BUSINESS SUCCESS AND FAILURE: THE UNITED STATES

HOOSIER INVENTOR AND BUSINESSMAN: THE ALLOYS AND AUTOMOBILES OF ELWOOD HAYNES

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Elwood Hanes is one of Indiana's most famous sons. He is best known as one of the pioneers of the American automobile industry, but his most lasting influence has resulted from his metallurgical genius. Haynes was one of the many discoverers of stainless steel, and he alone was responsible for the introduction of Stellite, an enormously valuable alloy which is still being produced. Two major companies resulted from Haynes' inventiveness, the Haynes Automobile and the Haynes Stellite firms, and he became, as a patentee of the alloy, a director and major stockholder in a third enterprise, and American Stainless Steel Company, which controlled the production of stainless steel in the United States until the mid-1930's.

Yet Haynes would never accept the designation of "businessman." He considered himself a scientist, specifically a chemist or a metallurgist, and he believed that the alloy development work he did was the "most natural outcome"[1] of his lif's work. Designing and building the Haynes "Pioneer," as he named his first automobile, was a specific response to a specific problem he had encountered during his employment in the natural gas business in the late 1880's-early 1890's period, and he left it to others to manage the company eventually organized to manufacture "Haynes-Apperson" automobiles.

Indeed, Haynes withdrew from the active direction of all of his businesses as early as possible, retreating to the metallurgical laboratory and his chief delights as a research scientist. "Father hated business--deciding who would do what," Haynes' daughter stated in 1970,[2] but he was nevertheless an eminently successful businessman into the 1920's. When his automobile company finally succumbed in 1925 to the dual pressures of indebtedness incurred in the business depression of 1920-21 and increasingly strong competition from Detroit, his alloy companies continued to thrive. In the pages that follow, an attempt will be made to outline the multifaceted life of Haynes and to evaluate his significance as both inventor and businessman.

Haynes was born in the small agricultural village of Portland, in east-central Indiana, in 1857, the fifth of eight children of Judge Jacob M. Haynes. His childhood was the usual one for boys growing up in an area just recently removed from frontier status. There were the customary chores, frequent roams in the woods, and a public school education up through the eighth grade, all that the school system then offered. The only mildly exceptional trait in Haynes was his love of books, which led to a persual of his sister's college chemistry text when he was about 14 years old.[3] Fascinated by it, especially its metallurgical section, Haynes set out to perform many of the experiments it described. The local legends of Portland include accounts of young "Wood" Haynes scouring the neighborhood for broken pewter spoons and other metal objects so he might melt them in the small furnace he had constructed. Several of the experiments Haynes performed with his makeshift equipment were quite dangerous, and explosions occurred more than once. ". . . that [Elwood] should have remained active and not a cripple," stated a younger brother in 1936, "is one of the things of his life that ha[s] never been explained."[4]

Another unusual act on Haynes' part was his return to the Portland public schools just one month short of his nineteenth birthday. The first two years of high school had been added to the curriculum, and Haynes endured the jeers of his younger classmates and the raised eyebrow of his family members to enroll. He thus qualified himself for admission into a new technical school in Massachusetts, the Worcester County Free Institute of Industrial Science, later renamed Worcester Polytechnic Institute. The school required only two years of high school for matriculation; moreover, it was free to residents of Worcester County. Since Haynes would soon be 21 and able to establish a legal residence there, he traveled to Worcester in the fall of 1878, passed the entrance examination, and enrolled in the Class of '81.

Haynes did not return home during the next three years, as much for financial as educational reasons. He applied himself vigorously to his studies, but the poor preparation for college work he had received in the Portland public schools nearly proved disastrous. Required to have an average of 60 in order to enroll for the second semester, Haynes could manage only a 59.2 (that "wicked algebra" was blamed) but he was retained because of "recent progress."[5] The following semester he made up the deficiency but had "no margin"--presumably his average was 60.8 or slightly above. His work improved in his subsequent two years, and when Haynes graduated he ranked near the middle of his class. Although three years older than the class average, Haynes was a popular member of the class, served as class president during the fall term of his second year, and wrote the words and music for the class song at graduation.[6]

Haynes enrolled in the chemistry program (one of five options offered) and was fortunate in having thorough and competent instruction. Charles O. Thompson ("CO_2" to his students), both the chemistry professor and the school principal, enjoyed a considerable reputation in both fields.[7]

Under his tutelage Haynes had his first introduction to a bona fide chemistry laboratory and was fascinated by it. He excelled in the "practice" or laboratory phase of his studies, which was heavily stressed in the total program (at least ten hours a week throughout the 42-week school year, forty hours a week during one of the two summer months).[8]

For his senior thesis Haynes chose to analyze "The Effects of Tungsten upon Iron and Steel." He thus became one of the first to produce tungsten steel, out of which he made at least one razor for himself and another for one of his profe-sors; he also began to examine the effect of chromium on the alloy (which in the proper quantity produces stainlessness) but was prevented from doing so becasue chromium had not been included in the original thesis proposal. Even in its limited form, the thesis work proved most significant for Haynes' later metallurgical accomplishments: it was the addition of tungsten to the original Stellite, a binary alloy of cobalt and chromium, which transformed it into the immensely valuable tool metal it became, and Haynes later discovered that the addition of sufficient quantities of chromium to steel makes it stainless. The proportion of chromium in standard stainless steel today ranges from 12 to 30 per cent; Haynes' 1919 patent specified a range of from 9 to 60 per cent.[9]

