that, finally, they would demand the application of the strictest examination tests to the successive parts of the course prescribed, not only in respect to the translation of students from lower to higher classes, but, especially, in all cases of ultimate graduation with professional degrees.

It was in accordance with such views as these that, in 1849-50, this institution was wholly reorganized upon the basis of a general POLYTECHNIC INSTITUTE, when it received the distinctive addition to its title, under which it has since been more or less generally known. Its objects were thenceforward declared to be "The education of ARCHITECTS and CIVIL, MINING, and TOPOGRAPHICAL ENGINEERS, upon an enlarged basis, and with a liberal development of Mental and Physical Culture." It was, however, also declared that, the educational advantages of the Institute should not be restricted to those only who might be destined to professional pursuits, but "should be made available and eminently useful to all others, whether contemplating a future professional career or not, who, appreciating and desiring such a course of educational training, would be willing to submit to the discipline required for its successful accomplishment."

But it is proper to remark that, with the comprehensive statement and formal announcement, then made, of what was proposed to be the future work of the Institute, there was associated in the minds of its Managers no immediate expectation of realizing more than a very partial development of their plans, with the comparatively limited resources in *matériel* of every

kind at their command. Accordingly, it was resolved, that, of the entire Institute Curriculum, they would at first proceed to develop the GENERAL COURSE—the common scientific basis of the four Professional Courses—and the two specialities of CIVIL and TOPOGRAPHICAL ENGINEERING, to as good a degree of excellence as should be practicable under the existing circumstances; while they would defer any attempt to effect the more complete development of their plans, including the important specialities of ARCHITECTURE and MINING ENGINEERING, to a period when they might hope to be able to invoke effectively the aid of conditions more favorable to realizations so desirable.

RESULTS OF THE RE-ORGANIZATION.

With the preceding somewhat general statement of the considerations which determined the present alterations in the Institute System, a pertinent inquiry might now be suggested, as to the results of experience in working out such a series of changes;—changes, too, so likely to be productive of important consequences, as those whose original inception has been referred to the period in question. But to answer this inquiry by a statement in detail of the actual experience of the Institute during a period of six years past, would be as tedious to the readers, as it would doubtless be inexpedient for the objects of this paper. Nevertheless, the following general comparison may serve the immediate purpose of illustrating these results as they appear from a certain point of view, and, at the same time, form a not inappropriate introduction to some more particular statements to be given hereafter:—In 1849, with a course of study which was, undeniably, somewhat vague, unsystematic, and incomplete, there was an attendance of thirty to thirty-five students; while the annual income from tuition fees—exclusive of that from other sources—did not exceed sixteen hundred dollars: At the present time, with a course of systematic, extended, and somewhat severe training, strictly wrought out, at least, in the case of every *graduate* of the Institute, there is an attendance of over one hundred students; while the annual income from tuition fees alone—now fifty per cent. higher than at the former time—amounts to more than seven thousand dollars. And, yet, while far from undervaluing the importance naturally attached to the number in attendance at an educational establishment, it may, nevertheless, fairly be questioned whether this, *in itself*, can be regarded as proof of any peculiar or remarkable excellence in such an institution; otherwise, it were necessary to admit the existence of such excellences in institutions—of not unfrequent occurrence in this country—whose basis for such a distinction it would be difficult to

find, save in a facility for gathering in hundreds of students from a surrounding country, at rates of tuition marvellously cheap.*

And, hence, we should be altogether unwilling to have the results of the Institute experience estimated by such a standard *alone*—a standard as superficial as it would be unjust. On the contrary, how *tangible* soever as indications of a vigorous and active life, we would prefer to have these results seen, when taken in connection with accompanying circumstances,—as we hope to be able to show,—to be evidence equally tangible, of the *complete and triumphant success of a most important educational experiment.*

The fact is scarcely appreciated—not, certainly, as it should be—by many citizens even in our own midst, that an institution located in a retired part of this city, occupying quarters as unimposing in exterior as they are limited in extent, enjoys a patronage—to say nothing of reputation—that, in view of all the circumstances, might well be coveted by any educational establishment in the land. We say, in view of all the circumstances; for, with buildings and surroundings less attractive than those of many a country academy,—with a comparatively high rate of tuition,—with the utter absence of all those means, so frequently resorted to, for attracting attention to an institution through the public prints;—with, in short, a display of resources so limited—of temptations so poorly contrived to allure public appreciation;—nevertheless, on a direct observation, the following facts are as conspicuous as they are significant, namely: that, from all parts of the United States,—from Upper and Lower Canada,—from the tropical regions of the West Indies and South America,—there is an annual accession of young men to the successive classes of this Institution, which, besides annually increasing, is even now quite respectable in number†; that, moreover, these are, in general, derived from those quarters in which an intelligent appreciation of the peculiar objects of the Institute would be likely to find place; and that, finally, these annual accessions comprise bodies of young men, who, for capacity, intelligence, and all those characteristics of manhood most suggestive of a promising future, are scarcely equalled, certainly not excelled by a similar collection of students at any other institution in this country.

We trust that we may be pardoned if we attach too much importance to this matter; but we are, nevertheless, constrained to believe that, in

*We do not, of course, refer to those institutions that, with large productive endowments, can afford to make low rates of tuition, and at the same time, exact *sound scholarly training* in the person of every recipient of their graduation honors.

† During the past year as follows: From foreign countries;—Brazil, 4.—Cuba, 5.—Canada, 7. From the United States;—Me., 3.—Mass., 9.—Conn., 4.—Vt., 2.—N. J., 6.—Penn., 9.—Md., 2.—S. C., 3.—Ga., 2.—La., 1.—Miss., 2.—Ill., 3.—Ohio, 2.—Cal., 1.—New York City, 9.—State at large, 33.—City of Troy, 9. Total, 116.

such results as these, we have a well-grounded basis, for all we claim in the conclusion enunciated in a preceding paragraph; that, indeed, with such an experience, the Institute may fairly and logically claim to have passed beyond the doubtful issue of a mere experiment, and to have reached a present position, in which it may, without serious presumption, assume *to know the ground on which it stands.*

ITS OBJECTS THOSE OF A POLYTECHNIC INSTITUTE.

And, now, it may be proper to repeat, or state in another form, the objects originally proposed in the reorganization of the Rensselaer Institute. These objects were, to develop the original and peculiar excellences of this institution, into a true POLYTECHNIC EDUCATIONAL ESTABLISHMENT, on a liberal basis and with elevated aims. An institution whose characteristics of development should be suggested, partly, by its own most instructive experience of more than thirty years as a School of Theoretical and Practical Science; partly, by the published organizations, courses of study, and practical workings of the Polytechnic Institutions and Special Industrial Schools of Great Britain and, more especially, of France and Germany; and, in part, also, by the results of observation and study of the *professional wants in this country* of those classes of men, for whose benefit the institution would be more especially designed. But in order to obtain a more distinct conception of the present objects of the Institute, and then be able to form an intelligent judgment of the importance which is here claimed for them, it will be necessary or, at least, highly serviceable, to take a brief preliminary survey of the plans and workings of that class of educational institutions of the old world, in which our institution finds its place.

SCIENTIFIC AND TECHNICAL INSTITUTIONS IN EUROPE.

The establishment of Polytechnic Institutions for educational purposes is in manifest obedience to a demand of the most general interest of the present age.

In all civilized countries, the prosecution of industrial pursuits, in some one of their multiform phases, constitutes the prime business of man.—Whether we regard his operations as an Agricultural Producer,—as a Manufacturer or Artisan,—as a Merchant or Factor,—or, finally, as an Engineer or Architect, adapting his works to the wants common or peculiar of all the rest,—still, how different soever the respective modes, they nevertheless concur in contributing to the advancement of the great business of life—PRODUCTIVE INDUSTRY.

But a new era for industry has been commenced during the present century. Science has cast its illuminating rays on every process of Industrial Art. The discoveries and improvements which have so frequently flashed into view, have indeed, attested, in a manner the most striking, the mutual advantage to Science and Art—to theory and practice—of a better mutual acquaintance. That there has been a large gain to both, as well of mutual enlightenment as of mutual rectification, is no longer, among intelligent and candid observers, a disputed question. And, in respect to Art, there is no point better established than that practical processes, by becoming more rational have become more certain, and thereby more economical.

Hence it is, that educational establishments, having for their object the training of young men in the various branches of *Theoretical and Applied Science*, respond to a want as generally as it must be earnestly felt in all civilized communities. Such Institutions are well known on the Continent of Europe under titles that, although somewhat varied, are nevertheless suggestive of the objects for which they were established.

SCIENTIFIC AND TECHNICAL INSTITUTIONS IN FRANCE.

The oldest organization bearing the appellation Polytechnic, is an Institution of world-wide celebrity, the *ÉCOLE POLYTECHNIQUE*—now the *École Impériale Polytechnique*—of Paris. Established near the close of the last century* by a few accomplished and zealous professors of the

*In 1794—opened in 1795.

Mathematical and Physical Sciences under the fostering care of the French Government,—an especial favorite with the first Emperor Napoleon, from whom it received the most watchful consideration, so long as his ever appreciative sagacity could be made available to its growth in usefulness,—it soon came to be, and, indeed, has been for the last half a century, undoubtedly, in certain respects, the first school of science in the world.

The POLYTECHNIC SCHOOL OF FRANCE differs from other institutions of its class, in not furnishing a *complete system* of technical instruction to those who go through its courses. Indeed, this institution is rather to be understood as a *School of General Science*, introductory to a class of *Special Schools of Application*—also government institutions—than as a general Polytechnic Institution; since, the Special or Technical Schools as such being essentially complementary to the *École Polytechnique*, would have to be joined to the latter in order to the realization of the full idea of a Polytechnic Institute. Such, in fact, is the use made of the *École Polytechnique*. Its pupils after graduation, with few exceptions, pass directly to the Special Schools, where they complete their courses of pupilage before entering those departments of the Government Service, Military, Naval, or Civil, to which they may be respectively destined.*

The following programme exhibits a general view of the course of study at this institution.

