Herbert Hoover, Engineer

Hoover's active interest in applied science brought about many advances in research and technology.

Frederick E. Terman

The earliest record of Herbert Clark Hoover as an engineer was one he set down himself in his *Memoirs* (*1*). Recalling the Iowa farm-implement business of his father, who died of typhoid when Herbert was six, he wrote:

"At the implement shop he had a machine for putting barbs on wire. After the barbs were fixed, the bundles were dipped in hot tar to prevent rust. While no one was looking I undertook an experiment in combustion by putting a lighted stick in the caldron. It produced a smoke that brought the town running and me speeding the other way in complete terror. Whenever I see a picture of a volcanic eruption I recall that terror. Another experiment in wood carving nearly cut a forefinger off."

Perhaps these early ventures were indications that Herbert Hoover was to become one of the outstanding applied scientists of the 20th century, rather than a research scientist. In the public mind, his genius for organization and leadership have overshadowed his engineering and scientific skills. But he amply demonstrated these skills first in a successful career as a mining engineer and later in his great humanitarian accomplishments and many acts of public service.

Hoover's mentor, by his own acknowledgment, was Stanford's great teacher and scientist, the geologist John Casper Branner, who later served as president of the university. As a freshman, Hoover was hired as an office assistant by Branner. Later Branner got Hoover his first professional job during summer vacation with the Geological Survey of Arkansas. It paid $60 a month and expenses—a magnificent sum to the young student who had to earn his own way through the college. In subsequent vacations Hoover worked for the U.S. Geological Survey under Waldemar Lindgren; this acquaintance with Lindgren ultimately led to Hoover's great opportunity as a mining engineer in Australia for the London firm of Bewick, Moreing and Company.

Hoover's application of scientific mining principles and techniques, first in Australia and then around the world, often proved spectacular and almost invariably successful. He had a particular genius for spotting rich ore deposits, such as the Australian "Sons of Gwalia" gold mine he ran across on one of his side trips. For $250,000 his firm bought a two-thirds interest in the mine, and in the ensuing 50 years it yielded $55 million in gold and paid $10 million in dividends. Later on he used modern techniques to open up old Burmese mines, thereby tapping one of the richest lead-zinc-silver ore bodies ever discovered; it produced more than $350 million worth of metal in the next 30 years.

Hoover joined the English firm at 23, and 4 years later he became a partner. In seven more years he "retired" at the age of 34. The firm's business was triple what it had been when he entered it, and his share yielded him one of the largest engineering salaries of the time. Hoover returned with his family to the United States and set up his own consulting firm, with the intention of easing the pressures of work and spending more time at home. He gathered a number of young engineers around him, and together they "doctored" ailing engineering projects back to health in return for a share of the profits. The firm was highly successful on a global scale and, though Hoover traveled less constantly, he spent much of the next 5 years in Europe and Asia. It was the start of World War I, however, that ended Herbert Hoover's career as an engineer.

"The ending of my professional career coincided with the ending of the golden age of American engineers in foreign countries," he wrote. "Within my lifetime it had been transformed from a trade into a profession. It was the American universities that took engineering away from rule-of-thumb surveyors, mechanics, and Cornish foremen and lifted it into the realm of application of science, wider learning in the humanities with the higher ethics of a profession ranking with law, medicine, and the clergy.

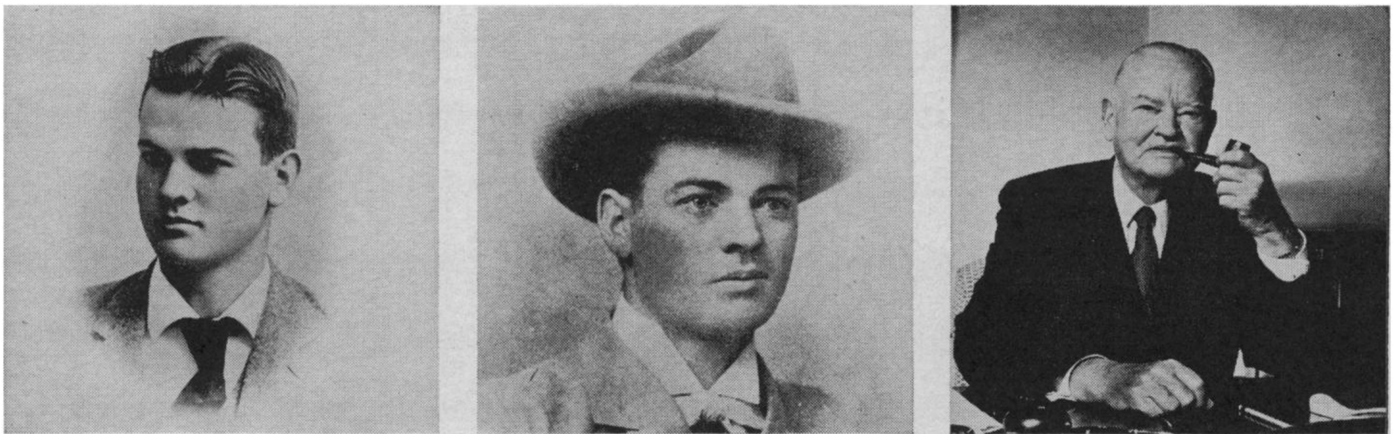
"The European universities did not acknowledge engineering as a profession until long after America had done so. I took part in one of the debates at Oxford as to whether engineering should be included in its instruction. The major argument put forward by our side was the need of university setting and its cultural influences on the profession. We ventured to assert that not until Oxford and Cambridge recognized engineering as a profession equal to others would engineering secure its due quota of the best English brains, because able young men would always seek the professions held in the highest public esteem. I cited the fact that while various technical colleges had been existent in England for a long time, yet there were more than a thousand American engineers of all breeds in the British Empire, occupying top positions."