It was several years after graduation, however, before Haynes was able to pursue his metallurgical work. Faced in 1881 with the necessity of earning a living, he became a teacher. The first year he taught in the "district schools" of Jay County, Indiana, but then he moved in to Portland High School, now offering a four-year program. Haynes served as principal of the high school for the next two years, then primarily a teaching post, before deciding to take some post-graduate work in chemistry at Johns Hopkins University. There for most of the 1884-85 school year, (Haynes was called home in May be the death of his mother), he decided not to return because his application for a fellowship had been denied and because he had been offered a position as science professor at the newly established Eastern Indiana Normal School in Portland. The year's study at Johns Hopkins, nevertheless, was extremely important in preparing Haynes for his life's work. His instructors, particularly Professor Ira Remsen, an outstanding chemist and later the second president of the university, were eminent men and helpful to their students. In Baltimore Haynes learned new experimental techniques and valuable laboratory procedures; in later life he stated that his university experience was responsible for his successes in metallurgy. Haynes also broadened his industrial experiences, as he had done in Worcester, by visiting the manufacturing establishments in the area.[10]

Professor Haynes proved to be an extraordinarily popular and successful teacher at "The Normal." He not only knew his subject well but was enthusiastic in conveying it to others. Only by chance did Haynes leave the academic and enter the business world. The catalyst was the discovery of natural gas in Portland in March, 1886, the first commercial gas well in the state. Haynes was able to provide much needed technical expertise during the drilling operation; when a company was organized to supply gas to the city of Portland, Haynes was prevailed upon to become the superintendent of the Portland Natural Gas and Oil Company.

He managed the company for four years, during which time he supervised the drilling of various wells and the installation of a fine gas system for the city. As the first wells near Portland were rapidly depleted, Haynes directed the drilling of wells several miles outside of town and the construction of the necessary pipelines. These jobs required much travel by horse and buggy over sandy roads, and led to Haynes' first ideas about horseless carriage travel. He was particularly concerned at first about overworked horses, not increased speed or economy. But his company duties left him no time to develop plans for an automobile; instead his inventive talents were devoted to improving the gas service. At this time he designed and installed gas meters to measure the flow of gas, and a thermostat to control the temperature of gas-heated homes. He did not patent either device, although both worked quite satisfactorily and he used the thermostat in his own home for fourteen years. By this time Haynes was married, having wed his childhood sweetheart, Bertha B. Lanterman, in October, 1887; they became the parents of two children.

If Haynes' abandonment of the classroom for a business office in 1886 marked a new departure in his career, his decision to join the Indiana Natural Gas and Oil Company in 1890 was no less significant. The INGO company, a Chicago-based organization, had been established in 1889 to build a pipeline from the rich natural gas field in north-central Indiana to Chicago. Haynes, then considered one of the outstanding gas men in the state, was employed to direct the operations. Under his leadership two eight-inch pipelines and a large pumping station were constructed, a feat which marked the first long-distance transmission of gas by pipeline under pressure.[11] There was great hostility on the part of the people of Indiana towards having the INGO company (known as the "Chicago company") pump the gas outside of the state, but attempts to prevent it failed.[12] As the representative of the company in Howard County, Haynes' introduction to his his adopted home area was hardly an auspicious one.

The job required not only that he move to Greentown, but also considerable travel in its prosecution. Haynes' ideas about a mechanically-powered vehicle were rekindled, and during a construction delay caused by litigation over the legality of pumping the natural gas from the state, Haynes had an opportunity to work out his first designs. He was unable to begin building a "horseless carriage," however, until the pipeline and pumping station were built, complete with equipment to dehydrate the gas before shipment, a Haynes suggestion. This kept the gas from freezing in the pipelines during the winter months, and has become a standard procedure since then. In December, 1892, Haynes moved to Kokomo to become the manager of the gas company office there. With the plant in operation and the city piped, Haynes found sufficient free time to resume work on his automobile plans. The year 1893, then, marks the date when Haynes began serious work towards building his first car, and he remained in the business until the year of his death, by which time the automobile industry had risen to first place in the nation. Haynes retained his association with the gas company, however, until 1901. By then his automobile company was well established and he had made considerable progress in developing the alloys which were to give Haynes most of his fortune, if not his fame.