ÉCOLE IMPÉRIALE POLYTECHNIQUE.

[Course two years.]

Higher Analysis.
Rational Mechanics.
Theory of Machines.
Descriptive Geometry.
Analytical Geometry.
Astronomy.
Geodesy.
Social Arithmetic.

Physios.
Chemistry.
Architecture.
French Composition.
German Language.
Topographical Drawing.
Free-hand Drawing.
Geometrical Drawing.

The advantages of this School are open to the free competition of natives of France of the proper age. But the standard of requirements for admission, besides being high is rigidly held; so that not unfrequently five or six times as many applicants are examined as found qualified for admission. The course of study is arranged for two years; and, yet, so elevated is the range of some of the studies on the foregoing programme as carried out

*It may be remarked that the *École Polytechnique*, although under government control and possessed of an interior discipline which is strictly military, is not—as is too frequently supposed—in any proper sense a *Military School*. All instruction bearing directly on subjects of Military and Naval Science, as well as on Civil and Mining Engineering, are excluded from this and referred to the different Special Schools of Application.

at this institution that, with a standard of requirements for admission, particularly in Mathematics, considerably above those required for graduation in many institutions, the ÉCOLE POLYTECHNIQUE has sent forth among its graduates the first men of France, and, indeed, of the age in Theoretical Science.

It has been mentioned that the École Polytechnique is incomplete in technical specialties.* Provision for this deficiency is, however, very fully made, so far as the requirements of the State are concerned, in the various Schools of Application, under the administrative control of different Ministerial Departments, which furnish courses of special training for the several branches of Government Service. Of these, besides a number of Schools for the several special arms of the Military and Naval Service,—such as Artillery, Cavalry, etc., located in different parts of the Empire,—we have the following Schools for various specialties of the Civil Service:†

| | |
|---|--|
| L'ÉCOLE DES PONTS ET CHAUSSÉES | 3 ÉCOLES NATIONALES DES ARTS ET MÉTIERS. |
| L'ÉCOLE NATIONALE DES MINES. | |
| L'ÉCOLE DES MINEURS DE SAINT-ÉTIENNE. | 44 ÉCOLES D'HYDROGRAPHIE. |
| L'ÉCOLE DES MAÎTRES-OUVRIERS MINEURS D'ALAIS. | L'ÉCOLE NATIONALE DES CHARTES. |
| LE CONSERVATOIRE DES ARTS ET MÉTIERS. | L'ÉCOLE IMPÉRIALE FORÊSTIÈRE. |
| | L'ÉCOLE IMPÉRIALE D'AGRICULTURE. |

The SCHOOL OF ROADS AND BRIDGES was established as early as the year 1747, but it attained to its present importance at a much later day. Its objects embrace the education of CIVIL ENGINEERS especially destined for the service of the State, but it also admits "external" pupils to its educational courses who may be otherwise destined. The former class is made up of graduates of the École Polytechnique, while the latter includes any who are able to submit to the somewhat elevated examination requirements prescribed for matriculation in this School. The course of study is arranged for three years, providing for instruction in the construction of common roads, railways, canals, river and harbor improvements, as also of works of drainage, irrigation, and works for the supply of water to towns, mills, etc.†

*An exception in part may be made perhaps in respect to *Civil Architecture*. The courses of the School appear to furnish some special instruction relating to this branch of constructive art.

† *The School of Roads and Bridges*
[Civil Engineers].

The National School of Mines.
The School of Miners at Saint-Etienne.
The School of Master-miners at Alais.
The Conservatory of Arts and Trades.

Three National Schools of Arts and Trades.

Forty-four Schools of Hydrography.
The National School of Charts.
The Imperial School of Forestry.
The Imperial School of Agriculture.

† "Programme, etc., de l'École des Ponts et Chaussées."—MINISTÈRE DES TRAVAUX PUBLICS,—Paris,—1852.

The NATIONAL SCHOOL OF MINES at Paris, and the SCHOOL OF MINERS AT SAINT-ÉTIENNE, have for a common object the technical education of those destined to the direction or superintendence of Mines and Furnaces,—functions which are generally recognized as appropriate to the profession of the MINING ENGINEER. The regulations for the reception of a class of graduates from the Polytechnic School, as well as a class of “external” pupils not destined for the State service, are similar, though less restricted, in the National School of Mines, to those which obtain in the School of Roads and Bridges. The School of Miners at Saint-Étienne receives none but external pupils, while its requirements for admission are of a still lower grade. The courses of instruction in these Schools, which are three years in duration, embrace Technical Chemistry, Mineralogy and Geology; the smelting, refining, working and assaying of metals; the surveying, drawing and working of mines. The scientific collections in these Mining Schools are represented to be admirable in every respect. The SCHOOL OF MASTER-MINERS AT ALAIS, is designed for a lower grade of mining service,—as its title indicates, for the education of *master-miners* to an extent sufficient to enable them to comprehend and execute the orders of a Chief, or Mining Engineer.*

The CONSERVATOIRE OF ARTS AND TRADES at Paris, and the three NATIONAL SCHOOLS OF ARTS AND TRADES, at Châlons-sur-Marne, Angers, and Aix, constitute an educational system of considerable extent for the instruction of ARTISANS, the national or provincial schools being under the general superintendence of Gen. MORIN, as Director of the Conservatoire. The Conservatoire itself, with its princely endowments and splendid collections, is intended to convey instruction to artisans by means of lectures adapted, with a little preliminary instruction, to the popular mind. The three provincial Schools of Arts and Trades have each a course of three years, with an attendance of about 300 pupils to each School. These Schools are supported at an annual expense to the Government of 300,000 francs each—about \$56,000—the students attending which being, for the most part, not only educated but boarded at the expense of the National Treasury. The pupils thus educated, in general, become master-workmen on the public works, or foremen in manufactories and work-shops.†

Our limits do not permit further notice of these Special Government Schools. In order, however, that the liberal views of the French Govern-

* “*Programmes, etc., des Ecoles des Mines.*”—MINISTÈRE DES TRAVAUX PUBLICS,—Paris,—1852,

† “*Programme, etc., des Ecoles Nationales des Arts et Métiers.*”—MINISTÈRE DE L’AGRICULTURE ET DU COMMERCE,—Paris,—1851.

ment in respect to scientific and technical education may be properly appreciated, it should be understood that, *the tuition is, in general, free* in all of these schools to those who shall become qualified to enter them; and, moreover, that, *to a considerable extent*, the expense of the student's living is also a charge upon the Government Treasury.

Still, these institutions, the Polytechnic School included, being adapted and more or less restricted to government wants, have not been sufficiently available to the nation at large; hence, the desire early felt by the people of France for an institution which should meet their own needs in the educational training of those who might wish to devote themselves to the scientific professions of Engineering, Architecture, Metallurgy, etc. Impelled by the urgency of this want, an enlightened and spirited capitalist, M. LAVALLÉE, founded at Paris, in 1829, a private institution, and devoted a large fortune to investments for its permanent establishment. Thus arose the ÉCOLE CENTRALE DES ARTS ET MANUFACTURES, now, confessedly, one of the most conspicuous as it is one of the most important of Polytechnic Institutions.

The objects of the École Centrale are declared to embrace the educational training of Civil Engineers, Directors of Works, Superintendents of Manufactories, Professors of Applied Science, etc. Four specialties of instruction are recognized, as follows:

- I. SPECIALTY OF MECHANICIANS. — Construction and Establishment of Machines; Mechanic Arts.
- II. SPECIALTY OF CONSTRUCTORS. — Construction of Edifices and Public Works; Physical Arts.
- III. SPECIALTY OF METALLURGISTS. — Mining; Metallurgy.
- IV. SPECIALTY OF CHEMISTS. — Chemical Manufactures; Manufactures dependent on Chemistry.

The following programme exhibits the general course of study at this institution.

ÉCOLE CENTRALE DES ARTS ET MANUFACTURES.

[Course three years.]

| | |
|--------------------------------------|--------------------------|
| Analysis. | Construction of Bridges. |
| Mechanics. | Theory of Stone Cutting. |
| Descriptive Geometry. | Architectural Drawing. |
| Transformations of Motion. | Industrial Physics. |
| General Physics. | Applied Mechanics. |
| General Chemistry. | Machines. |
| Chemical Manipulations. | Machine Drawing. |
| Hygiene. | Analytical Chemistry. |
| Natural History applied to Industry. | Industrial Chemistry. |
| Mineralogy and Geology. | Architecture. |
| Physical Geography. | General Metallurgy. |
| Working of Mines. | Metallurgy of Iron. |
| Steam Engines. | Technology. |
| Common Roads. | Hydraulic Works. |
| Railways. | Designs for Works. |

To enter this school, applicants must be at least sixteen years of age, and must be found duly qualified in a certain required knowledge of elementary mathematics and drawing. The courses of instruction are obligatory on all, with the exception that a part of the practical exercises in design are allotted to each student in accordance with his choice of one of the four specialties for a future professional career. A feature of this school is the prominence given to drawing and *design*. Students are exercised, as well in the principles, as in the details of professional practice, by being occasionally required to prepare an elaborated design, either for some Construction, or for a Manufacturing Establishment,—for example, a Chemical Works, Pottery, Smelting Works, or something similar.

There are 40 professors and assistants at the present time, with an attendance of 300 students. The number of the latter is, however, limited by the size of the building, which it is in contemplation to remedy, by the erection of larger and more commodious edifices. The annual charges to each student for tuition are 775 francs, about \$145, so that the annual revenue of the school from its tuition proceeds alone, amounts to about \$44,000. It is worthy of remark, that the Central School, which was established by M. Lavallée with the expectation that it might return to him a fair dividend on his total investment, has fully justified these anticipations, by proving eminently successful as a mere *business speculation*. M. Lavallée still remains, as he has been from the first, the *general* Director of the School—that is, of its financial matters, correspondence, etc. A “*Director of Studies*,” (M. Empaytaz,) and nine of the Professors, constitute a “*Council of Studies*,” who conduct the general internal administration of the school.

