CAST TO SHAPE

A History of the Steel Castings Industry in the United States

by

William P. Conway, Jr.

STEEL FOUNDERS' SOCIETY OF AMERICA
Rocky River, Ohio
1977

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PREFACE

All steel is cast at one point in its production process. Pouring molten steel into a mold and letting it solidify is the act of casting. A steel ingot, symbol of the steel industry in general, is cast but must undergo reshaping before finding its way into car bodies, construction I-beams, and the myriad other end-products of "Big Steel".

A steel casting, on the other hand, is a steel part which has been cast to final form or shape. Casting to final shape requires overcoming a number of special problems. Perhaps the most illustrative and dramatic of these is the problem of shrinkage. As molten steel cools and solidifies it contracts. The production of a casting of specific dimensions therefore requires a tremendous amount of skill, and this requirement multiplies with the complexity of the casting. The mold must be hard enough to insure the castings shape, however if it is too hard the shrinking steel will tear.

Yet a number of benefits make overcoming these difficulties worthwhile. Steel castings provide advantages which cannot be matched by alternate products. Chemical and physical uniformity, strength, resistance, weight and appearance have all combined to provide the engineer with qualities available in no other product. The demand engendered by these qualities has given rise to what is today part of the sixth largest basic industry in the United States—the Steel Castings Industry.

This book is the story of the industry's rise. Each of the following twelve chapters deals with a ten year span of the industry's one hundred sixteen year history. Forces and factors which had a hand in shaping the industry are presented. Beginning with an historical over view of each decade, the discussion will move to the production accomplished within this historical framework. The industry's transition from art to science will be traced through the technology sections in each chapter. The stories of widening applications will fall into the market sections. Periodically, leading personalities will so affect the industry that their stories will have to be told. And, as the laissez-faire economic position of government shifts to increasing regulation, the changes will receive their dues. Through these chapters and their sections these themes appear as they weave themselves into the pattern of the industry's development. The increasing sophistication of technology, the drive for expanded application, attrition, regulation, co-operation, success and failure are all a part of the story.

Mingling with these themes is a sense of urgency. Mr. C. E. Haney of ESCO Corporation, and current SESA President, noted the sense of urgency associated with working with molten steel. This urgency, he felt, has spread to the industry at large. However, this contagious urgency has colored the industry from its beginnings. It will emerge from each of the following twelve chapters. Always present as an undercurrent, occasionally it surfaces as a wave. There is an urgency associated with a nearly bankrupt William Hainsworth opening the first exclusive commercial steel foundry. The same sense of urgency is apparent as John Roach set about establishing a shipbuilding monopoly. It surfaces again as Jim McRoberts defies foundry tradition on the basis of his own intuition and revolutionizes the art of molding. The urgency is apparent in the early meetings of the Steel Founders'. Society, and is not lost in later years as Frederick Lorenz and Charles Briggs assumed dominant roles in the organization and the industry.

This book is drawn from the lives of the men who built and are building the steel castings industry. Most of them are not mentioned by name. To all of them this book is dedicated.

William P. Conway, Jr.

ACKNOWLEDGMENTS

Most readers have a tendency to come to an acknowledgment section of a book and rather quickly turn to the next page. I have done it in the past. I'll not do it again. Please do not do it now. A great many people have contributed to the production of this book. They have patiently answered an historian's bothersome questions. They have typed and retyped two hundred odd pages. They have read and made comments on the manuscript. They have coped with me and my own frustrations. Now, I would like to take this opportunity to thank them.

A number of very busy men in the industry granted me their valuable time for interviews. To Mr. Thomas H. Shartle, Sr., Texas Electric Steel Casting Co.; Mr. R. E. Fisher, Jr., Fisher Cast Steel Products, Inc.; Messrs. John M. Quinn, Thomas S. Quinn and Charles W. Mellinger, Lebanon Steel Foundry; Messrs. M. G. Moore, Jr., Donald J. Volk, Vincent Tripodi, Empire Steel Castings, Inc.; Messrs. Lawrence S. Krueger, Charles Stull, Elroy Eberhardt, Pelton Casteel, Inc.; Messrs. Ralph L. Wabiszewski, Robert Korevec, Maynard Steel Casting Co.,; Messrs. Richard A. McBride, Richard W. Krieg, Howmet Corporation, Crucible Steel Casting Division; Mr. B. V. Thompson, Jr., Texas Steel Co.; Messrs. Leonard Neef, Robert Wood, Dale Hall, Honorary Members SFSA; Mr. William J. Shive, Sterling Steel Casting Co.; Mr. E. F. Marquardsen, Pacific Steel Casting Co.; Mr. John McBroom, Sr.; Stainless Foundry and Engineering, Inc.; Mr. E. Walcher, Jr., American Steel Foundries; Mr. James P. Cooper, Genecast; and Mr. C. E. Haney, ESCO Corporation, I offer my sincere thanks.

The members of the staff of the Steel Founders' Society went out of their way to make what could have been a task, a pleasure. Jack McNaughton, Peter Wieser and Betty Winzer saved me from making serious errors relating to both the technical subjects and Society history. To Miss Cheryl Hallstrom, who typed and retyped this manuscript, a special thanks. And, to Fred Simonelli, whose efforts I can't begin to recount, I truly owe a tremendous debt of gratitude.

Men in positions not directly associated with the Steel Founders' Society graciously offered their assistance. Mr. Chauncey Belknap of Patterson, Belknap, Webb and Tyler; Messrs. Charles Sheehan and Kenneth Pattow of the National Foundry Association; Messrs. Jack Schaum and Dudley Gould (to whom I owe a special thanks) of American Foundrymen's Society; and Mr. Jack Miske of *Foundry*, offered to me all the resources to which they had access.

The manuscript was read and critiqued by Dr. Marian J. Morton, Dean Albert Hamilton, Mr. Donald Smythe and Mr. James Natural. They saved me from a number of errors, and in so doing spent a great deal of valuable time.

Finally, to my family who coped with typewriters in the night, sour dispositions, and occasional frenzy. Thank you.

To all of these people I offer my heartfelt thanks. Your graciousness and warmth (and kind criticism) has made this task worthwhile.

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FOREWORD

The publication of this book is timed to coincide with the 75th Anniversary of the founding of the group which later became known as the Steel Founders' Society of America. It is not, however, a history of the Society. It is, rather, a history of the steel foundry industry; an industry born a scant half century prior to that 1902 meeting of steel founders in New York City:

The history of metal casting, dating back to centuries before Christ, is well documented. These castings, however, were iron or one of a variety of non-ferrous metals and alloys. It was not until 1740 that reusable crucibles which would hold molten steel were developed. It was many years later in 1845, before the first steel castings were produced.

This new metal, casteel, has a short but rich history which is told in the pages that follow. Its heritage is one of frustration, experimentation, courage and success. Its history closely parallels the industrial revolution in the United States and, in fact, its development is a major factor in that revolution. Without casteel, our current industrial society and high standard of living would not exist.

The story of casteel is dynamic; one of an industry changing and adapting. We have come from the days of the steel "doctor" through the introduction of green sand molding and "electric steel." Our industry experienced the "bull-of-the-woods" era and survived the days when "it was to the highest degree inadvisable to allow the impression to get abroad that heat treatment of steel castings was either possible or advisable." Steel foundrymen have met the customers demands for reliable, lighter, stronger, more serviceable casteel components. Sophisticated melting and molding techniques have been and continue to be developed. Modern quality control and nondestructive testing techniques place casteel products at the heart of critical applications. The future is being shaped now with research and development into the use of industrial robots, laser beam cut-off and molding processes without binders, some without using sand at all. From these and other developments will come solutions to current challenges of environmental, safety and health concerns, energy and materials shortages, as our industry continues to change and grow.

To tell the story of casteel, we enlisted the aid of a professional historian and writer, William P. Conway. In the year that Bill has worked on this project, he has come to know steel foundrymen well, through hours of personal interviews and days of researching original documents in our offices and foundries. He has produced a book which is easily readable, yet thorough. It is not, however, all inclusive.

References to individuals are made to give the reader a flavor of the times and are not necessarily unique. Often, many similar stories could have been told. Statistics are used only to show trends, not to present all the information which is available.

Therefore, we ask the reader to join us for only a few hours in reliving the history of our industry. I am confident that it will be a rewarding and enjoyable experience.

JACK D. McNAUGHTON
Executive Vice President
Steel Founders' Society of America
August 1977

CAST TO SHAPE

CHAPTER 1—The 1860's

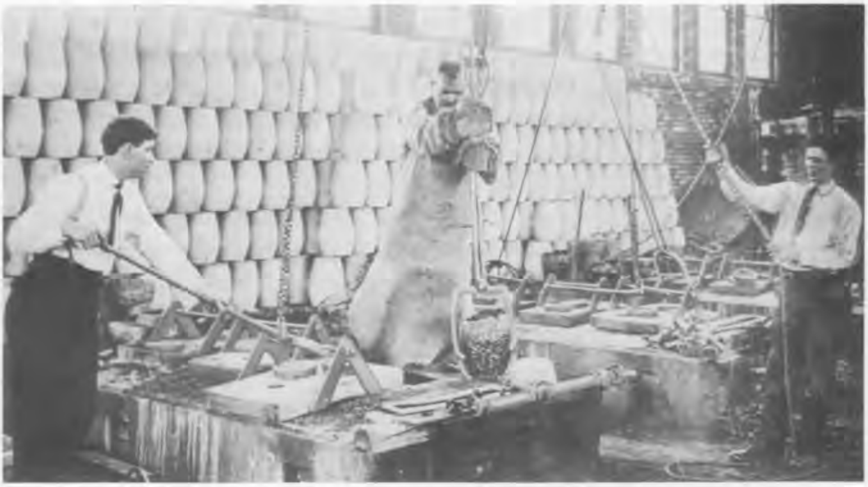
The steel castings industry was born in one of the most critical decades in American history. Frontier expansion, territorial settlement and industrial growth gave way to the Civil War of the 1860's. From 1861 to 1865 the once united states engaged in a bloody war which decimated an entire generation. At the war's end, the United States had achieved a unity that was imposed and a harmony maintained at gun point.

The war dominated the decade and colored later American history. It is hard to think of any aspect of the 1860's without thinking of it in terms of the Civil War. Even the nation's Presidents, the most visual of political symbols, are remembered in terms which relate to the conflict. Abraham Lincoln, one of our best known and best loved Presidents, is recalled for his role as a national war-time leader, Commander-in-Chief of the Northern forces, and preserver of the Union. Andrew Johnson, unable to work with Congress in bringing about a post-war reconstruction of the South, suffered impeachment and near removal from office. Ulysses S. Grant, who followed Andrew Johnson, enjoyed a much greater success and earned a better reputation as Lincoln's ablest general than as the nation's 18th Chief Executive.

The national economy was closely tied to war efforts and achievements. On the eve of the conflict a shaky economy foreshadowed the impending crisis. But the increased rate of government spending and the ensuing inflation combined to produce a boom. The nation's business and industrial community rode this wave throughout the war.

The end of the war produced little distress in the North. Here solid industrial advances had been made during the war years, and these provided a base for continued growth in both the second part of the decade and the remainder of the century. For the South, however, the war's end brought financial chaos. But the Northern economy was a victorious economy, a thriving economy, and now a national economy. In the remaining years of the decade severe stock market fluctuations would threaten this ascendancy, but these alarums were insignificant in comparison to the recent upheavals of the war.

Amid the conflict and confusion of the 1860's, the steel castings industry was born. The Buffalo Malleable Iron Works (later Pratt and Letchworth) poured the first steel castings in the United States in 1861. The steel was melted in crucibles charged with scrap. Descrippendicular thrust. Thus the melter could not stand two or three feet away, but was required to stand in the intense heat directly above the small space brought about by moving the cover back. When the coke was sufficiently poked down, more was added and the cover replaced.



A Prime Steel Castings Company dramatization of the removal of crucibles from the furnace. Although this photo was taken c. 1905, the principles of crucible operation had not radically changed from the 1860's when steel castings were produced exclusively of crucible steel.
Courtesy: Foundry

This process was repeated regularly through the six-hour melting time generally required. At the end of this period, the crucibles were removed and pouring commenced.

The art of molding in these early days also provided a great deal of room for improvement. Various materials in varying proportions were tried in a never-ending search for a mixture which would produce a casting of smooth finish. The mold employed by the Butcher Steel Works in the production of their 1867 railroad castings consisted of ground firebrick, finely ground black lead crucible pots, and fire clay. The finished mold was given a black lead wash.

European leadership in the steel casting industry during this period was taken for granted, and with good reason. Concerning metallurgy, the United States had to be content with the occult rituals of the "steel doctor." However, in France, during the Paris Exposition of 1867, the Terre Noire Works had begun a series of experiments revolving around the production of projectiles for naval guns. As a part of these experiments the metallurgy was considered to be of foremost importance. Using the Siemans-Martin furnace, a number of heats of iron were melted, refined, with scrap steel in varying amounts being added, and the resulting products scrutinized. This inspection revealed that the addition of scrap improved the product, and the variations in the breaking points of this steel corresponded directly with the amounts of silican it contained.

1867 may have underlined the imperfect state of the casting art in America, but American practicality and Yankee ingenuity were making contributions to what was then a vain attempt to compete with Europe. It was in this year that James Naismith, the inventor of the steam hammer, put on the market a safety ladle which in the course of years has prevented countless accidents in the foundry. Naismith's safety ladle was controlled by gearing, and it was quickly adapted by the foundry industry for pouring all sizes of castings.

Quality control, in keeping with the general state of United States steel casting, showed considerable room for improvement. During the '60's and for the rest of the nineteenth century, a popular determination of the carbon content of a melt was made by breaking a small part of the casting. This piece was then subjected to the eye of the operator. These men became quite expert in their determinations, and their method served as the principal means of analysis until the advent of plant laboratories early in the twentieth century.

The first ten years of the industry's existence in the United States quite naturally had a limited market. In Europe, business developments had begun with horseshoes and church bells. In fact, commercial steel castings, or steel cast to final shape, was born when Johann Conrad Fisher applied for a British patent for a new way of making horseshoes. Unfortunately casting horseshoes never did become the commercial success the developer had envisioned. Church bells on the other hand did become successful. As a result of the work of Jacob Meyer, Technical Director of the Bochum Works in Westphalia, Germany. Though first produced in 1851, by 1855 Bochum bells were exhibited in Paris where experts declared their performance perfect with tones as clear as traditionally cast bronze bells.

U.S. founders considered producing bells such as these. The Tredegar Iron Works in Virginia is said to have successfully cast such a bell and subsequently shipped it to Ireland. Unfortunately neither date nor office report offers proof that such a bell was indeed cast.

Another market being considered was that of hammer dies for die casting. The fact that it was possible to produce castings with one solid side had given rise to this, but it was not until the 1870's that this speculation was confirmed and such a casting produced.

The railroads, however, did provide an opportunity for castings. This is seen in the production of the foundry at the Butcher Works. Yet crossing frogs were only the first of a line of products which expanded with the railroads themselves. But the process of acceptance was slow, for steel was new and steel castings even newer. The problems of the industry were numerous. And, though successful castings were made, many attempts were failures and these gave all steel castings a reputation of being unreliable — a reputation which died hard.

Today the railroads absorb between 40 to 50 percent of the steel castings industry's annual production. This percentage has naturally fluctuated during the course of the industry's development, but has traditionally remained large. Moreover, the railroads enjoy the added distinction of being the first market to which steel castings were applied. In light of this, railroad industry's growth must be considered an important factor in the development of the steel castings industry.

A number of reasons led to the railroad's pre-eminence as a market for steel castings. First, castings produced for the U.S. railroads were the first to be commercially successful. Second, the nature of steel — its greater tensile strength — was best suited to the railroads needs. Third, there was the sheer magnitude of the railroads, the consequent size of the market this produced, and the railroads' place in the U.S. economy. Finally, systematic technical developments within the railroad industry would increasingly necessitate the use of the steel castings.

The railroad served as the leading industry during the 1860's and '70's. In 1860, 30,626 miles of road were operating. Following four years of slight construction during the war, railroad construction boomed. By 1870, 59,922 miles of road were being operated. The first transcontinental railroad was completed in 1869, and by 1873 every important American town had its railroad connections. In 1876, 15,618 locomotives pulled 399,524 revenue cars (passenger, freight, and baggage) across 94,665 miles of track.

