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THE BEGINNING OF THE SCHOOL[1]

IT is appropriate, upon this occasion, that reference should be made to the condition of scientific education in this country at the time of the foundation of the institute and that an outline of its early history should be given.

At the beginning of the nineteenth century the study of the physical sciences in the United States was in its infancy. Scarcely any provision was made for scientific instruction in any of the colleges of the country. Astronomy, physics, chemistry and botany had indeed been taught, during the preceding century, in a few institutions of learning, a department of mathematics and natural philosophy having been created in Harvard College as early as 1727, a professorship of botany in Columbia in 1792 and a class of chemistry at Princeton in 1795. Instruction had also been given in physics and chemistry in the University of Pennsylvania and Dartmouth College and in physics in Union College. This short list, however, includes all the colleges which had given the physical sciences more than an insignificant place in their curriculums. Even in these the instruction was given by lectures, supplemented, at times, by experiments which the teachers performed. Anything approaching laboratory work by the student was almost wholly unknown. When Professor Silliman was elected, in 1801, to the chair of chemistry, geology and mineralogy in Yale College, he visited Dr. McLean, who was professor of chemistry at Princeton, and there for the first time saw experiments in chemistry performed. Considering the state of scientific knowledge at this period and the general lack of opportunity for the study of science, even in Europe, it is not remarkable that this should have been the case in a new country, the total population of which, in 1800, was less than that of the city of New York to-day.

With the general awakening to the value of a knowledge of the natural sciences, during the first quarter of the nineteenth century, came provision for their study in other of the academic schools of the country. Within that time courses in various branches were inaugurated at Yale, Williams, Bowdoin, Dickinson, William and Mary and Hobart Colleges, and in the universities of Georgia, North Carolina and South Carolina. Facilities for practical

[1] Address of the president at the centennial celebration of Rensselaer Polytechnic Institute, Friday, October 3, 1924.

work by the students were still wanting in nearly all of them, though the apparatus used for illustration had grown in quantity and variety. A chemical laboratory, already mentioned, was in existence at Princeton, one was fitted up at Williams College in 1812, and one at Harvard shortly after this date. A few others were also to be found. They were all, of course, crude and unpretending, compared with those thickly scattered over our country to-day.

The time had now come, not only for the addition of scientific courses to the curriculums of institutions of learning, but for a general diffusion of scientific knowledge among those who could not have the advantage of an education higher than that offered by the common schools. Attempts in this direction had already been made in Europe. When Count Rumford returned from Munich to London in 1795 he endeavored to interest the people of England, as he had those of Germany, in his plans for public and domestic economy, more particularly in the economic consumption of coal, improvements in the construction of fireplaces and the heating of buildings by steam. Or as he put it in a circular issued in London in 1799, to interest them in the *application of science to the common purposes of life.* His efforts and those of others in this direction resulted in the establishment, in the year 1800, of the Royal Institution of Great Britain. Other men had not been blind to the benefits which would result if the people generally could be instructed in the application of science to the common purposes of life. Franklin's opinions upon this subject are well known. John Adams believed that the state should make provision for this purpose and Jefferson also proposed a school of technical philosophy, to be maintained wholly at public expense, where various artisans could learn as much of the sciences, as then known, as might be necessary to pursue their work understandingly.

The influence of such opinions gave impetus to the diffusion of scientific knowledge among the people of this country, and during the first quarter of the century two schools were established here avowedly for the purpose of giving instruction in the applications of science. The first was incorporated under the name of the Gardiner Lyceum in Gardiner, Maine, in 1822 and opened in 1823 by Benjamin Hale, who afterwards became president of Hobart College. In his inaugural address, delivered January 1, 1823, this young man, who was graduated only four years before from Bowdoin College, referring to the students to be, said:

> It is not sufficient for them, as for the general scholar, to be taught the general laws of chemistry, they must be instructed particularly in the chemistry of agriculture and the arts. It is not sufficient for them to be able to repeat and to demonstrate a few of the general laws of mechanics, they must be taught the application of the laws. They must be made acquainted with machines.

All honor to the young scholar who foresaw the trend of the times, but his school had a short life. The lyceum existed only about ten years and was discontinued on account of the withdrawal of a legislative appropriation.

The second school, the centenary of which we are gathered here, at this time, to celebrate, was founded in 1824 in Troy, New York, by Stephen Van Rensselaer, of Albany, and was called the Rensselaer School, since changed in name to Rensselaer Polytechnic Institute. Thus was inaugurated the first school, having a continuous existence, to be established in any English-speaking country primarily for the teaching of science and engineering.

