HAYNES INTERNATIONAL

The Last 100 Years

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INTRODUCTION

Haynes International celebrates the 100^{th} anniversary of its founding in October, 2012. Begun by Elwood Haynes, the company traces its origins back to a day in September, 1912 when Haynes learned that he would be granted patents for two of his special alloy inventions. He immediately purchased property and constructed a building to house melting furnaces for commercially producing the material he called STELLITE® alloy. By October, 1912 the “Haynes Stellite Works” was in business, with production actually underway by December.

The company began with just four workers, consisting of Haynes, his wife, his brother-in-law, and his 16 year old son March. March worked evenings and Saturdays as a grinder. Haynes has been described as much more of an “inventor” than a businessman. While actively managing the manufacturing plant, he continued to spend time researching new compositions for his STELLITE alloys

As with most new businesses, growth was slow during the early years. Equipment initially consisted of 16 gas-fired furnaces, each capable of melting 15 pounds of alloy. Three different grades of STELLITE alloy were produced and cast using graphite molds. Applications principally consisted of cutting tools for machining other materials. The STELLITE tools exhibited considerable advantage over tool steels, and became popular for that reason.

Annual sales for the new company were around $7,000 in 1913, growing to $48,000 by 1915. It was in 1915 that the company structure underwent a significant change. Haynes agreed to incorporate the business with two local businessmen, Richard Ruddell and James C. Patten. The Haynes Stellite Company was incorporated on October 26^{th}, 1915.

Patten was given responsibility for active management of the company, while Haynes focused upon his alloy research. Under Patten’s leadership, sales growth began to accelerate, and soon the company was selling more volume of product in a month than previously had been sold in an entire year.

From these beginnings grew the Haynes International we are all a part of today. With sales of roughly $500 million, Haynes is in the top 0.2 % of all US companies. Our products are utilized in essential applications throughout the USA and the world. Products made in Kokomo are used in parts for almost every commercial airplane that flies today, as well as in military aircraft for the US and many of its allies.

Our alloys enable the production of hundreds of drugs, from the latest cancer fighting agents to common aspirin. Alloys invented and produced by Haynes International flew on every Apollo and Space Shuttle flight, and are found in parts for most rockets used in satellite launches today.

The following sections contain many examples of where Haynes International products have been used, and reveal how critically important they are in both commercial and military applications. Haynes International has been solving customer materials problems for 100 years, often providing solutions where no other materials would work. Each section marks some important internal or external event that shaped the history of the company and, in many cases, helped to define the Haynes International of today.

A Tradition of Innovation Spanning a Century.

True for the past 100 years. True for the next 100 years.

THE EARLY YEARS

The beginning of Haynes International could easily be equated to a “Mom and Pop” operation, since the original four workers were Elwood Haynes, his wife Bertha, his son March, and brother-in-law Harry Lanternman. Haynes, of course, was involved in several activities, including his work on the automobile. A tireless inventor, his research work around the turn of the 20^{th} century involved finding a suitable spark plug electrode material for his automobile engines.

Over the course of the next decade, Haynes experimented with various alloys, and became interested in finding a good material for cutlery, among other things. This work was focused on alloys of cobalt and chromium, which he called his “Stellite” alloys. He obtained patents in 1907 and continued his experimentation. In July of 1912, he submitted patent applications for alloys of cobalt and chromium with ternary and quaternary additions of tungsten and molybdenum. These patents were the origin of the materials that ultimately would become known today as the STELLITE alloys.

Having found that an alloy of cobalt, chromium and tungsten had particularly good hardness and wear resistance, properties, Haynes evaluated it as a tool material, and found it to be far superior to anything then available. In May 1912, Haynes introduced this STELLITE alloy as a tool material for use in his automobile plant. It became an instant success, reducing some part machining times by more than half.

Having returned home for the summer in 1912, and upon learning of the success of her father's new alloy at the auto plant, Haynes' daughter Bernice urged her father to promote the new alloy for commercial use as lathe tools. When, in September, the US Patent Office informed him that he would be granted two patents for his latest work, Haynes immediately undertook to form Haynes Stellite Works in order to do just that.

After acquiring a building on Union Street in Kokomo, the company began manufacturing product. Delivery of customer orders began by December, 1912. All of the products made at this time were castings of the cobalt-base alloys. The largest market was for lathe tools used for machining steel, with some additional use in cutlery.

The company grew sales over the next few years from $7,000 in 1913 up to $48,000 in 1915. It was in 1915 that the company structure underwent a significant change. Haynes agreed to incorporate the business with two local businessmen, Richard Ruddell and James C. Patten. The Haynes Stellite Company was incorporated on October 26^{th}, 1915.

Haynes’ partner, James C. Patten was chosen to actively manage the company. Patten was an aggressive manager and this was to be a big turning point for the company. Sales increased dramatically and a new building was added next to the existing plant. In 1916 sales rose to around $1,000,000.

The use of STELLITE alloys for lathe cutting tools was largely responsible for this rapid growth. Stellite cutting tools became so popular that machinists using them would often take their tools home at night for safekeeping (since it would be impossible for them to make their quotas if they had to use the more common tool steel tools). This application set the stage for arguably the most important contribution the Haynes Stellite Company was to make to the country in its first decade of existence.

It was, in fact, during World War I that the true strategic importance of the company's alloys became clearly apparent. In this wartime period, demand for industrial production increased dramatically. This was especially true for the manufacture of military aircraft engines. The most important aircraft engine of WWI was the Liberty engine:

> *"The Liberty 400-horsepower (298-kilowatt) V-12, air-cooled engine….. was one of the war's most powerful engines and one of the workhorses of the war. Designed to be mass-produced with interchangeable parts, the Liberty became the standard wartime aircraft engine, produced by Packard, Lincoln, Ford, General Motors (Cadillac and Buick), Nordyke, and Marmon. It was used most often on the DH-4, the only U.S.-made airplane to go into combat on the Western Front. More than 13,000 engines came off the assembly line before the Armistice, and more than 20,000 were built by the time wartime production ended early in 1919."*

In a letter to Elwood Haynes in May, 1918, Henry M. Leland (inventor of Cadillac and Lincoln automobiles) highlighted the importance of Haynes' STELLITE alloys to the war effort:

> *"Now Mr. Haynes, allow me to explain that we are trying to machine 850 steel cylinders for Liberty Aeroplanes 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 works that ranks ahead of this in importance…"*

Another critical lathe application for STELLITE alloy during the war involved the production of shells and shrapnel. Haynes himself often estimated that between 75 and 90 percent of all of the shrapnel produced by the US during the war was turned on lathes using STELLITE tools.

In addition to the cutting tools, which proved vital to the war effort, the Haynes Stellite Company also supplied nearly 40,000 STELLITE alloy lancets (scalpels) to army field hospitals. The ability of these lancets to resist tarnishing and maintain a sharp edge often proved to be lifesaving on the front lines.

This pattern of national strategic importance was to be repeated many times in the company's ensuing years, as will be discussed in the following sections.

UNION CARBIDE AND CARBON

The onset of the 1920's marked the beginning of a new era for the company. The product line at that time was still focused upon machining tools, but featured such specialties as tableware, pocket knives, and dental instruments. Advertisements touted the exceptional nature of STELLITE alloys. One ad for pocket knives cleverly claimed that all new knives were good, but only STELLITE knives "never cease being new."

In part due to the tremendous growth of the company during the First World War, the Haynes Stellite Company became an acquisition target of the Union Carbide and Carbon Company. In April, 1920 the purchase was finalized and Haynes Stellite became owned by "a group of eastern capitalists", as the Kokomo Daily Tribune reported it. Union Carbide's ownership of the company would last for 50 years, and would see some of the most important and long lasting events in the company's history.

By the mid-1920's, changes in the company following the acquisition by Union Carbide began to become evident. Specialty items such as cutlery were no longer being produced, but the 1922 development of the "hard-facing" process by company personnel out of the Cleveland sales office became a major new commercial opportunity for the wear-resistant alloys. This process involved welding just a surface layer of the STELLITE alloys over the wearing parts of tools and machinery.

Suddenly, whole new markets for welding rod of the company's wear-resistant alloys became available. Applications where solid STELLITE alloy construction was not technically feasible, or was cost prohibitive, could be addressed economically with hard-facing. The ensuing search for applications for hard-facing using an oxy acetylene torch uncovered literally hundreds of potential uses, many of which were developed over time.