This rapid and extensive construction played dual, leading roles roles in the national economy. Not only could it contribute to economic stability, but at the same time it served as a powerful stimulus to economic growth. During the 1870's, railroad construction accounted for 20 percent of the United States' gross capital formation.

This figure fell to 15 percent of the total in the 1880's and remained at 7.5 percent of the total in each of the decades to 1920.

Future market sources were to result from technological developments within the railroad industry. Two such inventions were the automatic coupler designed by Janney and patented in 1868, perfected in 1873, and the air brake patented by George Westinghouse in 1869. Basing his device on the principle of two interlocking hands with thumbs extending around to the sides, Janney whittled his first model of wood and presented it to the Pennsylvania Railroad for testing. The Pennsylvania found the idea good, but used it sparingly. Not until 1882, when the Master Car Builders' Association finally adopted it, did Janney's company begin to prosper. Yet, it took another ten years for the automatic coupler to finally replace the link and pin system.

George Westinghouse, an upstate New Yorker, was 22 years old when in 1869 he patented his air brake. The original air brake had a serious defect — it stopped the train's cars in order of front to rear. This caused a great deal of discomfort to the passengers, but improvements were made, and by 1873 the air brake was operating successfully.

Neither of the above inventions enjoyed a quick acceptance. Their application would require the full efforts of Lorenzo Coffin, an early consumer advocate pushing for legislation requiring the widespread adoption of both, to eventually bring them into widespread use. The railroads were slow to accept Coffin's reasonings in view of the fact that it would require a considerable capital outlay to switch from the link and pin to the automatic coupler and to install air brakes on all of the cars then in use. By 1888 there were over 1 million revenue cars traveling the nation's rails, and Coffin's efforts had not yet borne fruit.

Such was the infant steel castings industry and the world which received it. Initial acceptance was limited and required the efforts of dedicated men to meet even this. Though many felt the steel casting would never match the iron casting, a few men of dedication and vision continued to push the development of their industry.

CHAPTER 2—The 1870's

The Civil War had interrupted the western movement in the United States, but the end of the war revealed the four year interim had not cooled America's desire to go West. Spurred by the promise of free or cheap land, or untold wealth in the mining fields, Americans continued to undertake the arduous task of frontier settlement. In the thirty years after the Civil War more land was settled than in the whole of earlier American expansion before that time. As the Plains States filled up, the increasing agricultural population spilled into the semiarid lands reaching to Wyoming and Montana. Reflecting, aiding and abetting this phenomenon was the railroad construction of the period. From 1864 to 1900 the greatest percentage of railroad track, varying from one-third to nearly one-half of the country's total annual construction, was laid in the Great Plains States.

Yet, despite the population drain brought about by the Western movement, the cities were growing ever larger. The desire for wealth, or at least for escaping poverty, was bringing greater numbers to the cities than to the rural areas. Immigration accounted for the vast majority of this population increase, for between 1870 and 1880 alone, over 3 million immigrants landed on the U.S. shores. Having barely enough money for their passage, most of these arrivals remained in the ports which they entered providing a ready and ever-increasing urban citizenry.

While France and Prussia filled the European military stage, the United States found her military attention directed to an unrepentant South and the Indians of the West and Southwest. The military occupation of the South was finally lifted in 1877 when Federal troops left South Carolina and Louisiana. Indian troubles continued throughout the decade, although by now serious troubles were only sporadic. The last serious threat from the Sioux was in 1876 when the Dakota gold rush invaded the Black Hills and George Armstrong Custer became an American legend.

Politically the U.S. muddled through the corruption of the Grant administration and the financial conservatism of Rutherford B. Hayes. (Hayes' election resulted from a post-ballot compromise which remedied the fact that his opponent had secured more ballots than he.) Ironically, with the country languishing in a severe depression, Hayes directed his efforts to reforming the Federal bureaucracy, a bureaucracy which had made his Presidency possible.

The prosperity of the late 1860's lasted until 1873 when the failure of J. Cook's banking house, brought about by overextension of railroad securities, precipitated one of the nation's worst depressions. Lasting until 1879 the depression took the economic heart out of the decade.

A low level of steel castings production reflected the business of the decade. Writers of the period noted castings of plain sections weighing 100 pounds sold for as high as 20 to 25 cents per pound. Yet, though not for lack of trying, the output of steel castings remained very small.

The appearance of castings still worked against them, even those castings judged suitable for sale. Surfaces were imperfect with sand adhering in large quantities. Considerable trouble was caused by piping and cracking which necessitated rejection. Figures relating to the rejection rate no longer exist, but they were apparently high. The above prices were by no means artificial, for any number of attempts were necessary to produce a suitable casting.

From a production standpoint the industry's future seemed rather bleak. However, production statistics never have told the whole story. For, as bleak as the production picture looked, it was offset by tremendous strides made in the field of technology. Directed by attempts to solve problems and establish market inroads, technology became the focal point of the steel casting industry in the 1870's.

The area of melting received early attention with the introduction of the open hearth to steel casting in 1870. Although the crucible melting process would assure a high quality steel, it was also characterized by limited production capabilities and the fact that little refining was possible. In an effort to circumvent these problems the Siemens-Martin or open hearth furnace entered the casting picture. The open hearth was a European development in the true sense of the word. It was developed in England by two German engineers, William and Frederick Siemens. An improvement on the furnace was made by two other brothers, Pierre and Emile Martin of France. Their improvement involved the use of gas generators which provided the fuel necessary for the high degree of heat used in the refining process. The open hearth produced not only greater amounts of steel, but produced this steel from a wide spectrum of ores and scrap. From this it produced a steel which was close to the quality achieved in the crucible process, and when properly installed, the furnace could produce the steel at a cost only 15% higher than iron.

The open hearth had been used with great success in Europe. The pioneering work being carried on at Terre Noire in France was based on open hearth production. But one man's success does not insure that of everyone else. The Siemens-Martin process had been perfected and patented in Europe, the theory was sound, but the practice in the United States had yet to be proven.

In 1868 Cooper Hewitt & Company of Trenton, New Jersey, installed an open hearth and experimented with it two years. As a result of faulty installation, the furnace was abandoned in 1871. In 1870 the Bay State Iron Works of Boston, Massachusetts, installed and operated what proved to be the first successful open hearth in the United States. Closely following this success was the 1871 installation of an open hearth at the William Butcher Steel Works. This three and one-half ton furnace was installed with the express intention of producing steel castings. But, after 92 heats — all of which were unsatisfactory — the furnace was shut down.

This poor, early showing of the open hearth did not restrict continual experimentation. In 1874 the first plant set up solely for the production of open hearth steel was constructed by the Otis Iron & Steel Company in Cleveland. This plant contained two 7-ton open hearths. In 1875 William Hainsworth of Pittsburgh Steel Casting Company constructed an open hearth which proved practical. And in 1876, undaunted by their earlier failure, the Butcher Works (which had become the Midvale Steel Works) set up another open hearth which indeed proved practical. Steel from this open hearth was used in the April 1876 production of two hammer dies. The next month the company cast a hammerhead weighing 2,535 pounds. The speculations of the 1860's concerning market applications of steel castings were being brought to fruition.

The early molding mixtures of ground brick, ground pots, and fire clay were satisfactory for smaller castings. But when the mixture was applied to the larger castings made possible by the open hearth, the facings were found to be inadequate. The castings' surfaces were very imperfect, and sand adhered to them in large amounts. Little improvement was made, although a great deal of experimentation did take place. Exotic mixtures, such as the one patented by William Hainsworth in 1877, were composed of finely ground Connelsville coke, small amounts of loam, flour, and Welsh mountain clay. The mixture was moistened with molasses, glue and clay water and mulled from 10 to 15 minutes.

The Midvale Company decided to leave the finely ground black lead crucible pots out of their molding mixture in the 1870's, but retained the ground firebrick and fireclay. These molds were then washed with finely ground clay firebrick. This resulted in a marked improvement in the casting's general appearance, especially the heavy castings. Although an improvement, the new molding mixture continued to cling strongly to the castings and only simple shapes could be made with complete certainty. Molds made from this mixture became almost as hard as firebrick when dried and as such offered a tremendous amount of resistance to the natural shrinking which occurs as steel solidifies. This posed so great a problem that only simple shapes could be cast; anything else would result in hot tears. It seemed that the successful manufacture of complicated shapes was virtually impossible.

The use of silica sand bonded with flour produced a good small casting which was easily cleaned. But this mixture was not without its problems. The melting temperature of silica sand was 3200 degrees, and great care had to be taken when pouring a 2800 degree steel into the mold. Beyond this was the problem of drying the mold. In the drying process there was a tendency for the flour to burn away leaving the sand without a proper bond. When producing a mold for a large casting, it was almost impossible to dry the mold thoroughly without burning the flour on the mold's facing. As a result, the flour bonding concept was abandoned.

Although experimentation continued, a suitable molding mixture was found by the Midvale Steel Company. In the late '70's Midvale used a molding mixture composed of silica sand and molasses with the two being thoroughly ground together.

Part and parcel of the '70's molding advances was the use of the early machines for treating and mixing the sand. These machines aimed at grinding and compounding rather than mixing and mulling primarily because of the use of loam seen in the mixture advocated by Hainsworth. Early in the '70's machines appeared which were essentially paddle mixers, but these gave way to centrifugal machines in which iron balls were spun and ground a mixture of sand and clay rigged in coke.

Mechanization did not end with machines for mixing. W. H. Worrilow described the turning point in the development of labor saving machinery as being the invention and improvement of the first molding machine. This occurred in 1879 when a New Haven mechanic, Frank Reinholds, put a hand presser on the market. But this was soon overshadowed by the 1880 invention of the stripping machine.

Other mechanical solutions offered to the industry aimed at the problems of the cleaning room — long a nemesis of the foundry. Philadelphian, Benjamin Tilman, in 1870 marketed a sand-blasting machine. Used on large castings this machine pumped sand through a rubber hose — the sand being played upon the casting.

Smaller castings were dealt with by the tumbling machine developed by the W. W. Sly Company of Cleveland. Castings to be cleaned were placed in the mill with other star shaped castings. The revolving machine knocked the castings against each other removing sand and scale. A later development married the two methods when a machine was brought forth which tumbled castings in a barrel and exposed them to a blast of sand at the same time.

The growth experienced by the industry in the 1870's was primarily of an internal nature. There was the promise of great potential; the internal developments revolving around technology were in progress, but the consumers were wary and the markets thus limited.

The wariness with which consumers approached the industry finds illustration in the conditions of the following sale. The underground cable system of the Chicago Street Railways required gears of cast steel, and an order for such gears was placed with the Sargent Company of Chicago. However, the railway demanded Sargent post a $100,000 bond guaranteeing the gear's performance! The company agreed to the customer's demands, produced the casting, and waited. Eventually, the gears proved better than the ones cast of iron previously in use. The bond was returned, the founders at Sargent breathed a sigh of relief, and the steel casting industry moved one step further toward acceptance.

The promise of great potential stemmed not only from U.S. technological advances and characteristic American confidence, but also from the successful application of steel castings being made in Europe. In 1870 the Terre Noire Company in France produced industrial and ordnance castings. Inroads in industrial markets included the production of cast steel car wheels, crossing frogs, roll pinions, and the like. By 1879 the company was producing 200 tons of steel castings per month. Half of this production was for army ordnance. The company produced a 9-½ inch projectile which had the capability of penetrating at a 30 degree angle armor plates 8 inches thick. The elastic limit of the steel was about 32 to 36 thousand pounds per square inch and an elongation of 2.5 to 15 percent.

An equally impressive product line was being advanced by the Hadfield Steel Foundry Company of England. In 1878 at the Paris Exposition the company exhibited a line of industrial castings which included double spur wheels, railway crossings, wheels, pulleys, hydraulic cylinders, and others.

In comparison American markets were relatively few. Steel produced for the railroads was going mainly into the rails themselves. Crossing frogs continued as the only strict casting application. The potential had not really been realized by the railroad industry. They continued to rely on standard hand brakes and the link and pin coupling process. As a result, 1881 witnessed over 30,000 tragedies including the maiming or loss of life due to accidents involving these methods.

Mechanization provided the foundry not only with molding and cleaning machines, but also a developing market. Even though French experiments with cast steel shells had proven a steel casting superior in both strength and regularity to a forged steel projectile, in America, forged metals still held sway. However, their ability to do so was dependent upon castings. The hammers necessary for the forgings were castings.

As great as the railroads and industrial markets were to become, to this point they were rather limited. Surpassing both these fields in production were steel castings made for agricultural machinery. America was still an agrarian nation and a large one at that. To make full use of the land required increasing mechanization and agricultural implements. In 1870 farm implements and machinery had a value of $271 million, but by 1900 this figure stood at $750 million. Steel castings were used in the continued improvements of earlier machines, and new machines being developed invited further steel casting applications.

The production of finger guards for McCormick's mowing machines became the first large scale market for steel castings. One of the first to recognize and develop this market was a man many considered the father of the American steel casting industry. This man was William Hainsworth. In 1961 in an address to the Newcomen Society in Philadelphia William H. Moriarty of the Steel Founders' Society summed up the early history of the industry: "If we consider Buffalo our birthplace and the Delaware Valley the cradle of our industry, then surely Mr. Hainsworth, — must be considered the father of the steel casting industry."

William Hainsworth was born in 1832 in England and came to America by way of Canada. At 13 he was apprenticed as a molder, and in 1865 he was working in Canada as a blast furnace laborer for $1.00 a day. Entering the United States, Hainsworth settled in the Pittsburgh area. Here he became associated with the Knapp & Totten Foundry in Pittsburgh, but opened his own brass foundry in the late 1860's. Selling the brass foundry, Hainsworth began experimenting with a-small two-pot cupola furnace in producing steel castings as the cutting parts for agricultural implements. He continued his experimentation until his capital had nearly run out, but the success of the experiments encouraged him to incorporate the Pittsburgh Steel Casting Company in 1871 — the first company in the United States to produce steel castings exclusively. At this foundry Hainsworth produced not only cutting edges for the machinery, but also finger guards for the McCormick harvester. As castings came into increasing demand and increasing application, Hainsworth expanded both his operations and markets.

William Hainsworth — "Father of the Steel Castings Industry".
Courtesy: American Foundrymen's Society

Hainsworth's Pittsburgh plant was constructed on the corner of 26th and Railroad Streets. The size of the plant and the size of the plant's output is a matter of speculation. Reports have it that the demand frequently called for castings weighing from 7,000 to 8,000 pounds and requiring the entire furnace capacity of 70 to 80 crucibles. Other reports limit the production to castings weighing close to a ton, requiring 25 crucibles at one time.

However, the demand was great enough for Hainsworth to increase his capacity. To do so he went to Europe in search of a small open hearth furnace. After returning to the States with his furnace builder. Hainsworth began construction, and after a few failures, he succeeded in 1875 in producing successful open hearth castings. Hainsworth did not content himself with crucible and open hearth production, but in 1881 erected the first Bessemer convertor used to produce steel castings. All three methods of production continued to be employed by Hainsworth.

Hainsworth's impact on the industry stemmed from a continually high output and a surprising number of firsts along the way. He is credited with no less than 40 (and no more than 140) patents. These had been applied for prior to 1880 and among them were included molding sands and molding machines. He was the first to operate a plant exclusively as a steel foundry, and was the first to employ a Bessemer convertor in the manufacture of steel castings.

Hainsworth eventually sold out and left the Pittsburgh area in 1889. At this point he moved to Seattle, but in the time spent in Pittsburgh (a little over 20 years) Hainsworth developed into a personality which completely fulfilled the requirements of "leader in his field," — he was the field. Reports indicate that Hainsworth's foundry between the years 1871 and 1883 produced 98 percent of the steel castings in the United States. As such, during this period he was the only serious competition to the European steel works both in Sheffield and Bochum, Germany.

CHAPTER 3—The 1880's

America in the 1880's witnessed the continued concentration of her citizens on settling and developing the spaces between the Atlantic and Pacific. In keeping with this, the country was disinterested in foreign entanglements. Military operations were carried on only in the West and Southwest. This was due in part to a feeling of isolationism, but also resulted from the fact that regardless of her continuing industrial progress, the United States ranked low as a military power. The United States Navy in 1880 was thirteenth among the nations of the world.