The Government of France was not slow to perceive the manifest promise in such an institution as this. Accordingly, in 1838, the National Budget received an augmentation for the special purpose of maintaining a certain number of students of distinguished aptitude at this school, and the Conseils Généraux of twenty-nine Departments of France have made a similar provision. The estimate in which the Central School is held in France may be best appreciated by an extract from a Report of the Commission of the Chamber of Deputies, appointed to inquire into the Budget for 1838.

“You are aware, Gentlemen,” says the Report, “of this useful establishment, founded in 1829, by an association of eminent professors, with the intention of training Civil Engineers, the Directors of Works, the Chiefs of Workshops, and Manufactories. This private institution, which by its importance rivals in excellence our first public [national] establishments, has created and put in practice a complete system of industrial education. It is, at the same time, a supplement to the *École Polytechnique*, and an addition to our various schools of Applied Science. Such an

institution ministers to one of the first necessities of the age,—hence, its success is complete. This is confirmed, as well by the unanimous opinion of the first manufacturers of the country, as by the facility with which employment is obtained by all of the students who have been trained at the Ecole Centrale.*

One of the most satisfactory tests which can be applied to the working results of any educational establishment, will, in general, be furnished by the statistics of the professional employments of those who were educated at the institution in question. In a late catalogue of some 550 former students of the Central School, we have an instructive illustration of the *tendencies* of this admirable institution, as displayed in the present occupations of these former students, the greater proportion of whom had been regularly *graduated* with the degree of Civil Engineer, while a part had received a certificate only of some special capacity. These employments are classified, as follows: †

| | |
|--|-----|
| Agriculture, Agricultural Engineering,..... | 18 |
| Architecture, Constructions, etc.,..... | 39 |
| Railways,..... | 118 |
| Textile Manufactures,..... | 36 |
| Superintendence, etc., of Public Works,..... | 53 |
| Chemical Arts,..... | 57 |
| Civil Engineering,—general,..... | 56 |
| Machinery,..... | 30 |
| Mining and Metallurgy,..... | 79 |
| Manufactures,—Paper, etc.,..... | 22 |
| Industrial and Scientific Instruction,..... | 42 |

This table sufficiently demonstrates, that the objects of the *École Centrale* are realized; that the graduates of the school *do* enter upon the practice of those professional pursuits, for which their educational training had been intended to adapt them; and their *success* in these pursuits, is shown in the well known fact, that the graduates of this school are in request not only by manufacturers and managers of works throughout the Empire of France, but also, to a considerable extent, by those of other countries.

SCIENTIFIC AND TECHNICAL INSTITUTIONS IN GERMANY.

Under the usually recognized distinctions of *primary*, *secondary*, and *superior education*, we have the following general classification of educational establishments in the German States.

First, the Primary, comprising all of the *Elementary Schools*; secondly, the Secondary of three kinds, including the *Classical Schools* [Gymnasia], the *Real Schools* [Realschulen], and the *Trade or Artisan Schools* [Gewer-

*“*Ecole Centrale des Arts et Manufactures—Prospectus*,” etc.,—Paris,—1852.

† *Ibid.*

beschulen]; and, thirdly, the Superior, which includes the *Universities* and *Polytechnic Institutes*.*

Passing over the primary systems, we may remark of the secondary schools that, the Gymnasias, from having been almost exclusively classical, have, under the reaction of the growing public sentiment, introduced some of the useful sciences [*realities*] into their courses; they are, nevertheless, chiefly classical.† The Real Schools profess a general education, like the Gymnasias, but substitute the modern languages for the ancient; preserving, however, the Latin to a certain extent, and giving more prominence than the Gymnasias to the Physical Sciences. Indeed, the avowed purpose of these establishments was that “not mere words should be taught to the pupils, but realities,—explanations being made to them from nature, from models and plans, and of subjects calculated to be useful in after life.”‡ Hence these schools were called “Real Schools,”—a name still preserved. The Gymnasias and Real Schools are, therefore, two parallel, and, for the most part, distinct systems of secondary education,—each having its class of advocates as to their relative merits. Our present object will not permit further reference to these two systems of secondary education. Our main object in referring to them at all has been to call attention to the fact, “that the general character of *all* secondary education in Germany is tending towards giving instruction in the wants of the nineteenth century, rather than stopping at that considered sufficient in the thirteenth, as in many of our classical schools.”§

It is, moreover, proper to remark that, what has been said with respect to secondary education, is more or less applicable to the superior systems. The Universities have generally established chairs of some one or more branches of physical science,—in occasional instances of applied science,—thus illustrating a similar tendency among the superior to that displayed by the secondary systems. The Trade or Artisan Schools of the secondary systems, and the Polytechnic Schools or Institutes of the superior, are, however, directly *technical*, as well as scientific, in character. To the consideration of the characteristics of these institutions, we propose to devote a few succeeding observations.

The Trade Schools of Germany hold the general relation of *preparatory* systems to the Polytechnic Schools. But while the latter exist in

* Or those of the third class might be termed, respectively, *Humanistic* and *Industrial Universities*.

† The Gymnasias of Germany have their analogues generally in the classical colleges and higher grammar schools of the United States.

‡ Prof. Playfair, — “*Industrial Instruction on the Continent*,” — London, — 1852.

§ *Ibid.*—The remark contained in this quotation seems scarcely less applicable to this country than to Great Britain.

almost every German State, the former have not been so generally established. A brief notice of these institutions, as they find their most characteristic development amidst the enlightened public opinion of Prussia, will convey a more precise idea of their intended objects.

The following programme exhibits the general course of study of two years in the Prussian Lower Technical or Trade Schools:—

| | |
|-----------------------|----------------------------------|
| Synthetic Geometry. | Physics. |
| Descriptive Geometry. | Mechanics and Machinery. |
| Elementary Algebra. | Chemistry. |
| Practical Arithmetic. | Chemical Manipulations. |
| Land Surveying. | Mineralogy. |
| Plane Trigonometry. | Chemical Technology. |
| Use of Logarithms. | Architecture and Building Plans. |
| Mensuration. | Mechanical Technology. |
| Free-hand Drawing. | Geometrical Drawing. |

The subjects of study, whether theoretical or practical, being pursued only through their elements, and this being thoroughly done, it is manifest that the course above presented, of the Trade Schools of Prussia, adapts them admirably to the purpose of schools of preparation for the higher Polytechnic establishments. It may be thought, at first sight, that these schools are deficient in certain fundamental studies, but it should be borne in mind that the requirements for admission to the Prussian Trade Schools, are as follows:—an age of fourteen years,—a good primary education in the vernacular language,—a thorough understanding of the elements of arithmetic,—and a fair degree of proficiency in free-hand drawing. In point of fact, the age for admission is such that the greater part of those who enter the Trade Schools have previously had an educational course in the Real Schools.

In general, these schools are supported in part by the State, the balance being derived either from a small tuition fee, or from local endowments.—According to Professor Playfair's recent observations, there are twenty-six Technical or Trade Schools in Prussia, three in Saxony, and twenty-six in Bavaria; while the statistics of these schools show that in Prussia there are 1200 students, and in Bavaria 3000, who are annually receiving the benefits of this eminently valuable course of educational training.* And,

*"Industrial Instruction on the Continent." It should be remarked, however, that there appears to be an organized system of Trade Schools in the kingdom of Hanover, which have their culminating point in the Polytechnic School at the capital. According to Prof. Karmarsch, there are twenty-two Trade Schools in the kingdom of Hanover, in regard to which he gives from the report of the "Königlichen Verwaltungs-Kommission der Gewerbeschulen" for 1843, certain statistics, from which it appears that, in 1836, there were 84 Instructors and 1805 students in these Schools, and in 1843, there were 102 Instructors and 2840 students—an average of 130 to each school. These schools are mainly supported from the Royal Treasury. In a few instances, municipal appropriations are made, and small tuition fees are paid by the students.—*Karmarsch,—Anhang, "Die höheren Gewerbeschulen in Hanover."*—*Hanover,—1845.*

although these institutions may be considered natural nurseries of future students of the Polytechnic Institutes, still, a large proportion of the students of the Trade Schools finish their days of pupilage in these establishments, and enter at once on the practical pursuits of life, as masons, builders, and artisans in various industrial pursuits.

With these remarks on the subject of the Secondary Technical Schools of Germany, we proceed to the consideration of the higher Polytechnic Institutions.

PRUSSIA.

Besides several special schools for Engineers, Architects, etc., in different parts of Prussia, there is a general institution of considerable celebrity which was established in 1821, at Berlin, under the name of the "KÖNIGLICHES GEWERBE INSTITUT,"—*Royal Trade Institute*. This Institution was originally intended to fulfil the purpose of a Central Technical School,—by presenting a more elevated course of training than that given at the various Secondary Technical Schools. It was, moreover, originally designed to give instruction by means of work-shops in certain mechanical crafts,—a feature which was preserved for some twenty-five years, but has recently been given up, in a late reorganization of this Institute, on conviction of its practical unsoundness. At the present time, the objects of the Technical Institute are substantially identical with those of the Central School of France and other Polytechnic Institutions; that is, these objects are stated to embrace the education of Engineers, Architects, Mechanists, and Managers of Manufactories and Chemical Works.

The following programme exhibits the course of study at this Institution.

KÖNIGLICHES GEWERBE INSTITUT.

[*Course three years.*]

GENERAL COURSE.

| | |
|-------------------------------------|---------------------------------|
| Higher Algebra. | Special Physics. |
| Stereometry. | Special Chemistry. |
| Spherical Trigonometry. | Mineralogy. |
| Analytical Geometry. | Pure Mechanics. |
| Differential and Integral Calculus. | Applied Mechanics. |
| Descriptive Geometry. | Materials used in Construction. |
| Free-hand Drawing. | Laws of Architecture. |
| Geometrical Drawing. | Architectural Drawing. |
| Machine Drawing. | Practical Calculations. |

SPECIAL COURSES.

