
Chapter 1

Towards the Establishment of a School of Chemical Engineering (1887-1911)

The origins of chemical engineering can be linked to the industrial revolution of the 18th and 19th century in Europe and the United States¹⁻⁴ and the sociopolitical changes following the 1848 revolution in France and Germany⁵⁻⁶. One can claim that chemical engineering was practiced even in ancient Mesopotamia where clay distillation vessels with lids shaped to collect the condensed volatile distillate have been dated as over 5000 years old⁷ and by the ancient Greeks and Romans when they were making soap or wine, or treating ores in Lavrion or Sicily. Davies⁸ notes that by the end of the 14th century the production of strong alcoholic drinks had become an industry, petroleum distillation was started in England in the 17th century and coal tar distillation was first patented in 1746. Furthermore, Davies⁸ stresses the influence of 18th century chemistry, physics and mathematics on the emergence of chemical engineering, and Astarita⁹ clarifies the importance of Italian scientists of the 15th and 16th century in this development. Yet, it was not until the first quarter of the 19th century, especially in England and Germany, that chemical processes in the form of what we now call "unit operations" became the basis of many, instead of just a few, industries. Soap and wine production, spirits distillation, sulfuric acid production, and coal treatment are only a few of a range of processes practiced.

In the beginning of the 19th century, chemistry was flourishing in Germany. Prominent among all scientists, Justus von Liebig (1803-1873) was a major force in 19th century chemistry, not only because of his own research but also because of his great gift as an educator². Educated in Paris under Joseph Gay-Lussac (1778-1850) and with a doctorate from the University of Erlangen in 1822, von Liebig established in 1825 a small chemistry laboratory at the University of Giessen, a small town 50 km north of Frankfurt. During the next thirty years, a plethora of students, later famous scientists, would be educated there, including August von Stradonitz Kekulé (1829-1896), August W. von Hoffman (1818-1892), C. Adolph Wurtz (1917-1884), and Charles F. Gerhardt (1816-1856).

At one of the two major German Universities, the University of Göttingen, Friedrich Strohmeyer (1775-1835) and later his student Robert Bunsen (1811-1899) established another major chemistry laboratory. Educated in Paris (1800) under Louis N. Vauquelin (1763-1829), the famous French chemist, Strohmeyer had received an education similar to that of von Liebig, since both Gay-Lussac and Vauquelin had been influenced by Antoine L. Lavoisier (1743-1794) and his School.

The other major German University, the University of Heidelberg, also had a good chemistry laboratory under the direction of Leopold Gmelin (1788-1853) and his student Friedrich Wöhler (1800-1882) who by 1830 had joined Göttingen. Meanwhile Bunsen became Professor at Heidelberg.

Thus, in the second quarter of the 19th century, three major chemistry laboratories at the Universities of Giessen, Göttingen and Heidelberg were educating a number of outstanding organic and physical chemists, who would in turn establish laboratories (and "Chaired Professorships") elsewhere, including the United States. Two of the most prominent chemists in the third quarter of the 19th century, Ira Remsen (1846-1927, Professor and later President at Johns Hopkins, 1876-1913) and Josiah Cooke (1827-1894, Professor at Harvard University), were first educated in Germany.

What made von Liebig and his students "different" from other chemists was their effort to apply their fundamental knowledge to the development of specific chemical processes and products. von Hoffman's aniline dye process is only one of many processes developed in Germany between 1840 and 1880. This trend, however, did not continue past the third quarter of the 19th century. For example, in 1852 von Liebig moved to a "better chaired professorship" in Munich, where he became involved in pure, theoretical chemistry.