The decade's political experience included four Presidents. James Garfield, an Ohio Republican, was assassinated within six months of his inauguration. The assassination by a disappointed office seeker (a member of a minor faction of Garfield's own party), pointed out the necessity for civil service reform. This necessity was not lost on Chester Arthur, Garfield's running mate, who proved to be a surprisingly able President. Initially chosen to placate the rival faction in the Republican party, Arthur was described as a perfect "representative of machine politics." Turning against his former cronies, Arthur backed the Pendleton Act, the first effective civil service reform. In taking the reins of office, Arthur brought about a wholesale change in Cabinet positions, retaining only the Secretary of War, Robert Todd Lincoln.

The Secretary of the Navy became William E. Chandler who replaced the outgoing William H. Hunt. Both Hunt and Chandler realized the state of the Navy and in keeping with the reform spirit brought about a change which was to turn America into one of the world's highest ranking military powers.

Grover Cleveland succeeded Arthur and was the first Democratic President since Andrew Johnson left office in 1869. Cleveland dealt fairly effectively with the most obvious and immediate problems facing the government, and one of his greater concerns was the reduction of tariffs which had served to protect American industry at the expense of agriculture. In this, he was ineffective. Benjamin Harrison succeeded Cleveland, and although he lost the popular election by 91,000 votes, he gained seven more electoral votes to replace Cleveland. Harrison picked up the Republican tradition of high tariffs and thwarted Cleveland's earlier attempts. The tariff at this time was at such high levels that it actually produced a treasury surplus—a surplus in the days before the income tax. Democrats felt that this surplus should be alleviated through tariff reductions. Republicans, on the other hand, felt that this surplus should be put back into the economy through programs ranging from subsidizing harbor construction to increased veterans' pensions.

Descriptions of the '80's economy range from uneven to depressed. Farm prices were certainly depressed throughout the decade as was the agricultural economy in general. The industrial sector, on the other hand, saw both booms and recessions. Business had recovered in the late '70's, and the recovery continued into the '80's. However, depression, once again of financial origin, entered the scene in 1883, and the ensuing downturn lasted until 1885. A quick, sustained business recovery in '85 carried the economy and the nation through the remainder of the decade. But, the recovery did not last much beyond the decade, for there occurred a minor panic in 1890 as the inevitable ups and downs of an unregulated economy continued to take place.

The nation's industrial growth in the '80's paralleled the rise in the production of steel. The technology and capacity developed in the '70's was tapped in the 1880's. The production of steel was increasing and with it the production of steel castings. In 1880 less than 2 million tons of steel were produced, but by 1890 production rose to 4½ million tons.

The steel casting industry was not yet given widespread statistical recognition, and the percentage of the above total which belonged to steel castings is not known. However, in 1883 the American Iron and Steel Association published production statistics which included 1,684 net tons of steel castings made from open hearth furnaces. As an addendum, the report concluded that "the production of steel castings is rapidly increasing in this country."

With this growth in steel castings production the number of steel casting establishments naturally increased. The 1885 Edition of the *Transactions of the Institute of Mining Engineers* listed ten steel companies then producing steel castings and the price each company asked per pound: Solid Steel Casting Company, Alliance, Ohio—10 cents; R. G. Johnson & Company, Spuyten Duyvel, New York—12 cents; R. G. Flag & Company, Philadelphia—12 cents; The Chester Steel Casting Company, Chester, Pennsylvania—11 cents; Solid Steel Casting Company, New York—no price listed; Pittsburgh Steel Casting Company, Pittsburgh, Pennsylvania—10 cents; Mackintosh Hemphill & Company, Pittsburgh—10 cents; Collins Steel Casting Company, Cleveland—no price listed; Standard Steel Casting Company, Chester, Pennsylvania—10 cents; The Eureka Cast Steel Company, Chester, Pennsylvania—10 cents.

Not only had the industry grown, but there was considerable room for future growth. In a paper read before the Institute of Mining Engineers in 1885, Pedro G. Salom stated that of the six steel casting establishments of which he knew in the United States, their output was certainly not as much as 20,000 tons per year and probably not more than 10,000 tons. He was convinced the output ought to be over 200,000 tons to supply the needs of the country.

As steel gained acceptance so did the steel casting. Steel was a miracle metal, mystical with magical powers. Popular descriptions of the steel making process always called forth classical allusions to Dante's *Inferno,* Vulcan, and the Forge of Haephestus, all of which led to common misconceptions serving both as a blessing and a curse. With only scanty knowledge, many believed that defects were inherent and that steel was just not as dependable as iron. On the other hand, this same superficiality prompted others to regard steel as a cure-all. An ignorance of limitations stimulated dreams of steel's endless and successful applications.

The rudimentary state of steel casting technology was the genesis of this mystery and misconception. The advances initiated in the 1870's were refined and served to meet the market demands of the 1880's. Often the application of a steel casting would end in disheartening failure. But such a failure, far from signalling defeat, only intensified research.

Vigor, dynamism, and broadened confidence became watchwords of the industry as the Age of Steel came into its own.

As the industry and its acceptance grew, so did the controversy which it engendered. Naturally one source of controversy came from the iron men. Remarks such as "Men who have spent a lifetime treating iron will laugh as a steel plate breaks or a casting fails" were not uncommon in a period when steel castings were described as rough chunks composed of about equal parts of steel and holes.

Customers of the day issued varied requirements. For instance, the specifications given by the Pennsylvania Railroad in 1888 for steel castings required a tensile strength of 70,000 pounds and listed an elongation of 15 percent in 2 inches. The following advice was given to the "practical consumer" of steel. The buyer was instructed to decend from the heights of arts and science and take refuge in knowing that he should buy the steel which his workmen told him was full of "nature and body."

The search for better melting techniques introduced the Bessemer convertor to the steel casting industry in 1884. The convertor method had been known in the steel industry since its simultaneous, yet independent, development in both England and the United States in the late 1850's. As early as 1861, the Kelly convertor was being profitably employed in the manufacture of steel at the Cambria Iron Works, in Johnstown, Pennsylvania.

The most distinctive feature of the convertor was the forcing of a blast of air through molten iron during the final stage of the melting process. This brought about a rapid combustion and removal of carton, silicon, and other impurities as the iron became steel.

The converter process had certain advantages over the open hearth, which had a profitable capacity ranging from 5 to 20 tons. To pour 5 tons of steel into castings averaging 100 pounds each would take too long and result in the last castings being poured with metal of insufficient temperature. Generally, large castings were poured first and the smaller later. This resulted in the smaller ones receiving the cooler, least desirable metal. This difficulty was alleviated by the Bessemer convertor which, because of its smaller size, could produce 2 to 3 tons of metal to be delivered as hot as desired. Also the composition of the metal could be more readily determined by using the Bessemer convertor, since it could be changed every half hour throughout the day. While open hearth steel was limited to two to three heats per day, the Bessemer convertor could produce any number of heats, thereby increasing the variety of steels produced on a given day.

Steel from the Bessemer convertor also had considerable advantages over that melted in crucibles. Beyond the fact that crucible melting lacked the refining capability of the convertor was the crucible castings reliance upon this high degree of carbon to insure fluidity. To make the casting soft enough for machining then required annealing. Even then the casting often remained too hard and, therefore, useless.

The foundryman continued to be concerned with the effect of improper molding, which was not only obvious, but dramatic. A casting's internal defects could pass unnoticed, but the surface conditions hardly would. In early, large castings, mold material would burn onto the metal, or the metal would penetrate the molds in a spongy mass. The inherent shrinkage of solidifying steel also contributed to molding problems, and it would take many years to overcome this difficulty. In an 1883 article in *Iron Age*, P. G. Salom, President of Standard Casting Company, noted, "It is almost impossible to make certain thin, complicated castings of steel on account of the shrinkage problem." At this time all molds were baked in ovens with the result that many times the mold had all the giving properties of a firebrick. This did not permit or allow for the shrinkage, consequently, Salom's lament.

Thus, mold composition continued to be a primary concern. George Callahan of Cleveland is credited with first making a mold composed of nearly pure silica, glue, water, and molasses. The success of molds of this type was indicated by Midvale's acknowledgment that the improvement in the appearance of castings resulting from the use of such molds was the cause of castings' rapid adoption. The clean, smooth surfaces were apparent at Midvale when they produced their first gun carriages in 1887.

Mechanization continued its influence on the steel casting industry with the invention of the jolt machine for molding in 1887. The first pneumatic tool was invented by James A. McCoy in 1889, and for this achievement, McCoy was awarded the John Stoch Medal by the Franklin Institute.

Though improvements such as the sand blast, tumbling machine, and the pneumatic tool were available, foundries continued to rely upon old and primative methods in the cleaning room. W. H. Worrilow stated that one of his earliest recollections was of watching a group of laborers in a foundry in Chester. These men were notching the bases of the gates and feeding heads on hot castings. While one man held a chisel, the other wielded a mallet with a handle fashioned from a tree limb. When the casting had cooled, two other workers broke off the risers and gates by flogging. This was followed by an operation which may have been called machining but was carrried on with simple tools such as planers, shapers, sliders, and once again the sledge and chisel.

Fueled in part by these technological developments, the decade of the '80's witnessed a wider use of steel castings in comparison with the preceding decade. The climate was one of limited acceptance coupled with the willingness to experiment for the benefits of the superior characteristics of steel casting. Defects such as the inherent problems of honeycombing and hot tears had not disappeared, but they were not as common as before. Moreover, some applications were enjoying spectacular success. A cast steel worm in a steam crane had been used in placed of one cast of iron. The iron worm had ground itself away in two to three days; the cast steel replacement lasted eight to nine months. A pinion gear in a British rail mill when cast of iron usually gave way in from one to three weeks, failing through the breakage of the teeth. When replaced with a cast steel pinion, the part's life extended to two years. This was only because the teeth were so worn that they did not mesh properly.

Certainly not every application produced such a dramatic result. But those that did served to offset the outraged cries of those who had found steel to be neither homogeneous nor reliable. To the cries of "We can cast in steel anything that can be cast in iron," steel castings were being applied in an ever growing variety of circumstances. And, nowhere is this more evident than in a study of the markets of the 1880's.

Railroads continued to be a prime source of orders for steel castings. Yet the full potential of the railroads as a market was far from being fully developed. Although 1884 saw the use of cast steel car wheels, as late as 1885 very few steel castings were employed in car and locomotive construction. In discussions carried on that year at a meeting of the Railway Master Mechanics' Association, a number of members said they were using steel castings for crossings only. However, some of the roads were using driving boxes, link hangers, eccentrics, and rocker arms made of cast steel.

In industry larger and more efficient machines spurred castings' development. The steam shovel first appeared in 1883. In 1884 the steam turbine provided another market for steel castings. The initial successes of castings applications of these products have continued. Today, the sophisticated successors of these prototypes still rely heavily upon steel castings.

Other industrial applications revolved around a further integration within the steel industry. In 1888 Mackintosh-Hemphill in Pittsburgh cast the first steel rolls in this country at its Fort Pitt Foundry.

Records in casting size were shoved upward when the industry was tapped by the builders of the Brooklyn Bridge. Completed in 1883 the bridge was anchored with heavy chains fastened to cast steel anchor plates. Each of these plates weighed 24, 240 pounds.

Today's founders are quick to cite government, and especially military, specifications as being the most exacting. This is by no means a recent or even 20th century phenomenon. As early as 1888 this tradition was operating in force.

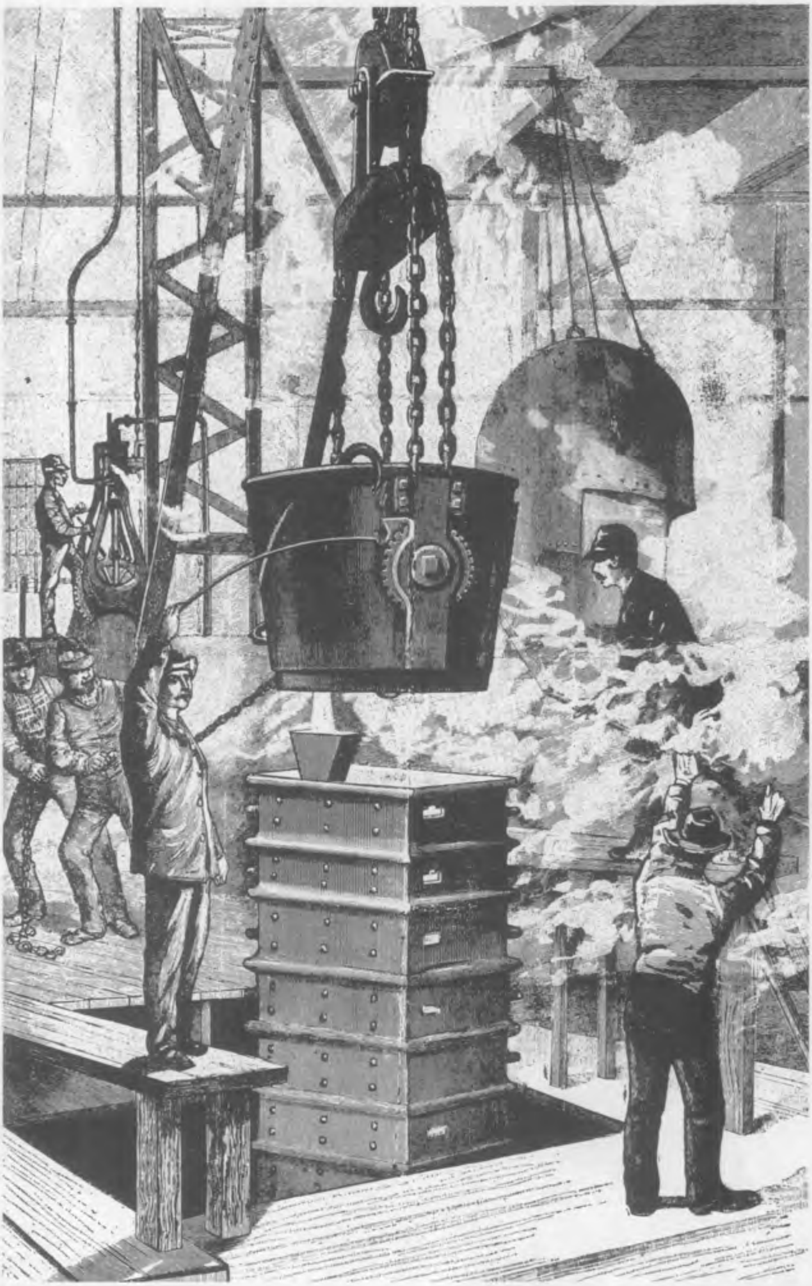
Although stories are told of ordnance castings being produced during the Civil War, the first documented use occurs in 1887. At this time gun carriages were the focus of the industry's attention, though greater things were in the offing. Ordnance had been a mainstay of the French industry. The Terre Noire Works was the leading French producer; their castings evoked considerable awe at the European expositions. (Britain, France and the newly created state of Germany all participated and attached great nationalistic importance to their shows.)

Regardless of U.S. founders' hopeful prospects of entering the enticing concerning the possibilities of ordnance field, the initial move of the next step had to be taken by the government. The remarkable thing is 1) that the step was taken when it was, and 2) the magnitude of that step. 1887 had seen the first government acceptance of steel castings for use in ordnance—the gun carriages produced by Midvale. But in the same year, Congress passed an act calling for the manufacturing of three cast steel 6-inch breech loading rifles to be made by the crucible, open hearth or Bessemer process. Weighing approximately 11,000 pounds, these guns were to have an ultimate strength of 80,000 pounds per square inch; an elastic limit of 40,000 pounds per square inch; an elongation of 7 percent in 2 inches; and a reduction of area of 7 percent. The overriding motive here was cost. Such a gun could be made for about $3300, while a gun of the same size, manufactured by traditional means, would cost at least $22,000.

Two foundries accepted the challenge. The first rifle was produced by the American Steel Casting Company of Thurlow, Pennsylvania, and was not submitted to any mechanical treatment after its casting. The cannon withstood the statutory test of ten rounds being fired, but post-firing measurements showed a slight increase in the diameter of the barrel. This was enough to insure its rejection by government officials.