One of the first applications for hard-facing with STELLITE alloys was in the oil well drilling industry. This was an important market for the company, and it is widely believed to have helped the company survive both the financial problems of the late 1920s and the Depression of the 1930s. Oil field drilling was to be a growing business throughout the Depression, and drill bits hard-faced with STELLITE alloys lasted several times longer than the best available alloy steels.

There were other applications for the hard-facing process, including farm plow shares, dredging cutters, and valves and valve seats in gasoline and diesel engines. This last application was likely a forerunner of Haynes International's currently most important market, the aerospace industry, including the gas turbine/ jet engine.

The "hard-facing" or "weld-overlaying" process is still in worldwide use today by thousands of companies in applications ranging from farm equipment to nuclear reactor containment vessels. It is a common fabrication process for the HASTELLOY and HAYNES® alloys and the Haynes Wire Company sells welding wire for this purpose.

Being a division of a large industrial company such as Union Carbide, in the 1920's the Haynes Stellite Company found itself with access to resources that might otherwise have been unavailable. This was especially true for research and development. Union Carbide had excellent metallurgical laboratories in Long Island City and, later Niagara Falls, both in New York. In the mid 1920s the development of several nickel-base alloys was initiated, broadening the company's prior essential focus upon cobalt-base wear-resistant alloys.

Four new proprietary materials were invented as a result of this original research, and were designated HASTELLOY® A, B, C, and D alloys. Alloy A was a malleable iron-nickel-molybdenum composition, with corrosion resistance nearly as good as alloy B, while alloys B and C were castable nickel-molybdenum and nickel-chromium-molybdenum compositions, respectively. Alloy D was a castable nickel-silicon-copper material. All had excellent specialized resistance to corrosive media of various types, and each represented a significant advance over the corrosion resistance of the best available materials of the day in their areas of specialization.

What is so remarkable about these alloys is that most of them (or their descendents) *are still in production today*. The company's history of innovation has been, and remains, a cornerstone of its success. That applied equally, of course, to the wear alloy side of the business, and the 1920's saw some significant wear-resistant product development as well. One of these was "J-Metal", the improved version of which was later called "Star J-Metal". This cast cobalt-chromium-tungsten high carbon alloy was reputedly 50% faster as a cutting tool material than previous STELLITE alloys.

Of even greater importance to the company was the development of HAYSTELLITE series of products. These were tungsten carbide welding rod alloys, a new arena for the company at the time. Originally cast, then later composite rod products, these were initially sold into the desert southwest oilfield market for “fishtail” drill bits, significantly increasing “down-hole” time and life. This product line may have been responsible in large part to keeping the company “in the black” during the later dark days of the Great Depression.

With all of the new products offered during the 1920’s, extensive efforts were made by the company to afford the trade educational materials detailing the proper application and use of STELLITE products. In 1926, a 4-part series appeared in Abrasive Industry magazine describing all aspects “Grinding of STELLITE Tools”. Numerous similar articles for hard-facing were also published.

THE DEPRESSION YEARS

The 1930s was a time of rapid advancement in the aircraft industry. New, higher horsepower air-cooled gasoline piston engines kept pushing back altitude ceilings and speed barriers. To provide increased reliability and power, aircraft engine exhaust valves were hard-faced with cobalt-base Stellite alloys. Both Charles Lindberg’s Spirit of St. Louis and Amelia Earhart’s Lockheed Electra had engines with valves hard-faced with STELLITE alloy produced right here in Kokomo, Indiana.

Tail skids on military airplanes landing on rough runways originally required replacement after every two to three landings. When equipped with STELLITE alloy skids, over *four hundred* landings could be made with one skid. Another military application involved the US Navy’s use of STELLITE alloys for their searchlight mirrors. Once again, Stellite Division products proved their strategic importance to our military.

The invention of the nickel-base HASTELLOY alloys in the 1920s opened up new markets for the company. A new casting foundry was added in 1929 to manufacture product for the growing chemical processing, petrochemical, and pharmaceutical industries. Sand or graphite molds were used in the casting process to make parts such as agitator blades for chemical plants. All of the products the company offered in the 1930s were castings of some type. (At that time, the company did not have rolling mills for the production of “wrought” products. That was to come later.)

In the late 1930s a new type of casting process, called “precision casting” was being used to make parts such as dental restorations and surgical bone pins. Austenal Laboratories used STELLITE 21 alloy for these applications. This process, also known as the “lost wax” or investment casting process, would lead to what might be considered the most important period of growth for the Haynes Stellite Company.

Another product line was instituted at the Haynes Stellite Company in the 1930's, known as the HASCROME alloys. These manganese-chromium-iron alloy rod products were less expensive than the nickel- or cobalt-base alloys, and were used for less demanding hard-facing applications, for base coat layers before applying STELLITE alloys, or to build up highly worn parts before hard-facing.

Hard-facing and wear product application areas numbered in the hundreds during the 1930's, spanning dozens of industries. Included were power, oil and gas, mining, machining, lumber, paper, iron and steel, excavating, coke and gas, cement, brick, automobile, and agriculture, among others. Among these, of very significant importance were oilfield and automotive applications. In automotive, automated hard-facing machines applied thin but critically important layers of STELLITE alloys on engine valves and valve seats.

One particular individual application of note during 1938 was for the Western Union Telegraph Company. It had developed a huge plow device to bury its Transatlantic cables 24-inches deep in the sea bed. To ensure success all the way across the Atlantic, the cutting edge of the 10-ton plow was hard-faced using a STELLITE alloy.

The variety of applications established for the STELLITE alloys amazed even the management of the company. "Pat" Gormely, General Manager of the Haynes Stellite Company, said of STELLITE alloys in a presentation he made to the Kiwanis Club in Kokomo:

> *"Elwood Haynes little realized when he invented the automobile that another invention of his would be instrumental in grinding the cylinders, cutting the rubber for the tires, grinding the pigments in the paints, cutting the top materials, hardening the bushings and the bearings, and even drilling for the gasoline and oil for the automobiles of the future."*

He further stated that he felt that Haynes' fame in the future would be greater for his having been a metallurgist than it would be for his having been an automotive pioneer.

THE WAR YEARS

As the company embarked upon the 1940s, the United States was entering the most defining period of the 20th century. The war in Europe was just beginning and US involvement was only a matter of time. For the Haynes Stellite Company, usage of the HASTELLOY alloys continued to grow in many markets. Industrial demand for wrought product was growing. To satisfy this demand, the company worked with firms such as Ingersoll Steel and Disc in New Castle, Indiana to have cast ingots converted into wrought sheet and plate products.

By this time HASTELLOY C alloy had become established as both a highly corrosion resistant and a heat resistant material, with wide usage in chemical plants as well as aircraft engine components. Learning to manufacture the HASTELLOY alloys in wrought product form was challenging, but ultimately rewarding.

At this time, the United States Navy was using STELLITE 6 alloy for reflectors in their 24-inch and 36-inch shipboard searchlights, used to spot enemy aircraft at night. Making the reflector for the 12-inch searchlight was proving difficult using Stellite alloy 6 due to the tight radius required. HASTELLOY C alloy was the answer. Slabs were cast in Kokomo, IN, rolled by Ingersoll in New Castle, IN, blanked by Struthers-Wells in Warren, PA, and finished by Bausch & Lomb in Rochester, NY. As the US was drawn into the Second World War this type of effort would prove all too common.

In the 1930s aircraft engines commonly employed superchargers to boost performance and increase horsepower. (A supercharger increases the air forced into an engine by compressing it with a small turbine.) Supercharger turbine blades can experience operating temperatures of over 1,500°F. Early supercharger blades were made from HASTELLOY B alloy, which was forged and then machined to proper dimensions. In a meeting with supercharger manufacturer General Electric Company, the Haynes Stellite Company broached the idea of using the “precision casting” or “lost wax” process, to produce turbine blades. Using this process, which was known at the time to work for other, unrelated applications, it was possible that the supercharger blades could be cast to very close dimensions. This would dramatically reduce the manufacturing time.

The work with GE pushed the company into one of the most important war efforts the company has ever been involved in. The Moss supercharger, invented by General Electric, was one of the most popular. The need for better blade materials brought the Stellite Division and the “precision casting” process together just as the conflict in Europe was turning into World War II. By combining a STELLITE alloy with the precision casting process, the company was able to produce a turbine blade (also called a ”bucket”) that was able to withstand the high temperatures and stresses encountered in the supercharger. In addition, the cast blades required little finish machining.