Although the subsequent phases of Haynes' career overlap and indeed are interrelated, the story of Haynes and the automobile will be taken up first. It will be possible here only to suggest the considerable preliminaries involved as Haynes investigated which of three sources of power (steam, electricity, or gasoline) would be best--the editors of Scientific American in response to his inquiry in 1890 and recommended steam--and as he used his laboriously acquired mathematics to calculate torque and gear ratios. Finally, in the fall of 1893, Haynes purchased a one-cylinder, one-horsepower engine from the Sintz Gas Engine Company of Grand Rapids, Michigan. Following its delivery in November and some initial, nearly calamitous testing in Mrs. Haynes' kitchen, Haynes arranged to have the vehicle to accommodate the engine built in the Riverside Machine Shop in Kokomo. Elmer Apperson operated the shop and agreed to do the job, according to plans and specifications drawn up by Haynes, during slack time at the going rate of 40 cents an hour. After several months of intermittent labor and some modifications to the original plans, the vehicle was ready for its initial test run on July 4, 1894.

Because of the crowd which assembled when the machine was pushed into the street, Haynes and Apperson decided to have it towed to the outskirts of town before attempting to operate it. Consequently, the first run of the "Pioneer" was along the twisting Pumpkinvine Pike leading from the southeastern sector of Koko-o. To the delight and amazement of its builders, the car started at once, moved off under its own power, and reached a speed of from seven to eight miles an hour (there was no engine throttle; speeds were controlled by changing gears). After traveling a mile and a half eastward, the car was stopped, turned around, and driven back into town.[13] Unknown to Haynes, J. Frank Duryea had roadtested his first vehicle the previous fall (in September, 1893), but its initial run was far less successful than the "Pioneer's."

In 1895 Haynes and Apperson, now in partnership, built a second car, powered by a two-cylinder engine of their own design, to enter the race held in Chicago on November 28, 1895. This race, the first in America for automobiles, had but a few entrants, including European cars and electrics. Only the Duryea brothers, who won the race, and Haynes-Apperson entered gasoline-powered vehicles built in America. Most unfortunately, the new Haynes-Apperson car broke a wheel en route to the starting line (the streets were snow-covered and the driver skidded into a curb while swerving to avoid a streetcar) and was unable to make the race.[14] The company won a prize, however, for the design of its "double opposed" engine, and the interest the car attracted in Chicago induced Haynes and Apperson to continue their partnership and begin producing automobiles on order. In 1898 the Haynes-Apperson Company was organized to begin relatively large-scale production--fifty cars were courageously planned for the year--and the company enjoyed reasonable success for nearly thirty years.

During the period from 1896 to 1901, while endeavoring to establish themselves in the business, Haynes and Apperson made several notable improvements in their automobile. Some of their ideas were patented, but others were merely incorporated into their cars without protection.[15] Of particular pride to Haynes were the metallurgical innovations. Haynes was the first manufacturer to use aluminum in an engine (the crankcase, 1895) and a nickel steel alloy elsewhere in an automobile. The Haynes-Apperson Company catalog for 1904 claimed the following "standard features of automobile construction": electric ignition, magneto generators, make-and-break spark, throttle control, and a "perfectly satisfactory" change-speed gear or transmission.[16] Another distinction of the company was an early long distance travel record. In 1899 Haynes and Apperson fulfilled the terms of a buyer's agreement by driving one of their automobiles to New York. Done to demonstrate the reliability of the car, this marked the first one thousand mile trip by automobile in the United States. The journey attracted national attention, as did Haynes-Apperson advertising and several papers Haynes published in such journals as the Horseless Age and MoToR.[17]

Apperson withdrew in 1901 to start his own business, at which time Haynes left the gas company to devote, for a brief time, his full attention to automotive affairs. Haynes personally managed the company only in times of crisis--following the departure of Apperson, after the 1911 fire, during the financial problems of 1923-24. In 1905 Haynes changed the corporate name to the Haynes Automobile Company. In the years that followed, both Haynes and Apperson, now competitors, stressed the longevity of their careers in the automotive business and vied with each other for recognition as the builder of "America's First Car" (the Haynes Automobile Company slogan), although Haynes clearly (and properly) prevailed here.

Indeed, as early as 1908 Haynes was generally recognized in the United States as the inventor of the American automobile. He enjoyed this reputation throughout his lifetime, although critics from time to time sought to strip it from him. Charles Duryea was particularly upset at the neglect of the Duryea claim to priority, but he damaged his cause by claiming an 1892, not the proper 1893, date for the first Duryea and by claiming personal credit for things his brother had done.[18] Henry Ford and others were similarly vague and misleading, if not intentionally dishonest, in dating their first vehicles. As a result of the confusion created, Haynes' claim to priority was not challenged successfully until after his death. It must have been especially gratifying for Haynes when he led the "historical section" of a 2,000-car parade down New York City's Broadway in April, 1908. The celebration, designed to commemorate the first decade of the automobile in New York, featured an evening parade headed by Haynes driving his "Pioneer," followed by ten other Haynes automobiles, one for each year of the decade. What may have pleased the inventor even more was the performance of his first car, then 15 years old and once termed by Haynes as "never much account." While testing it shortly after his arrival by train from Kokomo on the afternoon of the parade, Haynes was arrested by a New York City policeman for "speeding."[19] Two years later the "Pioneer" was donated to the Smithsonian Institution, where it is on permanent display in the new Museum of History and Technology.