The second rifle was produced by William Hainsworth's foundry in Pittsburgh. The Pittsburgh Steel Casting Company successfully molded and on Wednesday, January 21, 1888, cast what was called "the greatest gun yet attempted in the history of Bessemer steel." The gun weighed 5½ tons with a total length of 193.53 inches, almost 17 feet. Its largest diameter was at the breech, and on the outside measured 23 inches. The smallest diameter, at the muzzle, was 10 inches. The thickness of the wall between the bore and the outside was 7½ inches. The pressure in the chamber would be 15 tons per inch and the muzzle velocity 22,000 feet per second.

About 60 workmen were employed in the various operations connected with the gun's production. The metal was brought from the blast furnace and poured into the great convertor in the center of the Pittsburgh Works. The operation of the convertor evoked colorful commentary in the press. "When the air was forced into the convertor



"Casting the Great Steel Gun" at William Hainsworth's Pittsburgh Steel Casting Company.
Courtesy: SFSA

the flames leaped from its mouth in a solid column, and accompanying this were myriads of sparks bursting forth which fell on every side like meteorite stars." The convertor was in operation for 20 minutes after which the steel was transferred to a ladle and poured into an upright mold. The pouring took about 2 minutes and subsequent cooling about 1 week. The gun was cast without cores, and as a result, when the metal cooled the bore had to be machined. Following this, the rifle was sent to the government trials, where it unfortunately failed on the second round.

The failure and subsequent rejection by government officials provoked Hainsworth to proclaim his leaving the field and to state that he would absolutely undertake no more governmental work. The tests, he declared, were conducted unfairly. The art of casting such a weapon would not be perfected by the industry until the first World War, and even then production would be limited.

Shipbuilding was yet another market for the expanding steel casting industry and a prime illustration of the truism that the acceptance of steel as a construction material brought with it the steel casting.

The three decades from 1850 to 1880 had been the heyday of the iron ship, but as early as 1858 British shipbuilders had been experimenting with steel. It was stronger than iron, and the amount needed weighed less. By 1881 over 80 percent of all British steamships under construction were being made of steel.

The position of the United States however was not quite as enviable. After the Civil War, the U.S. Navy, consisting of obsolescent wooden ships, had fallen into decline, and by 1880, the U.S. stood thirteenth among the world's naval powers. The Civil War battleship was a steam frigate with sails and wooden masts and little or no armor plating. However, by 1898 the battleship was to evolve into a great steel clad vessel with sides of armor plate and collections of turrets mounted on revolving turntables, thickly armored and placed on steel bases. Two years later, in 1900, the United States ranked third among the world's leading naval powers. The remarkable transformation begun in 1881 revolved around the naval construction and policies formulated in his decade.

In 1881 a Naval Advisory Board under Secretary of the Navy William Hunt recommended the construction of three steel cruisers. On March 3, 1883. Congress, taking the necessary steps toward this construction, authorized the building of three steel cruisers and one steel dispatch boat. Sealed bids were submitted to the Navy Department with the contract being awarded to the John Roach Shipbuilding

Company of Chester, Pennsylvania. The contracts were signed on July 23, 1883. The four ships constructed were known as the "A, B, C, D ships." They were the *Atlanta,* built at a cost of $617,000; the *Boston*. costing $619,000; the *Chicago,* costing $889,000; and finally the *Dolphin*, with a total cost of $315,000. The materials entering into the construction of the vessels included steel castings, which came primarily from Roach's own foundry existing as a part of the shipyard works, though a number of castings were ordered from the Chester Steel Casting Company.

The *Dolphin's* failure to consistently perform to its designer's expectations aroused a tremendous amount of initial controversy, much of which focused upon builder John Roach. Yet the *Dolphin's* overall performance during its subsequent 36 years of service would draw nothing but praise. A 58,000 mile cruise around the world in 1888 and 1889 required the ship's machinery to run over 9,000 hours. During this time only one minor repair was necessary, and it was accomplished in two hours. More spectacular was the performance of the hull, which withstood the heaviest of seas without a fault. The ship went on to carry dispatches between Key West and Santiago during the Spanish American War. Later it served as the personal ship of Presidents Theodore Roosevelt and Woodrow Wilson.

William C. Whitney, Secretary of the Navy during the first Cleveland administration, continued the reorganization of the Navy Department and the construction of improved naval vessels. With his insistence upon steel of American manufacture, Whitney further strengthened the steel and steel casting industry. Twenty-two steel vessels had been built or authorized by the time Whitney left office in 1889. The policies advocated by him were continued by succeeding administrations and by 1900 the United States had assumed its leading position among the world's navies.

The birthplace of the modern U.S. Naval vessel was the John Roach & Sons Shipyards in Chester. This "city within itself" comprised the largest and most fully integrated shipyard of its day and was the result of an enterprising iron molder not content with the "wife, trade, and community status" an iron molder held in the 1830's.

Roach's rise to the level of molder was in itself an accomplishment. Born in Michaelstown, County Cork, Ireland, on Christmas Day 1815, a prediction of his future would hardly dared to have suggested the importance of the role he was to play. Roach received a sparse education consisting of a smattering of the three R's. His father's death in 1831 left the family impoverished and Roach without a skilled trade or future. His arrival in America was occasioned by a cousin's refusal to leave Ireland. Roach gladly accepted the passage money which relatives in America had sent, and in 1832, he arrived in New York.

America at this time was undergoing one of her more intolerant periods, and the New York in which John Roach found himself can be typified by the following help wanted advertisement from the *New York Evening Post:* "Wanted—a cook or chamber maid, they must be American, Scotch, Swiss or Africans—No Irish!"

Roach eventually secured employment at the Allaire Iron Works in New Jersey. At this 19th century industrial community Roach worked first as a 25-cent a day hod carrier.

In time he began an apprecticeship as a molder. His recollection of the initiation provides an interesting insight into iron molding in the 1830's. "I remember very well how they laid me face down over a barrel and rolled me back and forth while a big Englishman spanked me with a board until I agreed to give them whiskey enough to pay my footing (initiation)."

This custom of footing required each man to pay for the gang's daily ration of whiskey. Whiskey was consumed prior to and after the pouring of each heat. First to steel the men for the ordeal and finally to "drown this breathing of vapors."

The panic of 1837 temporarily halted Roach's career as a molder. Responding to a desire to return to the soil, Roach spent a year discovering the hardships of Midwestern agrarian life. Returning to New York, he resumed employment for Allaire—this time at the New York foundry, which specialized in marine engine castings.

Roach and three fellow molders had accumulated by 1852 enough capital to go into business for themselves. At a receivership sale they purchased the old Etna Iron Works for $4700. Distressed at his partners' lack of desire to see the business grow, Roach eventually bought them out and assumed sole proprietorship.

Living in an era which would later be analyzed and characterized in terms of "survival of the fittest," John Roach was to stand out as one of the most fit. Examples of his business methods illustrate both the type of man he was and the intensity of the business community in which he functioned. In 1858 a boiler exploded in a three-story building at Roach's foundry. The explosion leveled the building, killed one man, injured two others, and left the foundry without steam power. But within 48 hours, Roach was back in production, having settled the insurance claim and laid 100 feet of pipe to a nearby factory where he obtained steam.

The problem of capital shortage was solved for Roach when he was appointed the administrator of a trust fund set up for the five children of a deceased friend. The provisions stated only that the funds were to be invested in a profit making venture. The $70,000 estate was invested in Roach's own profit making venture.

When he decided to enter the marine engine casting field, Roach faced as competition the seven leading producers in the U.S.—all located in New York City. Realizing his only chance for success lay in employing the latest in technology and method, Roach set out to obtain them. His superintendent was sent to France to garner all he might in terms of metallurgy, equipment, and method. Roach, on the other hand, hired himself out as a mechanic in the foundry of a chief competitor. Here he studied their organization, methods, mixtures, and markets. So with a sound, complete picture of the industry based on this first-hand knowledge of the competition's strengths and weaknesses, Roach returned to his foundry and began to build his empire.

The same energy and drive which established Roach as a leading producer of marine engine castings was to carry him into shipbuilding. And, not only into, but on top of that industry. By 1884 his would be the leading shipbuilding company in the United States.

The modernization and expansion of his Chester, Pennsylvania, shipyard pushed Roach along the path of vertical monoply. The need for iron plate occasioned his purchase of the Chester Rolling Mill and then the Chester Furnace Company for pig iron supply.

The Combination Steel and Iron Company was formed by Roach and Associates to meet the demands of the booming steel market, and by Spring 1881, it was producing 150 tons per week. To insure a supply of steel stock for this mill, the Standard Steel Casting Company was created and began production in 1884. Employing a ten-ton Siemens-Marin furnace and an eighteen pot Siemens crucible furnace, Standard's annual production capacity reached 3,000 tons of castings and 18,000 tons of ingots.

This vertical integration brought about by Roach was responsible for the low bids which won him the contracts for the Whitney Squadron—the first steel ships of the U.S. Navy. His sharp business acumen provided John Roach with a monopoly ten years prior to the one built by J. D. Rockefeller.

CHAPTER 4—The 1890's

THE UNITED STATES EMERGED as a world power during the 1890's. Yet, domestically, there was little cause for the gaiety which has been memorialized as "The Gay Nineties." Militarily, politically, socially, and economically, the United States faced crises which, viewed as a whole, brand the 1890's as one of the most crisis-prone decade in our history.

On the political scene the years saw three Presidents. Benjamin Harrison took office in 1889 and concerned himself with admitting the Dakotas, Montana, and Washington as states, increasing Civil War veteran's pensions, and raising tariffs to provide money for these increases. Grover Cleveland won a second term in the 1892 election as the country was poised on the brink of economic disaster—and the fall was not long in coming. 1893 set off a financial panic and the onset of one of the country's worst depressions, resulting in the development of the Populist party—most serious third-party threat in the political history of the United States.

McKinley's inauguration in 1897 marked the turning point in the decade. The economy had begun to turn upward, and the once formidable power of the Populists passed its peak.

Born of the adverse agricultural conditions prevailing since the Civil War, the Populist Party had come to demand reforms benefiting farmers and industrial workers alike. The depression years of the early '90's brought this discontent to a fevered pitch. Farm prices, the money supply, shorter working hours, political and tax reforms were only a partial list of the planks of the party's platform. Later led by loquacious William Jennings Bryan, the Populists had gained over a million votes for the Presidency in 1896. Not only that, but the party succeeded in electing a number of senators, representatives, and governors.

One source of discontent was the depressed state of the economy. The farmer had been fighting depression since the early '70's. In the industrial sector, the economic picture was quite a bit better; but by no means good. Sharp fluctuations had resulted in unstable growth. The late 1880's recovery reverted into a short recession in 1890-91. In turn, this recession was followed by an upswing, particularly in heavy industry. However, early 1893 brought the failure of the Philadelphia & Reading Railroad and the National Portage Company—a sign the boom was over. In less than one year, 491 banks and more than 16,000 commercial institutions failed. Almost one-third of the nation's total railroad mileage was being held by receivers when the economy began its next upswing in 1897.

The Spanish American War closely followed the economic upturn and spurred the entrance of the military's role in the 1890's. The war, the country's first full scale military action in over 30 years, lasted a little over three months and cost about $250 million. Although 5,462 men died during the mobilization, fighting, and demobilization, only 379 of these were battle casualties. In its fourth military test, the United States had shown the world its military industrial might and assumed a leadership role in global affairs.

1893 witnessed the closing of the frontier in the continental United States—The Spanish American War had redirected this frontier spirit as the United States acquired Cuba, Puerto Rico, the Phillippines, and Hawaii by the end of the decade.

The United States had survived a number of serious threats during the 1890's. Not only had it survived, it had grown. A social consciousness in both foreign and domestic affairs had appeared in the nation. By the decade's end, Americans and the world were taking the country seriously with the realization that a new economic, industrial, and military power had entered the world arena.

The steel casting industry had benefited from the overall industrial development of the United States, and the 1890's would see first technological gains. But another aspect, that of governmental regulation, was beginning to play an increasingly important role in this evolving progress. In the future governmental regulation of business would take myriad forms and produce an even greater number of results. But in the 1890's industrial leaders would find these regulations in only four distinct areas. First, the overt limitation of the size and scope of a particular business derived from the 1890 Sherman Anti-Trust Act. The second area fostered the traditional tariff on imported steel, while the third dealt with the more subtle concept found in governmental purchase orders specifying material of American manufacture. Finally, future legislation would require compliance with certain safety standards.

The passage of the Sherman Anti-Trust Act had a great impact on the nation's business community. It provided that any contract in restraint of trade was illegal, that any attempt to create a monopoly was a federal misdemeanor. The Act enabled the government to take the great initial steps toward the federal regulation of business.

Adding strength to the Sherman Act in the 1890's was the traditional force of government regulation — the tariff. By nature tariffs had always served a dual function, the one constitutional, the other not and a cause of the Civil War. On one hand they were established as a primary source of revenue for the expense of operating the government. Of equal or greater importance, the tariffs served to protect the country's growing industries. The McKinley tariff of 1890 raised the average level of protection to 50 percent. The Dingley Act of 1897 revised this average to almost 60 percent. At this point more goods were subject to duties upon entering the United States than entered free.

Government purchases subject to regulation benefited the steel casting industry. The construction of naval vessels for the government involved the use of steel of exclusively American manufacture.

The twenty year crusade of Frederick Coffin finally bore fruit as President Benjamin Harrison signed the Railroad Safety Appliance Act into law on March 2, 1893. This statute required the installation of both the airbrake and the automatic coupler on all passenger and freight trains by January 1, 1898.

The act had far-reaching effects. The most immediate involved a reduction in the number of railway injuries and fatalities. The railroads found employee accidents fell 60 percent, and passenger accidents to almost nothing. Furthermore, the use of both features permitted the construction of longer rolling stock, resulting in an obvious increase in railroad revenue.

The benefits which would accrue to the steel casting industry were brought about by this increased car length. To this time, Janney's coupler, when it had been employed, had been almost exclusively cast of iron. But iron would not stand the increased weight and shock occasioned by an increased series of longer cars. Hence production of steel couplers was a bonanza to the steel casting industry.

In retrospect there is no doubt that these early attempts at governmental regulation served to stimulate steel castings' growth. The Sherman Act, although loosely enforced, protected the small producer from the tyranny of the large trusts. Protection also came as a by-product of the tariff and the purchasing policies of the government.

However, forces of an internal nature continued to hinder the industry's development, and overcoming these loomed as a challenge in the century's last decade. The industry's slow acceptance of innovations and its religiously maintained secrecy obstructed the industry's growth. Pneumatic tools were finally coming to general use by the end of the decade — ten years after their development. Molding machines, tumbling machines, and sand blasts were likewise being accepted and soon being regarded as necessities.

The problem of secrecy was slowly being eroded, through little progress had been made by 1890. In *Steel and Iron*, a 500-page text published in 1890 by the Sheffield Professor of Metallurgy, William Henry Greenwood, steel castings receives little notice. The work ends with its sole reference, a paragraph lamenting: "The details of the manufacture of steel castings are very carefully kept secret by all engaged in their production."

These obstacles notwithstanding, technology continued to advance. Metallurgy grew and was highlighted by the production of alloys. The alloying of steel for castings gained considerable momentum in 1894 with the combination of manganese and steel. These first manganese steel castings were railway crossing frogs, produced by the Taylor Wharton Company. In 1896 a new height was reached with the first casting of nickel steel rolls.

An offshoot of the strict alloying process was the development of castings having one or more faces of a steel much harder than their respective bodies. The process consisted of lining the faces of the mold with a crushed or powdered alloy material which was melted and absorbed by the molten steel as it entered the mold. Ferro-manganese was employed in this process to produce the permanently hard faces necessary for hammer dies, crusher jaws, brake shoes and the like. The use of ferro-chrome would impart characteristics to allow machining the casting without imparing a permanent hardness afterwards.

A variation of this process was employed by the Chicago based foundry of George M. Sargent in the production of railroad car wheels. Here the alloying mixture (ferro-manganese) was added to molten steel at the first pouring into a whirling centrifugal mold. This initial alloyed metal was forced to the rim of the mold, and subsequent pouring of an unalloyed steel filled the remaining space. The resulting wheel had a hard tread and a tough, yet machinable, center.

Molding continued to produce breakthroughs. Though the composition of molding sands remained as the primary research focus, the far reaching advance occurred in the state of the molds and the process of mold creation itself. Checking the trend of controlled scientific application's responsibility for advances, the dramatic introduction of green sand to the process of molding resulted from the practical experience and necessity occasioned on the foundry floor.

