Replacing hit-or-miss guesswork with laboratory precision.

GROWING UP

WITH CHEMICAL ENGINEERING

By

A. H. WHITE

Chairman of the Department of
Chemical and Metallurgical Engineering

THE students with whom I associated in college were the chemists. Chemical engineering had not yet been born and even chemists were few in number, much fewer than the students in pharmacy. On graduation I was fortunate to get a position as a full-time teaching assistant in chemistry at the University of Illinois at a salary of $750 for the year. Most of my class found jobs in the steel mills which were then the largest employers of chemists in the country. Steel was all made by the Bessemer process and every quarter of an hour a new sample would come into the laboratory for routine analysis. The most economical method was to divide the work so that each man devoted his whole attention to one constituent. One table was equipped for the determination of sulfur and another for phosphorus, and a chemist stood in front of each for eight hours, seven days a week if the mill was running fully, and did nothing but make the same determination again and again, month in and month out,—and all for a standard wage of $50 a month. The eight hour day was a concession to the white collar class. The men working in the mill had a twelve-hour day.

The requirement of a chemical analysis was relatively new in the steel industry. The story was current of the steel salesman to whom a customer complained that he had heard that the salesman's steel was higher in phosphorus than a competitor's. The resourceful salesman asked if he could examine a piece of the competitor's steel. When it was produced, he carefully put his tongue on the two pieces alternately. After he had done this a few times, his face brightened and he said to the customer in a triumphant tone, "I knew that other salesman was a liar. Taste these pieces yourself and you can tell that our steel is actually the lowest in phosphorus."

After three years teaching chemistry at the University of Illinois, I decided that the application of chemistry to manufacturing processes was a new and attractive field. There were no specialized courses in this subject in the United States, so I went abroad for a year's study and while there received a letter offering me the position of instructor in chemical technology at the University of Michigan. I accepted gladly, but when I arrived found that my title aroused some curiosity on the campus. The professor who compiled the faculty lists made a special trip to ask if that strange title was really correct, and the assistant secretary who made up the payrolls was firmly convinced that my salary should be charged against the

Prof. A. H. White

College of Pharmacy and not the College of Engineering.

The curriculum in Chemical Engineering was authorized by the Regents in 1898 and was the second curriculum to be offered in the country under that name. The countries of Europe did not develop courses in Chemical Engineering until they had found wide acceptance in the United States, so the course on this campus was the second in the world. The honor of establishing the first course went to Massachusetts Institute of Technology. These programs did not arouse any great commotion in the industrial world or in the University. The dean of the College of Engineering in his formal letter to the Regents asking that the program be established remarked that "It is not expected that the number of students will be large." The first class graduated in 1904, although one student who transferred from the course in Mechanical Engineering graduated in 1903. In the early years of the department, the specialized courses were all listed in the department of Chemistry and there was no separate grouping of courses in Chemical Engineering until 1907. In that year the importance of the new department was recognized by the appointment of the writer as Junior Professor of Chemical Engineering, and by the appearance of the courses in Chemical Engineering under their own heading in the bulletin of the Engineering College on the same footing as the courses in Civil or Mechanical Engineering. This early and complete recognition was due to Dean Cooley, who was a firm believer in the future of the still infant department and prophesied that he would live to see it the largest department in the Engineering College —a prophecy which has substantially come true.

The old chemistry building still stands in the center of the campus, unchanged externally, and is now occupied by the departments of Economics and Pharmacology. It was already crowded by 1900, and the new department of Chemical Engineering had to use space whereever it could be found. The square brick tower at the east end of what is now the Economics Building contained a large tank which had been a part of the campus water supply. This tank was supported on brick piers which rose through the first floor and were continued by cast iron columns at that point. The basement space was used as a coal bunker. This water tank was removed about 1897 and the space was made available for laboratories. The new Department of Chemical Engineering was assigned the coal bunker which was cleaned out and fitted up as a laboratory for gas analysis and photometry, the room on the first floor was used as a balance room for quantitative analysis, and the rooms on the second and third floors were given over to research and metallography. The assay laboratory in the basement of the south wing was also assigned to the new department.