After the withdrawal of Elmer Apperson from the automobile company, its affairs were under the personal direction of Haynes. This arrangement lasted only until 1905, when a reorganization took place and Haynes returned to the metallurgical experiments which had reached such a promising point before their abandonment in 1901. Only slight company growth occurred during the next half dozen years. Production had averaged just under 250 cars per year during the first half of the decade, and the annual output was up to approximately 350 cars by 1910. Haynes was called back into action following a disastrous fire in 1911, and he oversaw the rebuilding of a newly designed, modernized manufacturing plant. This, coupled with another management reorganization in 1912, kicked off the most prosperous period in Haynes Automobile Company history. A. G. Seiberling, the new general manager of the business, is usually given credit for the company's rapid development, which saw it reach sales of well over $10 million on a volume of 7,100 units in 1916, the peak year.[20] The succeeding war years, however, were difficult ones, and Seiberling's postwar plans for a small car were ignored. In the meantime, his overly eager purchases of high priced raw materials to replenish plant inventories plunged the company into a debt from which it never recovered. A successful million dollar bond drive in Kokomo in 1923 kept the company going for another year, but it failed in 1924. The final cars, assembled from the stock on hand, rolled off the line in February, 1925. Two months later, in not an altogether unrelated development, Haynes died.

In summing up this phase of his career, it is perhaps appropriate to give the inventor's own view of his role in developing the automobile. Asked to comment in 1919 on a biographical sketch prepared for publication in an Indiana history, Haynes replied:

> The only exception I take to this sketch occurs in the prelude, which gives me credit for originating the automobile. I have never claimed this distinction, and I do not believe that it belongs to me.

> It is generally conceded, however, that the little machine which I constructed in 1893-4 was the first complete gasoline automobile built in the United States.
>
> Some attempts were being made in Europe at the time, but I was not aware of them.
>
> Otherwise, the sketch seems to be remarkably accurate.[21]

It remains to discuss Haynes as a metallurgist. As indicated above, Haynes experimented with metals throughout his life--as a boy in Portland, for his senior thesis at Worcester, in his spare time in Portland, Greentown, and Kokomo while primarily engaged in the natural gas and the automobile industries. Eventually two companies based upon his metallurgical discoveries--the Haynes Stellite Company and the American Stainless Steel Company--were established. The initial developmental work had been done in a small laboratory the gas company permitted Haynes to establish in the room above his office. A subsequent series of metallurgical experiments, conducted between 1904 and 1912, was carried out in a converted barn located at the back of Haynes' residential property.

In a biographical sketch published in 1919 after being read and approved by Haynes, Indiana historian Jacob P. Dunn reported that Haynes began a series of experiments in search of an alloy that "would resist the oxidizing influences of the atmosphere, and . . . take a good cutting edge" in 1887.[22] At that date, in other words, Haynes was searching for a non-tarnishable metal suitable for table cutlery. At first he tested various copper alloys but "after some years of trial" rejected them as unsuitable. He next worked with some of the rarer metals with minor success; his first satisfactory alloy, a pure nickel-chromium combination, was produced in 1898, and the following year he made a pure alloy of cobalt and chromium. These two binary combinations were the first ones for which Haynes, in 1907, obtained patents.[23] He claimed for these alloys the general properties of durable luster, resistance to atmospheric oxidization, and hardness, and suggested that the cobalt-base product, which he subsequently named Stellite, could be "substituted for mild tempered steel in the manufacture of edge tools, as table and pocket cutlery, physicians' and dentists' instruments, or standards of weight, measures, etc. etc."[24]

These alloys were announced to the scientific and industrial world in 1910. In that year Haynes attended the San Francisco conference of the American Chemical Society to read a paper. Entitled "Alloys of Nickel and Cobalt with Chromium," it contained a brief resume of the history of each metal. Haynes then recounted some of the details of his long years of experimentation with them, and reported on their chemical properties and possible uses. He noted that razors and table cutlery made of cobalt and chromium had been in use in his home for nearly two years with most satisfactory results. In combination with small quantities of other substances, moreover, the properties of the alloys could be modified considerably. Such promising items as chisels and lathe tools had been produced already, although Haynes emphasized that "I do not recommend this material as yet for lathe tools . . . . "[25] For the moment, he predicted only that the uses of Stellite would include pocket and table cutlery, surgical instruments, chemical laboratory equipment, and standard weights and measures. He was unable to project the probably cost of Stellite, but thought it would be only slightly higher than steel. At the conclusion of his talk, Haynes distributed some samples of Stellite.

The paper aroused considerable interest in the new alloy. Not only did Haynes get several calls for it (which he was unable to supply), he also received a number of letters from owners of mining properties offering him chromium, nickel, and cobalt ores. The most significant contact of this type came from Thomas Southworth, an official of the Deloro Smelting and Refining Company in Canada. The Deloro firm, near Cobalt, Canada, was seeking an outlet for its vast supplies of cobalt, then considered nearly a worthless by-product in the production of silver. Its primary use prior to Stellite's development was as a coloring agent in the manufacture of ceramics.[26]

Southworth explained in 1918 the roundabout way by which he first learned of Stellite. In 1910 a business associate in Wales sent him a clipping from an English newspaper that reprinted an account from an Australian paper referring to Haynes' San Francisco address.[27] Southworth immediately contacted Haynes directly, who thereupon visited him in Toronto and arranged to obtain a supply of cobalt. At the same time Southworth obtained a license from Haynes to produce Stellite in Canada and certain other countries. Apparently Haynes made these arrangements in exchange for, in addition to the customary royalty, assistance in developing Stellite cutlery. Some of this work was done in Sheffield, England, although the cutlers there learned, as did Haynes and the firms in this country he engaged to produce pocket knives, that Stellits's hardness made it very difficult to work with in this way.