James G. McRoberts, cast steel expert at Sheckel, Harrison & Howard Iron Company in St. Louis, was in a mood of equal parts of disgust and despair. After ten days of working on an order for 24 car wheels of an intricate design, his production amounted to a few good wheels standing beside a pile of scrap about five times as high. The problem lay in the design of the wheel and the mold necessary to produce them. The baked molds were offering too much resistance to the cooling/shrinking metal. As a result, the wheels were pulling apart within the molds and the scrap pile growing ever larger.

With his panic and the customer's ire increasing, McRoberts recalled pouring the surplus of a heat into a small, unbaked ingot mold at the St Louis Foundry one year before. Long and widely held foundry tradition had prohibited the use of such molds. It was well known that the moisture in the unbaked mold would produce tremendous steam pressure and result in an explosive shower of molten metal. The melters refused to pour the metal and took cover when McRoberts threatened to do it himself. To everyone's, including McRoberts', surprise the molds did not blow up and the metal began to cool. However, the idea had seemed to cool as well; pouring a small ingot was one thing; pouring a complicated casting quite another.

Faced with this current crisis, McRoberts recalled the green sand mold and ordered two like molds rammed up. The men on the floor reacted in the same way as those did the year before. Standing 40 feet away, they awaited the inevitable fireworks. But the metal slowly filled the molds, sputtered, and began to cool. With grins faded a foundry tradition. McRoberts had revolutionized the steel casting industry.

McRoberts and Edward Goltra took the process to a south Chicago foundry near the site of the Columbian Exposition and invited veteran foundryman Rolla Wells to a demonstration. Wells and his party watched with skeptical eyes (from 100 feet) as the steel was poured. Only McRoberts and Goltra remained by the mold. The next day the casting was shaken out and found to be suitable in shape and size. Breaking it in two they found the texture also proved satisfactory. The process was now a proven success and there remained only to patent it.

McRoberts and Goltra returned to St. Louis, and on July 8, 1893, they applied for a patent "covering certain green sand procedures for casting steel." Patent No. 504,361 was issued to James G. McRoberts on September 5, 1893.

All accounts of the green sand molding development regarded it as revolutionary. It certainly was this. More intricate shapes could now be cast at less cost and in less time. Dry sand molds were baked, and depending on size, this took from a few hours to a number of days. This resulted in a loss of time, tied up flask equipment, and required the substantial cost of running a drying over. In 1961 SFSA President, W. H. Moriarty credited green sand molding with being the principal factor in the rapid adaptation of cast steel to railway use.

Technological advancement was one thing; acceptance by founders was quite another. Secrecy, patent rights, product demands and distrust were all factors standing in the way of general acceptance. However, other forces arose to combat these obstacles, and the 1890's saw them making great strides.

Iron Age, a national publication of the American Iron and Steel Institute, appeared in the 1880's. But its main thrust lay with the iron and steel industries in general, with slight regard to the steel casting in-


THE FOUNDRY

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The cover of the first issue of The Foundry, *September 1892.*
Courtesy: Foundry

dustry. However, the magazine's success reflected the welcome with which it was received. The appearance of *Foundry* in 1892-93 provided the foundry man with a national publication of interest and value to this specific industry. Both publications served to stir the industry from its clandestine isolationism and impart a sense of unity. With these general, yet subtle, benefits rested a host of specific advantages all brought by improved communications.

On another front, European developments and successful applications continued to spur American efforts. The Krupp Steel Works of Germany had cast a locomotive frame for the Pennsylvania Railroad and exhibited it at the Columbian Exhibition of 1893. While visitors marveled at the casting, the American Society of Mechanical Engineers voiced varied opinions ranging from the American industry's total inability to produce such a casting—to the possible production given several attempts. Five years later similar frames were being turned out by several American foundries.

Finally, a new phenomenon sprang from within the industry. The idea of a technical society did not originate with the American Foundrymen's Association (Society in 1948), which was formed in 1896. Rather, the idea was fostered in Philadelphia, where a group of foundrymen organized a technical society, in 1891, the Philadelphia Foundrymen's Association, known informally as the Eastern or National Foundrymen's Association. Although this group contained members from as far away as Alabama, Colorado, New York, and Detroit, proportionally the organization retained a regional quality. Successive regional groups were formed in Texas, Chicago, and New England. With this interest apparent, in 1896 Frederick Riehle of Riehle Brothers Testing Machine Company, proposed at a meeting of the Philadelphia Foundrymen's Association that "there shall be formed an American Foundrymen's Association to further the closer relationships among the foundrymen."

Two men stand out in bringing about and maintaining the AFA in these early years. Howard Evans, a partner in the foundry supply dealership of J. W. Paxton & Company, had served as secretary of the Philadelphia Association. Invitations to the initial meeting were written in his office. While he continued serving the Philadelphia foundrymen as secretary for 37 years, he became the first President of the national organization and maintained a leadership position for a number of years.

The second important role was played by John A. Penton, a labor organizer, writer, and publisher. As publisher of the trade magazine, *The Foundry*, Penton was in the unique position of having

John Augustus Penton, first Secretary of the AFA and publisher of The Foundry.

Courtesy: Foundry

Howard Evans, first President of the AFA.

Courtesy: Foundry

access to founders and foundries across the country. The invitations written by Evans were sent by Penton, who used his magazine's mailing list. His obvious qualifications brought him the position of Secretary of the association, and he continued to exert his leadership throughout his career. Even after his retirement from the publishing business in 1924, he remained active in the association's affairs.

Delegates to the first American Foundrymen's Association Convention.
Courtesy: Foundry

The efforts of these two men carried the society throughout the decade and into the early years of the 20th century. Subsequent officers continued the pioneering work of these two men to lesser and greater degrees, and the fortunes of the society reflected the results of their efforts. But with the inevitable ups and downs of the society, there remained the prime objectives—the advancement of the science of founding.

The 1893 Columbian Exposition in Chicago provided a view of the industrial market place early in the decade. Against the backdrop of the world's first ferris wheel, Little Egypt, and electric lights which consumed more electricity than the rest of the city of Chicago, industrial exhibits fascinated an industry-conscious country. Steel castings took their places amoung the more glamorous exhibits—the Pullman palace cars, expansion engines, and the linotype.

The Krupp locomotive frame mentioned above spurred American founders efforts, but the same founders could look with pride upon their own entries. Among others there stood a mining dredge with buckets, backs, and links which had been poured as a single steel casting. And, it was during this exposition in a foundry near the fair site that McRoberts and Goltra demonstrated the green sand process.

Although doubt had then been expressed concerning American founders' ability to cast a frame equal to Krupp's, locomotive frames served as a casting market. In 1893 the Standard Steel Casting Company, which had acquired a reputation for undertaking difficult casting orders (the cannon of the late '80's), produced a number of rear frames for the Rock Island Railroad switch engines and the complete frame for Baldwin locomotives.

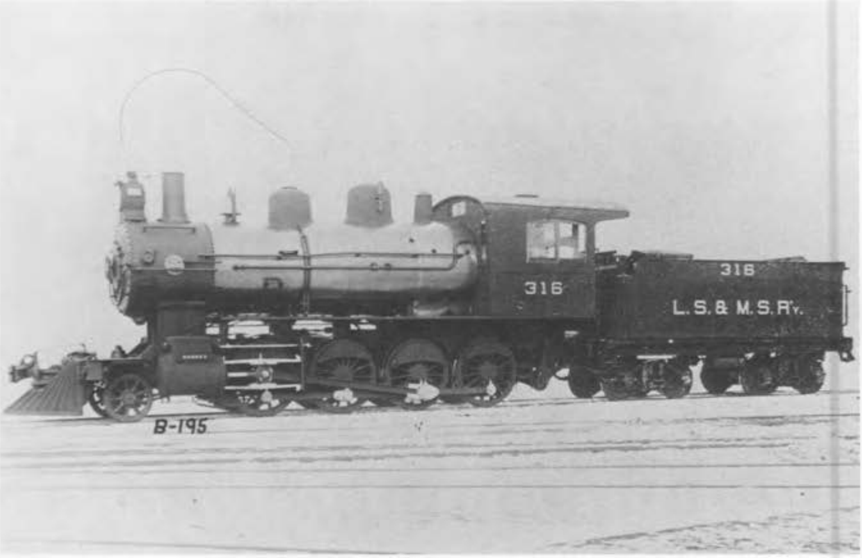
Crossing frogs continued as a market for steel castings, and the metallurgical advances concerning manganese steel were successfully applied to the frogs. In 1892 the Taylor Iron and Steel Company had experimented with manganese steel in the hope of casting car wheels. However, the wheels would not stand the two kinds of wear to which car wheels are subjected. The treads proved satisfactory, but the flanges, which experienced no shock, would not stand the additional wear.

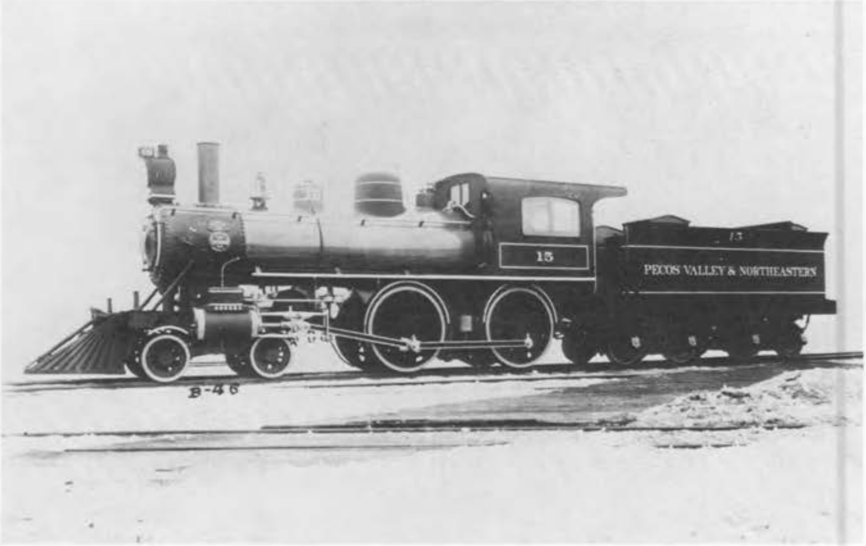
Fortunately, the steel quality suited it perfectly for rail and frog production. Working in conjunction with William Wharton, Jr., & Company of Philadelphia, the Taylor Iron and Steel Company produced a frog with a manganese steel plate in its center. Installed August 28, 1894, on the street railway in Brooklyn, New York, at Fulton Street and Boerum Place, the frog out-performed all expectations. Subjected to a daily traffic rate averaging one car every 27 seconds, the frogs performed perfectly.

Steam railroads were slower to accept the innovation. Not until 1900, and only after extensive experimentation by engineers of the Pennsylvania Railroad and the Philadelphia & Reading Railway, was the manganese steel crossing used for tracks of railroads with steam locomotives. This installation took place at the crossing of the Union Traction Company tracks at 12th Street and Washington Avenue in Philadelphia.

A final spur given the industry by the railroad came with the rapid adoption of the Janney coupler as a steel casting. Under the terms of the Railroad Safety Appliance Act, after June 1, 1898 all passenger and freight cars were to be equipped with the Janney coupler and air brake. At that time there were close to 2 million such cars traveling American railways.

Production of ordnance castings continued during the '90's, and reached record proportions during the Spanish American War. Although the guns themselves were not cast, both the carriages they





Built during a transition period, 1897-1898, these two locomotives illustrate the link and pin and Janney coupling devices. The Pecos Valley and Northeastern's No. 15 carries a needle-like bar, or link, over the cawcatcher. The Lake Shore and Michigan Southern Railway's No. 316 made use of the Janney coupler which is visible over the catcher.

Courtesy: ALCO Historic Photos

High-carbon cast steel shells produced by Taylor-Wharton and used in the Spanish American War.

Courtesy: Taylor-Wharton Iron and Steel Company

Casting steel artillery shells for use in the Spanish American War.
Courtesy: Bettman Archives and SFSA

rested upon and the shells they fired were. Eight, 10, and 12-inch shells were all produced to meet ordnance standards and needs.

Ordnance was not the industry's only contribution to the war effort. The newly redesigned navy was tested for the first time, and played a deciding role in the conflict. The new steel cruisers continued to be designed and built with the increasing use of steel castings. Cast steel crank shafts, 10 feet in diameter propeller wheels, torpedo boat rudder frames, and anchors all found their way into naval construction by 1900. The *Alabama* built in 1898 had a 24,623 pound cast steel sternpost. At the same time an 11,480 pound cast steel shaft tube was used in the construction of the battleship *Wisconsin*.

The Battle of Manila Bay, May 1, 1898, was the first test of the newly designed navy. Surprising the Spanish fleet (ten vessels— cruisers and gun boats), the United States force under Admiral Dewey opened the battle which lasted seven hours. In the end the Spanish suffered 381 men killed and the loss of all ten vessels. The United States suffered only eight men wounded. No one was killed, and not one of the ships was damaged.

By the decade's end, 85 firms were producing steel castings. The production was now over 200,000 tons, the vast majority (over 90 percent) being open hearth steel. The industry was growing in several directions—number of foundries, size of foundries, and the variety of products produced by them. The conclusion of the 19th century found the steel casting industry firmly established in the full sense of the word. Moreover, the art to science transition, while not fully accomplished, had at least received a solid foundation. On this foundation would rise an ever higher technological structure, the overriding characteristic of the 20th century.

CHAPTER 5—The 1900's

DECEMBER 31, 1899. There was a special significance in this New Year's Eve. The world was entering the 20th century. The 20th century—it was to be a panacea, a golden age, an effortless age. The marvelous achievements of the 19th century were to be dwarfed in comparison with those of the 20th. Man had survived 19 centuries, and seemingly, had passed the crucial test. Pipe dreams—they are spun at every anniversary, and the more significant the anniversary, the more grandiose the dreams.

The 20th century would soon prove itself only heir to the 19th. Any great achievements were to be built on foundations laid in the 1800's. More important, great achievements would not come with any less effort or dedication than had been necessary earlier.

Central to this buoyancy was America's recent victory in the Spanish-American War. Never had military victory come at so little a cost, in so short a time, and with so little effort. It was, in the words of Secretary of State John Hay, "a splendid little war." America had flexed her muscles and now stood back to admire the reflected physique.

The United States was not to become involved in any large scale military action in this first decade of the new century. Military action would be limited to quelling an insurrection in the newly acquired Philippine Islands and the Boxer Rebellion in China. On the other hand the United States would shirk the responsibilities of her newly attained global position. While "making our future even larger than the past," Theodore Roosevelt declared, "our place must be among the great nations . . . . Even if we would, we cannot play a small part."

Roosevelt's highly touted "speak softly, and carry a big stick" philosophy would find application in the foreign policy of his successive administrations. "Speakingly softly," Roosevelt would negotiate the 1905 settlement of the Russo-Japanese War and receive the Nobel Prize for his effort. The right to speak softly was maintained by the "big stick" which was growing ever larger. The bulk of the U.S. Navy embarked on a world cruise in December 1907 to demonstrate proof of its number two status among the world's navies.

Proof was early put forth that the 20th century was linked politically to the 19th. The buoyant optimism which greeted the new century was blighted as the third American President fell victim to an assassin's bullet. McKinley's death in 1901 brought America's youngest President, Teddy Roosevelt, into the White House.

Roosevelt matched his aggressive foreign policy with a domestic policy colored with the Progressive spirit welling up in the United States. Although Progressivism is best remembered as the basis for Roosevelt's "trust-busting" activity, its spirit was diffused throughout American life — socially, politically, economically and intellectually. And, as far as trust busting goes, Roosevelt was more inclined to favor regulation and registration rather than breaking up and limiting the growth of industry

The crusade for more effective government and political reform, as well as regulations of big business, came more and found fuller scope in the hands of Roosevelt's successor, William Howard Taft, who brought to the presidency a long list of credentials. He had served as: the first civil governor of the Philippines, Secretary of War, and Presidential trouble-shooter. However, Taft was not the politician that Roosevelt was. His support of more effective Progressive movement and Republican Party. Yet this legislation was effective. During his term of office the Mann-Elkins Act, which strengthened the Inter-State Commerce Act, was passed. The Postal Savings and Parcel Post Act, the establishment of both the Federal Bureau of Mines and the Children's Bureau, the separation of the Department of Labor from the Commerce Department all were brought about. During his term, Taft brought twice as many suits of an anti-trust nature against big business than his reputed trust-busting predecessor.