This work was absolutely crucial to the US military, since the supercharger with the STELLITE alloy buckets allowed allied bombers like the B-17 and B-25 to fly above much of the anti-aircraft fire directed at them. This ability to conduct high altitude precision bombing saved many flight crews and helped to bring about a quicker end to the war in Europe.

The company shipped over 25 million turbine buckets during the war years, with production reaching a peak of over 2 million units per month. The process for making these turbine buckets was a closely guarded secret during the war, and plant security was high. (This same process would subsequently be used to produce parts for the new military and commercial jet engines being developed by GE, as well as by the Westinghouse, Allison, and Pratt & Whitney companies.)

As a consequence of the war effort, employment at the Haynes Stellite Company grew dramatically, reaching a peak of about 2,000 workers. With many of the men in the country away serving in the military, there was a shortage of men available for labor at many companies. The Haynes Stellite Company in Kokomo was no exception to this, and as much as half of the workforce during the war years was made up of women.

One particular application of key importance to the war effort arose during the latter stages of the war, when strategic bombing was in full swing. Problems with limited gun barrel life for the 50 caliber machine guns on our aircraft were handicapping our fliers in combat. The company was consulted by the government, and a crash improvement program led to the development of HAYNES STELLITE 21 alloy cast machine gun barrel liners. The life obtained was an astounding 10 times improvement!

The government tasked the Stellite Division with seemingly impossible production goals for supplying the machine gun liners in cast 21 alloy, but the company was up to the challenge, and marshalled all resources needed to meet the requirements. So excellent was the company’s response to the need, that the government financed and built an entirely new casting facility for the liners within the existing plant. This facility was not yet complete at war’s end, and was subsequently purchased at great advantage by the Stellite Division in the post-war years.

The need for the new supercharger blade technology would continue during the Korean war years, with demand so high that the company was contracted to run an Air Force owned facility in Alexandria, IN that produced the STELLITE alloy turbine buckets.

While turbine buckets were a vital contribution to the war effort, the Haynes Stellite Company continued to deliver STELLITE alloy lathe cutting tools to machine shops and manufacturers all over the United States. These cutting tools were essential for the high output demanded for the production of war materials. In addition, thousands of pounds of Stellite Division alloys were being used in the ultra-secret Manhattan Project for the development of the atomic bomb.

Business was also robust in the many industries where the wear-resistant alloys were used. This was particularly true for the oil drilling arena, in light of the war needs for petroleum products. The company was also building and selling automatic welding machines, custom designed for use in a number of different manufacturing applications. Often, these were utilized for hard-facing with the company’s alloys. One important application was in the hard-facing of automotive valves and valve seats.

Following the conclusion of the Second World War, employment at the company dropped to about 900 workers, and considerable efforts were made to find opportunities for increasing business. The HASTELLOY alloys were being used in more and more applications, both as castings and as wrought sheet or plate. Producing wrought products using outside conversion sources was difficult, and plagued by both production problems and unreliable deliveries. In light of the increasing demand for wrought products and the difficulties with outside conversion, a decision was made to build a new plant for the production of wrought alloys.

Land for the new plant was procured on Defenbaugh Street in Kokomo in late 1945. Construction of the new Wrought Alloy Operation (WAO) plant proceeded apace, and the facility was completed in December, 1948. This plant is also often referred to as the Defenbaugh Street Operations (DSO).

The R-1 building was the first facility to be brought on-line. It housed a three-high hot rolling mill for plate, a two-high mill for hot rolling sheet, a 24-inch bar mill, and a 10-inch bar mill. These same pieces of equipment are still in operation in the R-1 building, and are used today to manufacture some of Haynes International's more difficult to produce alloys.

The decision to enter into onsite production of wrought alloys in the mid 1940s was perhaps the most important decision ever made by the company. Up to this point, most of product offered by the company had been in the form of castings. While both cast and wrought products were to be produced for some 26 years after the WAO facility was built, the future of the company was to become more and more closely linked to the production of wrought products. Today, wrought alloy products constitute the whole of Haynes International's business.

Change always being the order of the day, the decade of the 1940's came to a close with the renaming of the company. The Haynes Stellite Company, which had operated essentially as a division of Union Carbide and Carbon Corporation, officially became the Stellite Division of Union Carbide in 1949. This name was to last until the 1980's.

MODERNIZATION

During the Korean conflict in 1950-1953 large government defense contracts provided great opportunities for the company and its new wrought alloy operations. Chief among these opportunities was the development of the gas turbine jet engine for the expanding military and commercial aircraft industry. Following a meeting of Union Carbide R & D personnel and Stellite Division management in the early 1950's, it was determined to pursue compositional modifications to HASTELLOY C alloy. This work lead to reducing the tungsten and molybdenum contents and increasing the chromium content. The new alloy thus developed was named HASTELLOY X alloy.

The initial application for alloy X sheet product was as the material of construction for the burner cans (combustion chambers) in the Pratt and Whitney JT3D gas turbine engine, which powered the Boeing 707 commercial passenger jet airliner.

The Boeing 707 dominated the commercial aircraft industry in the 1960's, with more than 1000 planes being built. It is generally credited with ushering in the jet age. The extensive use of HASTELLOY X alloy, a proprietary Stellite Division product, provided significant growth for the company throughout this period. The alloy continues as a major income producer today, as it approaches its 60th year in production.

Alloy X was invented in 1953 as a low strategic element content composition, capable of being readily manufactured at the Wrought Alloy Operations. The immediate success of this alloy in jet engine burner cans, combined with the predicted growth in the engine market in the next decade, allowed the company to begin a large capital investment project in equipment and buildings. These improvements would significantly increase the production capacity, provide new capabilities, and create a more fully integrated manufacturing operation.

In 1956, the company expanded its manufacturing capabilities with the addition of vacuum induction melting (VIM) facilities at WAO. VIM capability was needed to maintain a market advantage in the annual supply of 360,000 pounds of investment casting remelt bar to Fabricast (a division of General Motors), to provide for internal investment casting requirements, and to open the possibilities for sales of new wrought alloy products. Continuous improvements to the VIM process at the Stellite Division, coupled with considerable effective interaction with customers, enabled the company to garner a significant share of the vacuum melted alloy sheet market.

The company was the primary supplier of these materials for numerous special projects, later on including the pioneering NASA Mercury space program in the early 1960s which first put astronauts into limited earth orbit. This was followed by the highly successful Apollo space program. The Apollo spacecraft was able to carry three astronauts on a circumlunar flight and land on the moon. Nearly half of the vacuum cast remelt bar produced by the company at that time was consumed internally for making precision castings for the space program and other aerospace applications.

Recognizing the growing need for close tolerance single sheet product capability (principally for the new jet engine designs), the company committed to procuring a new sheet Sendzimir Z-mill in 1957. Product from this mill provided greater sheet-to-sheet uniformity, eliminated the need for sheet conversion at outside facilities, increased product yield, and reduced production lead times. The company couldn't have retained its commanding position in the high performance alloy sheet market without this Z-mill.

The purchase of a 2000-ton Birdsboro forge press (and new building to house it) followed closely on the purchase of the Z-Mill (circa 1958). The press was needed basically to reduce billet conversion costs. Initial results exceeded expectations, with cost reductions far surpassing typical conversion cost. Product yield and quality were enhanced as well. The Forge Press proved to be very crucial to the growth of the Wrought Alloy Operation during this period.

The company also made very clear its long-term commitment to research and development during this period when, in 1955, it committed to build new centralized technology laboratories, R&D test facilities, and a research pilot plant. Construction of these R&D facilities, together with an office complex with a technical library, was completed on Kokomo's Park Avenue in 1958.

The 1960's brought great challenges and opportunities as President Kennedy declared America's intention of landing a man on the moon. As previously mentioned, the Apollo program was crucial to this mission. The Saturn V rocket designed for this mission was powered by five Rocketdyne F-1 engines containing nearly 14 tons of nickel- and cobalt-base "superalloys" and approximately 2000 investment castings for each Apollo vehicle.

By the end of the decade, a total of 24 astronauts traveled to the moon with 12 men subsequently walking on the moon. The rocket engines powering the Apollo vehicle generated nearly 8 million pounds of thrust. The space race afforded the company many great opportunities in the aerospace markets.