A.—FOR MECHANISTS AND CIVIL ENGINEERS.

| | |
|---|-------------------------------------|
| Theory of Construction and of Machines. | Railways and Buildings. |
| Steam Engines and other Motors. | Technology. |
| Practice in Workshops. | Designs and estimates for Machines. |

B.—FOR CHEMISTS.

Chemical Technology.
Analytical Chemistry.

Machine Drawing and Designs.
Laboratory Practice.

C.—FOR ARCHITECTS AND BUILDERS.

| | |
|--|---|
| Free-hand Drawing. | Heating and warming arrangements. |
| Architectural Drawing. | Architectural Designs. |
| Modelling in Clay. | Theory of Stone cutting. |
| Modelling of Buildings in plaster, wood, and stone. | Designs for Buildings in stone, brick, and wood. |

The instruction given in the General School is a common basis of the courses given in the Special Schools,—the class after having completed the general course being resolved into the three Technical Sections named above, in accordance with the predilections of its different members.

For admission to the Technical Institute, the candidate must present a "maturity" certificate from a Secondary School, or submit to an examination of an equally elevated grade. Indeed, the requirements for admission are such as to secure a body of students prepared to advance, at once, into the higher departments of scientific education. With the well-known names of its present Director, (Drückenmüller,) and his staff of Professors,* the character of the instruction, as might be expected, though eminently practical, is at the same time highly scientific.

The collections of Drawings and Models of Machines and of Architectural and Engineering Works; the collection of casts of Works of Art; and the collections and appliances generally applicable to the educational purposes of the Technical Institute of Berlin, are mentioned in terms of high admiration by those who have seen them.

The Technical Institute of Berlin is supported wholly by the Government, at an annual expense of 45,000 thalers, or about \$35,000. Not only is its instruction gratuitous, but 50 out of 170 students—its total number—receive about \$150 each, for living expenses; in addition to which the Government appropriates about \$5000 annually, for traveling expenses of certain students on foreign tours,—both professors and students being occasionally sent to foreign countries, to acquire a knowledge of recent inventions in the Arts.†

*WÖLF—Mathematics,
DOVE—Physics.
RAMMELSBURG—Chemistry.
MAGNUS—Technology.
WIEBE and FINK—Machinery.

SÖHDE and MANGER—Architecture.
FREIBERG—Free-hand Drawing.
POHLKE—Geometrical Drawing.
KISS—Modelling.
BOETTLICHER—Design.

† Prof. Playfair,—*Industrial Instruction*; also, Prof. Bache,—*Report on Education in Europe*.—Philadelphia,—1839.

AUSTRIA.

The "POLYTECHNISCHES INSTITUT" [*Polytechnic Institute*] at Vienna, the largest institution of its class in Europe, was established in 1815 by command of the Emperor FRANCIS I. Its present buildings, embracing an extensive double quadrangle of most imposing palatial architecture, were finished in 1838, at a cost of 759,384 florins—over \$300,000; and its Scientific and Technical Collections, as, indeed, its appointments generally as an educational institution, are on a similar scale of princely magnificence.

The educational objects of the Polytechnic Institute comprise the education of Architects, Engineers, Manufacturers,* and Merchants. In addition to these, however, the Institute is made a National Conservatory of Arts and Manufactures, with permanent collections, and is also intended to discharge the functions of an Institute for the promotion of National Industry, by means of occasional exhibitions of the products of Manufactures, held under the direction of the Institute. The permanent collections of the Conservatory of Arts are used for instruction in the Institute.

In the organization of the Austrian Institution we recognize, first, a Real or Preparatory School; and, secondly, the Polytechnic Institute proper, which includes two sections, namely, a Technical Section for Architects, Engineers, etc., and a Commercial Section for Merchants.

The following programme exhibits the courses of instruction of this institution.

POLYTECHNISCHES INSTITUT.

A.—REALSCHULE.

[*Course two years.*]

| | |
|-------------------------------|------------------|
| Religion. | Natural History. |
| German Composition and Style. | Mineralogy. |
| French language. | Mathematics. |
| Italian Language. | Calligraphy. |
| Geography. | Drawing. |

B.—POLYTECHNISCHES INSTITUT.

I.—TECHNICAL SECTION.

[*Course five years.*]

| | |
|-------------------------|------------------------|
| Elementary Mathematics. | Technology. |
| Higher Mathematics. | Agriculture. |
| Lower Geodesy. | Hydraulic Works. |
| Topographical Drawing. | Construction of Roads. |

*Preparatory to a future superintendence of Manufactories, etc., of the Austrian Empire,—such as Distilleries, Chemical Works, Glass and Porcelain Works, Sugar Manufactories, Metallurgic and Iron Works.

| | |
|---|-------------------------------|
| Mechanics. | Architectura. |
| Theory and Construction of Machines. | Technical Chemistry. |
| Descriptive Geometry. | Analytical Chemistry. |
| Mineralogy and Geology. | Practical Chemistry. |
| Physics. | Architectural Drawing. |
| General Chemistry. | Machine Drawing. |

2.—COMMERCIAL SECTION.

| | |
|--------------------------------------|------------------------------------|
| German Style and Composition. | Mercantile Correspondence. |
| Commercial Science. | Book-keeping. |
| Commercial Law, | Raw Materials and Products. |
| Commercial Arithmetic. | Mercantile Geography. |

Besides the foregoing, there is—under the direction of the Institute—a “Technical Drawing Section” or Technical School of Design, and a “Popular Section” or Sunday School.*

The number of students attending the several schools of the Polytechnic Institute of Vienna, during the fall of 1852,† was as follows:—

| | |
|-------------------------------|-----------------------------------|
| In systematic courses, | In occasional courses, |
| Preparatory School,..... 419 | Technical Drawing Section, ...360 |
| Technical School,.....1092 | Sunday Section,.....1381 |
| Commercial School,..... 126 | |
| | Total,.....1741 |
| Total,.....1637 | In both,.....3378 |

The number of professors and teachers engaged in this Institute amounts to 58, exclusive of the executive staff of the Director. The annual revenue of the Institute is about 116,000 florins—\$48,000—of which about \$34,000 is given by the State, and the balance comes from the funds of the school. The instruction is nearly gratuitous, there being only a small entrance fee charged for attendance on any of the courses of instruction.

It is sufficiently evident that the Polytechnic Institute of Vienna is on a very large scale. And it has been largely successful. Its course of study is extensive, though less systematic in its arrangement, and less strictly carried out than in some of the other Polytechnic Institutions; and yet, notwithstanding these defects and the large number of students attending this Institute, the demand for them by industrial establishments is said to be greater than can be readily supplied.

Besides the Metropolitan Institute at Vienna, there are five provincial Polytechnic Schools in Austria, the number of students in which in 1852, being about 4000. Of these, the one at Prague, the capital of Bohemia, under the title of the “TECHNISCHE BÖHMISCHE STÄNDISCHE LEHRAN-

* *Sunday Schools* for secular rather than religious instruction, in accordance with the habits very generally of the nations on the continent of Europe.

† Prof. Playfair,—“*Industrial Instruction, etc.*” Dr. Schödler,—“*Die höheren technischen Schulen nach ihrer Idee und Bedeutung,*”—Braunschweig,—1847.

STALT,"* is one of the oldest of its kind in Germany, having been established by the Bohemian Nobles as early as the year 1806.

The Technische Lehranstalt has for its objects, the education of Officers of State, whose functions connect them with the concerns of national industry; the education of Architects, Engineers, and Machinists; and the education of those destined to the superintendence of Glass and Porcelain Works, Metallurgic Works, Sugar Works, etc.

The institution consists of a Real or Preparatory School and Technical School proper—with courses of instruction of two and three years respectively. The course of the latter is seen in the following programme.

TECHNISCHE LEHRANSTALT.

[Course three years.]

| | |
|------------------------------|------------------------------|
| Religion. | Special Technical Chemistry. |
| Elementary Mathematics. | Constructions. |
| Physics. | Construction of Roads. |
| Zoölogy and Botany. | Agriculture. |
| General Technical Chemistry, | Agricultural Economy. |
| Mineralogy. | Architectural Drawing. |
| Practical Geometry, | Machine Drawing. |
| Mechanics. | Topographical Drawing. |

Besides 10 instructors in the Real or Preparatory School, there are 12 professors and adjuncts, in addition to the Director, in the Technische Lehranstalt. The whole number of students in attendance in 1847 was 1600.

The yearly appropriation to the support of the institution is Fl. 28,759, or \$11,300. The tuition fees are Fl. 18, or \$7.20 per annum.†

BAVARIA.

It has been already mentioned, when speaking of the lower Technical or Trade Schools of Germany, that there are twenty-six of these schools in Bavaria alone. These schools have courses of three years each—receiving pupils from the age of twelve to fifteen years—of a character to adapt them admirably well to discharge the functions of preparatory schools for the higher technical institutions. Of these, there are three "Polytechnic Schools" at Munich, Augsburg, and Nurnberg; two "Commercial Schools" at Furt and Nurnberg; and a "Building School"‡ at Munich.

The "POLYTECHNISCHE SCHULE ZU MÜNCHEN" [*Polytechnic School at Munich*—the oldest of these—was established in 1827, for the education of Technists, and for the scientific preparation of those destined to the

**Technical Institution of the Bohemian Nobles.*

†Dr. Schödler,—"*Die höheren technischen Schulen.*"

‡*Bauschule*; a school for the technical instruction of *builders*,—carpenters, masons, decorators, etc.—in drawing, modelling, embossing, use of materials, etc.—This school is said to be a model of its kind.

Civil Offices of the State. In its organization it comprises a Preparatory School [Kreislandwirtschafts-und Gewerbschule*] and the Polytechnic School proper, both located in the same building. The following programme presents the course of study of this institution.

POLYTECHNISCHE SCHULE ZU MÜNCHEN.