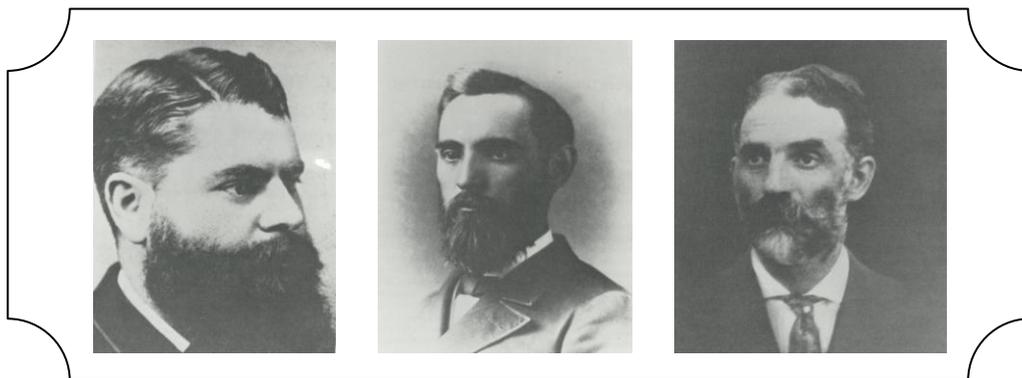
The political revolution of February 1848 in France swept eastward across the Rhine, overthrew established authority in Germany, put in power men who had been asking for change and gave central Europe a taste of liberal reform^{5,6}. One of the main results of these changes was the improvement of working conditions in the industrialized European countries⁴. Industrial workers demanded shorter work weeks, higher pay and safe working conditions. This led to a need to revise industrial processes with an emphasis, albeit primitive, on safer and more efficient methods. Like a phoenix, chemical engineering would emerge from the need of the mid 19th century for safer and more efficient methods. This need is echoed in the second decade of the 21st century.

The Education Hall (then Chemistry Building) where the School of Chemical Engineering was housed in 1911



Despite these developments, education in processes, safety and chemical engineering in general was not formalized. At best, students obtained some superficial knowledge about these processes in chemistry courses. The operation of distillation columns, filtration units, etc. was taught in "technical" schools, not in Universities. For example, the Technical University of Braunschweig, would soon give such "industrial" courses, but in the eyes of the academic descendents of von Liebig at Göttingen, Heidelberg and Berlin, Braunschweig was not a "University!"

In 1887 an undistinguished industrial inspector from Manchester, England, George E. Davis (1850-1906) decided to transfer his vast knowledge from his years of inspecting chemical plants in the industrial region of England to the classroom.¹⁰ In the fall of 1887 he gave a series of 12 lectures, later published in the *Chemical Trade Journal*. The material was quite empirical, but it had a definite advantage in that, at last, an individual had put on paper a series of articles on the operation of some of the important chemical processes of those days. This activity was not greeted with joy by the owners of chemical plants who had enjoyed a brisk business with modest competition.



Left: George E. Davis (1850-1906) taught the first chemical engineering course in Manchester, England, in 1887.

Center: Professor Lewis M. Norton (1855-1893) of the Chemistry Department of M.I.T. taught the first chemical engineering course in the United States in 1888.

Right: Frank H. Thorpe (1864-1932), professor of chemistry at M.I.T., published in 1898 the precursor to chemical engineering textbooks, *Outlines of Industrial Chemistry*.

At the end of the 19th century the competition of England, Germany and the United States for industrial chemicals had become rather fierce. It was not surprising then that only one year after Davis' lectures in Manchester, Prof. Lewis M. Norton (1855-1893) of the Chemistry Department of M.I.T. started teaching a course in chemical engineering. As Weber¹¹ notes, the material was mainly descriptive and was taken predominantly from his notes on industrial chemical practice in Germany, which at that time had the most advanced chemical process industry in the world.

When Norton died in 1893, Professor Frank H. Thorpe (1864-1932), who had received a B.S. degree from M.I.T. only four years earlier and a doctorate from the University of Heidelberg in 1893, took responsibility for Norton's course and published in 1898 the precursor to chemical engineering textbooks¹², entitled *Outlines of Industrial Chemistry*. [Most commentators have given honors for the first chemical engineering textbook to the classic *Principles of Chemical Engineering* by Lewis, Walker and McAdams]. The term "Industrial Chemistry" first appearing in Norton's book to broadly describe industrial processes applied in the production of chemicals would become strongly associated with chemical engineering in the next fifty years. It co-existed quite comfortably with the unit operations concept for years. Not until the radical approach to analysis of chemical engineering problems introduced by, among others, Neal R. Amundson and Rutherford Aris in the mid 1950's at the University of Minnesota, and by R. Byron Bird, Warren E. Stewart and Edwin N. Lightfoot at the University of Wisconsin would "industrial chemistry" be clearly separated from the main goals of "chemical engineering." This separation caused significant discord at Purdue.