The founder was a man of position and education. He was the fifth in direct line of descent from Killian Van Rensselaer, a merchant of Holland who purchased from the Indians, in 1637, a district about twenty-four miles in breadth by forty-eight in length, comprising the territory which has since become the counties of Albany, Columbia and Rensselaer in the state of New York. Stephen, born in 1764, was graduated from Harvard in 1782 and in 1783 took charge of his estates. He became a man of great prominence, experienced in large affairs. He was lieutenant-governor of New York State for six years; a member of the National House of Representatives for three terms; the general in command of the state militia in the war of 1812; a member of two constitutional conventions, of one of which he was president; for twenty-six years a trustee of Williams College; a regent of the University of the State of New York for twenty years and its chancellor during the last four years of his life; a member of the Erie Canal Commission from its creation in 1816, he was its president from 1824 until his death in 1839. As a great landholder he was naturally interested in agriculture, and while in the House of Representatives was chairman of its committee on agriculture. Some years before this time he was elected president of the short-lived Central Board of Agriculture of the state. Although the life of the board was brief, it was long enough to permit a geological and agricultural survey of the counties of Albany and Rensselaer, made under its direction though at the expense of its president. This survey was executed by Professor Amos Eaton and was the first attempt made in this country to collect and arrange geological facts with a direct view to the improvement of agriculture. Analyses of soils were included, as well as a consideration of the proper methods of culture adapted to them, and the results were published in three volumes of transactions. Im-

bued with strong opinions as to the value of such scientific investigations, when the board ceased to exist Stephen Van Rensselaer was unwilling to discontinue work of this character and in the years 1822 and 1823 he caused to be made at his own expense, under the direction of Professor Eaton, a geological survey extending from Boston to Lake Erie, a distance of about five hundred and fifty miles. It embraced a belt fifty miles in width which covered, in this state, the line of the Erie Canal.

The intelligence and benevolence of the founder were now, when he had reached the age of sixty years, to be directed into a new channel. He had long been interested in the instruction of the poorer families of his tenantry and had reached the conclusion that the most valuable education to be given persons engaged in the ordinary occupations of life was one which would enable them to apply the principles of science to the "business of living." His first step in this direction was to engage Professor Eaton to deliver, in various places along the line of the Erie Canal, during the summer of 1824, a series of lectures, accompanied with experiments and illustrations on "chemistry, natural philosophy and natural history." This undertaking was entirely successful. Encouraged by it he determined to establish an institution, the object of which he defined in a letter written from Washington, while he was a congressman, to Rev. Dr. Samuel Blatchford, the school's first president. The letter was dated November 5, 1824. In it he appoints trustees, notifies them that a suitable building has been acquired and funds provided for necessary apparatus, gives rules for the government of the school, and defines his object as follows:

> I have established a school in the north end of Troy, for the purpose of instructing persons who may choose to apply themselves in the *application of science to the common purposes of life. My principal object is to qualify teachers for instructing the sons and daughters of farmers and mechanics,* by lectures or otherwise, in the application of experimental chemistry, philosophy and natural history to agriculture, domestic economy, the arts and manufactures.

His primary object, therefore, was to establish a school of high grade for teachers of science, and in his mind, as his letter shows, the broad field to be covered included *the application of science to nearly every branch of human endeavor.* It will be noticed that the *daughters as well as the sons were to be taught* by these teachers and that domestic economy was one of the subjects in which instruction was to be given.

In his letter the founder appointed Amos Eaton professor of chemistry and experimental philosophy, and lecturer on geology and land surveying. He well knew his man and he appointed no common one to be the first director. Surveyor, chemist, botanist, geologist, author of many works on these subjects, called in after years "the father of American geology," Eaton was above all a born teacher. His reputation was already established. In the catalog of 1826, the first one containing a list of students, of the twenty-five whose names were given, seventeen came from the state of New York and eight from five other states, Vermont, New Hampshire, Massachusetts, Pennsylvania and Ohio. Some of these must have come on foot or on horseback, part of the way at least, to reach Troy. For while there were some canals and some steamboats, there were no railroads and few highways in those days, and it is a great tribute to the reputation of Eaton and of the school, then less than two years old, that students should have come to it so early after its foundation from such distant places. It may be said that since those times students have continued to come from distant places, the records showing that they have come from all the states and territories of the Union and from thirty-eight foreign countries.