I. KREISLANDWIRTHSCHAFTS-UND GEWERBSCHULE.

[*Course three years.*]

| | | |
|------------------|-----------------------|-------------------|
| Religion. | Descriptive Geometry. | Trade-knowledge.† |
| History. | Trigonometry. | Agriculture. |
| Geography. | Chemistry. | Drawing. |
| German Language. | Natural History. | Embossing. |
| Book-keeping. | Physics. | Modelling. |
| Algebra. | Mechanics. | |

II. POLYTECHNISCHE SCHULE.

[*Course four years.*]

| | |
|--|---|
| Analysis—Theory of Equations and Functions; Series; Analytical Polygonometry; Plane and Spherical Trigonometry; Analytical Geometry. | Analytical Chemistry. |
| Physics. | Constructions—Roads, Bridges and Water-works. |
| Machines and Machine Drawing. | Geodesy and Topographical Drawing. |
| Differential and Integral Calculus. | Architectural Drawing. |
| Materials used in Construction. | Descriptive Geometry. |
| Applied Mechanics. | Analytical Mechanics. |
| | General Chemistry. |
| | Designs for Constructions. |
| | Stone-cutting. |

The "POLYTECHNISCHE SCHULE ZU AUGSBURG" [*Polytechnic School at Augsburg*] was established by Royal Ordinance in 1833. It has for its objects the conveying of scientific and technical instruction on the following subjects:‡

1. Mining, Metallurgie and Salt Operations.
2. Civil Architecture
3. Roads and Hydraulic Works.
4. Higher Forestry.
5. Plastic Arts.

In its organization it comprises a Preparatory School [Kreisgewerbschule §] and the Polytechnic School proper, both in the same building. Without, however, giving further details, it may be remarked that the courses of study of the Polytechnic Schools at Augsburg and Nurnberg are substantially the same, both being somewhat inferior in these as in other respects to the School at Munich. According to Prof. Playfair,|| the

* *Local Farming and Trade School.* † *Gewerblehre.*

‡ Dr. Schödler,—*"Die höheren technischen Schulen nach ihrer Idee und Bedeutung."*

§ *Local Trade School.*

|| *"Industrial Instruction on the Continent."*

specialties of these Schools, or the excellences which they respectively exhibit, are, Architecture and Civil Engineering at Munich, Machinery at Augsburg, and Technical Chemistry at Nurnberg.

These Schools are mainly supported by Government, which appropriates 39,000 florins [\$16,250] yearly, in addition to which a small tuition fee is charged. The buildings of the Polytechnic Schools are described as being very ample; while some of the scientific collections, particularly at Munich, are said to be of a high order of excellence.

In the Munich Polytechnic School there are 15 professors and 344 students; there are also 205 students in the Preparatory School. In 1852, there were in the three Polytechnic Schools 34 professors and assistants, and 481 students in attendance.

The excellence of the Architecture and Engineering of Bavaria is well known to intelligent observers, and is directly traceable to the influence of the admirable Polytechnic Institutions, established and largely sustained by the enlightened liberality of the Royal Government of that State.

SAXONY.

The system of scientific and technical education of the kingdom of Saxony, has a similarly elevated rank to that which has long been accorded to its humanistic or literary counterpart. In both, Saxony takes its place among the first of the German States. The lower Technical Schools, of which there are three, located respectively at Chemnitz, Plauen, and Zittau, are of a high grade of excellence. Of these, the one at Chemnitz is quite a remarkable specimen of its class, and seems to warrant something more than a passing notice.

The "KÖNIGLICHE GEWERB-UND BAUGEWERKENSCHULE ZU CHEMNITZ" [*Royal Trade and Building School at Chemnitz*] comprises two schools—a Trade and Building School. The following programme gives the course of study for each school.

KÖNIGLICHE GEWERB-UND BAUGEWERKENSCHULE ZU CHEMNITZ.

I.—GEWERBSCHULE.

[*Course four years.*]

General Arithmetic.
Geometry.
Plain and Spherical Trigonometry.
Theory of the Higher Equations.
Analytical Geometry.
Commercial Arithmetic.
Physica.

General Chemistry.
Natural History.
Chemical Manipulation.
Analytical Chemistry.
Mineralogy and Geology.
Descriptive Geometry.
Perspective.

| | |
|-----------------------------|---------------------------------|
| Geometrical Drawing. | Agricultural Economy. |
| Architectural Drawing. | Cattle-Breeding. |
| Machine Drawing. | Plant Culture. |
| Surveying and Plan Drawing. | Study of Soils and Fertilizers. |
| Free-hand Drawing. | Technical Chemistry. |
| Mechanics and Machinery. | Commercial Book-Keeping. |
| Culture of Field Stock. | Spinning Machines. |
| Science of Construction. | Fabric and Pattern-drawing. |
| Mechanical Technology. | Embossing in Clay and Wax. |
| Agricultural Machinery. | German Language. |
| Agricultural Architecture. | Geography and History. |
| Agricultural Chemistry. | French Language. |
| Agricultural Excursions. | English Language. |

II.—BAUGEWERKENSCHULE.

[*Course two years.*]

| | |
|--|---------------------------------------|
| Arithmetic. | General Architecture. |
| Geometry. | Architectural Drawing. |
| Geometrical Projections. | Free-hand Drawing. |
| German Language. | Ornamental Drawing. |
| Mechanical Physics. | Modelling in clay and wood. |
| Special Masonry and Carpentry of Road, Bridge, and Hydraulic Constructions. | Perspective. |
| | Embossing of Ornaments, &c., in clay. |

There were in the Chemnitz School in 1853, 16 professors and assistants.

| | |
|-----------------------------------|------|
| Students in the Trade School..... | 192. |
| “ “ Special Drawing Class..... | 53. |
| “ “ Building School..... | 59. |
| Total,..... | 304. |

The instruction in this School commences with the elements of the subject taught; and, in fact, the aim appears to be to carry this instruction no farther than to secure a good theoretical and practical knowledge of the *elements* of the various subjects embraced in this somewhat extensive programme. If we may judge from the character of the courses of study here presented and of the modes in which they are said to be carried out in these schools,* there can be no doubt of their capability of furnishing an admirable training for agriculturists, artisans, builders, etc., as also of their peculiar excellence as training or preparatory schools for the higher Technical Institutions.

There are two Higher Technical Schools in Saxony; one the “KÖNIGLICHE POLYTECHNISCHE SCHULE” [*Royal Polytechnic School*] at Dresden; the other the “KÖNIGL. SÄCHSISCHE BERGAKADEMIE” [*Royal Saxon Mining Academy*] at Freiberg.

* Director SCHNEDERMANN,—“*Nachrichten über die Königl. Gewerbe- und Baugewerkschule.*”—*Leipzig*,—1858.

The former of these Schools was established at the capital of the kingdom of Saxony, more than twenty years ago, under the name originally of the "Technische Bildungsanstalt zu Dresden"—[*Technical Institution at Dresden*]. It was recently reorganized, when it took its present name. Besides the Polytechnic School there is a "Königl. Baugewerkschule" [*Royal Building School*] under the same general organization. The Polytechnic School comprises a "Lower" and an "Upper Section." The following programmes exhibit the respective courses of study, of these two schools.

KÖNIGLICHE POLYTECHNISCHE SCHULE.

I.—LOWER SECTION.

[*Course three years.*]

| | |
|------------------------|------------------------|
| Stereometry. | Logic. |
| Trigonometry. | French Language. |
| Algebra. | German Composition. |
| Mechanics. | Machines. |
| Natural History. | Perspective. |
| Theoretical Chemistry. | Machine Drawing. |
| Experimental Physics. | Plan Drawing. |
| Practical Geometry. | Modelling in Wood. |
| Descriptive Geometry. | Field Surveying. |
| Analytical Geometry. | Technology. |
| Mineralogy. | Chemical Manipulation. |
| Architectural Drawing. | Technical Chemistry. |
| Architectural Science. | Ornamental Drawing. |

II.—UPPER SECTION.

[*Course two years.*]

| | |
|------------------------|------------------------|
| German Composition. | Constructions. |
| Logic. | Designs for Machines. |
| National Economy. | Higher Geodesy. |
| Popular Jurisprudence. | Higher Mechanics. |
| English Language. | Technology. |
| Book-keeping. | Roads and Railways. |
| Higher Analysis. | Hydraulic Engineering. |
| Higher Physics. | Practical Surveying. |
| Astronomy. | Topographical Drawing. |
| Geology. | Designs for Buildings. |
| Mill Machinery. | Technical Chemistry. |
| Motive Powers. | Geological Excursions. |

KÖNIGLICHE BAUGEWERKENSCHULE.

[*Course three years.*]

| | |
|-------------|-------------------------|
| Arithmetic. | Building and Carpentry. |
| Mechanics. | Architectural Drawing. |

Geometry.
German Composition.
Industrial Physics.
Perspective.

Building Economy.
Ornamental Drawing.
Designs and Estimates.
Architectural Science.

It will be observed that a different principle of subordination is recognized by the managers of the Dresden Polytechnic School to that which obtains in the German Schools previously considered. The Under Section in itself presents a general Scientific and Technical Course of instruction. The differences between the course of this and that of the Upper Section, are partly, in the addition of certain scientific and technical subjects to the latter, and in part, in the development and specializing of subjects taught in the Under Section. The Course of the Under Section is, indeed, very well adapted to the wants of those who might wish to pursue a general course of scientific education, without reference to the wants of those professions for which the Course of the Upper Section is more especially designed. Such, in fact, appears to be in part the use made of the Under Section in this Polytechnic establishment;—it serves as a preparatory department to the Upper Section for those who are to be Engineers, Machinists, and Chemists, and it supplies a finishing course for those who wish a mere accomplishment in the less severe and less technical studies of theoretical and practical science.

In 1853, there were in the Polytechnic School, 22 professors and assistants; also,

| | |
|---|------|
| Students in Under Section,..... | 162. |
| Students in Upper Section,..... | 43. |
| Students in Special Drawing and Modelling,..... | 18. |
| Students in Building School,..... | 86. |

Total.....309.*

The annual revenue of the Dresden establishment is only about \$12,000 of which from \$8000 to \$9000 are appropriated by the Government, and the balance comes from a small tuition charge of about \$23, annually.†

In addition to the Polytechnic School of Dresden, Saxony contains the most celebrated School of Mines in the world. The *Royal Saxon Mining Academy* of Freiberg, is not only the oldest,—having been established in 1765—but pre-eminently the first institution of its kind, in experience and other resources, for the accomplishment of its objects.