Although Norton and Thorpe were the pioneers of the industrial chemistry enthusiasm at M.I.T., it was Arthur A. Noyes and later William H. Walker (1869-1934) who converted industrial chemistry into chemical engineering, which brought the discipline the respect it eventually enjoyed within engineering¹³. After an M.S. in Chemistry at M.I.T. (1887) and a doctorate at the University of Leipzig with Ostwald (1890), Noyes established the MIT Research Laboratory of Physical Chemistry in 1903. William Walker, who had received his doctorate in 1892 at the University of Göttingen with Otto Wallach (Nobel Prize 1910), saw the importance of chemical research laboratories and established in 1908 the Research Laboratory of Applied Chemistry.

During the same period in England, Davis proceeded with the publication of his *Handbook of Chemical Engineering* in 1901 and 1902, which was revised and published in a second edition of over 1000 pages in 1904. Davis was responsible for adopting the idea of "unit operations" (especially in the second edition of his books¹⁰) although the term was coined by Arthur D. Little⁸ at M.I.T. much later, in 1915. This was the idea that all chemical processes can be analyzed by dividing them into distinct operations (distillation, extraction, filtration, crystallization, etc.) which are governed by certain principles. More than any one, however, Davis deserves credit¹⁰ for coining the term *chemical engineering* to describe this new engineering area. Davis' *Handbook* is fascinating for the way that theory is presented – there are no equations! Mass and energy balances are solved with spreadsheets (on paper). Some of our current students would probably prefer this approach.

In the United States, M.I.T. is considered to be the first university to offer a four-year curriculum in chemical engineering (a "course" X in M.I.T.'s parlance), in 1888. However, as a Department, Chemical Engineering did not become independent until 1920! Until then it was the Division of Applied Chemistry of the Department of Chemistry. In those early days Walker (for whom a prestigious AIChE Award is named) was the main driving force of the Division, assisted by Warren K. "Doc" Lewis (1882-1975, for whom the prestigious AIChE Education Award is named) after his return from the University of Breslau where he had studied with Richard Abegg, receiving his doctorate in 1908. Abegg was a student of A.W. von Hoffman. Thus, the circle closes. Even the early 20th century chemical engineers were educated according to von Liebig's ideals! Noyes, after a few more years at M.I.T., would move to Pasadena, California in 1913 to become president and transform Throop College into the world-known California Institute of Technology.

Other universities followed the examples of M.I.T.^{14,15} The University of Pennsylvania (1894), Tulane University (1894), University of Michigan (1898), and Tufts University (1898) created four-year programs in Chemical Engineering, but always as part of their Chemistry Department.*

* In recent years many faculty members of Departments of Chemical Engineering wrote "histories" of their Departments (see for example the 1968-1986 issues of *Chemical Engineering Education*). In these articles one finds a persistent effort of many authors to prove that their Schools have existed for more than 75 years, in one case since 1853! Unfortunately, even if an "industrial chemistry" course was taught at a university, this did not constitute acceptance of a chemical engineering curriculum. If the chronological judgment is based on the establishment of a separate Department, the University of Wisconsin appears to be oldest (1905)¹³ and Purdue is probably the fifth oldest (1911) in the USA. Worldwide, one of the earliest separate departments was at the short-lived Industrial and Commercial Academy established in Athens, Greece, in 1894.¹⁶

In the middle 19th century in the open fields of Indiana, roughly equidistant between Gary and Indianapolis and built on the then navigable Wabash river, lay La Fayette (now Lafayette), a small town of 4,000 inhabitants. A trade center for northwest Indiana, the town was inhabited mostly by German and Anglo-Saxon farmers and traders. As a result of the 1862 Morrill Act, the General Assembly of Indiana voted in 1865 to establish a land-grant university¹⁷. The established Indiana University, disdaining from including the mechanical and agricultural arts, refused to become a land grant university. The resulting fierce competition between various towns continued for four years with Monroe, Marion and Tippecanoe counties becoming the three finalists. Finally, the balance tilted in favor of La Fayette, mainly because of the then very generous contribution of \$150,000 by John Purdue, \$50,000 by Tippecanoe County and 100 acres of land from local residents. Thus, in the fourth and final ballot in the Indiana House, Tippecanoe County received 52 votes, with 17 voting for Monroe and 8 for Marion county. In the Senate questions arose and the representatives of Bloomington (Monroe County) and Indianapolis (Marion County) "stigmatized as selfish vanity for Mr. Purdue to ask that the institution be named Purdue University¹⁷" The opposition finally capitulated on May 4, 1869, and Purdue's offer was accepted with 32 to 10 votes in the Senate and 76 to 19 in the House. By the day that John Purdue was sworn in as a life member of the Board of Trustees on May 25, 1869, the endowment fund had increased to \$233,000. The University was named Purdue University and with it came the acceptance of a number of questionable "preferences and requests" of John Purdue (1802-1876), an uneducated man who gave merit only to manual labor and technology, but who had the foresight to greatly aid the birth of Indiana's land grant university.