During the 1960's, the involvement of the United States in Vietnam brought about several applications for the company's alloys in military hardware. Stellite Division wrought products such as HASTELLOY X alloy were widely used in the engines of all jet aircraft and helicopters of the time, together with a number of investment cast alloys. One novel product supplied was HAYNES 6B alloy sheet. This was used to produce erosion shields for the leading edges of the rotor blades of military helicopters. Such blades were highly subject to damage from debris encountered while landing on unpaved sites.

By this time, it was evident to company management that additional melting facilities were needed to meet the growth anticipated for air melted alloy products. The growth of the air melted alloys was so great at that time, that the 15-ton Swindell electric arc furnace installed in a new melt shop in 1963 was immediately scheduled for production runs with essentially no time for a break-in period. The original 5-ton Lectromelt furnace from R-1 building was also placed in the new air melt shop building.

At the same time, an in-house wire shop was constructed and equipped to produce large quantities of HASTELLOY W alloy wire for turbine blade tip repairs. This rapid growth in alloy requirements in the early 1960's occasioned management of the Stellite Division to review the WAO facilities for an expansion and replacement program. This expansion was not only to address maintaining the position of the company as the leading producer of superalloy flat products, but also to enable the manufacture of new products for penetration and development of existing and future markets.

In 1963, a four part capital investment program of $6-8 million was proposed. The investments were to be made over two to three years, and consisted of

1) a new vacuum melt shop facility, housing a large vacuum induction furnace (VIM) and a consumable electrode vacuum arc remelt furnace (VAR);
2) additional cold rolled sheet and annealing equipment;
3) pickling facilities; and
4) cold forming facilities.

This expansion plan enabled the achievement of new in-house production capabilities. Today, these capabilities form the "core" manufacturing processes for Haynes International.

In order to capitalize upon these improved production capabilities, and increased product capacity, Union Carbide Corp sales distribution was expanded through Europe and Asia at this time. UCC European distribution was headquartered in Geneva, Switzerland. A number of privately owned distributors including Castelli in Italy, Robert Zapp in Germany, Merrem LaPorte on the Netherlands, Langley Alloys in the UK, Syrabruk in Sweden, Nickel Contor in Switzerland, Mio in France, Algol in Finland and Nechustan in Israel were employed to help grow the business and maintain market share in Europe.

The main company sales presence in Asia was handled by Mitsubishi Metals Corporation in Japan through a license agreement to manufacture and distribute the HAYNES and HASTELLOY alloys.

Back in Kokomo, implementation of the "core plan" in the mid 1960s was both an exciting and troubling time, with many obstacles to overcome. The vacuum melt shop, including a 5-ton Stokes VIM furnace and the #1 vacuum arc remelting (VAR) furnace, became operational in late 1964. It was several years, however, before the Stokes furnace operated at full capability. The VAR furnace, on the other hand, began operations with a rectifier fire on day 1! Once corrected, the unit performed quite satisfactorily and another unit (#2) was installed the following year.

The heart of the new “core production” concept was the design for the expansion of the WAO sheet and bar production facilities in 1963. This designed expansion had as its objectives to:

1) Increase sheet production capacity by at least 50%
2) Satisfy customer demand for tighter sheet thickness tolerances and thinner gauge sheet capability
3) Reduce manufacturing costs for sheet and bar products
4) Maintain or improve then current levels of metallurgical and surface quality

The initial project was the 1965, $8 million design and installation of the Cold Strip Mill on the south side of Defenbaugh Street. This embodied a revolutionary manufacturing technique for producing wide, cold-rolled strip, and then cut to size sheet:

1) Input coils were produced by welding hot-rolled plates together end to end to build a coil utilizing a build-up line (CBUL),
2) The built coils were conditioned utilizing continuous strip annealing and pickling lines.
3) Sheet coils were produced by continuously cold rolling the built coils utilizing an MKW-100 Mill and continuously bright annealing the cold-rolled strip in a hydrogen atmosphere (BAL). This was repeated as often as needed to achieve desired gauge.
4) Once final gauge was achieved, coils were trimmed/ cut to length and width utilizing a slit and shear line (S&S)

Once implemented, the new process more than exceeded the original project goals.

The second stage of the master plan was initiated in the late 1960s. This was intended to remove production bottlenecks, improve operating efficiencies and increase overall manufacturing capacity. Also included were additions to provide fabrication capabilities at both the Lindsay Street and DSO locations, as well as a new Refractory Metals Center (which operated briefly from 1967-1969). The DSO Fabrication Shop was a main source for the fabrication of the previously mentioned HAYNES 6B alloy erosion shields used for the leading edges of military helicopter blades. The Fabrication Shop also manufactured a wide array of equipment components for the chemical processing industry.

The end of the 1960s was once again an era of significant change for the company. A major sea change was occasioned by the certification of the United Steel Workers as the collective bargaining unit for the hourly employees in March 1965. The hourly workforce up to this time had been non-union. A strike over wage terms in the labor contract was called on September 29, 1966, and lasted until the 23rd of December, when President Lyndon Johnson invoked the Taft-Hartley law, and ordered the employees back to work. In February of the following year, a new contract was successfully negotiated.

Other changes arose out of the introduction of new or improved melting and manufacturing processes, enabling the development of new types of alloys. One example is HAYNES 188 alloy, a cobalt-base, highly oxidation-resistant high-temperature alloy which employs the addition of “rare earth” elements to the alloy composition.

The establishment of electroslag remelting (ESR) capability for wrought alloys afforded considerable yield improvements, enhanced alloy hot workability and overall quality improvements. The argon-oxygen decarburization (AOD) process was another new technology adopted by the company which enabled the creation of very low carbon, corrosion-resistant alloys such as HASTELLOY C-276 alloy. This process dramatically expanded the applications for the Stellite Division’s corrosion resistant alloy products in the chemical process industry.

In mid-1964, a major management reorganization occurred within the company. Manufacturing and marketing functions were segmented by product line:

Investment castings,
Wrought alloy products,
Specialty and hard-facing products.

Later in that year, several personnel from the Oak Ridge National Laboratory (which was then managed by Union Carbide) joined the Stellite Division’s R&D staff. In the following years the Technology Department grew to include some 200 plus employees. This era of equipment modernization and commitment to R&D was the springboard for the incredible inventions/ innovation era yet to come.

THE EXPANSION ERA

The long and rewarding association between the company and Union Carbide finally came to an end in January 1970 when the company was purchased by Cabot Corporation, a multifaceted chemical, oil and gas company headquartered in Boston, MA. In a measure of respect to the history here in Kokomo, Cabot management continued the “Stellite Division” company name.

Additional to the procurement of the Stellite Division assets, Cabot Corporation received a number of other assets from Union Carbide Corporation in the purchase. These included a powder metallurgy laboratory in Speedway, IN (later moved to Kokomo), and a diffusion coating plant in Bethel, CT. In September 1970, the Stellite Division added a further facility in Norwalk, CA specializing in the production of tungsten carbide hard-facing rods.

From the outset, the intent of the business strategy developed by Cabot's management was to have the Stellite Division become the dominant producer and supplier of flat products for both the aerospace and chemical process industry markets. Although the company at that time did have a defined positional niche in these markets, the focus was rather narrow, and linked mostly to in-house developed alloys. In order to broaden the range of products offered, a program was initiated to aggressively pursue the addition of commercially established, non-proprietary alloys to the lineup.

Utilizing the company's substantial in-house process research capability to scale up the materials from laboratory trials to the production facility, materials such as alloy 718, alloy 625, alloy 75 and alloy 600 (to name a few) were quickly adapted to the company manufacturing process. For the first time in 50 years, the company began to produce a significant volume of alloys which had neither been invented nor commercially introduced by the company.

While this foray into the realm of commodity products was very important, of equal importance was the second part of the strategy: to focus the R & D efforts of the Technology group upon the development of whole new families of alloys designed to push the envelope of material capabilities. This effort was to prove extremely successful, as some 10 new alloys were to be introduced over the course of the next 15 years.

The sale of the Stellite Division by Union Carbide in 1970 made necessary the reorganization of the international product distribution function. With the Union Carbide office in Geneva no longer available for Stellite Division product sales and services, the company established the Brussels, Belgium sales office for Europe in 1971. Several of the Union Carbide staff made the move to Cabot. Previously, customer contacts were generally the responsibility of the company's licensed European distributors, with all commercial activity being handled through the International Group in Kokomo.