While at the beginning the principal object of the founder was to establish a school for the instruction of persons who would disseminate among the people generally information relating to the application of scientific principles to their various occupations, neither the founder nor the management of the institution had in mind the narrowing of its scope or the limiting of its usefulness as a school for teaching the applications of science to the *"business of living."* And so while many of those who had been graduated in the early years afterwards became eminent in various departments of pure and applied science, the renown of the school is principally due to the work of its alumni in the field of engineering—a course in which was soon added to the curriculum.

Some of the principles of certain branches of the science now broadly called civil engineering had been known, of course, since the earliest historical times. Besides various branches of natural science, some of these principles were taught, in this country, in the early founded schools and colleges to which reference already has been made. They were taught, also, in the Military Academy at West Point, which was established in 1802, though it was a school in name only until its reorganization after the war of 1812. On the continent of Europe a number of technical institutions had already been founded, most of which were maintained partly or wholly by the state. The École des Ponts et Chausses was established in France as early as 1747, though it did not become of importance as a school for engineers until a much later period. The Königliche Sächsische Bergakademie was founded in Freiberg in 1765; the École Polytechnic in Paris in

1794; the Polytechnisches Institut in Vienna in 1815, and the Königliches Gewerbe Institut in Berlin in 1821. The latter at the time of its foundation and for twenty-five years thereafter was, as its name indicates, a trade rather than an engineering school. A technical high school was also established in Prague in 1806. The École Centrale des Arts et Manufactures, a private institution, was established in Paris in 1829.

The continental schools of science antedated those of Great Britain. Mention, however, should be made here of Anderson College of the University of Glasgow, founded in 1796 with a bequest of Professor John Anderson, who provided for an institution for the instruction of artisans and others unable to attend the university. In 1799 lectures on mechanics and applied science were begun and these ultimately led to the establishment of mechanics institutes in many towns. But the college never developed into a school of engineering. It was later converted into a medical school. Among the English schools in which scientific instruction was early given may be mentioned University College, established in London in 1828. In the University of London engineering subjects were first taught in 1840. The school of engineering in Dublin University was founded in 1842. Other well-known British schools of science and engineering were established at still later dates.

Although science and some branches of engineering were taught in the early foreign schools, at the time of the foundation of Rensselaer School, there were few engineers, other than military engineers. The term civil in distinction from military engineer had been coined during the last quarter of the eighteenth century, it is believed by Smeaton, but it did not come into general use until the end of the first quarter of the nineteenth century. There had been, of course, inventors and constructors of genius throughout all the ages. Great ruins on more than one continent attest the skill of forgotten engineers. During the Renaissance, Brunelleschi, Michael Angelo and the great Leonardo da Vinci lived and builded and at the later period about which we have been speaking such names as Smeaton and Watt and Fulton come to our minds. But these engineers were born; not made in schools.

There were no schools of engineering in the United States because civil engineering had hardly yet been recognized as a profession. A consideration of the condition of the country and of the state of scientific knowledge as applied to the constructive arts towards the beginning of the nineteenth century shows why this was the case. In comparison with the European states, in which early schools of science above mentioned had been established, the country was new and sparsely settled. Methods of communication were primitive and traveling was expensive. The first canal of considerable length, and these were the first engineering works of great magnitude to be built here, was begun in 1816 and finished in 1825; no steam railroad existed, locomotives not becoming practically successful until about 1830.

Steam navigation was in a more forward state, Fulton's Clermont having made the trip up the Hudson in 1807. In 1815 there were steamboats running between New York and Providence. It was not until 1838 that a transatlantic voyage was made wholly by steam. Steam had however been used for pumping water at a comparatively early date, and there were about seven steam engines in this country at the beginning of the century, although the small amount of power required for manufacturing purposes was obtained from wind and water. During the first quarter of the century many wooden bridges of long span were built, but the era of iron bridges did not begin until 1840. The first tunnel was built in 1831.

The few historical facts above given serve to indicate the condition of engineering science at the period of the school's history we are now considering. Although many of the fundamental principles of applied mechanics were known as well then as now, the development of the science, particularly in its application to structures and machines for the production of useful work, had taken place largely upon empiric lines. Most of the eminent men to whom this development had been due were self taught, were mechanics whose results had been obtained by successive experiments and with little knowledge of the resistance of materials or of the principles of the design of engineering constructions as practiced to-day. And if with these conditions there are taken into consideration the comparative smallness of the population and its extended geographical distribution, the wise forethought and liberality of mind displayed by the authorities of the school in establishing at such an early date a department of civil engineering will be thoroughly appreciated.