The University was built in the village of Chauncey (now West Lafayette), on the bluff above the right bank of the Wabash river opposite La Fayette at equal distance between Fort Ouiatenon and the site of the battle of Tippecanoe. The first regular classes began on September 16, 1874 and the first degree was awarded in June 1875 to John B. Harper; it was a B.S. degree without designation. Engineering was one of the first subjects taught, and Mechanical (1882) and Civil Engineering (1887) were early Schools.

The Chemistry Department of Purdue was established in 1874. Under the expert leadership of several professors, especially Harvey Washington Wiley, who was probably the most influential figure of the University from 1871 to 1885, it soon developed a national reputation¹⁸. Thus, it was not surprising that its Head Percy N. Evans suggested in 1900 that some industrial applications be incorporated in the course Chem 15, Technical Analysis. Percy Norton Evans was born in Canada in 1868 and received his B.S. from McGill University in 1890 and his doctorate from the University of Leipzig in 1893 working under Wilhelm Ostwald. He became a faculty member in 1895 and Head in 1899. Evans was fascinated by the news he was receiving from M.I.T. about the development of a chemical engineering curriculum, and by a copy of Davis' Handbook that had just been purchased by the Purdue Library. Therefore, in September 1902 he offered for the first time the course Chem 7, Industrial Organic Chemistry Lectures, to a select group of undergraduate students in Chemistry. In the course he covered such diverse subjects as aniline chemistry, production of sulfuric acid and production of steel. Chem 7, the first industrial chemistry course given at Purdue University, became immediately very popular among Chemistry students. Thus, in 1904 Evans introduced three more courses: Chem 9 and 10 Industrial Chemistry and Technical Analysis, and Chem 24 Metallurgy, which he shared with Edward G. Mahin.

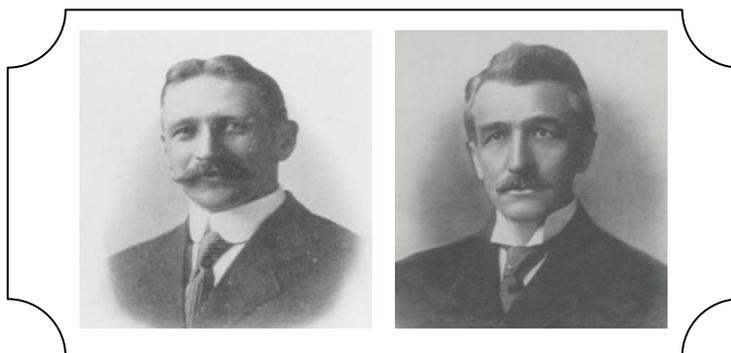
Early Contributions of the Chemistry Department

One should not underestimate the contributions of the School of Chemistry in the establishment of the School of Chemical Engineering. President Winthrop Ellsworth Stone (1862-1921, B.S. '84 Massachusetts Agricultural College, Ph.D. '88 University of Gottingen), so influential in the beginning of the century, was a chemistry professor (1889-1900) before he became President of the University (1900-1921). When Stone joined the faculty, he decided that no new Chemistry faculty member would join Purdue without a Ph.D. degree. This was done at a time that only about 10-12 professors on campus had that degree²³. Percy Evans was not only a strong supporter of the curriculum of chemical engineering, but he continued teaching the early generations of chemical engineers even after 1911. James Harvey Ransom (B.S. '90 Wabash College, M.A. '93 and Ph.D. '99 University of Chicago) also taught many courses for ChE's in the early years. Edward Garfield Mahin (1876-1952) was considered for many years a chemical engineering professor by the students. Educated exclusively in the USA (B.S. '01 Purdue, M.S. '03 and Ph.D. '08 Johns Hopkins), he was one of the last students of the legendary Ira Remsen, the founder of the Journal of the American Chemical Society. He stayed on the faculty from 1901 until 1925 and supervised many of the B.S. theses of ChE students and the first M.S. thesis of the School in 1921. He left for the University of Notre Dame in 1925 where he rose in the ranks to become Head of the Department of Metallurgy (1932-1949). He died in 1952.