In terms of economics, the decade saw the traditional rises and declines which had become characteristic of the American economy, but the intensity known previously was missing.

Overall the decade was one of prosperity. The recovery of the late '90's carried into the first part of the new decade, and the period 1897 to 1903 saw not only recovery, but substantial growth. Financial panics in 1903 and again in 1907 were to mar this prosperity. The period 1907 to 1910 saw an upturn in the economy and renewed growth.

An increase in the production of steel castings reflected this prosperity of the decade. The growth of the industry in production terms was quite simply, dramatic. Production increased over 300 percent. In 1899, 198,414 tons of steel castings were produced; in 1909, the total was 615,143 tons. The ten-year span witnessed the continued development/recognition of the steel casting industry.

The years to 1907 had seen a rapid expansion in the foundry industry. M. J. Kellner, in tracing the history of the industry in the Pittsburgh area, states: "Up until 1907 there seemed to be no end to the growth in the foundry industry in Allegheny County." But this expansion was checked by the 1907 panic, and subsequent growth took a new form. He adds: "The urge to build new foundries tapered off, and most of the expansion in the foundry industry came through the enlargement and modernization of the then existing plants." Although the expansion enjoyed by the Pittsburgh area did not occur throughout the United States, yet the number of steel foundries in the United States rose to 83 by 1907. According to Sanders' and Gould's *History Cast in Metal* these 83 steel foundries were spread throughout 16 states and had an annual capacity of over 760,000 tons. A breakdown of the foundries by states reveals over half existing in Pennsylvania and Ohio.

State	Number of Foundries	Annual Capacity	State	Number of Foundries	Annual Capacity
Alabama	1	10,000	Illinois	7	150,100
Minnesota	1	—	Ohio	11	144,000
California	1	300	Indiana	6	44,000
Missouri	1	20,000	Pennsylvania	32	296,500
Colorado	1	—	Massachusetts	3	22,500
New Jersey	4	28,500	Tennessee	1	—
Connecticut	1	4,000	Michigan	1	5,000
New York	4	19,000	Wisconsin	8	19,300

Actual production reflected this growth in the number of foundries and capacity. Statistics published by the Department of Commerce based on their Census of Manufacturers showed the 300% production increase.

Census Year	Total Tonnage	Open-Hearth Total	Basic	Acid	Electric and Crucible	Converter
1899	198,414	185,392	40,907	144,486	8,810	4,212
1904	326,490	304,641	100,432	204,210	5,691	16,158
1909	615,143	562,905	300,443	262,462	13,637	38,601

A number of variables accounted for this expansion and increased production. These ranged from an obvious increase in demand, to strides in technological improvements, to improved communications among foundrymen.

"To further close relationships among foundrymen" had been a primary goal of the technical society — AFA. The same purpose on a more restricted scale was evidenced in the establishment of the Steel Founders' Society in 1902. This formation was described by Moriarty as "in the instinct of self preservation, mutual advancement, and the common good."

The most outstanding feature of this early society was its informality. In place of casting congresses, exhibitions, and the like, the new society met as a luncheon club with meetings usually held in New York City at the old Waldorf Astoria or the Murray Hill Hotel. There were no elected officials, though C. C. Smith of Union Steel Castings Company, Pittsburgh, acted as "custodian of the funds." Other leadership positions were assumed by men such as O. P. Letchworth, G. H. Johnson, and Stephen C. Mason. The meetings were occasional, as opposed to regular, and consisted of the pooling of ideas and discussions of the problems faced by the growing industry.

1907 saw the transition from luncheon club to structured society. Meeting at the Murray Hill Hotel, July 11, 1907, the luncheon club members formally organized "an association in the interest of the steel casting business." Equipped with constitution and by-laws, the Society completed its structure with the election of O. P. Letchworth as President, and Johnson, Mason, and Smith as Board members. This organized society continued to meet at the Murray Hill or Waldorf-Astoria Hotels. When using the Waldorf-Astoria, the chosen meeting room was on the second floor of the "Astoria side" (Thirty-third Street and Fifth Avenue), which was deemed "the least conspicuous." For, according to Arthur Jameson, who attended these early gatherings, "this was a time when trade associations, if having no passion for anonymity, certainly did not court publicity."

Representatives of 17 companies attended this July meeting, formed a charter membership, and were acknowledged in the first written minutes. They included: Cleveland Steel Casting Company, Cleveland, Ohio; American Brake Shoe and Foundry Company, Chicago Heights, Illinois; Duquesne Steel Foundry Company, Pittsburgh, Pennsylvania; Union Steel Casting Company, Pittsburgh, Pennsylvania; Isaac G. Johnson Company, Spuyten Duyvil, New York; Pratt & Letchworth Company, Buffalo, New York; Mesta Machine Company, Pittsburgh, Pennsylvania; Solid Steel Castings Company, Chester, Pennsylvania; Atha Steel Casting Company, Newark, New Jersey; Penn Steel Casting Machine Company, Chester, Pennsylvania; Birdsboro Steel Casting Company, Birdsboro, Pennsylvania; Mackintosh Hemphill Company, Pittsburgh, Pennsylvania; United Engineering and Foundry Company, Pittsburgh, Pennsylvania; American Steel Foundries, New York, New York; McConway & Torley Company, Pittsburgh, Pennsylvania; Pittsburgh

Steel Foundry, Pittsburgh, Pennsylvania; and General Castings Company, Pittsburgh, Pennsylvania.

The general meetings would be attended by twenty or so members with O. P. Letchworth calling them to order. According to Jameson, Letchworth was "a most admirable presiding officer: dignified, polished, urbane." Calling upon each member to report current business conditions, he would carefully skirt controversial subjects. Finally he would throw the meeting open to informal discussions, which quite frequently became heated and topically restricted. In Jameson's words: "We were interested in merchandising only; questions and problems of manufacturing, of labor relations, of metallurgy, of safety, these were never mentioned or introduced; prices were frankly our only interest."

Occasionally, these informal discussions would digress to one-on-one confrontations between two members. In one such instance, a particular member accused another of cutting his prices. The accused flatly denied it. When the accuser maintained he had seen the other's name signed to a telegram authorizing the lesser price, the accused denied having sent it. Finally, the injured party simply stated: "it seems to resolve itself into a question of veracity" and the discussion ended.

The leadership of O. P. Letchworth continued throughout the decade as did that of G. H. Johnson, Stephen C. Mason, and C. C. Smith. 1909 saw the addition of W. H. McFadden, A. R. Broker, and Felton Bent to Board positions and the election of Thomas C. Pears as Secretary.

The retaining of Arthur J. Eddy as counsel to the society in 1910 sprang from the distressing position in which price discussions were placing the members. According to Jameson, "When he saw what we were groping for, he outlined a method of reporting and exchanging price information that was believed to be entirely legal and served us well for a good many years. Up to that time there was no filing of prices, the only exchange of information was by word of mouth, the written word was strictly taboo."

Founders' cooperation in the interest of spurring technology (AFS) and industry promotion (SFSA) was matched by cooperation in other areas. At the 1897 Casting Congress of the American Foundrymen's Association, a number of members caucused and formed the National Foundry Association. The NFA was an offshoot of the AFA with the specific purpose of attempting to deal collectively with organized labor then, for the most part, molders. In this area it was unique and in no way competed with the AFA.

Initially the association was composed of 66 members. Its support came mainly from the larger and more successful foundries. With the avoidance of strikes and lock outs in mind, the members hoped to set up a series of joint conferences between labor and management. These conferences were to produce a code of principles under which negotiations between the two parties would be carried on. This idea became embodied in the New York Agreement, signed in March 1899.

The association entered negotiations with their own policy statements firmly established. They staunchly opposed: 1) union restriction of output; 2) union limitations of one man's earning capacity; 3) the limitation of apprentices; and 4) union firings and other restrictions imposed upon workmen. At the same time it advocated: a fair day's work for a fair day's pay, the employer's right to hire whomever he desired, apprenticeship without union interference, and the operation of labor-saving devices within the foundry.

In the event of negotiations reaching an impasse, the association's by-laws stipulated that the member might be aided by the association in one of three ways: 1) procuring men to take the place of the strikers, 2) granting compensation for the loss of production, or 3) making the production the member required.

The association grew rapidly. From 66 members in 1898 the rolls had increased to 94 by 1899. In 1900 there were 369 members, and the first membership classification on a work produced basis was compiled. This compilation revealed 24 members producing agricultural work, 9 architectural, 4 brass and bronze, 77 engines, 10 furnaces and heating, 143 general foundry work, 33 light gray iron, 8 machine tools, 29 malleable, 18 pumps, valves, hydrants, and pipes and 10 steel.

The 1899-1900 membership spurt was largely the result of negotiation progress made by the association.

In February 1899 the so-called New York Agreement was signed by the National Foundry Association and the Iron Molders' Union of North America. Based on the ideal of harmony and the principles of arbitration and annual agreements, the pact provided that arising disputes be dealt with by the immediate parties to the dispute. Failure to resolve the dispute permitted either party to ask for the recommendation of the Committee of Arbitration. While the dispute was in the hands of this Committee, there was to be no cessation of work brought about by either party.

The Committee of Arbitration proved to be the agreement's downfall. Its composition consisted of "the President of the National

Founders' Association and the Iron Molders' Union of North America, or their representatives, and two other representatives from each association appointed by the respective Presidents." Being made up of six members, it could not hope to arbitrate any dispute, the best that could be hoped for was conciliation.

Members of the NFA by 1904 felt the agreement had accomplished nothing beneficial. In fact, during the period the agreement was in effect, foundry owners had witnessed the continued strengthening of the Iron Molders' Union. Moreover, this strengthening had taken place at the owners' expense. As a result, the 1904 annual convention was one of the best attended in the association's history. This, and the one vote cast against abrogation of the agreement, illustrated the regard with which the membership had come to hold the attempt to "conduce to the greater harmony of their relations as employers and employees."

The failure of the agreement did not bring about the failure of the NFA, however. The association continued to operate and afford protection to its members. For the most part this protection was in the form of preparing men to take the place of strikers. Membership by 1910 stood at 426, with 492 foundries being represented. By the First World War, the association could count 13 percent of the nation's foundries as members and 85 percent of these maintaining open shops.

During the course of the decade the steel castings industry maintained a successful search for application. The railroads continued as a mainstay market. Steel castings had almost entirely replaced iron and rolled steel from both frogs and crossings. They were used extensively in car construction ranging from couplers to wheels, bolsters and sideframes. Increasingly they were being used in the construction of locomotives and 1901 predictions that it would soon predominate were fulfilled. Statistical acknowledgment was given this market as the production figures relating to steel castings came to be subdivided by "railroad castings" and "all others."

Mechanical construction increasingly included steel castings. Cylinders for hydraulic presses, valves, shafts, covers (housing) and foundation plates are only some of the mechanical uses found for steel castings in the centurys first decade. Plates and housings were found to be half the weight and twice as shock resistant as cast iron. Gear wheels were cast with diameters up 12 to 15 feet. And, a field of

Manganese steel enjoyed increasing railroad application. Pictured above is the first manganese steel movable point crossing. The crossing was installed on the Pittsburgh, Cincinnati, Chicago and St. Louis Railway, October 1905.

Courtesy: Taylor-Wharton Iron and Steel Company

vast potential was initiated in 1905 when the first automotive steel castings were made.

Ordnance construction continued as a wide market. *Scientific American Magazine*, in 1901, marvelled at the complicated forms being cast, and marvelled even more when the castings proved every bit as resistant to shock as forgings. According to the magazine, "castings were being turned out which 10 years prior would not have been dreamed of." Gun carriages, long a popular application were being made increasingly stronger and lighter.

Naval construction not only demanded more, but continually larger castings. In 1904, a 75,800 pound cast steel shaft bearing was produced for a line of the International Steamship Company.

Mining and dredging equipment increasingly called upon steel castings as mechanization made further inroads in those respective industries. Spurred by the demands of the recently opened Alaskan gold fields, the Columbia Engineering Works (now Columbia Steel) added cast steel buckets for gold mining dredges to their product line. Dredge buckets soon became a company mainstay — a position they maintained until World War II.

However, an equally dramatic use of steel castings proved to be in construction of the Panama Canal. The Canal had long been a dream, but the enormity of the task forced it to remain so. The French had worked on the Canal in 1880 and excavated some 27 million

Industrial expositions provided the steel castings industry with opportunities to display the ever-growing range of products. The 1905 Lewis and Clark Exposition held in Portland, Oregon, gave such an opportunity to the Columbia Engineering Works (now Columbia Steel Casting Company).
Courtesy: Columbia Steel Casting Company

cubic yards, but corruption, disease and inadequate technology resulted in bankruptcy in 1884. Such a canal would have been a tremendous boon to shipping, but it was the United States national defense which finally brought about its construction. During the Spanish American War, the battleship *Oregon* had been sent from San Francisco to reinforce the Atlantic fleet. The *Oregon* travelled over 13,000 miles to do so—had the Canal been in existence, the voyage would only have been 4,600 miles.

Congressional authorization was given in 1899 to a commission to study a possible route. The Hay-Bunau-Varilla Treaty of 1903 finalized the Canal negotiations and the stage was set for construction to begin.

The construction of the Panama Canal required a wide and dramatic use of steel castings. Buckets for shovels and dredges cut into the mountains and swamps of the Canal Zone.
Courtesy: Taylor-Wharton Iron and Steel Company

President Roosevelt had taken an active interest in the Canal from the beginning. In November, 1906, he visited the Canal and described the progress in a letter to his son, "They are eating steadily into the mountain, cutting it down and down."

The steady eating into the mountain was being done by steel castings, for industry's efforts in the construction stemmed from their use in both power shovels and dredges. Taylor-Wharton produced for both these types of machines. Their "Panama" patented two part-teeth of manganese steel were used by the power shovels working on the Canal. As work progressed at and below sea level, dipper and bucket dredges had to be used. Equipment such as the dredge Corozal employed 40 cubic feet Taylor-Wharton buckets.

Roosevelt witnessed only a small part of the excavation effort, for the height of the work was not reached until 1913 when more than 43,400 persons worked on the Canal. The Canal had required the excavation of 211,000,000 cubic yards of earth. Using only 27,000,000 yards of the dredge work, United States efforts required the moving of 186,000,000 yards. Construction costs alone stood at $310,000,000.

The most dramatic technological advances of the century's first decade occured in the field of melting. The Tropenas side load converter had been developed during the '90's in England and by 1900 was installed in the U.S. The side load converter seemed to hold great promise for the industry. Forcing air through the side of the

A scene from a turn of the century foundry shows a Bessemer convertor operating at the left and pouring in the background.

Courtesy: Columbia Steel Casting Company molten mass enabled greater amounts of air to be used, and a greater action of the molten metal—both leading to a higher temperature steel (200°-300° higher than open hearth) and greater refining capabilities.

A higher temperature metal permitted the accumulation of steel by means of successive heats. In this manner, it was possible to produce from the 1 to 2-ton capacity furnace a casting of 4 to 5 tons. The higher temperature limit of the furnace would keep the metal sufficiently liquid to receive the second heat. By 1901, 5 to 6 ton capacity furnaces were used to produce castings of 15 tons, and plans were made to cast up to 30 tons with a 12-ton capacity furnace.

The open hearths, in attempts to keep up with demands for more and larger castings, were being constructed with ever-increasing capacities. By 1901, these had reached 50 tons. Open hearth steel, both acid and basic, saw the reduction of the hardening element (carbon, manganese and silicon). An average analysis showed a carbon range of 0.25 to 0.50%, manganese 0.50 to 1%, with silicon at 0.20 and 0.45%. The use of aluminum in the basic process permitted the use of high phosphorous pig iron to produce softer steels. These steels were suited for products requiring the resistance for standing strain or shock. Test results showed that this steel would stand 30 tons per square inch, has an elongation of 25 to 28% and resistance to 30 plunger strokes.