Sailing home to the United States after these debates, Hoover met an English lady "of great cultivation and a happy mind" at his ship's table. At their farewell breakfast as they were coming into New York harbor, she said to him:

"I hope you will forgive my dreadful curiosity, but I should like awfully to know—what is your profession?" Hoover replied that he was an engineer, at which she exclaimed, "Why, I thought you were a gentleman!"

Herbert Hoover's services in medical and food relief during and after World War I saved millions of lives and put his countrymen and the world forever in his debt. He directed a humanitarian enterprise on a scale never before attempted, and neither he nor his close associates in the enterprise ever accepted payment for their services or reimbursement for their travel expenses. While this task drew on the full spectrum of his talents, it was

The author, an electrical engineer, is Vice President and Provost of Stanford University, Stanford, California.



Brown Brothers Halsman, New York

Herbert Hoover at Stanford in 1894, as a mining engineer in 1900, and on his 88th birthday, 10 August 1963.

after his appointment as Secretary of Commerce that his applied scientific abilities came into full view.

He transformed his department from one of comparative unimportance to a department of the first rank. The Bureau of Standards, which had been largely a weights-and-measures agency, became an important research organization whose scientists made notable contributions in radio, strength of materials, metallurgy, and electrical transmission. The Bureau of Fisheries stepped up its research, and the annual catch of fish increased. The Bureau of Mines added safety inspection to its duties, and the Bureau of Patents cut its time lag on applications from 18 to 6 months. He made the Census Bureau into one of the greatest fact-finding institutions in the world. In his first 6 years as Secretary, Hoover persuaded 86 industries to standardize their products to eliminate waste, improve quality, and save money for everyone concerned. He also created a committee of scientists and industrialists to develop industrial support for basic research in universities and other centers. Annual contributions from industry, distributed through the National Research Council, averaged $1 million a year for ten years before the plan was halted by the depression.

It was the scientific approach, too, that had led Hoover in 1920 to propose to the Carnegie Corporation that a Food Research Institute be founded at Stanford University. He wanted a scientific approach to mass food problems that would be concerned with "products after they left the farmer" —their processing, distribution, and pricing. In the same spirit of scientific inquiry he founded the Hoover Institute on War, Revolution and Peace at Stanford in 1919, which has since become the world's greatest repository of factual material on human strife. It was Herbert Hoover's conviction that all human problems are insoluble without the scientist's fundamental approach to truth: "first to determine the facts, arrange these facts in proper perspective, and then distill truth from them in the retort of experience."

Herbert Hoover's continuing good works, first as President of the United States and then as a benefactor to all humanity until his death on 20 October 1964, are too well known to recount here. His first publication, in 1905, was a contribution with others to the book, *Economics of Mining*. In 1909 he published *Principles of Mining*, a widely used textbook comprised of lectures he gave at Stanford and Columbia. His most scholarly work was a monumental translation, in collaboration with Mrs. Hoover, of an "untranslatable" Latin treatise on mining, metallurgy, and industrial chemistry which had served as the great textbook of those industries for two centuries during the Middle Ages. To determine the meaning of many terms required endless hours of patient detective work, searching in old texts of other languages, or even laboratory experimental work to repeat certain medieval chemical processes. The Hoovers carried this project around with them all over the world for 5 years, working on it in spare moments. Their translation of Agricola's *De Re Metallica* was at last published, lovingly, by an English printer in 1912. The original 3000 copies have since become collectors' items.

Elected to the National Academy of Sciences in 1922, Hoover was the only U.S. president ever to hold membership in that august company. He was a past president of the American Institute of Mining and Metallurgical Engineers, of the Mining and Metallurgical Society of America, and of the American Engineering Council. He was a Fellow of the Royal Geographical Society of London and, for 50 years, of the American Association for the Advancement of Science. His many awards from scientific groups included gold medals from the National Academy of Sciences, the National Institute of Social Sciences, and the American Museum of Natural History. In all, he was awarded approximately 300 medals, more than 60 of them gold, and nearly 100 honorary degrees from leading educational institutions throughout the world.