Consequently, although Haynes never abandoned the idea of Stellite cutlery and eventually marketed both pocket knives and tableward, he investigated other possible uses for the alloy. A major step forward came when Haynes added tungsten and molybdenum to the cobalt and chromium. This made an alloy of incredible hardness, and machine tools made from it proved far superior to the tools then being used. In one widely reported test, a Stellite lathe tool turned out a normal full day's production by 10:30 A.M. Haynes conservatively advertised these tools as two to three times faster than the best high-speed tools.[28]

Haynes applied for a patent on his tool metal alloy in July, 1912, specifying ternary compounds either of cobalt, chromium, and tungsten or of cobalt, chromium, and molybdenum, and a quaternary compound of all four metals. The patent office required that separate applications on the ternary and the quaternary alloys be made, but promptly allowed the new applications. When notified in early September, 1912, that the patents would be forthcoming, Haynes immediately began to arrange for manufacturing Stellite.[29]

He erected a small factory, barely 50 by 50 feet, near the site of his automobile plant, and there he began to produce Stellite. The work force consisted of only four persons, all family, at the outset, but the business, if not the number of employees, grew rapidly. Haynes' first secretary has recalled in a 1930 deposition that her office was just opposite "the little room where Mr. Haynes kept the different materials he worked with and weighed before taking them into the furnace room . . . ." She also remembered that Haynes "experimented almost every day," and that after being in the furnace room with its "terrific heat and noise," he would "come hurrying in and write the results in a notebook in longhand . . . ."[30]

During this time, indeed, Haynes was more interested in continuing his experimental work and in developing new and unusual uses for Stellite than in producing large quantities of metal. He was also lax in establishing proper quality control procedures. The business grossed only $7,000 in 1913, its first year of operation, $11,000 in 1914, and $48,000 in 1915. Three grades of tool metal were then being produced, using a battery of 16 tiny gas furnaces. The crucibles used held 15 pound charges, which were melted in approximately 90 minutes. Later Haynes converted to electric arc furnaces, the first two of which held 125 pounds. In 1918, the banner year for the Haynes Stellite Company for more than two decades, all of the Stellite produced in the United States came from the three Synder electric furnaces in the small concrete block building in south Kokomo. Their combined capacity exceeded four tons per eleven hour day, with total sales for the year exceeding $3,500,000.[31]

This enlarged production capacity resulted from bringing in others to manage the company. Late in 1915 Haynes had agreed to incorporate the business, with the stock being divided among three persons. These were Haynes, his banker, Richard Ruddell, and Ruddell's son-in-law, James C. Patten. To the latter, an intense, hard driving individual, went active control of the firm, and soon monthly sales exceeded the previous annual level. In the first year following incorporation, sales totaled $1,000,000, rose slightly the following year, and reached approximately $3,600,000 in 1918, with profits that year of $1,200,000. At one point during the year, Haynes casually remarked to a relative in Massachusetts that sales for the month were 66,000 per cent what they had been five years before.[32]

These figures can be explained in part by the relatively high prices Haynes was able to charge for his product (the three grades of tool metal were $6.00, $7.00, and $8.00 a pound), but they resulted most directly from the insatiable wartime demand for greater production, and hence for more efficient machine tools. A letter from Hency M. Leland of the Lincoln Motor Car Company, ordering 300 pieces of Stellite, indicates the nature of this demand:

> Now Mr. Haynes, allow me to explain that we are trying to machine 850 steel cylinders for Liberty Aeroplane engines daily. We have to take heavy cuts off these forgings and the steel is so hard it is impossible for us to get high speed steel that will stand the work.
>
> As you probably know by reading the papers, it would be difficult to conceive how any greater pressure could be exerted in regard to any product than that which is being pressed upon us to get out quantities of the Liberty Motors.
>
> We have found that this stellite is very superior to the high speed steel or anything else that we have found. We can and will furnish you with a Priority A certificate if you require it and it will help matters. We are confident that the authorities in Washington will tell you that there is no other Government work that ranks ahead of this in importance. . . .
>
> I wish to take this occasion to thank you most sincerely for your earnest and efficient attention to my telephone call in shipping the No. 4 stellite on Thursday.[33]

Another major use for Stellite during the war was in turning metal used in munitions--shells and shrapnel. In an oft-repeated statement by Haynes, he estimated that no less than 75 per cent, and perhaps as much as 90 per cent, of the shrapnel produced in the United States during the war was turned on machines equipped with Stellite tools. "People went so far as to say that they could not have afforded to make shells and shrapnel at the Government prices if they had been deprived of their Stellite tools," young March Haynes told his business college classmates in 1919, and Elwood Haynes remembered that some machinists came personally to the Stellite plant to handcarry whatever Stellite was available back to their shops.[34] Haynes also reported that after the war some machinists carried their Stellite tools home with them at night for safekeeping; meeting their daily quotas without them would have been impossible.