The outbreak of the World War in 1914, with the consequent cessation of imports of chemicals from Germany, caused widespread recognition of the importance of Chemical Engineering. The number of students grew rapidly and when the United States entered the War in April, 1917, the demand for trained engineers caused the depletion of the staff at the University. Five of the seven members of the staff listed in the Announcement of the College of Engineering for 1917-18 were commissioned in the Army. The writer was given leave of absence in May, 1917 to join the Ordnance Department as Captain. His duties were first in the organization of metallurgical inspection, and after two months he was transferred to the Nitrate Division which was in charge of all army projects for fixation of nitrogen. He was later promoted to Lieutenant Colonel and when he resigned his commission in 1919 he was Associate Chief of the Nitrate Division.

In the spring vacation of 1898 the writer sponsored his first inspection trip to Detroit, Cleveland and Toledo. At the plant of the Libbey Glass Company, the students were shown the furnaces for melting glass which were heated by producer gas—a relatively new development. The gas generators were located on the railroad siding about one hundred yards from the furnace house and the gas was piped to the furnaces through uninsulated steel pipes carried on trestles about ten feet above the ground. I asked if there was not a large loss of heat from these pipes and was told by the foreman in a pitying tone that everybody knew that you could not get any heat out of the hot gas and that it had to be cooled before it would burn properly. That foreman was costing his company a good deal more than his salary.

The story of the coal salesman belongs to this period when science was slowly making its way into industry. A customer had been studying the composition of coal. He asked the salesman how much ash his coal contained and was told there was not enough to see; he asked about the sulphur and was advised there was not enough to smell; he asked about the Btu and was electrified to be assured that the coal did not have a damned Btu in it.

Of later date, and less than thirty years ago, is the experience of one of our alumni who was a metallurgist of the General Motors Company and was investigating complaints about uneven and poor quality of forgings which were being received from a contractor. He visited the plant and was surprised not to see any pyrometers, which by that time had become standard equipment for measuring furnace temperatures. The foreman told him in a belligerent manner that he did not need a pyrometer, that he could tell heats without it. When asked what heat there was in a particular furnace he looked in, spat across the floor, and growled: "Well there's Fahrenheat in there anyway."

Young engineers and also workmen who now enjoy a forty-hour week find it hard to realize the long hours which prevailed even as recently as 25 years ago. In the summer of 1915 the writer was employed in a paper mill where the men on shift worked twelve hours a day for six days in the week. On Sunday the shift which came off after working all night could look forward to 24 hours of sleep and rest while the shift which replaced them at seven Sunday morning worked continuously for 24 hours. Thus each shift worked 84 hours a week, 72 hours one week and 96 the next week, the shift coming off the night turn getting the 24-hour respite and becoming the day shift for the following week. It was a hard and monotonous life and the 24-hour respite every two weeks, as one man expressed it, "just a hole between two weeks work with no chance even to get drunk because it was Sunday."

The following summer, 1916, saw the

In 1900, mill hands worked 84 hours a week

introduction of the 8 hour shift at that mill. The mill was a large one and the only industry in the small town, which was crowded along a narrow valley with all the available level ground taken by the mill buildings. There was only one motion picture theatre which opened at seven in the evening, but nothing else to offer entertainment except the saloon. With the eight-hour shift the men had leisure to get drunk, and the saloon steps were filled at all hours of the day with men not knowing how else to spend their time. It was a depressing sight. The writer did not see the town again until the summer of 1919. The management of the mill had built a well-equipped recreation hall and had found space for an athletic field. The saloons were closed because prohibition had come in the war time. Houses and yards were tidy and the town had gained immeasurably in self respect.