With the advent of the new office, Brussels quickly became established as the commercial contact for the distributors. The Brussels office also handled some selected customers directly, but the distributors initially remained the major contact points for most European customers.

The first deviation from this system came later in 1971, when the high-temperature alloys were removed from distributor contracts and these sales were handled directly through the Brussels office. The next modification came with the employment of salesmen in England around 1972 to push the high-temperature alloys in the aircraft industry and the corrosion-resistant alloys in the chemical business. In 1975, a sales/ service center warehouse was established as Cabot Alloys U.K. Ltd. in Corby, England. This was originally set up primarily to expand high-temperature alloy efforts in the UK, but also was intended to impact throughout Europe. It soon became apparent that selling direct within the UK was more effective for both the high-temperature and the corrosion alloy products.

The cancellation of the UK distributor agreement in 1976 was the first complete departure from the established European distributor network. It was perceived as a threat by the other distributors. Similarly, it was perceived as a move by Cabot and the Stellite Division toward a more direct involvement in developing business in Europe. We now had offices in Brussels and Corby.

The purchase of Nickel Contor in Zurich Switzerland in 1977 was to be a seminal event in the company's approach to European product distribution. This acquisition also included companies in both Germany and England. The English company had no on-site representation and was soon abandoned. A presence in Germany was created in 1978 by the formation of Nickel Contor Deutschland in Frankfurt. The office was opened for the purpose of promoting the high-temperature alloy business in Germany, thus not in direct competition with our distributor Robert Zapp's corrosion alloy business.

Cabot Berylco Corp. which had been acquired in 1977 had a sales/ service center in Oberussel, Germany. Our Frankfort sales office was moved to Oberussel in 1983, where we shared some of the warehouse. This was soon renamed Cabot Alloys, Gmbh.

In France at about that time, sales through licensed distributors were observed to be consistently poor. Cabot terminated these distributor agreements, and created its own office and warehouse in France in Nieppe near Lille. The company was originally named Nickel Contor France but was renamed Cabot alloys France in 1980. In 1987 a warehouse was acquired in Cergy Pontoise near Paris and cutting equipment was purchased to allow cutting of specific pieces for customers. This involved only shearing but in 1993 laser cutting equipment was purchased that allowed sheet product for aerospace customers to be cut to exact purchase required pieces. This purchase allowed the office to retain and secure additional business.

These changes in France, Germany and Switzerland moved Cabot further away from the original distributor system established by Union Carbide, and created additional anxiety among the remaining distributors. While all of this was developing on the sales front, the Brussels office was strengthened with respect to technical service capabilities for the wrought alloys by the arrival in late 1974 of personnel from the Technology Department in Kokomo. Several additional people were hired for the Corby operation to work in Brussels in support of marketing efforts.

Mitsubish Metals in Japan had been a distributor for Haynes for 25 years under the Union Carbide arrangement, and a joint venture was created in 1978 (HiPac) to serve the Pacific rim. The joint venture was later dissolved in 1984, and Mitsubishi returned to being a distributor for Haynes. They also had a license from Haynes to produce some proprietary Haynes alloys. That license was terminated in about 2004.

Organizational arrangements remained stable until 1981 when Cabot closed the Brussels Office, and commercial contacts reverted back to the International group in Kokomo. In 1985 when Cabot announced their intention to sell the business, the division was divided into 13 business units and one was European Sales and Distribution (ES&D). This required a new European Office to be created, located in Paris suburbs and sharing office space with the French office. This office contributed Market and Technical support to the service centers and distributors.

During the 3 years of ES&D operation a close cooperation existed between the European operation and the US Sales and Distribution organizations. Business grew significantly through the 1990’s and into the 2000’s because of the direct sales efforts and the significant Marketing support of all aspects of the business from Kokomo and the wholly owned service centers in Europe. The European Office was terminated in 1994 and the European business was managed from the US after that date.

In 1983, the company established its first manufacturing facility outside of the United States with the addition of a round products manufacturing facility in the city of Openshaw in the UK. The UK service center was subsequently moved from Corby to Openshaw.

Although not of immediate impact upon the company, the now famous Clean Air Act was passed by Congress in 1970. This was followed in 1971 by the establishment of the Environmental Protection Agency. These seminal events held great promise for future corrosion-resistant alloy business for the Stellite Division. The government’s many efforts to foster environmental improvements included a mandate for the reduction of sulfurous gas emissions by the nation’s coal-fired power plants. This mandate was ultimately to lead to the wide-spread adoption of flue gas desulfurization (FGD) technology in the power industry, mostly in the form of wet scrubbing units.

For such units, the dominant material of construction issue was resistance to corrosion by the acids formed from the flue gases. While these acids were largely known to consist of sulfuric acid, each FGD unit was subject to its own unique operating environment and conditions. Consequently, the selection of the best materials of construction could only be determined through extensive field exposure and evaluation of multiple alloy test racks. Hundreds of such test rack trials were conducted by the Stellite Division in the 1970s and 1980s. These tests were to lead to the adoption of HASTELLOY C-276 alloy and alloy 625 for FGD units, as well as the later development and use of Stellite Division proprietary products HASTELLOY C-22 and H9M alloys.

The geo-political landscape of the world was significantly altered by the OPEC oil embargo in 1973. This supposed protest of western bloc involvement with Israeli military preparations in many ways changed our everyday lives, bringing about such things as government price controls, gasoline rationing, and lower highway speed limits. The persistently higher prices for oil brought on by the embargo also drove the exploration for oil and gas deposits to more and more hostile environments in places such as Alaska, the middle of the North Sea & other areas.

Recognizing the opportunities these many changes afforded, the company began to place greater emphasis upon the application of its alloys in the oil and gas industry. This would later lead to development of a major product application in sour gas wells, and also to the eventual 1980 joint venture with the Vallorec Company in France to make tubular products for oil and gas exploration. New business was also developed as the new desire for alternative and renewable energy sources spurred much new research.

One very sad note occurred during the harsh recession years of 1973-1974. The difficult business climate eventually forced the closure of both the investment casting and the sand foundry casting operations in Kokomo. After over 60 years in the casting business, the Stellite Division was now principally a wrought products producer (there were still some wear-resistant alloy casting and powder metallurgy operations in California). The same difficult business conditions also brought about the sale of the high temperature alloy fabricating equipment and business to Acraline Company in Tipton, IN.

Subsequent to the 1973-1974 oil embargo and recession, the strategic business emphasis upon the development of new, more capable alloys began to bear fruit on the corrosion alloy side of the business. The corrosion alloy R&D staff developed a raft of new alloys aimed at the chemical processing industry (CPI). These included HASTELLOY B-2 alloy for acetic acid service, HASTELLOY G-3 alloy for phosphoric acid service, and HASTELLOY C-4 alloy for general purpose CPI applications.

In the mid-1970s, the company also secured the right to produce FERRALIUM® 255 alloy, a super stainless steel. The addition of this alloy to the product list enabled the company to offer a broader spectrum of materials to the chemical industry. One very interesting later application of FERRALIUM 255 alloy was the replacement of the internal support structure of the Statue of Liberty as a part of the 1983 restoration of the monument. The FERRALIUM bars used in this restoration were made in Kokomo, and donated to the National Park Service by the Stellite Division.

The growing level of product sales into the chemical process industry up to this time had prompted the company to develop tubular product manufacturing capabilities for its alloys. While sheet, plate, bar and forging billet products remained the bread and butter of the business, the profitable nature of tubing products, coupled with growing customer interest in them, led to a management decision to expand this part of the business. Accordingly, in 1977 a new tubular products manufacturing plant was built in Arcadia, Louisiana to service the CPI markets. This marked the first time the company had established a major manufacturing facility outside of Indiana.

Another major national development with significant impact upon the company occurred in 1978. The Airline Deregulation Act was enacted by the U. S. government in October of that year, removing all governmental control over fares, routes and market entry (of new airlines) for commercial aviation. The Act exposed passengers to market forces in the airline industry, while still maintaining FAA regulating powers for all aspects of airline safety.