The Stellite company also produced some 40,000 "lancets" or scalpels for the government during 1917-1918. These were used in field hospitals operating close to the front lines where the non-tarnishing and lasting qualities of the alloy were important. An interesting experiment using Stellite as a reflecting mirror for telescopes was also made in 1918, something which partially anticipated the considerable use of Stellite as reflectors in Navy searchlights during World War II and afterwards.

Haynes readily admitted that his enormous and well-publicized returns from Stellite far exceeded those from the automobile, even though he was in the automobile business many more years. In 1918, in fact, his combined Stellite and automobile income exceeded $1,000,000, but he paid nearly $500,000 of it as income tax to the federal government. He alienated a number of his Stellite workmen by refusing James C. Patten's suggestion of giving each employee a substantial year-end bonus, deducting the payment as a business expense. Haynes reportedly told one of his foremen, in explaining his refusal, that "it doesn't pay to give the working man too much money--it makes him independent."[35]

By this time the Union Carbide and Carbon Corporation was taking an increased interest in the Indiana firm. Corporate attention had been focused on Stellite by its huge orders for various ferroalloys manufactured by one of Union Carbide's subsidiaries, and this led in 1919 to purchase negotiations. An offer of approximately $3,500,000 was declined, however, because the excess profits tax then in existence would require 80 per cent of everything above the capitalization figure (still only $50,000) to go to the federal government, or more than $2,500,000. A year later, however, the transfer was effected by means of a stock exchange. Haynes and his partners obtained an undisclosed number of Union Carbide shares in return for their stock in the Haynes Stellite Company, and Union Carbide operated it for the next fifty years. In 1970 the Stellite plant was sold to the Cabot Corporation, and it continues to produce a great variety of high performance alloys, precision castings, and powdered ceramics for an international market.

During the last years of his life, Haynes was intimately connected with a second metals company, the American Stainless Steel Company, but it remains a controversial point whether or not Haynes should be credited with the discovery of stainless steel. A very useful article on the history of high chromium iron and the gradual development of stainless steel is Carl A. Zapffe's "Who Discovered Stainless Steel?" Zapffe considers this a European (specifically a French) discovery made between 1903 and 1908, and he credits Haynes and an Englishman, Harry Brearley, with its commercial development. These statements are based upon a thorough knowledge of the metallurgy involved and a broad study of the printed records, although Haynes' work is not examined in any detail. Zapffe does admit, as seems to be true in Haynes' case, that the work of some of the men popularly credited with discovering stainless steel "might have been truly performed without foreknowledge of the investigations here cited."[36] Neither is it inappropriate to note that Haynes, alone of all the men credited with a role in developing this alloy, worked independently of a large steel company and the resources this would have afforded him.

The case is surprisingly similar to that involving the automobile--many people in Europe and America were at work on both developments simultaneously, both resulted from a cumulative process, not instantaneous invention, and in both instances Europeans were at the forefront. It seems clear, however, that Haynes--working alone and without knowledge concerning the progress of his foreign counterparts--both produced an early American automobile, which he subsequently manufactured for thirty years, and learned that stainlessness could be imparted to steel by the addition of sufficient quantities of chromium. Haynes made this latter discovery in a series of experiments made between November, 1911 and April, 1912.

When inquiries Haynes caused to be made among the steel trade revealed that "a non-rusting or non-tarnishing" alloy could not be purchased because "no such alloy existed," he was encouraged to seek a patent for his discovery. An application was prepared in 1912, after Haynes spent some time in convincing his patent attorney, C. Clarence Poole of Chicago, that he had in fact come up with a patentable discovery. Chrome-iron alloys, of course, were not new, as Haynes recognized, but the discovery was not the alloy but the fact that chromium above a certain percentage imparted immunity to atmospheric influences. At the time of his first letters on this point to Poole, Haynes was specifying a chromium content of from 4 to 50 per cent, recognizing however that 10 per cent of more was best. He cited Taylor and White's patent on high speed steel as one which too narrowly defined its limits, which permitted companies profiting from their discovery to avoid paying royalties; he therefore wanted his claim as broad as possible. He also pointed out that their patent covered an alloy he had made in 1881 (tungsten steel), but that they deserved their patent for discovering a new and useful purpose for the alloy. The patent office, however, rejected Haynes' application in May, 1912. Haynes laid the matter aside temporarily, promising Poole that "I will make additional experiments and we will then make a new application."[37]