Less than twenty-five years ago I talked with the owner of one of the largest and most progressive tanneries in Michigan. His father had started the tannery when he came as a young man from Germany, and had continued to tan leather in the way of his ancestors. The son had started as a workman in the tannery as soon as he left high school, and had learned the traditional methods. Shortly after he was twenty-one he went to Germany and visited the grandfather, who said to him one day, "Now Karl, you are a man and it will not be many years before you succeed your father in the management of the tannery. I am going to reveal to you the family secret as to methods of tanning which have been handed down to us from generation to generation." The young man received the secret and promised to guard it, but he told me he would have thought more highly of it if it had brought the family more prosperity. He returned to his father's tannery and as he assumed a position of responsibility, he experimented with modifications of the tanning process and gradually changed the methods of operation without consulting his father, who had given up active management of the business and rarely visited the plant. One day he did notice something strange and asked the son about it. Karl told him that he had found a better way of doing some of the operations. The father was furious, not because he had been kept in ignorance of the changes, but because the son had dared to violate the family tradition.

In 1917 one of our large chemical companies took a contract to build a plant for the United States to fix the nitrogen from the air. This company represented that it had developed a successful process and agreed to proceed in accordance with its own designs. The company insisted that the details of the process be kept secret even from the government employees, although this country was at war and the plant was to supply an important war material. When the authority of the government was invoked to force disclosure, it was found that the design of a plant to produce 15,000 pounds of ammonia a day by a process working under a pressure of 1500 pounds per square inch had been developed from data acquired in laboratory equipment which was capable of producing only three pounds per day, and had rarely produced that much. The company had designed the plant on wholly inadequate data, and their policy of secrecy was largely to avoid exposure of their slipshod methods. The plant was a complete failure.

One of our alumni is now in the research division of this same company. He is occasionally allowed to attend a scientific meeting but is under positive instructions not to discuss scientific matters on the floor of the convention nor with individuals. The management prefers that he should not even indicate the name of his employer on his registration card. He is to keep his ears open but his mouth shut. This corporation was the subject of one of *Fortune's* illuminating studies about a year ago. *Fortune* criticized the management for its policy of secrecy and unprogressiveness. It stated, "It has been reluctant to put its vast resources to use, to take risks, to open up the future. Its research policy, confined almost entirely to cost cutting, has failed to create a new frontier; and its financial policy has failed even to take advantage of frontiers that have been opened up by others."

In contrast to this company we have the practice of the large petroleum and rubber companies. Twenty years ago each manufacturer of rubber tires had ideas as to the composition of the mixture and methods of vulcanizing which he tried to maintain a secret. I was visiting one of the plants in Akron at about that period and the Research Director told me that they were changing their methods because they had found that it was impossible to keep a secret for more than a few months. That morning one of their men had come back from a trip to the rubber plantations in Sumatra and had told him several things he had learned there about the operation of their competitor whose factory was only half a mile away. It was not long after this that the rubber companies decided that any process which made tires better improved the business of all of them. They now interchange information freely and at technical conventions their representatives take part in the discussions. The petroleum industry has a similar policy of exchange of fundamental information.

So long as secrecy and tradition reigned in the chemical industries there was little opportunity for trained men

Chemists were paid $50 a month

in industry. College graduates were held in little esteem and were required to spend many years in learning the "art" before indulging in any attempts to advance any ideas of their own.

In marked contrast is the attitude of today. The vice-president of one of our corporations once said to me: "When I start a young man in our plant, I tell him I am going to keep him on that job not only until he can do it as well as the older workmen, but until he has studied it carefully enough to see if he cannot improve the older operation."

Three hundred years ago the alchemist was primarily a magician and the mystery with which he enveloped his operations continued in our chemical plants until within a generation. The encouragement given to younger men and the liberal policy of exchange of information illustrated by the petroleum and rubber industries have been major factors in the rise of this country to a position of leadership in technical developments. It is an illustration of the proverb, "The rising tide lifts all the boats."