In its organization, the Mining Academy comprises a General or Preparatory School, and the two specialties of Mining and Metallurgic Schools. The following programme exhibits the courses of study at this institution.

* Director HÜLSE,—“*Nachrichten über die Königl. polytechnische Schule und Königl. Baugewerkschule,*”—Dresden,—1853.

† Prof. Playfair,—“*Industrial Education, etc.*”

KÖNIGLICHE SÄCHSISCHE BERGAKADEMIE.

[*Course four years.*]

GENERAL COURSE.

| | |
|--|--|
| Mathematics—Elementary, Higher and Practical. | Mineralogy—Systematic and Practical. |
| Mechanics—Theoretical and Practical. | Geology—Systematic and Practical. |
| Machines—Mining and Metallurgic. | Civil Architecture and Engineering |
| Chemistry—Theoretical, Analytical, and Practical. | Constructions. |
| Physics—General and Applied. | Mining Jurisprudence and Correspondence. |
| Descriptive Geometry, including Shades, Shadows and Perspective. | German Composition. |
| Drawing—General and Topographical, extended to Mining Implements, Mining and Metallurgic Machines and Constructions. | French Language. |
| | General Metallurgy. |
| | The Art of Mining. |
| | Crystallography. |
| | Land Surveying and Mapping. |

SPECIAL COURSES.

For Miners.

| | |
|-----------------------------|----------------------------------|
| Mine Surveying and Mapping. | Keeping of Books, Registers, &c. |
| Fossil Geology. | Mine Working. |

For Metallurgists.

| | |
|----------------------------|-----------------------|
| Practical Assaying. | Practical Metallurgy. |
| Analysis of Metallic Ores. | Blow-pipe Assaying. |

For admission to the Saxon Mining Academy, applicants must be not less than sixteen years of age, and must be prepared to pass an examination in certain required subjects of preliminary knowledge. The course of study of the Academy is arranged for four years, and is obligatory on all its students, with the exception of certain specialties in Mining and Metallurgy, which are pursued in accordance with the student's destination to one or the other of these two departments of professional practice.

This institution is supported by Government, from which it receives liberal provisions. A part of the students not only receive their instruction and board, but in addition, a certain pay per annum. These enter the Government Service with their appointments to the School, and when graduated are candidates for the Royal Corps of Mines. As such they receive the pay of this grade until appointed to vacant places in the Corps. Besides this class of students, others are permitted to attend the Mining Academy, who pay a small tuition fee and board in the town at their own expense. In this latter class are to be found students not only from Saxony and the other German States, but from nearly every country of the civilized world. The attendance, however, is never very large, varying from fifty to seventy-five of all kinds.

In a late General Catalogue of former members of the Mining Academy,

there are 1681 names from A. D. 1766 to 1850, embracing men from all parts of Europe, with some from the United States, Mexico, and the South American States. It appears, moreover, from the statistics obtained by the compilers of this Catalogue that, not only the foreigners who have attended the courses of this School, but a considerable number of its German graduates, have gone into every land, legitimately carrying out the teachings of their Alma Mater as Miners and Metallurgists,—as missionaries, indeed, of these important departments of Practical and Technical Science.*

The Professorial Corps of this institution has long been celebrated. Such names as WERNER†, BREITHAUP T LAMPADIUS, MOHS, LEHMANN, and others among the earlier, and WEISBACH, PLATTNER, SCHEERER, COTTA, and others—fourteen in all—among the present Professors, in the Mining Academy, are well known in the annals of theoretical and practical science.

BADEN.

In Baden the Trade or Artisan's Schools appear to be of a less elevated grade than in most other parts of Germany. There is, however, a Polytechnic Institution at Carlsruhe, the Capital of the Grand Duchy, which is one of the most complete in its organization, as well as one of the most important in its results of any in Germany. It was established in 1825 under the Governmental charge of the Minister of the Interior. In 1832 it underwent a reorganization; and, subsequently, other less important changes were introduced until it finally took the form which it has had for a number of years past.

Its educational objects will be rendered sufficiently apparent by the following statement of its present organization, in connection with its several courses of study.

POLYTECHNISCHE SCHULE ZU CARLSRUHE.

GENERAL MATHEMATICAL CLASSES.

[Course three years.]

| | |
|------------------|-------------------------------------|
| Religion. | Practical Geometry. |
| History. | Differential and Integral Calculus. |
| German Language. | Mechanics. |
| French Language. | Botany. |

* "*Die Bergakademie zu Freiberg: zur Erinnerung an die Feier des hundertjährigen Geburtstages WERNER'S am 25, Sept. 1850.*"—Freiberg.

Also, "*Die Bergakademie zu Freiberg, ihre Beschränkung oder Erweiterung, beleuchtet von B. Cotta, Professor an derselben.*"—Freiberg,—1849.

† WERNER, one of the distinguished fathers of Geological Science. He was one of the earliest Professors in this School—having been appointed in 1774—and remained as its most celebrated teacher until his death in 1817. His cabinet—the Wernerian Museum—is one of the valuable scientific collections possessed by this institution.

English Language.
 Pure Mathematics.
 Geometry.
 Trigonometry.
 Descriptive Geometry.
 Analytical Geometry.

Mineralogy and Geology.
 Physics.
 Technical Chemistry in general.
 Free-hand Drawing.
 Calligraphy.
 Modelling.

SPECIAL SCHOOLS.*

I.—ENGINEERING SCHOOL.

[*Course three years.*]

Ethics.
 English Language.
 Jurisprudence.
 Practical Surveying.
 Higher Geodesy.
 Topographical Drawing.
 Designs and Estimates for Works.

Landscape Drawing.
 Higher Analysis.
 Higher Mechanics.
 Roads and Hydraulic Works.
 Machinery.
 Architectural Drawing and Modelling.
 Higher Architecture.

II.—ARCHITECTURAL SCHOOL.

[*Course four years.*]

German Literature and Style.
 Ethics and Æsthetics.
 Archæology of Art.
 Higher Architecture; History; Styles.
 Jurisprudence [*Populare Rechtslehre.*]
 Trigonometry, Spherical and Analytical Geometry.
 Differential and Integral Calculus.
 Mechanics and Hydraulics.
 Descriptive Geometry.
 Theory of Machines.

Designs for Buildings,—Estimates.
 Technical Architecture.
 Construction of Roads and Hydraulic Works.
 Mineralogy and Chemistry.
 Building and Ornamental Drawing.
 Drawing of Constructions.
 Figure Drawing.
 Aerial Perspective.
 General Modelling.
 Modelling Ornamental.

III.—HIGHER TECHNICAL SCHOOL.

[*Course two years.*]

FOR TECHNICAL CHEMISTS.

General Chemistry.
 Analytical Chemistry.
 Practical Geometry.
 Ethics.
 Chemical Manipulation.
 English Language.
 French Language.
 Botany and Zoology.
 General Drawing.

Technical Chemistry.
 Popular Mechanics.
 Common Roads.
 History.
 Mineralogy.
 Geology.
 Book-keeping.
 Commercial Law.
 Mechanics of Transport.

FOR MECHANISTS AND TECHNOLOGISTS.

Theory of Machines.
 Construction of Machines.
 Physics.
 Higher Analysis.
 Higher Mechanics.

Technology.
 Technical Chemistry.
 English Language.
 Roads, Bridges, and Hydraulic Works.
 French Language.

* "*Fachschulen.*"

IV.—FOREST SCHOOL.

[Course two years.]

| | |
|-------------------------|---------------------------|
| Practical Mathematics. | Mineralogy. |
| Technical Chemistry. | Geology. |
| Botany. | Meteorology. |
| Practical Geometry. | Road Making. |
| National Economy. | Agricultural Chemistry. |
| Forest Trees. | Forest Economy. |
| Forest Laws and Police. | Forest Rights and Sports. |
| Wood Taxation. | Preservation of Forests. |

V.—COMMERCIAL SCHOOL.

FOR COMMERCE.

[Course one year.]

| | |
|----------------------|----------------------------|
| Commercial Law. | Commercial Correspondence. |
| Book-keeping. | Commercial Arithmetic. |
| History of Commerce. | Commercial Products. |
| German Composition. | Commercial Geography. |
| French Language. | Calligraphy. |
| English Language. | Drawing. |

FOR POSTAL SERVICE.

[Course two years.]

| | |
|-------------------|-------------------------|
| Arithmetic. | Popular Mechanics. |
| Geography. | Physics. |
| Religion. | General History. |
| French Language. | German Composition. |
| French Commerce. | Political Arithmetic. |
| National Economy. | Jurisprudence. |
| English Language. | Mechanics of Transport. |
| Calligraphy. | Commercial Contracts. |
| Ethics. | Æsthetics. |

Students may enter the lowest class of the General School or Mathematical Classes at fifteen years of age, with a certain required preparation. It should be observed, however, that the General School more appropriately precedes the courses of the Special Schools of Engineers, Architects, and Technists. The other Special Schools require a much lower standard of preparation, than that obtainable during the three years course of the General School.*

In 1852-3, there were 41 professors and teachers attached to this institution, with an attendance of 330 students, of whom 112 were foreigners,—72 from other German States, and 40 from other European nations.

The Government grant to the Polytechnic School of Carlsruhe is only 32,000 florins per annum,—about \$14,000,—while the expenses of the School amount to 50,000 florins—about \$21,000. To meet this deficiency a small charge is made to each student,—\$33,00 per annum.