The second application did not come until March 12, 1915, and in fact was prompted at that time by stories of a similar discovery in England, but it antedated by nearly a year the application submitted by Harry Brearley on the "rustless iron" he had developed. Even Haynes' resubmission of his application, now specifying a chromium content of from 9 to 60 per cent, was denied, whereas Brearley received his patent (No. 1,197,256) in September, 1916. Haynes filed for an interference, which he eventually obtained, and he received patent No. 1,299,404 on April 1,1919. By that time, however, Haynes and Brearley had merged their interests in the American Stainless Steel Company. Very few records are known to exist concerning this company and its licensing operations, for it purposely maintained a low public profile, but it was successful in having its two stainless steel patents upheld in court.[38] In 1930, according to a newspaper report, 35 large companies were manufacturing stainless steel products in the United States. "With one exception," the report continued, "all the steel made in these plants is under the Haynes patent."[39]

In 1920 Haynes summarized the very complicated situation regarding the invention of stainless steel, making the following points:

(1) Haynes learned of the non-corrosive qualities of chrome-iron and chrome-steel through experiments conducted in 1911-1912;

(2) the discovery rested "upon the fact that immune chrome steels must contain more than eight per cent chromium," though they may contain very much more than that, "even up to 60 per cent," and that such steels are "workable and useful whether subjected to heat treatment or not";

(3) Brearley discovered practically the same properties in chrome-steel two or three years later than Haynes, although his claims called for a more narrow chromium content (9 to 16 per cent);

(4) Brearley's patent application was granted on the grounds that it "contained a provision that it was necessary to polish and harden the steel in order to render it immune. This, however, was later found not to be correct. . ." and Haynes' patent application was approved; and

(5) because of the confused legal questions, the two inventors assigned both patents to a patent-holding company which issued licenses to steel companies desiring to manufacture stainless steel.[40]

Whether or not these circumstances entitle Haynes to be recognized as an inventor of stainless steel will probably ramain a moot point. It is clear that stainless steel, and the automobile, would have come onto the scene with or without Haynes, and at approximately the same time. This is emphatically not the case with Stellite; the remarkable cobalt-base alloys Haynes developed between 1895 and 1915 remain his greatest legacy to the industrial world.

In summary, then, it may be said that Haynes enjoyed success in a number of undertakings. He was a good and effective teacher in grade school, high school, and college, and he first made his mark in Indiana as the builder of a fine municipal gas system and as the engineer in charge of the Chicago pipeline. Later he invented a gasoline-powered vehicle, one of the first (probably the second) in America, and he subsequently manufactured automobiles until 1925. His greatest work, however, was in the development of new alloys, both ferrous and non-fe-rous, which helped pave the way for the great technological strides of the twentieth century. As a businessman, Haynes usually followed traditional, conservative practices, although in his science and in some aspects of his social philosophy he was not traditional and conservative, and he enjoyed success in all his business undertakings, excepting only the automobile business in the mid-1920's.

Good fortune, happy circumstance, and timing played a role in this success, but Haynes had an uncanny ability to be at the forefront of most of the exciting new industrial and technolgoical breakthroughs in his state during his lifetime. The first can be ascribed merely to good luck and circumstance--Indiana's first commercial gas well and drilled in Portland, but Haynes put himself in the right place at the right time to initiate the automobile industry in Indiana, to account for the development of Stellite, and to participate in the commercial development of stainless steel. Neither exceptionally bright nor a fast learner, Haynes had the ability to absorb completely that which he did learn, and he exhibited rare tenacity and perseverance in pursuing his goals and fighting for his rights of invention and discovery. The professional scientists laughed at Haynes' amateurish research techniques and his seat-of-the-pants metallurgy, until they saw the results he obtained, and this was true in other areas of endeavor too.

The ultimate success or failure of his business ventures, however, was the responsibility of others, for Haynes was quick to turn away from the daily routine of business. In his later life this served to give him time to devote to "causes," and he espoused many. His most cherished reform was Prohibition, something for which he had worked since the 1870's, buthe also strongly advocated United States adoption of the metric system and entry into the League of Nations, and he warmly supported a number of religious and charitable organizations. The state was diminished upon the death in April, 1925, of "Kokomo's First Citizen" and Indiana's most famous inventor and businessman.

Footnotes

[1]Kokomo Daily Dispatch, September 26, 1920.

[2]Interview with Mrs. Bernice Haynes Hillis, Kokomo, Indiana, December 8, 1970.

[3]Kokomo Daily Dispatch, April 14, 1925. The book was Wells's Principles and Applications of Chemistry . . . (New York: Ivison & Phinney, c. 1858), by David A. Wells.

[4]Frank Haynes to Hurd Allyn Drake, quoted in the Portland [Indiana] Daily Sun, September 30, 1936.

[5]Elwood Haynes to Bertha B. Lanterman, Worcester, Massachusetts, January 26, 1879, Haynes Papers, Elwood Haynes Museum, Kokomo, Indiana (hereafter this eollection will be cited as Haynes Papers).

[6]Ibid., June 29, 1879, and passim, 1879-1881.

[7]Mildred McClary Tymeson, Two Towers: The Story of Worcester Tech, 1865-1965 [Barre, Mass.: Barre Publishers], 1965, p. 41.

[8]Eighth Annual Catalog of the Worcester County Free Institute of Industrial Science (Worcester, 1878), pp. 15-16.