This sudden exposure to competition led to significant airline financial losses and labor conflicts, and eventually to a number of major and small carrier bankruptcies. At the time, however, no one could foresee the ensuing spectacular growth in the industry. Over the next 25 years, as the average ticket price was to drop by as much as 60%, the number of flying passengers was to soar to more than triple pre-deregulation levels. The associated demand for new commercial passenger aircraft was to prove a source of major opportunities for the Stellite Division.

The requirement for thousands of new passenger aircraft prompted a major, continuing market demand for existing high-temperature alloys, such as HASTELLOY X alloy, and new proprietary high-temperature alloys which were to be developed by the company over the next 20 years. The aerospace industry requirements for new gas turbine engines with ever increasing needs for higher thrust, better fuel efficiency and lower required maintenance provided an excellent climate for a culture of alloy innovation. This fostered the company's development of a whole new generation of successful high-temperature superalloys, such as HAYNES 188 alloy, HASTELLOY S alloy, HAYNES 556® alloy, HAYNES 214® alloy, and HAYNES 230® alloy.

During this same period, an escalation in Cold War tensions between the West and the communist bloc resulted in an expansion of defense equipment budgets, thus further increasing the demands for high-temperature alloy products. A typical application was the use of HASTELLOY X alloy sheet for the tailpipes in the Navy A-6's surveillance aircraft and ground attack aircraft, which were powered by the Pratt and Whitney's J-52 engines.

Growth on the corrosion-resistant alloy side of the business during this period was also significant. The chemical process industry continued to pose challenges to existing construction materials as their process environments grew more and more corrosive. Such opportunities brought about the invention and introduction of improved products such as HASTELLOY C-22® alloy (with improved pitting, crevice, weldment and oxidizing environment corrosion-resistance over C-276 alloy) and HASTELLOY G-30® alloy (with far improved corrosion resistance to super phosphoric acid environments over G-3 alloy) by the early 1980s.

The significant growth in demand for superalloy products, coupled by the market demands for increased corrosion-resistant alloy plate size capabilities, prompted the company once again to make a major investment in production capabilities in the early 1980s. A new 84-inch wide, 4-High hot reversing mill was purchased and installed in 1982. This major new facility opened significant opportunities for market share increases for both high-temperature sheet products and wide corrosion-resistant alloy plates.

Success in the use of this new mill had been dependent upon the prior development of Electroslag Remelted Slab technology by the company's process R&D personnel. Many years of difficult work in the 1970s and early 1980s had led to the capability to produce the stock-in-trade 12-inch thick by 42-inch wide ESR slabs of the nickel- and cobalt-base alloys. These heavily alloyed materials do not lend themselves to successful static slab casting technology, making ESR slab technology absolutely essential.

A most important opportunity for the company arose in the early 1980s. It involved the Lycoming Company's AGT 1500 gas turbine engine for powering the U. S. army's Abrams M-1 main battle tank. The 4-High mill was crucial in affording the company the capability to provide the alloy 625 thin gauge coil product required for the engine heat recuperator. (Alloy 625 was one of those commodity materials which had been "scaled up" in the early 1970s as part of the strategy to broaden the company's product base.) Ultimately, several million pounds of this product were to be produced by the Stellite Division to support tank production, which proved vital to military success in Middle East during Gulf War I.

In the area of tubular products, the Stellite Division pursued further expansion in the 1980s with the acquisition of the Zirtech Company, a tube manufacturer in the northwestern U. S. The main interest in Zirtech was its titanium seamless tubing business. The principal application for the titanium tubing was in aircraft hydraulic control systems.

In another major growth and diversification effort in the 1980s, the company acquired the Deloro Stellite Company, a major manufacturer and distributor of a wide spectrum of hard facing products. This eventually led to the reorganization of the Stellite Division into two separate business units, the High Technology Materials Division (High Tech) and the Wear Technology Materials Division (Wear Tech). This arrangement was ostensibly established to more efficiently serve the markets in the 1980s, but was relatively short-lived.

REALIGNMENT – A TIME OF CHANGE

The mid 1980s marked the beginning of an almost 20-year period of ongoing financial and organizational change for the company. There was ownership by various investment bankers. There was a company name change. It was a turbulent time, accompanied by significant political and economic change worldwide.

In October 1985, Cabot Corporation announced that it would sell the Stellite Division and other metals businesses it had acquired over the previous two decades. A partial spin-off was affected by July, 1987. The wear-resistant alloys part of the business was sold off to the Stoody Company, and the remainder of the Kokomo-based company was renamed Haynes International, Inc. In September, 1989, the sale of Haynes International to the investment banking firm of Morgan, Lewis, Githens, and Ahn was consummated, and the era Cabot Corporation in Kokomo came to an end.

Haynes International was now effectively a stand-alone company with a large debt burden. Managing such a large debt load was a challenge. It brought on tight inventory controls and reduced capital investments and, of course, meant meeting the interest payments on the debt. At the time, the interest payments to the bond holders were close to $20 million a year.

The international political landscape was changing dramatically as the fall of the Berlin Wall and the dismantling of the Soviet Union approached. China was beginning to exert its economic muscle in the Asian markets. Airline deregulation was in full swing in the USA. The European Union was expanding and beginning to bring down trade barriers across Europe.

The proprietary alloys developed by the company's R&D group in the early 1980s began to make significant contributions to the bottom line by the middle of the decade. By the decades end, fully 50% of the company's sales were in alloys which didn't exist 10 years earlier. Most of these were proprietary to Haynes International.

In the gas turbine arena, HAYNES 214 alloy applications for turbine honeycomb seals were developed, requiring significant quantities of thin foil product. Major applications were secured for HAYNES 230 alloy in the land-based gas turbine market, with the associated requirement for large quantities of plate and sheet product for combustion chambers and ducting. Applications also were developed for HASTELLOY S alloy in flying gas turbine seal rings, providing reasonable requirements for bar product.

Efforts to promote the use of the company's proprietary high-temperature alloys in non-traditional markets also began to bear fruit. Significant applications for HAYNES 230 alloy were established in the industrial heating and chemical processing industries, including plate product for nitric acid catalyst grid supports, and plate and bar product for trays, baskets and other equipment in industrial heat treating operations. HAYNES 214 alloy was used for support pins and woven wire belts in the firing of fine china (its stable oxide surface did not mark the china), while HAYNES 556 alloy was used for baskets in hot dip galvanizing operations (it had unusual resistance to molten zinc).

In the corrosion-resistant alloy area, opportunities for HASTELLOY C-22 and G-30 alloy applications in the chemical processing markets grew substantially. In the case of C-22 alloy alone, over one million pounds of product were sold for a single FGD project at the Drax power station in North Yorkshire, England. Meanwhile, HASTELLOY G-30 alloy was found to have excellent resistance to nitric/hydrofluoric acid mixtures, and began to be sold into commercial stainless steel pickling operations.

Alloy developers in the R&D group continued to be active during this period. In light of the successful penetration of the industrial heating market with 214 and 230 alloys, new alloys specifically designed for non-traditional high-temperature markets were developed and introduced. These included HAYNES HR-120® alloy and HAYNES HR-160® alloy. HR-120 alloy was a high-strength material designed to be a cost-effective upgrade for existing iron-base alloys used in industrial applications (i.e., 330, 800H, etc.). HR-160 alloy was designed to provide premier resistance to high-temperature corrosive environments, such as encountered in waste incineration.

Also developed during this time, nickel-base HAYNES 242® alloy combined low thermal expansion characteristics with high-temperature strength derived from a unique long range ordering mechanism. It was used in Pratt & Whitney's military jet engines as a seal ring material due to its ability to operate at higher temperatures than competing materials. Interestingly, it also found application in the production of fluoropolymers and plastics as a consequence of its resistance to high-temperature fluorine-bearing environments.

Applications for existing alloys also continued to contribute to the business through this period. As previously mentioned, millions of pounds of alloy 625 thin foil for the Lycoming Company AGT-1500 (for the turbine recuperator on the Abrams M-1 main battle tank) were supplied in the late 1980s and early 1990s, right through the Desert Storm period. Also, dozens of satellites were launched using the Ariane 5 heavy lift rocket, which employed HAYNES 25 alloy for the ”skirt” or exhaust nozzle on the Ariane’s Vulcan rocket engine. The Ariane is used by Arianespace, a French satellite launch company. To date they have made almost 300 launches, putting several hundred satellites into earth orbit.