However, the most dramatic, long-range advance in melting technology was to stem from the introduction of the electric arc furnace to the steel casting industry. In 1896 a retired Italian army officer, Stassano by name, established himself in Italy's Alpine region and began testing a theory held by many leading scientists of the day —that electric current could be used as a satisfactory heat source for melting and refining steel. It was not until 1899 that Stassano achieved success, but his achievement immediately drew the attention of other European experimenters and a developmental race began. French, Swiss, German, Swedish, Norwegian and Italian steelmakers all played significant roles in this rapid process so that by 1901 the electric furnace was hailed as "a revolution in steelmaking."

It was not until 1909 that the electric furnace was used here for steel casting production, and its introduction was not without its difficulties. A high purchase price and cost of installation were two obvious reasons for steel founders' reluctance. And beyond this, certain "bugs" had to be worked out. A reason given for the Heroult furnace design change (from square to circular), rested with such problems. The square furnace provided a maximum capacity but as a loss of structural strength. When one foundry's furnace was titled for pouring, the back caved in.

In 1909, nearly 13,637 tons of steel castings were produced from electric and crucible steel. These two methods combined accounted for only 2.2% of the 615,143 ton total.

From this inauspicious start would stem tremendous inroads during the next decade and produced a revolution within the U.S. industry. The electric furnace provided a super temperature range which could not be matched by conventional melting processes. Beyond this was the element of greater temperature control by which the product's uniformity was much easier to obtain and maintain. Other advantages lay in the neutral atmosphere within the furnace. This neutral atmosphere, or absence of undesirable gases in the furnace, reduced the oxidation of the metal and the tendency toward blowholes.

Having been introduced late in the century's first decade, the electric furnace was to continue its dramatic development during the next decade. During this time, it would constitute the number one technological development affecting the steel casting industry.

CHAPTER 6—The 1910's

The Progressive party had achieved national prominence during Theodore Roosevelt's first term in the White House, yet the movement continued to grow throughout the first decade and did not reach its peak until 1912. By this time it was responsible for a considerable amount of state legislation relating to wages and hours, employment of women and children, and health and safety in factories. Among state laws, a few of the landmarks were Maryland's adoption of the first workmen's compensation law in 1901, the 10-hour day for women adopted by Oregon in 1902, the enactment in Illinois of a law providing public assistance to mothers with dependent children, and the 1912 law of Massachusetts guaranteeing a minimum wage for women and children.

The peak of the Progressive influence came in 1912-13, when the 16th Amendment to the Constitution was adopted. Under this Amendment, the income tax on individual income was initiated. The 17th Amendment providing for the direct election of senators was ratified at the end of May, 1916.

Politically, the decade belonged to the Democrats with the power shift occasioned by the 1912 election of Woodrow Wilson. A falling out between Taft and Roosevelt had lead to a split in the Republican Party. Conservative Republicans backed Taft, while the liberal wing backed Roosevelt and his formation of the Bull Moose Party. This split divided the popular votes in a proportion approximately 6 to 4 to 3.5. Wilson's proportion, 6, resulted in a minority of popular votes, but he went on to garner 411 electoral votes—the largest number ever achieved in a Presidential election to that time. A former President of Princeton University and later Governor of New Jersey, Wilson became the first Southerner since Andrew Johnson to attain the Presidency. He continued the Progressive legislation, especially legislation on a national scale. During Wilson's first term both the 16th and 17th Amendments to the Constitution were passed. Along with these Amendments were passed in December of 1912 the Federal Reserve Act, and in 1914, the Federal Trade Commission Act. The Clayton Anti-Trust Act was passed in October, 1914 and marked the last of the Progressive legislation prior to America's entry into Worl War I.

Much as the Civil War dominated the 1860's, so World War I would dominate the decade. The war which broke out in August, 1914 lasted a little over 4 years, with the United States' 18-month participation being all limited, necessary and decisive. It was limited only by our late entry which marked an overnight susceptibility to war fever. The fact that "he kept us out of war" kept Woodrow Wilson in the White House in 1916. However, the sinking of the *Lusitania* proved to be the final link of a chain of events leading to our declaration of war in April, 1917.

In terms of economics, the decade began with a recession lasting from 1910 to 1911. Following a brief upswing in 1912, the economy again turned down in 1913 and 1914. The outbreak of World War I in August, 1914 brought with it a war boom as the economy fed on Allied war orders. This boom continued throughout the years of the war with a peak reached in 1916 and levelling off in 1917 and 1918. A temporary hesitation following the Armistice gave way to a 1918-1920 period of soaring prices, sales and production as America ended its involvement in world affairs and turned to an isolation position.

War has always been a stimulant to industrial production, and the resultant boom has intensified with the increasing "modernization" of warfare. Central to this modernization is the increased mechanization of the armed forces — mechanization dependent upon steel castings. Unsubstantiated reports tell of steel castings being used in the Civil War. Thirty-five years later they were an integral part of the Spanish-American War effort. As in earlier wars, the Spanish-American War spurred the nation's economy and industrial development, and for the first time, the steel casting industry.

Yet, the impact of World War I was greater than that of both previous wars combined, and this effect is readily apparent in the production statistics of the decade. In 1915 the steel casting industry was established and growing, and would have continued to grow without the influence of war. A 20-year production curve for steel castings plotted alongside one showing the ingot production of the country illustrates a considerably more rapid rate of growth for the steel castings.

Production in 1909 included a total tonnage of 615,143 tons of steel castings. Of this, 91.5 percent or 562,905 tons came from the open hearth. Electric and crucible steel accounted for 2.2 percent or 13,637 tons. Converter steel castings accounted for 6.3 percent or 38,601 tons. By 1914 the total tonnage had only risen to 659,343 tons. Of this, 90 percent was open hearth steel, 2.6 percent was electric and crucible, and 7.4 percent was from converter. However, in 1919 the total tonnage had risen to 825,485 tons. Open hearth production had dropped to 85 percent of this total or 701,923 tons. Electric and crucible steel castings had risen to 8.7 percent of the total production or 72,463 tons. Converter steel castings share of the production had dropped to 6.2 percent or 51,099 tons.

The demand made upon the steel casting industry by the war effort resulted in an ever-increasing percentage of the productive capacity of the industry being used. Orders for steel castings in terms of percentage of productive capacity from the years 1915 to 1920 make this quite clear. In 1915 orders for steel castings accounted for 73.9 percent of the miscellaneous capacity, and 66.3 percent of the railroad specialty capacity. 1916 saw these percentages rise to 92.7 percent of miscellaneous and 122.8 percent of railroad specialties. By 1917 the percent was 96.7 for miscellaneous and railroad specialties had fallen to 67.7. However, 1918 saw miscellaneous orders rise to 100.3 percent of capacity and railroad specialties rise to 106 percent. The end of the war was reflected in 1919 orders which accounted for only 46.3 percent of the miscellaneous production capacity and only 25.4 percent of the railroad specialties. By 1920 orders had again risen and now stood at 67.6 percent of the miscellaneous capacity and 69.2 of the railroad specialty capacity.

The flurry of activity occasioned by the war was especially noticeable in the Pittsburgh area, a leading center of the steel casting industry. In his history of foundries in the Pittsburgh area, Kelmer reports "from 1916 to 1919 there seemed to be no possibility of ever supplying the demand for castings. Every possible means of production was running night and day. The steel foundries had all surplus and spare open hearths making shell blanks. They were filled with orders for guns, locomotives, ship castings, railroad car castings, foreign and domestic electric equipment."

As it was, the first years of the decade found business to be good; the second part great.

Reflecting this increase in production was a corresponding increase in the number of foundries. The increase was not altogether healthy, and this statement mirrors the feelings of Mr. R. P. Lamont, who in May of 1917 reflected upon the industry's development to 1916. Mr. Lamont noted an early experimental developmental stage which was both difficult and unprofitable. Emerging from this were a few foundries which were deemed successful. The appearance of successful foundries sparked the too rapid expansion producing excess capacity, competition and no profit. From this, the strong foundries were to survive and the weak would not.

The above passage, gloomy and harsh as it is, was one successful man's view of the industry, and it was accurate as far as it went. But the weaker companies that failed did not disappear. Many times they were absorbed by larger outfits. Others were bought out by new entrepreneurs with the ideas of success and the ability and good fortune to bring it about. Some of the most successful foundries today had their roots in this period. For in this era, a failing foundry could be purchased and put on a profit-making basis for a capitalization of $25.000.

As a part of the war effort the Steel Founders' Society of America published a List of Manufacturers for the use of the purchasing departments of the United States government. This list provides an accurate picture of the size and distribution of the industry in America in 1918. Spread throughout 28 states and Canada were 192 foundries. The foundries in the United States were located as follows:

Alabama	1	Kentucky	1	Oregon	2
Arizona	1	Louisiana	2	Pennsylvania	38
California	7	Massachusetts	5	Rhode Island	1
Colorado	2	Michigan	10	Tennessee	2
Connecticut	3	Minnesota	4	Texas	2
Delaware	2	Missouri	5	Utah	2
Illinois	8	New Jersey	4	Virginia	1
Indiana	9	New York	13	Washington	4
Iowa	5	Ohio	23	West Virginia	3
				Wisconsin	16

Finally 16 foundries in Canada brought the total to 192 foundries. The capacity of the industry, according to R. P. Lamont, was approximately 2 million tons.

The effects occasioned by the Great War were considerable, yet the war was not the only force at work during the decade. The Progressive movement described in the preceding chapter had taken a hand in molding industrial America. And, this spirit was not to be lost on the steel casting industry.

Foundry conditions had always been hot, dirty, and dangerous —considering the nature of pouring 2800 degree molten steel into sand molds, it could be little else. As a consequence, foundries had offered higher wages than most industries. But this was not enough. Alleviating as many of the hazards and a greater concern for the workingman manifested itself in the 1910's.

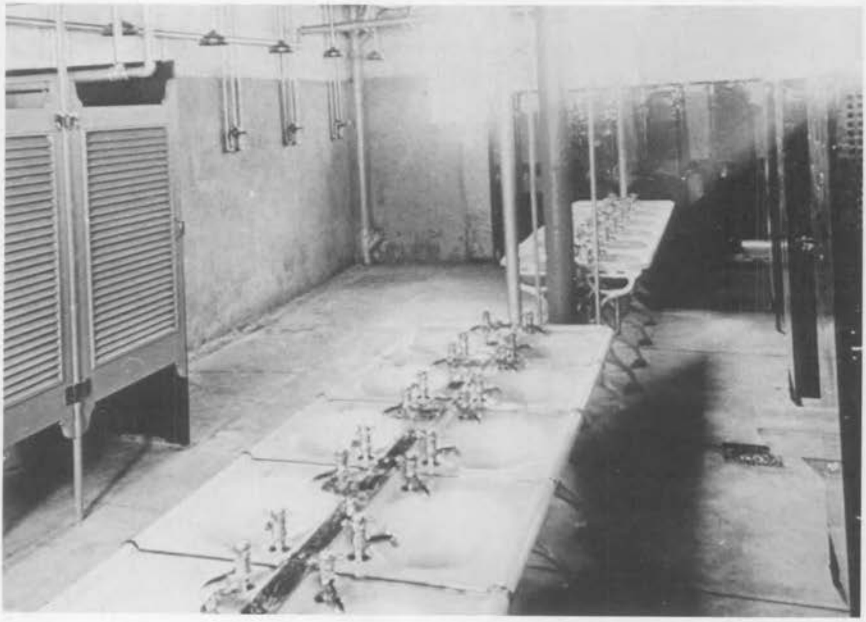
Programs such as the Reading Steel Casting Relief Association began with the employees when several got together and formed the organization on August 10, 1910. Prior to this time, it had been the custom to take a collection for a fellow workman who was reduced in circumstances by accident, illness, or otherwise. But under the plan of the new association, dues of 50 cents a month were paid and from these dues, benefits of $5.00 a week for injuries or illness, and $25.00 as a death benefit, could be drawn. By 1915, four years after the association's beginning, the membership had grown to 230 to 250 men.

In 1915 the Reading Steel Casting Company took a direct role in the association's affairs. The company erected a building at a cost of over $12,000. Adjoining the plant, the building consisted of three floors which included a basement with 290 lockers, five shower-baths, 28 stationary washstands and toilets. The first floor contained an emergency hospital, offices for the association's officers, a store where candy, cigars, tobacco, gloves, etc. could be purchased, a room for reading and writing, a billiard and pool room, and a kitchen which could be used to prepare lunches. The second floor consisted of a large assembly room used for association meetings and the like. Both the heating and lighting of the building were modern, and the grounds around it were landscaped with lawns and shrubs.

Another progressive effect was the creation of the National Safety Council in 1911. From the beginning steel foundrymen took an active interest in this council, and by the 4th annual Safety Congress held in October 1915 at the Bellevue Stratford Hotel in Philadelphia, a number of foundry representatives were included in the program. Papers delivered by foundrymen included "Foundry Floor" by Houston L.

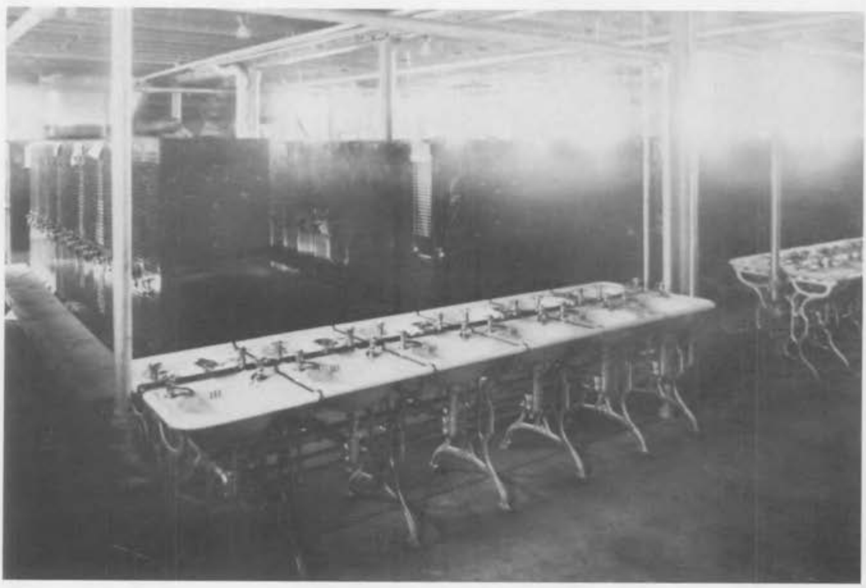
The Reading Steel Casting Relief Association building completed in 1915 at a cost of over $12,000.

Courtesy: Empire Steel Castings, Inc.



Two views of the relief building locker room which contained the latest in sanitary fixtures. Lockers, wash stands, showers and toilets served the 290 employees.

Courtesy: Empire Steel Castings, Inc.



Gaddis, Manager of the Accident Prevention Department, Ferro Foundry and Machine Company, Cleveland, Ohio; "Foundry Yards" by George P. Fonda, Safety Engineer, Bethlehem Steel Company, South Bethlehem, Pennsylvania; "Handling of Materials" by A. L. Clark, Superintendent, Western Foundries, American Brake Shoe and Foundry Company, Chicago; "Eye Protection" by F. G. Bennett, Safety Department, Buckeye Steel Castings Company, Columbus, Ohio; "Hand and Foot Protection" by B. W. Conlin, Safety Inspector, National Malleable Castings Company, Chicago; and "Lighting, Heating, and Ventilation from the Standpoint of Safety" by W. A. Herron, President, Duquesne Steel Foundry Company, Pittsburgh.

Beyond the relief and safety organization aspects of the industry was the wage structure available to foundrymen. Wages in the foundry were low compared to today, but above average for the time. In determining the costs per ton of melted metal, labor's share was $2.50 of the total cost of $26.14. This, of course, was one instance and would vary with the amount of metal melted. A separate breakdown for cost determination per day found labor costs to include: a melter — $5.00 per day; an assistant melter — $4.00 per day; a helper $3.00 per day, and a laborer — $2.00 per day.

Not surprisingly, the progressive era had little effect upon technological advances in the 1910's. What is surprising is the same lack of new technology in the era of World War I.

World War I did very little to bring about technological advances within the steel casting industry; however, the war did make tremendous use of conventional technology perfected to that time.

The most far-reaching improvement in the decade was the more frequent introduction and development of the electric furnace. Traditionally. Treadwell Engineering Company of Easton, Pennsylvania, had been credited with producing the first commercial steel castings from an electric arc furnace. Treadwell began its production on the 15th of October, 1911. Early experiments had been conducted by the National Malleable and Steel Castings Company in Sharon, Pennsylvania, as early as July 1910. National Malleable had at that time a 300-pound capacity "experimental" furnace.