Few other men in history have possessed the range of abilities demonstrated by Herbert Hoover, and perhaps none has ever equaled the distillation of humanism and science that were combined in this man.

"It is a great profession," he wrote of his calling. "There is the fascination of watching a figment of the imagination emerge through the aid of science to a plan on paper. Then it moves to realization in stone or metal or energy. Then it brings jobs and homes to men. Then it elevates the standards of living and adds to the comforts of life. That is the engineer's high privilege.

"The great liability of the engineer compared to men of other professions is that his works are out in the open where all can see them. His acts, step by step, are in hard substance. If his works do not work, he is damned.

"To the engineer falls the job of clothing the bare bones of science with life, comfort, and hope. No doubt as years go by people forget which engineer did it, even if they ever knew. Or some politician puts his name on it. Or they credit it to some promoter who used other people's money with which to finance it. But the engineer himself looks back at the unending stream of goodness which flows from his successes with satisfactions that few professions may know. And the verdict of his fellow professionals is all the accolade he wants.

"The engineer performs many public functions from which he gets only philosophical satisfactions. Most people do not know it, but he is an economic and social force. Every time he discovers a new application of science, thereby creating a new industry, providing new jobs, adding to the standards of living, he also disturbs everything that is. New laws and regulations have to be made and new sorts of wickedness curbed. He is also the person who really corrects monopolies and redistributes national wealth.

"But he who would enter these precincts as a life work must have a test taken of his imaginative facilities, for engineering without imagination sinks to a trade. And those who would enter here must for years abandon their white collars except for Sunday."

Reference

1. H. Hoover, *The Memoirs of Herbert Hoover, Years of Adventure 1874–1920* (Macmillan, New York, 1951).

Callanish, a Scottish Stonehenge

A group of standing stones was used by Stone Age man to mark the seasons and perhaps to predict eclipse seasons.

Gerald S. Hawkins

The stones and archways at Stonehenge point to the sun and moon as they rise and set during the year (*1*). Between winter and summer the sun rises further to the north every day, and the extreme position on midsummer's day is marked by the heel stone. The heel stone was placed with an accuracy of better than 0.2°, a remarkable precision for the period (2000–1500 B.C.). Between summer and winter the sun rises further to the south every day, and its extreme southern position on midwinter's day is marked by archways in the structure. The rising and setting of the sun at the equinoxes are also marked. Thus, altogether six solar directions are marked.

In a similar way the moon rises at a different point on the horizon every night, but the moon swings from its northern extreme to its southern extreme much faster than the sun does. The moon takes 2 weeks to complete its swing, whereas the sun takes 6 months. For the moon there is a further complication—the slow wobble of its orbit. Without this wobble the full moon nearest midwinter's day would rise over the heel stone every year, and the moon would be furthest north on the horizon at this time. Because of the wobble, the midwinter full moon swings first to the left and then to the right of the heel stone through an angle of about 20°. The moon requires 18.61 years to complete one cycle, and it requires almost exactly 56 years to complete three cycles. The swing of the moon provides 12 extreme positions of the full moon on the horizon that could have been marked by the Stone Age astronomers, in summer and winter, and at the equinoxes—two extreme positions for each of the six extreme positions of the sun. Figure 1 shows these directions for the latitude of Stonehenge, 51°N. (The equinox alignments are unpublished.)

When the full moon rises opposite the setting sun, an eclipse of the moon is possible. An eclipse of the sun may occur 15 days later, when the moon has moved around its orbit to line up with the sun. The periods in which eclipses are possible are known as "eclipse seasons." Their occurrence in the calendar is controlled by the 18.61-year cyclic precession of the moon's orbit, and an eclipse year of 346.620 days contains two eclipse seasons. After 56 years the sequence of eclipse seasons returns to within 3 or 4 days of the starting point in the Gregorian calendar. This fact is confirmed by the commensurate length of 56 tropical years and 59 eclipse years. This is the eclipse cycle which synchronizes most accurately with the tropical year, with a period of less than 90 years.

I have suggested (*2*) that the 56 Aubrey holes at Stonehenge were used to predict the eclipse seasons. These holes are set at equal spacings around a perfect circle. Each hole was dug into the chalk to a depth of about 1½ meters and then refilled with white chalk rubble. Cremated human remains were later placed in the holes, a finding which lends support to the archeological opinion that the holes were ritual pits. By moving marker stones around the circle, changing the position by one Aubrey hole each year, the Stonehengers could predict the particular year in which there would be danger of, say, an eclipse of the winter moon. By means of the 30 archways, the Stonehengers could predict the actual day of an eclipse. The archways were set in a perfect circle within the circle of Aubrey holes, and I have suggested that each gap represented a day of the lunar

The author is professor of astronomy at Boston University, Boston, Mass.; Astronomer at the Smithsonian Astrophysical Observatory, Cambridge, Mass.; and Research Associate at the Harvard College Observatory, Cambridge.