An outline of the course of study given in the first catalog, published in 1825, includes land surveying, mensuration, measurements of the velocity of flow of water in rivers and aqueducts, besides mathematics, chemistry, experimental philosophy, astronomy and geology. The catalog of 1826 shows that instruction was given in hydrostatics and hydrodynamics and in calculations upon the application of water power and steam, and in that of 1827 reference is made to land surveying and general engineering. In the catalog of 1828 the duties of Professor Eaton included lectures on civil engineering. This is the first appearance of the term "civil engineering" in any of the catalogs

and no well-defined course in the subject was formulated for several years, though the curriculum of 1831 included elements and applications of civil engineering. In 1835 the trustees created a department "for the purpose of giving instruction in Engineering and Technology" and in the same year the first class in civil engineering was graduated. The course in civil engineering was reorganized in 1849–50 by Director B. Franklin Greene, one of the ablest men ever connected with the faculty. Departments of mechanical and electrical engineering were established in 1907 and that of chemical engineering in 1913.

It will be noticed that this sketch has had reference almost entirely to a few of the early years in the life of the school. Much of interest, even of those days, has had to be omitted. Van Rensselaer's first orders for the government of the institute, the rugged character and original methods of instruction of Amos Eaton, sidelights on the lives of the students, all would be of interest to the historian. Nor have I touched upon the influence of the school upon the development of scientific education and the practice of engineering in this and other countries. These phases of its influence, admittedly great, will be considered to-morrow by Dr. Ray Palmer Baker, distinguished in letters, professor of English in this institution.

PALMER C. RICKETTS

AFTER ONE HUNDRED YEARS[1]

WE are met to celebrate the hundredth anniversary of the foundation of Rensselaer Polytechnic Institute. It is therefore fitting that we should ask ourselves how far the aspirations of its founders have been justified by its fruits.

To-day the first fruits seem remote indeed. As President Ricketts explained yesterday, Stephen Van Rensselaer proposed to establish in Troy a school for the "sons and daughters of farmers and mechanics." Nominally, therefore, the institute was devoted to the education of both sexes. Actually, it existed for men only. Nevertheless, it exerted a profound and lasting influence upon the colleges and universities which opened their doors to women during the nineteenth century. Before its incorporation, Eaton had conducted courses in botany, zoology, physics and chemistry throughout the eastern states; and not a few of the women who had attended these courses followed him to Troy. One, Mary Lyon, who had been a student in Northampton, became the founder of Mount Holyoke College. Others, also, profited directly by the facilities provided by the authorities of the institute. Naturally, however, its greatest services were rendered by its sons who had been moulded in the spirit of the senior professor. One of them, Eben Norton Horsford ('38), believing, like him, that the failure of women to achieve intellectual distinction was due to lack of opportunity and not to the "perversion of female genius," endowed the laboratories of Wellesley College. Others were active in the state universities. In two at least they were largely responsible for the inclusiveness of which they rightly boast; and in many others they upheld that equality of privilege which we now accept as a matter of course. To the education of women, therefore, Rensselaer made no slight contribution.

Not only was it the first institution to provide—though unofficially—for the scientific education of women, but it was also the first to offer a curriculum in agriculture leading to a degree. Of the interesting features of that curriculum, which it maintained for ten years, I can not speak to-day. Suffice it to say that the young men who enjoyed its advantages established the first state department of agriculture, the first state bureau of entomology and one of the first state experimental stations. The influence of the institute was not limited, however, to governmental departments, bureaus and stations; for in the universities of Alabama, California, Iowa and Wisconsin, as well as in a number of smaller institutions, its alumni served as first professors of the sciences in their relation to agriculture. As in its provision of educational facilities for women, Rensselaer was thus a pathfinder in a field which it has long since abandoned.

Somewhat similar has been the history of its influence upon the academic college. Rensselaer was the first institution to offer the degree of bachelor of arts to students who had completed a course of study in the natural, mental and social sciences. The curriculum leading to this degree—a curriculum embracing mathematics, the sciences, public speaking, literature, rhetoric, composition, government, political economy and philosophy—foreshadowed, in many ways, the type toward which instruction has tended in the last two decades. More significant, however, than this fact, striking as it is, is the theory on which it was based. "Things, not words," was Eaton's motto; and this touchstone he applied to every subject which he professed. As a result of his success, he lived to see the experimental methods which he advocated introduced into many of the colleges which had attacked his proposals. Indeed, before his death he was generally recognized as the originator of field work and laboratory practice in the United States. In themselves these two contributions, rich in result and richer in promise, would almost justify the foundation which we are met to commemorate.

There are other reasons, however, for this celebra-

[1] Address at the centennial celebration of Rensselaer Polytechnic Institute, Saturday, October 4, 1924.