[9]Patent File No. 1,299,404, United States Patent Office, Washington, D.C.

[10]John C. French, A History of the University Founded by Johns Hopkins (Baltimore: Johns Hopkins University Press, 1946), p. 38; Elwood Haynes to Frances Haynes, Kokomo, November 8, 1921, Haynes Papers.

[11]E. N. Tiratsoo, Natural Gas: S Study (London: Scientific Press, 1967), p. 305.

[12]Jamieson v. Indiana Natural Gas and Oil Company, 128 Indiana 555 (1891). For a discussion of this case, see Ralph D. Gray, "The Puritan and the Robber Baron: An Episode in the Exploitation of Indiana's Natural Gas," Proceedings, Indiana Academy of the Social Sciences, 3rd Series, VII (1972), 102-110.

[13]Elwood Haynes, "How I Built the First Automobile," Haynes Pioneer, VI (July, 1918), 5-6.

[14]Chicago Times-Herald, November 29, 1895; cf. Kokomo Daily Dispatch, November 30, 1895.

[15]Haynes and Apperson together received four patents, and Haynes, either singly or, in one case, with two others, received four more. Patent Files, Stellite Division, Cabot Corporation, Kokoko, Indiana.

[16]The Haynes-Apperson Company, Manufacturers of Automobiles, Gasolene System (Kokomo, Indiana, [1904]), p. [6].

[17]Kokomo Dispatch, July 22, August 9, 1899. Curiously, however, this feat has been overlooked in recent automobile histories. See, for example, John B. Rae, The American Automobile: A Brief History (Chicago: University of Chicago Press, 1965), pp. 30-31.

[18]For a careful statement concerning the Duryea cars, issued following the death of Charles E. Duryea, see J. Frank Duryea, America's First Automobile (Springfield, Mass.: D. M. Macaulay, 1942); for a restatement of the Charles E. Duryea case against Haynes (and against the J. Frank Duryea book), see M. J. Duryea, "The Haynes--Indiana's First Car," Antique Automobile, VII (December, 1943), 19; see also Charles E. Duryea to Elwood Haynes, Lansing, Michigan, March 14, 1925, Haynes Papers.

[19]Newspaper clipping, January 17, 1923, Haynes Papers; Kokomo Morning Dispatch, April 14, 1908.

[20]Kokomo Daily Dispatch, September 26, 1920.

[21] Elwood Haynes to Mr. Pelgrem, June 30, 1919, Haynes Papers. The sketch, as modified, appeared in Jacob Piatt Dunn, ed., Indiana and Indianans: A History of Aboriginal and Territorial Indiana and the Century of Statehood (Chicato and New York: American Historical Society, 1919), III, 1215-1219.

[22]Dunn, Indiana and Indianans, II, 949.

[23]Patent File Nos. 873,745 and 873,746, United States Patent Office, Washington, D.C.

[24]Ibid.

[25]Elwood Haynes, "Alloys of Nickel and Cobalt with Chromium," Journal of Industrial and Engineering Chemistry, II (October, 1910), 397-401 (the quotation comes at p. 6 of a reprint of this article).

[26]B. E. Field, "The Metal Cobalt and Some of Its Uses," Mining and Metallurgy, XIV (July, 1933), 303-305.

[27]Thomas Southworth, "Stellite," clipping, General Folder, 1918, Haynes Papers.

[28]See [Elwood Haynes], Stellite Lathe Tools (n. p., n. d. [1914?]), a small pamphlet in the Indiana Division, Indiana State Library, Indianapolis, and various advertising cards printed in 1912-13 in the Haynes Papers.

[29]Patent File Nos. 1,057,423 and 1,057,828, United States Patent Office, Washington, D.C.

[30]Deposition by Marie Huffer Englert, Los Angeles, California, July 26, 1930, Haynes Papers.

[31]Elwood Haynes to Edward L. Hettinger, Kokomo, May 2, 1918, ibid.; Archives File, Stellite Division, Cabot Corporation, Kokoko, Indiana.

[32]Elwood Haynes to George Haynes, Kokoko, August 15, 1918, Haynes Papers.

[33]Henry M. Leland to Elwood Haynes, Detroit, May 11, 1918, ibid.

[34]March Haynes, "Stellite," January 31, 1919, ibid.

[35]This story, in several versions, turned up in a number of interviews conducted with former employees of the Haynes Stellite Company during the summer of 1970. Archives File, Stellite Division, Cabot Corporation, Kokomo, Indiana.

[36]Carl A. Zapffe, "Who Discovered Stainless Steel?" Iron Age, CLXII (October, 1948), 128.

[37]Elwood Haynes to C. Clarence Poole, Kokomo, April 15, 1912, Haynes Papers.

[38]American Stainless Steel Company v. Ludlum Steel Company, 290 Federal Reporter 103, 16 Federal Reporter (2d) 823.

[39]Kokomo Dispatch, January 3, 1930.

[40]Elwood Haynes, "Stellite and Stainless Steel," Proceedings, Engineers' Society of Western Pennsylvania, XXXV (January, 1920), 482.