In the name of Melvin Guy Mellon (1893-1993), Professor Emeritus of Analytical Chemistry, who taught at Purdue from 1919 until 1962, the first generation of Purdue chemical engineers recognized probably the most likable and influential figure of their undergraduate years at Purdue. Educated at Allegheny College (B.S. '15) and at Ohio State University (M.S. '17, Ph.D. '19) where he worked with William E. Henderson, another student of Ira Remsen, Mellon received honorary degrees from Allegheny College (1940), Mount Union College (1958) and Purdue University (1974). He taught the course on Technical Literature to chemical engineers from 1921 until about 1960. At age 93 he was still active, coming to his office every morning and passing by the Chemistry library, which appropriately enough has been named after him. He died seven weeks shy of his 100th birthday. It is a small indication of the appreciation of his former students that almost every chemical engineering student who graduated roughly from 1915 until 1930 mentioned him as an influential figure of our School!

Two more Chemistry faculty members left a strong mark on Purdue chemical engineering education. Henry Bohn Hass (1902-1987) received his B.A. from Ohio Wesleyan University (1921) and his M.A. and Ph.D. from Ohio State University (1923 and 1925, respectively, where he worked under William L. Evans). He came to Purdue in 1928 as an assistant professor, was rapidly promoted, and served as Head of the Chemistry Department from 1932 until 1949. During World War II he worked on the Manhattan project. After 1949, he worked for General Aniline and Film Corporation and became President of the Sugar Research Foundation in New York (1952-60). His last job before retirement was director of chemical research for M.W. Kellogg Co. (1960-69). Hass was one of the favorite professors of ChE students and many anecdotes survive about his life, teaching and paternal concern for his students. Earl Thurston McBee (1906-1972), was a student of Hass who became Head of Chemistry from 1949-67. He received his A.B. from William Jewell College (1929) and his M.S. (1931) and Ph.D. (1936) from Purdue University. He was on the faculty from 1929 to 1972 and was an excellent educator. In 1967 he received the title Shreve Professor of Industrial Chemistry.

Evans was very much affected by the writings of Davis and then Thorpe of M.I.T. The term chemical engineering sounded to him like a good description of the plan of study he was developing around the courses Chem 7, 9, 10, 15 and 24. Thus, in 1906 he approached Dean William F.M. Goss (Dean of the Schools of Engineering, 1900-1907) and asked for his support in establishing a chemical engineering curriculum in the Chemistry Department. Goss was very positive¹⁹.



Left: Professor Percy N. Evans, Head of the Chemistry Department in the critical years of 1906-1911, was instrumental in establishing the School of Chemical Engineering.

Right: Winthrop E. Stone, President of Purdue University (1900-1921) and a chemist by training, did much to convince the faculty and the board of Trustees that Chemical Engineering was needed at Purdue.

December 20, 1906 is an important date in the history of Chemical Engineering at Purdue. On that date the faculty approved the new curriculum. This approval was followed by the legally necessary approval by the Board of Trustees upon recommendation by President Winthrop E. Stone (1900-1921), on April 26, 1907. Here is a portion of the recommendation²⁰ of President Stone.

A distinct course has been arranged by combining certain subjects in chemistry and engineering now taught in the Schools of Science and Engineering. Such a combination has not before been available to a student of any of these Schools. The purpose is to train students for service in those industries which involve the application of the principles of both chemistry and engineering. It includes the subjects of chemical science and the elements of engineering such as shop practice, drawing, mechanics and electricity, together with the general cultural subjects required of all candidates for the bachelor's degree.