STAYING AFLOAT - THROUGH UPS AND DOWNS

The 1990's were ushered in by the military action of Gulf War I, which led to significant volume increases for Haynes’ high-temperature alloys. General Dynamics’ M-1 tank was immensely successful in its mission and, consequently, demand for 625 alloy thin gage coil for Lycoming’s AGT-1500 engine recuperator surged. Demand for specialty high-temperature alloy flat products for fighter aircraft components also increased. These surges in demand were to be short-lived, however, as the longer term impact of the unrest in the Middle East was to be a severe reduction in the demand for both commercial and military aerospace products during and following the recession of 1991.

The early 1990's were also to present an opportunity for the company to further capitalize upon the drive for cleaner air arising out of the environmental legislation of the 1970’s. The company had already achieved a leadership role in the supply of construction materials for Flue Gas Desulfurization (FGD) installations at power plants in the 1980’s, including both "wallpaper" and “solid” constructions designs. Unfortunately, the lead time for new power plant design approval was becoming greatly extended by the early 1990’s. Utilities began to look more and more at land-based gas turbines for meeting base load power generation requirements.

Land based gas turbine (LBGT) technology was perfectly positioned to fill the power supply gap looming due to FGD installation delays for traditional facilities. LBGT units had long been used by utilities for "peak shaving" in times of high electrical power demand, but these did not employ robust enough materials of construction for use as long-term, low-maintenance base load power generation facilities.

Existing equipment was upgraded utilizing aerospace materials, such as HASTELLOY X and HAYNES 263 alloys, enabling components to meet base load unit performance requirements. New LGBT designs also began to incorporate such existing aerospace materials, as well as to spark the adoption or development newer materials, such as HAYNES 230 and HAYNES HR-120 alloys. Haynes International has supplied many millions of pounds for LBGT applications, and it remains one of the company’s major market segments to this day.

Haynes' aerospace and military segment sales declined significantly into the fall of 1992, matched by worsening projections for future high-temperature alloy product business. This occasioned a painful period of restructuring and staff reductions that greatly impacted marketing, sales, and particularly product and process development programs. (The staff reductions in the company's Technology Department were in fact the first in many years.) Several efforts were made to either sell the company. or merger it with another alloy manufacturer during this time. All were unsuccessful.

The company continued to face lower business volumes in the years following the first Gulf War with the related post-war recession. By 1994, prevailing business conditions, coupled with the company's high debt service requirements, began to tax the company's finances to the limit. Managing the company's cash position became the highest business priority. At one point, a short-term cash infusion from the company's owners was needed in order to continue running the business. While managing its cash position was a difficult and stressful task, laudable efforts on the part of all company personnel assured the company's survival.

Fortunately, another revival of the airline and aerospace industries by 1995 afforded the company a path back to profitability, as well as a new business opportunity. Recovering from the recession, the gas turbine manufacturers began to focus more upon just-in-time delivery and near-net shape strategies for component manufacturing in assembling their gas turbine products. Just-in-time delivery would limit their raw material inventory, handling and inspection costs. Procuring material inputs that were nearer to the net shape of final components would minimize machining and cutting, together with associated operation and scrap generation costs.

Haynes International negotiated partnership arrangements with the gas turbine companies allowing Haynes to be imbedded into their process streams. Utilizing a network of service center depots, Haynes could provide just-in-time delivery of standard size sheet, plate and other forms, or arrange for the cutting and delivery of nearer net shape pieces, as required.

Recognizing the need to focus more of the company's efforts upon value-added customer services, the decision was made in the mid-1990's to invest in establishing a modern, centralized final processing facility for the domestic service center network. With this decision, the basic nature of Haynes' "Service Centers" changed from sheet/ plate/ bar depots to that of processing centers, integrated into the customer production cycle. It became essential that customer need and Haynes production forecasts were accurately matched in order for on-time deliveries to be effectively managed.

The new facility was established in Lebanon, Indiana, becoming fully functional by the end of the 1990's. This investment and strategy was similar to that of the Haynes UK business model for Rolls Royce, and its subtier suppliers, which employed a technique know as value stream mapping (VSM).

The value-added focus of the facility was achieved largely by providing a more value-containing product closer to a customer's final part shape, while also significantly reducing the customer's associated scrap. By doing this all in-house, Haynes would realize a return from the value added, benefit from the more rapid and cost-effective recycling of the scrap, and achieve greater flexibility to adjust to any customer production schedule changes. New, state-of-the-art shearing, cutting and handling equipment at the new facility were all essential means to achieving this end.

Another chapter in Haynes International's ownership by investment bankers began in 1997 when the company once again changed hands. This time, the Blackstone Group purchased control of Haynes International from Morgan Lewis Githens and Ahn (with a consequent renegotiation and increase in the company's debt structure). The ultimate goal of the purchase was the creation of a mega supplier of superalloys by virtue of an intended merger of Haynes International with the competing Huntington Alloys Division of the International Nickel Company. The merger attempt was rejected by the Antitrust Division of the Justice Department in 1998.

Despite the financial challenges faced during the 1990's, and the rapid-fire pace of marketplace change, the company's strengths in its Manufacturing, R&D, Sales, Marketing and Distribution organizations kept Haynes International's ship afloat. Manufacturing processes and attendant quality were improved, new markets and applications were developed, and product innovation was continued.

New product development continued indeed throughout the 1990's, with the Haynes R & D group's development and introduction of such new products as HASTELLOY B-3®, C-2000®, and D-205™ alloys. These new alloys were designed for various applications in the chemical processing and pharmaceutical markets. B-3 alloy was an improvement over alloy B-2 with improved thermal stability and weldability. The alloy was designed using careful adjustments to iron, chromium and residual alloying element contents to avoid the formation of rapidly forming embrittling phases, thus preventing many of the manufacturing and fabrication problems still inherent with alloy B-2, which subsequently ceased to be made.

C-2000 alloy was a further advance in the performance of the C alloys, providing excellent corrosion resistance over a broader range of oxidizing and reducing environments. Similar to C-22 alloy, a high level of chromium was maintained in order to ensure resistance to oxidizing environments, while improved resistance to non-oxidizing environments was provided through a high molybdenum level coupled with a small addition of copper. Still relatively new early into the 2000's, it had received good acceptance due to its wider versatility and greater resistance to localized corrosion.

D-205 alloy represented an advance in terms of manufacturability over the old D alloy (which was a casting material), providing better performance in highly concentrated sulfuric acid than established Fe-Cr-Ni-Si alloys.

It's interesting to note that these alloys are all descendants of the original HASTELLOY B, C, and D alloys developed by the company in the late 1920s. HASTELLOY C-2000 alloy was actually the fifth generation of the original alloy C, and has been used in hundreds of applications, including those for pharmaceutical manufacturing companies such as Eli Lilly in Indianapolis.

THE NEW MILLENIUM

Following the failed INCO merger in 1998, the Blackstone Group essentially looked to unburden themselves of their investment in Haynes International. For several years, they pursued various sale alternatives, but to no avail. Meanwhile, the company continued to labor under the heavy debt service burden accrued from the several ownership iterations since the 1980's. The financial situation again turned difficult following the events of September 11, 2001.

The terrorist attacks of 9-11 gravely wounded the commercial airline industry, and the entire related supply chain of industries, right back to the aircraft and aircraft engine manufacturers. The resulting recession of 2001-2002 was again keenly felt by the company and, by 2004, the Blackstone Group decided to forego their ownership and investment in Haynes International, and in February. 2004 permitted management to take the company into voluntary bankruptcy. The debt was restructured, and the company emerged from bankruptcy in August 2004, less than 6 months after having entered it.

Seeking to expand its business in the wire products arena, Haynes International purchased the assets of the Branford Wire Company in November of 2004. Located in Mountain Home, North Carolina, Branford Wire was a family owned company established in the mid 1940's. It had originally been based in the Branford, Connecticut area.

The family relocated the company to Mountain Home, North Carolina in 1975. They operated it primarily for the manufacture of fine stainless steel wire, but also developed both wire braiding and stone cutting wire operations there in Mountain Home. The company also had a strong business in re-selling stainless steel rod coil to smaller wire re-drawers.

Following the acquisition, Haynes International began the process of converting the newly acquired company into a world class, high performance nickel- and cobalt-base alloy weld wire manufacturing facility. The wire braiding equipment was sold off, together with the stone cutting wire production equipment. Stainless rod coil re-selling operations were deemphasized as the stainless wire business diminished.