* "Das höhere und niedere Studien-Wesen im Grossherzogthume Baden,"—Konstanz,—1846. Also, Dr. Schödler,—*"Die höheren technischen Schulen etc."*

Of the results of this institution, it is said that the formal certificates of the Special Schools are held in the highest estimation, and command immediate employment to their possessors.*

In addition to the institutions already noticed, there are excellent establishments of the same class, in Hanover,† Wirtemberg, Hesse-Cassel, Hesse-Darmstadt, Brunswick,‡ and possibly in other parts of Germany, of which the writer possesses no information.§ Our limits, however, do not permit further citations of this kind; and, indeed, our present objects will be satisfied, we trust, with the introduction of the examples already given. They have been chosen, partly on account of their prominence in this class of institutions, and in part, for their well marked peculiarities; for although all aiming at the same general objects,—frequently, at objects precisely the same,—yet, they differ much in organization, in methods, and in the general spirit which animates their administration.

In the sketches which have here been given, the aim has been to present certain classes of characteristics, in as concise a form as practicable, to the exclusion of much other matter that might be interesting to the immediate managers of this class of educational institutions, but which would be scarcely essential to our present inquiry. Of the features thus brought under review, we have intended, especially, to include the age or duration of the institution,—the nature of its establishment,—objects,—organization,—courses of study,—number of instructors,—number of students,—endowments,—tuition expenses,—besides an occasional remark illustrative of its characteristics or the results of its practical working.

* Prof. Playfair,—“*Industrial Instruction.*”

† Director Karmarsch,—“*Die höhere technische Schule zu Hanover.*”—Hanover,—1844;—Also by the same, “*Die polytechnische Schule zu Hanover.*”—Hanover,—1848.

‡ Prof. Schödler,—“*Die höheren technischen Schulen, etc.*”

§ In Belgium, Denmark, and several other Continental States, there are provisions of greater or less extent for scientific combined with technical instruction. In Great Britain, there were no institutions for this kind of instruction,—with the exception of two or three schools of Civil Engineering,—prior to the advent of the London Industrial Exhibition of 1851. Since then, the Government has not only established a School of Mining Engineers, but has been building up a system of schools of General and Technical Design all over the Kingdom.

THE TRUE IDEA OF A POLYTECHNIC INSTITUTE.

We shall now seek to realize the more prominent object, originally proposed, for bringing together the preceding notices of the principal Scientific and Technical Institutions of the Continent of Europe,—which was, to illustrate the *true idea* of the Polytechnic Institute, by a direct appeal to its own most characteristic features, as displayed in a series of institutions presenting all the usual varieties of the class. The features most appropriate to this purpose are those which will best illustrate the Objects, Curriculum, and Methods of the Polytechnic Institute,—characters which may be obtained by simple inductions based on the data supplied by the foregoing sketches.

OBJECTS.

By a comparison of the different institutions embraced in our survey, it will be seen that their general objects may be properly stated to embrace the educational training of the following classes of Scientific Technists.

- | | |
|------------------------|---------------------------|
| 1. ARCHITECTS.* | 4. MECHANISTS. § |
| 2. CIVIL ENGINEERS. † | 5. TECHNOLOGISTS. ¶ |
| 3. MINING ENGINEERS. ‡ | 6. TECHNICAL CHEMISTS. ¶¶ |

* Whose duties connect them with the preparation of Designs and Superintendence of the Construction of *Edifices*, public and private.

† Having charge of the following specialties: Designs and Constructions of,—*Common Roads; Railways; Bridges; Tunnels; Canals; Docks; River and Harbor Improvements; Lighthouses; the Supply and Distribution of Water for Towns, Sanitary, Agritultural, and Manufacturing purposes.*

‡ Under Mining Engineering is usually included the two important specialties of *Mining and Metallurgy*,—embracing all that relates to the Surveying, Opening, and Working of Mines, and the Smelting of Ores, Reduction of Metals, Assaying, etc.

§ Or *Higher Machinists*; also sometimes called *Mechanical Engineers* in Great Britain and the United States. Their professional functions embrace the Designing for, and Superintending of the Construction of the Steam Engine, Hydraulic, and other Machine Motors, as also heavy and complicated Machinery in general.

¶ Whose functions embrace those professional duties incident to the Establishment and Superintendence of Works for the Higher Manufactures and Physical Arts; such, for example, as Potteries, Porcelain and Glass Works; Manufactories of the various Textile Fabrics, Printed Fabrics, Ornamental Metal Work, etc.

¶¶ These include two classes, namely; first, those engaged in *Chemical Manufactures*, for example, in the production of Acids, Salts, Pigments, Coloring Substances, Oils, Fats, Resins, Sugars, etc.,—Preparation of Fuels, Illuminating Gases, Pharmaceutical Substances, etc.; secondly, those engaged in *Manufactures dependent on Chemistry*,—such as Bleaching, Dyeing, Printing on Textile Fabrics, etc.

In this generalization we have omitted all recognition of Schools of Forestry, Agriculture, and Commerce, because neither occurs in more than one or two instances in the whole number of institutions noticed. Besides, a School of Forestry, as here represented, is naturally limited to the wants of a few countries; while a School of Agriculture, with its peculiar requirements in respect to educational appliances would, in the majority of cases, as a matter of expediency, have a distinct organization.* There is, however, no reason why a Commercial School with elevated aims should not form one of the schools of a Polytechnic Institution. The relations between the pursuits of commerce and the various operations and results of constructive, productive, and manufacturing industry, are certainly such as to make the facilities possessed by a Polytechnic Institute peculiarly well adapted to the development of the most useful kind of commercial education. The course of the Commercial Section in the Polytechnic School of Carlsruhe is, in this connection, eminently suggestive.

THE CURRICULUM.

We may conveniently divide the system of instruction of a Polytechnic Institution into three parts;—first, the *Preparatory Course*, embracing all those studies necessary to matriculation in the institution; secondly, the *General Course*, constituting the foundation in general science and literature, on which, as a common basis, are erected the subsequent courses; and thirdly, the *Technical Courses*, which include all those special teachings, more or less peculiar to the objects of the institution.

The scholastic requirements for matriculation differ considerably among the institutions which have come under our notice; some, as in the case of the Polytechnic School at Paris and the Technical Institute at Berlin, have requirements, particularly the former, of an extremely elevated grade; while others, which embrace the majority of cases, prescribe a certain measure of preliminary training which experience has found to be both necessary and practicable. The following programme presents the course of preparatory studies *generally* required for matriculation in the Polytechnic Institutions of the Continent of Europe.

* A considerable proportion of the subjects of study at the Schools of Forestry on the Continent of Europe, is manifestly such as should form a part of the general course of study in every completely organized Agricultural Institution, wherever established. The finest Agricultural School in Europe, is the "Konigl. Lehranstalt für Land u. Forstwirthschaft"—*Royal Institution for Agriculture and Forestry*—at Hohenheim, in the kingdom of Wurtemberg, in which these closely allied courses of training are brought under a single organization.

PREPARATORY COURSE.

MATHEMATICS.—Arithmetic; Elementary Algebra; Geometry; Elements of Trigonometry.

EXPERIMENTAL SCIENCE.—Elements of Physics and Chemistry.

DESCRIPTIVE SCIENCE.—Geography; Political History; Natural History.

LITERATURE.—The vernacular Language,—including Grammar and, to a certain extent, Style in Composition.

GRAPHIC ARTS.—Writing; Drawing—to a greater or less extent.

The course here given, while more extended in physical science than that prescribed at the École Centrale, is very far inferior to that required at the École Polytechnique in mathematical science.* It more nearly represents the matriculation requirements of the German Institutions. But it will be observed that the latter frequently unite in the same general organization a Preparatory School, located in the same or separate buildings; and in such cases, the studies included in the preparatory courses are even more extended—at least in variety of subjects;† in fact, they present specimens of means well adapted to secure an *effective disciplinary training* preparatory to matriculation,—a desideratum of the utmost importance, in view of the fact that the subsequent courses of a Polytechnic Institute are of a nature to tax more or less completely the intellectual powers of any student.‡ As respects age, it is observable that students are rarely matriculated before sixteen; while, in general, they are from seventeen to nineteen years of age,—sometimes older than the latter limit,—before entering upon the regular course of a Polytechnic Institution.

GENERAL COURSE.

MATHEMATICS.—Social Arithmetic; Higher Algebra; Analytical Trigonometry; Analytical Geometry; Differential and Integral Calculus.

NATURAL HISTORY AND GEOLOGY.—Botany; Zoölogy; Mineralogy; Geology; Physical Geography.

PHYSICS AND MECHANICS.—General Physics; Theoretical and Practical Mechanics.

CHEMISTRY.—Theoretical and Practical Chemistry.

LITERATURE.—Composition and Criticism in the vernacular language; Modern Languages.

* The knowledge required for admission to the École Polytechnique comprises:

- | | |
|--------------------------------------|--|
| 1. Arithmetic. | 8. Physics. |
| 2. Elementary Geometry. | 9. Chemistry. |
| 3. Algebra. | 10. Cosmography. |
| 4. Plane and Spherical Trigonometry. | 11. French Language. |
| 5. Analytical Geometry. | 12. German Language. |
| 6. Descriptive Geometry. | 13. Drawing;—Geometrical,—Water Color,—Crayon. |
| 7. Mechanics. | |

“*Programme des connaissances exigées pour l'admission à l'École Impériale Polytechnique.*—MINISTÈRE DE LA GUERRE,—Paris,—1854.

† See under *Bavaria*, p. 22.

‡ That is, provided, always, the course as such be actually accomplished.

PHILOSOPHY.—Logic; Ethics; Æsthetics; Jurisprudence.

GEODETIC ARTS.—Lower Geodesy.

GRAPHIC ARTS.—Descriptive Geometry; Geometrical Drawing; Topographical Drawing; Free Drawing.

PLASTIC ARTS.—Modelling in Clay, Plaster, etc.

TECHNICAL COURSES.

GENERAL CONSTRUCTIONS.—Materials used in Construction; Stability of Architectural and Engineering Structures.

MACHINES.—Theory of Machines; Transformations of Motion; Construction of Machines; Prime Movers.

SPECIAL ENGINEERING CONSTRUCTIONS.—Roads and Railways; Bridges; Hydraulic Works; Machines used in Construction; Location and Surveying of Works; Designs and Estimates.