The following written communication was presented by
 Pres. Stone

1st Regarding the new courses in Forestry and Chemical
 Engineering. Paper received, read and approved.
 April 25-1907 to the Board of Trustees

I have to report
 that the Faculty, as authorized at a previous meeting of the
 Board, has organized new courses of study as follows

1st Forestry In connection with the School of Science,
 consisting of subjects in botany, zoology, and technical forestry
 subjects, administered during the last three years of the
 course. The purpose of this course is not to train
 professional foresters, but to offer such courses as will be of
 value to the farmer, lumberman, and owner of forest property.

2nd Chemical Engineering A distinct course has been
 arranged by combining certain subjects in Chemistry and
 engineering now taught in the Schools of Science and Engineering.
 Such a combination has not before been available to a
 student of any of these schools. The purpose is to train students for
 service in those industries which involve the application of the principles
 of both Chemistry and engineering. It includes the subjects of chemical
 science and the elements of engineering such as shop practice, drawing,
 mechanics, and electricity, together with the general cultural subjects
 required of all candidates for the bachelor's degree.

These new courses will go into operation next September, and are
 announced in the current catalogue.

The faculty of the School of Chemistry recommends an advanced
 course for graduates of the School, providing instruction in pharmacy
 and food analysis, the purpose being to train men for service
 in connection with the pure food and drug legislation now being
 enacted.

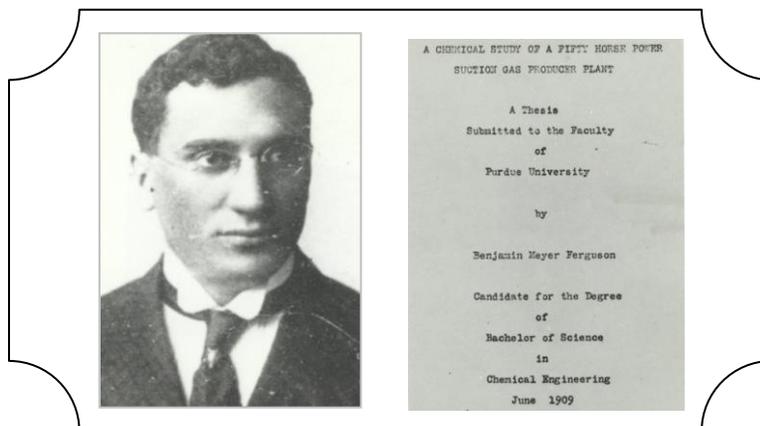
Also, the faculty recommends provision for a brief course
 of instruction in Chemistry to enable men to meet the
 requirements of the new law relative to Resident Practitioners.

Excerpt from the minutes of the meeting of the Board of Trustees of April 26, 1907, where President W.E. Stone made his recommendation for the establishment of a chemical engineering curriculum.

This was the beginning of chemical engineering at Purdue. But as Bray²¹ points out "there was no Head, no staff, no laboratory, only a plan of study." This plan of study is included in Appendix C and is further discussed in Chapter 7.

In May 1909, 51 students were registered in the new curriculum, 29 freshmen, 19 sophomores, 2 juniors and one senior. The senior, who graduated in June 1909, Benjamin M. Ferguson, has the honor of being the first Purdue graduate to receive a B.S. in Chemical Engineering. The class of 1910 had one more graduate, Emery C. Plank, who according to Bray²¹ was employed by Gulf States Steel Co., in Gadsden, Alabama, until he passed away in July 1942. Nine more students graduated in 1911.

Left: Graduation picture of Benjamin M. Ferguson (B.S. '09, first graduate in Chemical Engineering.
Right: The first page of Ferguson's B.S. Thesis



Benjamin Meyer Ferguson

(1886 – ca 1965)

Benjamin M. "Fergie" Ferguson, the first graduate in Chemical Engineering at Purdue, was born in Chicago in 1886. He came to Purdue in his junior year and enrolled in chemistry. Convinced by Prof. Evans that chemical engineering would be beneficial to his future career he designated this curriculum in his plan of study in 1907. The 1909 *Debris* gives us a good picture of the man²².

After a thorough course in football under (Amos Alonzo) Stagg (author's note: at the University of Chicago), Fergie joined the Boilermakers, a proud possessor of a "C." During the season he was never off the job – coaching day and night. But varsity coaching did not occupy all his time, for it was his grit and clever head work that caused '09 to win the championship. He is well liked, a good student and Purdue's first graduate in Chemical Engineering.