During this time, personnel at the newly named Haynes Wire Company undertook to develop the manufacturing and quality systems and procedures required to become qualified for high performance alloy wire applications. A custom computerized manufacturing router/ procedure system was developed and installed, together with a matching new computerized quality system, all during the early years following the Haynes purchase. ISO 9001 and customer quality system approvals were achieved in reasonably short order.

By the early 2010's, Haynes Wire was still producing a small amount of specialized stainless steel wire, but the vast majority of the products being made were nickel- and cobalt-base alloys, fully complementing the sheet, plate, bar, pipe and tube products produced by the company's Kokomo and Arcadia locations.

The development of new products at Haynes International continued unabated into the new millenium. Six new proprietary alloys were launched in the 2000's first decade, with seven more under development. at the decade's close. Among the new high-temperature alloys was HAYNES 282® alloy.

It had been determined by the early part of the 2000's that a significant opportunity existed in gas turbine engine markets for a new alloy with elevated temperature strength higher than HAYNES 263 alloy, also possessing that alloy's good formability and weldability. In a unique alloy development approach, a new quantifiable, elevated temperature test (which had been developed in-house) was adopted to gauge the weldability of experimental alloy compositions. This test proved critically important in defining the final alloy, which was ultimately christened HAYNES 282 alloy. With its introduction 2005, this alloy garnered many applications in the targeted market areas, and became an important candidate material for advanced ultrasupercritical steam plants.

Also during the 2000's, research into a very different approach for imparting high-temperature strength into an alloy was pursued. The approach involved strengthening already fabricated parts by diffusing nitrogen into them in a subsequent environmental treatment. Unlike past dispersion strengthened alloys, which employed powdered metals to produce a fine dispersions of oxides, the new alloy could be conventionally melted and converted into wrought products.

Another important advantage of the new alloy was that it could be welded by conventional methods prior to the strengthening process. The new alloy, with a nominal composition of Co - 28% Cr - 21% Fe - 9% Ni, was designated HAYNES NS-163® alloy. It began commercial testing for a variety of commercial applications in the early 2010's.

HAYNES HR-224® alloy was another high-temperature alloy developed near the end of the first decade of the 2000's. The new alloy possessed oxidation resistance comparable to 214 alloy, but with greatly improved weldability, fabricability and cost. Welded tubing of the Ni - 28% Fe - 20% Cr - 4% Al alloy was successfully produced, and the new alloy began testing for a number of commercial applications in the early 2010's.

HAYNES 244™ alloy (a Ni-Mo-Cr-W composition) was introduced by the company in the early 2010's. Age-hardened to increase its strength via the same ordering transformation used by 242 alloy, the new alloy possessed strength properties superior to 242 alloy, a somewhat lower coefficient of thermal expansion, and a potential service temperature ceiling as high as 1400°F (an important advantage over 242 alloy). The new alloy began commercial evaluation for use in seal ring and casing applications in gas turbine engines in the 2010's.

On the corrosion alloy side of the R & D ledger, new product development and introduction in the 2000's included HASTELLOY G-35® and C-22HS® alloys, and HYBRID-BC1® alloy. An outgrowth of its HASTELLOY G family antecedants, G-35 alloy was developed beginning in the late 1990's, and commercialized in 2004. Essentially a Ni - 33% Cr - 8% Mo alloy, the alloy provided a needed improvement over G-30 alloy in corrosion resistance in wet process phosphoric acid service.

C-22HS alloy grew out of research efforts to develop a C-type alloy that could be age-hardened without the loss of the excellent corrosion resistance of such alloys. With alloy design based upon HAYNES 242 alloy, success was obtained with a composition possessing a high level of chromium to ensure that corrosion resistance would be similar to C-22 alloy. The aging reaction produced a yield strength near double that of C-22 alloy, with only a small reduction of ductility. The resulting alloy was also found to possess excellent resistance to sour gas environments, and has found many applications in that area.

An alloy having excellent resistance to reducing types of environments (such as hydrochloric and sulfuric acids) without the susceptibility to oxidizing impurities (which had always been the Achilles' heel of B-type alloys) had been a long-sought goal of alloy development at Haynes International. That goal was essentially achieved at the end of the first decade of the 2000's with HYBRID-BC1 alloy. This high molybdenum and chromium composition provide it with the required corrosion resistance. The alloy was undergoing commercial evaluation by 2012.

A PUBLIC COMPANY

On March 23, 2007 the company completed an initial public offering (IPO) of its stock, and was formally listed on the NASDAQ stock exchange with the trading symbol HAYN. Haynes International was now truly a publicly owned company. Several hundred investors own Haynes International stock today, most of whom are mutual fund companies and investment firms.

The company competes in worldwide markets, mainly in the aerospace, chemical processing, oil and gas, land-based gas turbine, and flue gas desulfurization industries. Its products are used in the most demanding environments and critical applications, just as they were at the beginning of the 20th century. Now well into the 21st century, Haynes International uses its excellence in Manufacturing, R&D, Sales, Marketing and Distribution to continue the tradition of innovation established over the last 100 years.

As the company moves towards its second century in business, it does so clearly prepared for the challenges of the next 100 years. Three manufacturing locations in the USA provide product for 11 worldwide sales and distribution locations. The company serves customers all over the world, providing and developing new and innovative materials solutions for the energy, transportation, and materials sectors of the world economy.

Mindful of the pace of intensifying competition, the company has implemented capital expenditures over the last 5 years and planned expenditures over the next 5 years that will total well over $100 million. These capital projects are enabling Haynes International to prepare for the demands of the global markets in which it participates, and will provide the strength needed to meet future challenges.

Today, the company's technical and marketing experts are working together with customers in the materials selection process for such vital and exciting areas as solar panel and fuel cell electricity production, deep drilling oil and gas well exploration and production, high efficiency boilers for electricity generation, and equipment for the manufacture of new drug therapies not even dreamed of 10 years ago.

So this is Haynes International: in the tradition of Elwood Haynes, a company of dedicated and talented people, entering its second century of innovation and customer satisfaction.

® HASTELLOY, HAYNES, B-3, C-22, C-2000, C-22HS, G-30, G-35, 214, 224, 230, 242, 282, 556, HYBRID BC1, HR-120, HR-160 and NS-163 are registered trademarks of Haynes International, Inc.

® FERRALIUM is a registered trademark of Langley Alloys, Ltd.

® STELLITE is a registered trademark of the Kennametal Company.

™ D-205 and 244 are trademarks of Haynes International, Inc.

GLOSSARY

AOD – Argon Oxygen Decarburization

Alloy – Chemical combination of two or more elements (one of which is a metal)

Bucket – alternate name for precision cast turbine blade

CPI – Chemical Process Industry.

Casting – Something made by pouring molten metal into a mold with a shaped cavity

Chromium – Metallic alloying element that provides environment resistance to an alloy

Cobalt – Metallic element used as an alloy base.

DSO – Defenbaugh Street Operations.

EF – Electric Furnace.

ESR – Electroslag Remelting

FGD – Flue Gas Desulfurization.

Hard-facing – Weld depositing a wear-resistant material upon a substrate surface

Investment casting – See precision casting

LBGT – Land-Based Gas Turbine

Lost wax casting – See precision casting

Molybdenum – Metallic alloying element that provides either corrosion resistance, strength, or both to an alloy

Nickel – Metallic element used as an alloy base

O & G – Oil and Gas

Precision Casting – Method of casting simple or intricate parts so close to size that little or no finishing is required (also known as the “lost wax” or “investment casting”)

Rare Earth – One of several metallic alloying elements used in very small quantities to help impart high temperature environment resistance to an alloy.

Superalloy – Complex nickel- or cobalt-base alloy combining exceptional strength and environment resistance at high-temperature (often used in aerospace or other demanding applications)

Tungsten – Metallic alloying element that provides either corrosion resistance, strength, or both to an alloy

VIM – Vacuum Induction Melting.

VAR – Vacuum Arc Remelting.

WAO – Wrought Alloy Operations.

WAP – Wrought Alloy Products.

Wrought Product – Product made by an initial casting and subsequent hot- or cold-working operation (normally using a forge press or rolling mill) to create a final shape and condition (such as sheet, bar, or plate)

Z-mill – Special cold-rolling mill used to produce tight tolerance sheet product