SPECIAL ARCHITECTURAL CONSTRUCTIONS.—Components of Edifices; Architectural Design; History of Architecture; Architectural Decoration; Construction of Public and Private Edifices; Designs and Estimates.

GENERAL GEODESY.—Practical Astronomy; Higher Geodesy; Topographical Surveying.

INDUSTRIAL CHEMISTRY AND PHYSICS.—Technology; Technical Physics; Warming and Ventilating of Buildings; Technical Chemistry; Designs for Works and Processes.

METALLURGY.—Analytical Chemistry; Assaying; General Metallurgy; Designs for Works and Processes.

MINING.—Mining Geology; Mine Surveying; Mining Machines; Working of Mines; Mining Economy; Mining Jurisprudence.

GRAPHIC ARTS.—Free Drawing; Architectural Drawing; Machine Drawing; Topographical Drawing; Mine Drawing.

PLASTIC ARTS.—Modelling in Clay, Plaster, Wood, and Stone; Stone Cutting; Embossing.

The division of the Curriculum into general and technical courses is one rather of convenience than of fact, since there is scarcely a well marked instance of such a distinction to be seen in any one of the examples considered.* Our object in here recognizing the division named is, that we may indicate more precisely the subjects of study under their respective heads. The idea of a General Course is that of a *common basis* of all the specialties destined to follow—that is, of all the technical courses.

In respect to the General Course, it will be observed that the subjects included in our list, are common to almost every institution brought under our cognizance. The subjects thus named, although somewhat variable as regards extent of individual development in different institutions, may be considered to represent the *fundamental scientific and literary culture*,

* The organizations of the Berlin and Carlsruhe Institutions approximate to this condition, but are not strictly in accordance with it. Perhaps the closest approach is seen in the relations between the Polytechnic and Special Government Schools of France,—where the former becomes the General School in respect to all of the graduates who finish their educational courses in the Special Schools.

which experience has suggested to be appropriate to the objects of this class of educational institutions.*

It would be equally, nay more, difficult to generalize the distinctions observed in some of these institutions in respect to individual technical courses. Not intrinsically; but in having due reference to the facts as actually presented in the several cases. These are, first, in the absence, as already remarked, of the distinction of any really general or fundamental course; and secondly, in the diversity exhibited in the special courses. In certain cases, without doubt, this diversity has arisen in somewhat different local wants; in others it would be difficult of explanation except on grounds of merely arbitrary or at best temporary expediency. We have therefore been content to generalize the studies of the Technical Courses, as a whole, in accordance with the objects already stated, deeming this to be sufficient for our present purpose.

METHODS.

That which has been already presented under the two preceding heads, is perhaps suggestive of all that need be said under the present one. We will merely add a single observation. It should be noticed that, in connection with the large amount of technical study which enters into the Curriculum of a Polytechnic Institute, there is associated the feature of nearly continuous daily practice in some kind of *sensuous* discipline—discipline of the senses. Each student undergoes an almost daily drill in a class of exercises which, besides tending to secure a high degree of muscular training, in all that belongs to facility and precision of manipulation, are of a nature, by their direct appeal to the senses, to contribute to a largely increased command of sensuous power,—in quickness and accuracy of sight,—in delicacy of touch, etc. For example, in descriptive science,—botany, zoölogy, mineralogy, geology, etc.,—we have practice in the study and direct examination of hand specimens of minerals, plants, and animals, with excursions to localities; in experimental science, physical and chemical manipulations in the laboratory; in the geodetic arts, the use of instruments in the actual conduct of astronomical, trigonometrical, and topographical observations of practical data; in the graphic arts, practice to a large extent in free, topographical, and geometrical drawing; in the plastic arts, modelling in clay, plaster, and wood, and stone-cutting, etc. Moreover, this peculiar discipline is carried out so extendedly in each of

* We have omitted to include *Religion* in the general course, first, because it occurs in only two or three instances; and secondly, in view of the more than doubtful expediency of placing religious culture—how all important soever in itself—in the Curriculum of such an institution.

the several examples noticed, as to secure to the diligent and attentive student an intelligent and complete command of the various practical operations which, in after life, would be likely to make direct requisitions upon this kind of knowledge.*.

EDUCATIONAL GRADE.

In addition to the several characters already noticed, the question may arise as to the *status* or educational grade of the Polytechnic Institute among its various cotemporaries in other fields of learning. In answer to this question it may be remarked, in the first place, that general usage on the continent of Europe appears to assign the Higher Technical Institutions a place among Universities in the "Superior System of Instruction."—Thus Dr. Schödler, in the course of an analysis of relative characteristics, exhibits the following parallel between the two systems of Humanistic and Technical Education:†

| HUMANISTIC SCHOOLS. | | TECHNICAL SCHOOLS. | |
|-----------------------|-----------------------|--------------------------|-------------------------|
| Three-fold system. | Four-fold system. | Three-fold system. | Four-fold system. |
| 1. Elementary School. | 1. Elementary School. | 1. Elementary School. | 1. Elementary School. |
| 2. Gymnasium. | 2. Gymnasium. | 2. Techn. Middle School. | 2. Real School. |
| 3. University. | 3. Lyceum. | 3. Techn. High School.‡ | 3. Higher Trade School. |
| | 4. University. | | 4. Techn. High School. |

In a similar manner, Prof. Bache, in recognition of this usage, places the Polytechnic and Special Technical Schools of the continent of Europe with the Universities in the system of "Superior Instruction," thus distinguishing this class of institutions from those devoted to "Secondary Instruction,"—such as the Gymnasias, Lyceums, Real Schools, Trade Schools, etc.§ So Prof. Playfair, more recently, while ranking the higher Technical Institutions with the Universities, speaks of the former as *Industrial Universities*.|| Indeed, so far as we are aware there is no question as respects intelligent usage on this point.

But it may be remarked, that apart from the question of the fact, there are manifest reasons why such a usage should obtain. And these rest on the reality of the possession by each—by the Humanistic and Technical

* Of course, the observations contained in this paragraph, like preceding ones, are to be understood as *generalizations* of features of Polytechnic Institutions, as a class, rather than as strictly applicable to any single institution.

† "Die höheren technischen Schulen nach ihrer Idee und Bedeutung."

‡ Generic or synonymic for Polytechnic School, Institute, etc.

§ "Report on Education in Europe to the Trustees of Girard College for Orphans."—Philadelphia,—1839.

|| "Industrial Instruction on the Continent,"—London,—1852.

University—of all those characteristics in common which are deemed more or less essential to the University idea; such, for example, as considerable maturity of age and preparation before matriculation,—the elevated nature of the prominent studies,—the predominance of the lecture mode of communicating instruction,—the aggregation of two or more professional schools,—the conferring of certain degrees,*—etc.

A true idea of the Polytechnic Institute is, therefore, that of a *series of Special Schools* for the complete educational training of Architects, Civil Engineers, Mining Engineers, and other Scientific Technists,—all united under a common organization,—all alike aiming at the realization not only of exact and extended scientific culture, but of the utmost practical skill in the applications of science to the pursuits of active life. The name Polytechnic Institute—Institute of many Arts—becomes etymologically significant when thus applied,—alike of the plurality, the nature, and the importance of its objects.† It is also manifest that the subjects and methods of study here noticed present an array of means well chosen towards the attaining of results so important; for, besides the extensive system of disciplinary exercises for muscular and sensuous culture, if it be remembered that the various theoretical and technical courses, in addition to the large amount of positive knowledge which they are designed to convey to the student, are adapted to secure a discipline of the intellectual powers of a high order of excellence,—it may be seen how a judicious combination of these two parallel but intimately connected systems of culture might conduce to the exaltation of the intelligence and executive

* The conferring of degrees is, perhaps, scarcely to be included among the actual features of the Technical Institutions, either of France or Germany. Even to be graduated at the *École Polytechnique*,—a distinction, unquestionably, very high of its kind,—gives to the recipient of this honor the right to style himself nothing more than “*Ancien Élève de l'École Polytechnique*”—*Former Student* of the Polytechnic School.

† Hence the School of Roads and Bridges at Paris, and the Mining Academy at Freiberg, although Special Schools of a high order, are yet not properly entitled to the epithet *Polytechnic*. The most *complete*—though not necessarily the best—Polytechnic Institution of those noticed in our sketch, is the “Polytechnic School” at Carlsruhe; next to this we might perhaps place the “Central School” at Paris and the “Technical Institute” at Berlin. The Polytechnic School of France, *in connection with* the various Special Schools of Application, may thus be considered a Polytechnic Institute of a high order.

In a similar manner we use the term *Institute* in association with its descriptive epithet, for the aggregation of several specialties under one general organization, in accordance with what we conceive to be the better German usage, in preference either to the word School or College,—the latter of which being in fact only a more ambitious as well as more ambiguous name for the same thing,—thus leaving the word *School* very appropriately applicable to the separate specialties,—in fact to every organization, which, besides being more simple, is characterized by unity rather than plurality of objects. In this sense the Polytechnic School of France and the School of Roads and Bridges, etc., are very properly called Schools,—although the propriety of the prefix Polytechnic in the former case is somewhat questionable.

power of the student and future practical man, up to the utmost perfection of development, of which merely secular education would appear to be capable.

Such, at least, as suggested rather than described in the preceding paragraphs, embraces our idea of the true Polytechnic Institute. Such we believe to be the legitimate tendencies of an efficient practical carrying out of this system of educational culture. It may claim more of results than can be said of any single institution among those which have come under our notice; it may be more than is practicable of realization, between unlimited imaginings and limited possibilities; but no more, than, as an idealization predicated of the results of our study of the characteristics of plan and working of these institutions, we should feel warranted to adopt as our embodiment of the true idea of the Polytechnic Institute, —towards the attainment of which we might always be permitted to make progress.

With this notice of the Scientific and Technical Institutions of Europe, we shall resume our consideration of the present condition and of the plans proposed for the future permanent establishment of the Institute.