Ferguson was the quarterback of the Class 1909 football team that won that year's championship. His B.S. thesis was on *A Chemical Study of a Fifty Horse Power Suction Gas Producer Plant* and it was evidently performed with the facilities of the School of Mechanical Engineering. Upon graduation Ferguson kept only loose ties with the School, as one can guess from Bray's²¹ statement that he was unable to find his whereabouts in 1950. We have discovered that in the 1930's he was President of the Shop-towel Service, Inc. in Chicago. He retired in Los Angeles in 1951, where he passed away *circa* 1965.



Left: Charles H. Benjamin, a mechanical engineer by training (B.S. '81 Univ. of Maine, D. Eng. '08 Case) was the Dean of Engineering the year the School of Chemical Engineering was formed.
Right: Emery C. Plank (B.S.), the second graduate of Purdue in Chemical Engineering

In 1911 the ChE curriculum had 79 registered students. For a young curriculum that had started only five years earlier this was an impressive number. A large number of the students were residents of Indiana; and the industrial revolution in Gary, South Chicago and more generally the Midwest, had its impact on the career plans of the high school seniors of that period. Purdue had already developed a reputation for its excellent engineering program, and President Stone was sure that Purdue was ready to establish an independent School of Chemical Engineering. Whereas at M.I.T. independence of the curriculum from Chemistry took no less than 32 years, at Purdue an independent Department became a reality only 4 years, 5 months and 20 days after the establishment of the ChE curriculum – but who is counting?



Class of 1911, the first class to start in the ChE curriculum in the Department of Chemistry

References

1. A.R. Hall, *The Scientific Revolution, 1500-1800*, Boston, 1962.
2. R. Taton, *A General History of the Sciences*, New York, 1966
3. T.S. Ashton, *The Industrial Revolution, 1760-1880*, London, 1948.
4. P. Mantoux, *The Industrial Revolution in the Eighteenth Century*, London, 1928.
5. V. Valentin, *1848: Chapters of German History*, New York, 1940.
6. P. Robertson, *Revolutions of 1848*, Princeton, 1932.
7. RT, "Distillation through the Ages," *Chemical Heritage*, 25 (2), 40 (Summer 2007).
8. J.T. Davies, in *History of Chemical Engineering*, W.F. Furter, ed., ACS Advances in Chemistry Series, Vol. 190, p. 15, ACS, Washington, DC, 1980.
9. G. Astarita, in *History of Chemical Engineering*, W.F. Furter, ed., ACS Advances in Chemistry Series, Vol. 190, p. 205, ACS, Washington, DC, 1980.
10. D.C. Freshwater, in *History of Chemical Engineering*, W.F. Furter, ed., ACS Advances in Chemistry Series, Vol. 190, p. 97, ACS, Washington, DC, 1980.
11. H.C. Weber, *The Improbable Achievement: Chemical Engineering at MIT*, MIT, Cambridge, MA, 1980.
12. G.C. Williams and J.E. Vivian, in *History of Chemical Engineering*, W.F. Furter, ed., ACS Advances in Chemistry Series, Vol. 190, p. 113, ACS, Washington, DC, 1980.
13. J.W. Westwater, in *History of Chemical Engineering*, W.F. Furter, ed., ACS Advances in Chemistry Series, Vol. 190, p. 141, ACS, Washington, DC, 1980.
14. W.F. Furter, ed., *History of Chemical Engineering*, ACS Advances in Chemistry Series, Vol. 190, ACS, Washington, DC, 1980.
15. W. F. Furter, ed., *A Century of Chemical Engineering*, Plenum Press, New York, 1982.
16. E.G. Koukios and N.A. Peppas, *Bull. Greek Assoc. Chem. Eng.*, 25,16 (1981).
17. W.M. Hepburn and L.M. Sears, *Purdue University in Fifty Years of Progress*, Hollenbed Press, Indianapolis, 1925.
18. M.G. Mellon, *Purdue's Chemical Laboratories, 1873-1973*, manuscript deposited in Chemistry Library, 1973.
19. H.B. Knoll, *The Story of Purdue Engineering*, Purdue University Studies, W. Lafayette, IN, 1963.
20. Minutes of the Purdue Board of Trustees, April 26, 1907.
21. J.L. Bray, *History of the School of Chemical and Metallurgical Engineering*, privately published, September 1951.
22. Debris, Purdue University, 1911.