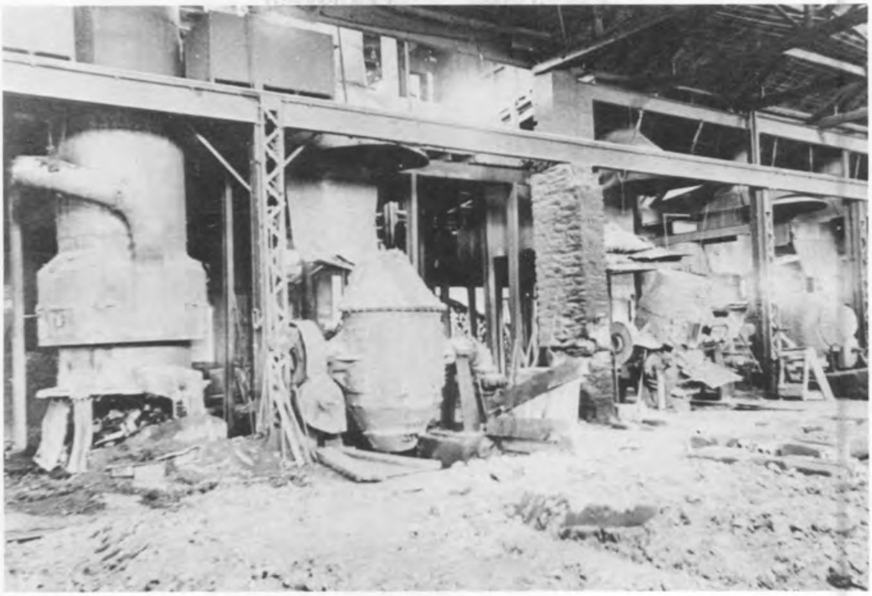
The 1909 melting statistics of the American Iron and Steel Institute show electric furnace products as being 0.05 percent of the total. The same set of statistics show in 1910, 0.14 percent of the production. 1911, Treadwell's first year of production, saw the electric furnace account for 0.29 percent of the steel produced in the U.S.

Charging cupolas in 1912.

Courtesy: Foundry

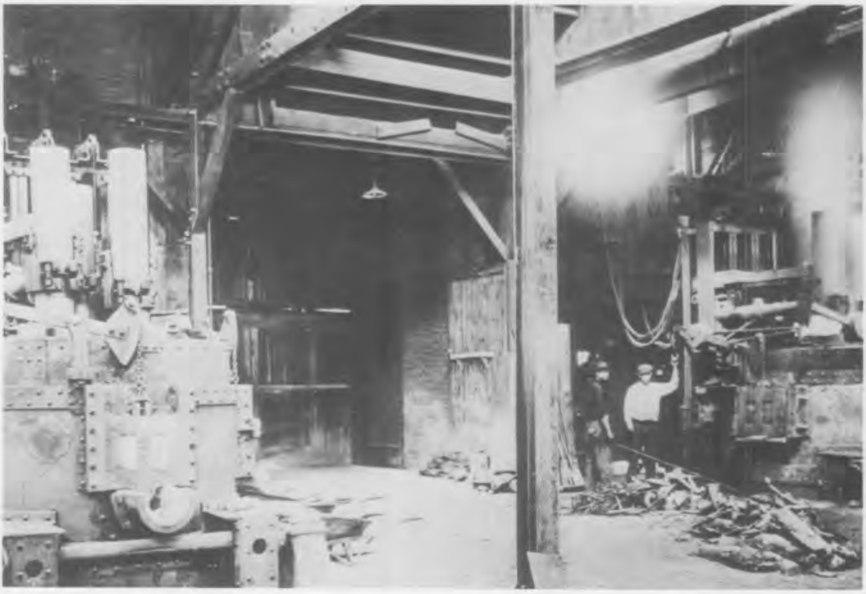
Treadwell's relation with the electric furnace began with its organization and absorbtion of the Lebanon Steel Casting Company of Lebanon, Pennsylvania. At this time Lebanon was producing castings by the crucible process. Treadwell was not satisfied by this method, and with the desire to increase its output, the new company began to look around for alternative melting methods. After an extended investigation which turned up the fact that customers were importing high grade castings of electric furnace steel, it was decided to install a Heroult furnace. The first heat was poured in 1911.

The Heroult design employed by Treadwell was modified somewhat. The furnace was rectangular with a charging door on each side and a tapping spout in the front. Three water cooled electrodes passed through a removable roof. The power to run the furnace was purchased and received at 11,000 volts. This was stepped down to about 85 to 90 volts and a phase at 60 cycles and 2500 amperes. The furnace was a tilting type which used three small motors to automatically raise and lower the electrodes. The switchboard had a voltammeter, a wattmeter, and three ammeters. The furnace had a basic lining. The roof was of silica brick, with a spare one always kept on hand. The current was introduced by means of the electrodes which would come to within one-half inch of the top of the slag after the charge had been melted. These were kept at about the same



Although the electric furnace was gaining rapid acceptance, the convertor still accounted for a greater percentage of steel castings' production. The photo above shows a convertor furnace department before starting work. Below, while the metal is removed from one furnace, a second is being blown and a ladle is pre-heated under an oil burner.

Courtesy: Empire Steel Castings, Inc.



The electric furnace was gaining rapid acceptance. Pictured here are two 2-ton circular Heroult furnaces. The furnace on the left was installed in 1915, and when its success was proven, the second furnace (on right) was installed.

Courtesy: Lebanon Steel Foundry

distance from the cold charge as it was melting. The furnace was charged with the heads and gates from previous heats and with a small amount of scrap purchased in the open market. No pig iron was used in the charge.

The furnace had a two-ton capacity and four heats could be made in a 24-hour period. The melting time necessary was two to three hours with an additional one or two hours needed for refining. After the elimination of the usual elements the oxidation slag was removed by tilting the furnace. The desulfurizing slag was removed by tilting the furnace. The desulfurizing slag was then introduced by adding coke, lime, fluorspar, and ferrosilicon. With the refining completed the usual additions of ferrosilicon and ferromanganese were made, and the steel was tapped by turning off the current and tilting the furnace 45 degrees. Large castings were poured directly from the ladle, but crucibles were used for smaller castings. By using this method the time of pouring was cut down, and there was less loss from waste.

The following table was published in *Iron Age* Magazine in an article dealing with the costs of running electric furnaces. The Treadwell furnace was used as the basis for compiling this chart.

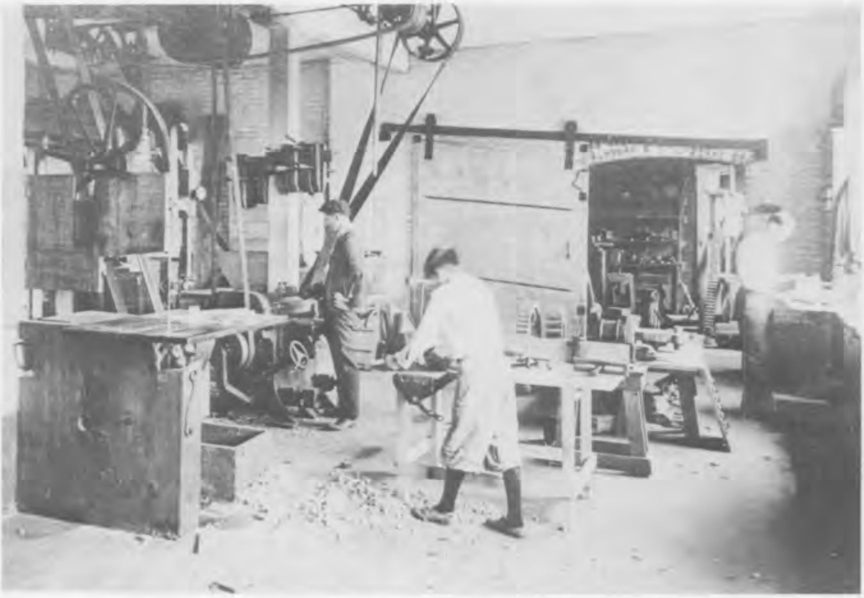
Average Number of Heats per Week—15
Average Weight per Heat in Pounds—4600
Average Power Consumption per 2,000 pounds in Kilowatt-hours—900
Average Repair Costs per 2,000 pounds—$2.50
Average Electrode Costs per 2,000 pounds—$2.50
Average Weight of the Castings Made in pounds—9
The Ratio of Clean Castings, Risers, etc. to the Charged Weight in Percent—92-95
The Ratio or Finished Castings to Charged Weight in Approximation in Percent—60
The Furnace Lining Would be Repaired after every 35 Heats

The fact that Mr. Treadwell was a firm believer in pouring hot steel was reflected in his high maintenance costs and the high amount of power which was consumed.

According to authorities of the day, the advantages of electric steel were myriad. Electric steel was reportedly a better quality steel. It possessed a high "elasticity" with an "elastic ratio" which was seldom under 62 percent and generally much higher. The quality increase in this direction was tremendous. Electric castings would stand two to three times the number of drop hammer blows required to break a fuel melted steel of the same carbon content. The tensile strength of electric steel was 5,000 to 10,000 pounds higher than the fuel melted steels with the same carbon content. This was due to the higher specific gravity of the electic steel occasioned by the smaller volume of microscopic blow holes contained in the casting. The uniformity of the steel, as well as its purity in terms of sulfur, phosphorus, oxides and nitrides, combined to make electric steel the answer to the comsumer's prayer.

A strict comparison matching the best qualities of fuel melted steels with electric steel found the electric achieving the best qualities of all processes. The electric furnace would produce steel as pure as that of a crucible furnace, with the added advantage of the possibility of refining. The electric furnace would produce steel as hot as the small Bessemer converter, and in addition, it would be free from oxides and occluded gases. The electric furnace would perform as well as an open hearth and its only disadvantage lay in the fact that it could not use pig iron. But the electric furnace was capable of producing a purer and hotter steel than the open hearth under usual operating conditions.

Robert P. Lamont, who had earlier described the development of the steel casting industry, finished his article with a prophecy



Large windows and white painted walls gave patternmakers enough light to meet exact specifications.

Courtesy: Empire Steel Castings, Inc.

concerning the electric furnace and its application to the steel casting industry. "A comparatively recent, important development in the industry was the coming in of the electric furnace. If it has not already done so, it will entirely replace crucibles and converters as a means of melting."

Though not as dramatic as the advances being made with the electric furnace, progress was being made in other areas of technology. In the field of molding, the first muller with individually mounted revolving mullers of varying weights was marketed in 1912 by Peter Simpson. Green sand molds continued to be accepted and although no figures exist to show the extent to which they were used, estimates at the time placed 60 percent of the molding as being done in green sand as opposed to 40 percent being done with dry molds.

Dry sand molding at the time was done with a mixture of silica sand and fire clay which was modified in some cases with small percentages of resin, dextrin, or flour. The finished mold would be dried in an oven kept at about 500° F from, depending upon the size of the mold, six hours to six days. The drying process tied up a large amount of flask equipment and required a great deal of fuel and extra handling. It was estimated that this added at least $1.00 per ton to the

Sand, shovels and packing tools were still the mainstays of the molding areas.

Courtesy: Lebanon Steel Foundry and Empire Steel Castings, Inc.

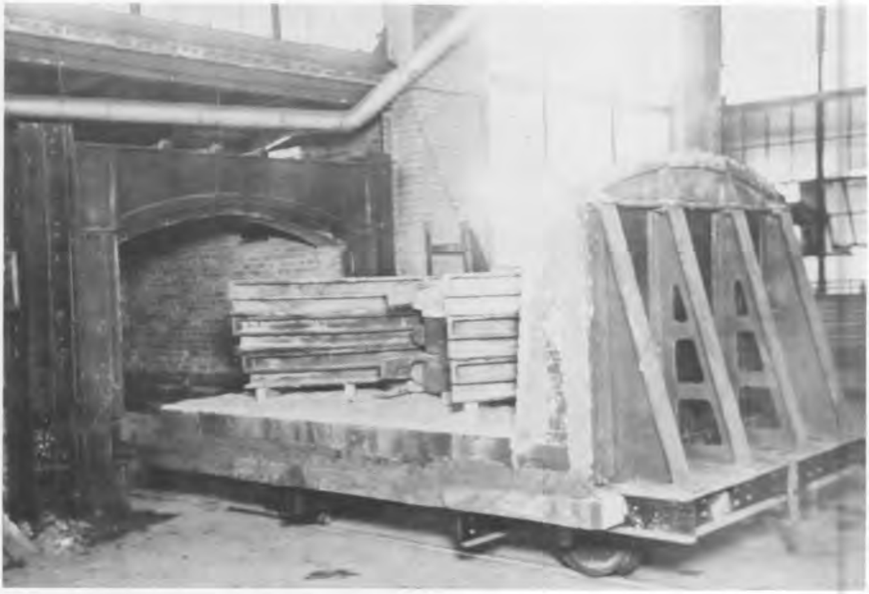
cost of castings. Beyond this was the amount of new sand needed for each mold. Green sand molds required only about 1500 pounds of new sand per ton of castings. On the other hand, a dry sand mold required about 2,000 pounds of new sand per one ton of castings.

Drying oven and car with racks to hold dry sand molds.
Courtesy: Empire Steel Castings, Inc.

The science of heat treating was still in its very primitive stages. In his memoirs John Paul Howe recalled his attempts to implement treatments recommended by the ASTM. Bent on using the pamphlet, "Recommended Practice for the Heat Treatment of Steel Castings," Howe was discouraged by the foundry superintendent on the ground that "it was to the highest degree inadvisable to allow the impression to get abroad that heat treatment of steel castings was either possible or advisable."

Heat treating furnaces were of the pit type and fired at only one corner. As a result, even the most expert firemen could not maintain an even heat. In terms of normalizing, the nearest that could be attained was the removal of one or all of the covers from the pit and allowing the castings to cool a little more rapidly. This would give the elastic limit a "kick up." Plain annealing was all that was considered possible for castings with even normalizing being regarded with suspicion.

Not all of this reluctance to anneal stemmed from ignorance. In a discussion of electric steel castings Hanson maintained there was little question that castings with a .20 carbon or .30 carbon could be improved by annealing. But the cost was high and the American attitude seemed to be against the added expense of annealing when it could be avoided.



A large annealer.
Courtesy: Empire Steel Castings, Inc.

Yet highly sophisticated scientific fields were being developed and applied to the industry. The development of a new X-ray tube capable of sustained operation at 140,000 volts revolutionized the making of radiographs. By 1915 Dr. Wheeler P. Davey of the Research Laboratory of the General Electric Company in Schenectady, had applied this X-ray tube to steel castings. In a paper entitled "The Radiography of Metals" presented to the American Institute of Mining Engineers and the American Electrochemical Society in San Francisco, Dr. Davey outlined his work. This included data prescribing exposures necessary for any thickness of steel to be examined, the thickness of the smallest air inclusions which could be radiographed in a given thickness of steel; the techniques for radiographing metals; and finally speculations of the future advances and applications of the X-ray.

The need for such practice, and the engineers' distrust of steel castings, was made tragically clear in September 1916 when the center span of the Great Quebec Bridge collapsed. Even before thorough investigations could be undertaken, newspapers and technical journals alike blamed the disaster on the failure of a steel casting. One technical journal went so far as to state, "It was the well known treach-

The increasingly important role of the metallurgist was noted but his tools were still rather primitive.

Courtesy: Empire Steel Castings, Inc.

ery of a steel casting." While the eventual investigations revealed the disaster had in fact been caused by a defective casting, the rash and premature generalizations on the part of the newspapers and journals was totally uncalled for. Steel founders in Canada and the United States reacted with a certain amount of justifiable indignation.

The quality of steel castings had improved and founders' wanted the fact recognized. Mr. Lamont in concluding his article on the history of the casting industry added in retrospect: "While the product even yet cannot be said to be perfect, a great deal of careful, painstaking, intelligent study has been given to overcoming the difficulties in the processes, and it can at least be said that steel castings have to a large extent lived down the somewhat uncertain reputation earned during the first developmental period."

The task of living down the uncertain reputation referred to by Lamont was aided by the successful application to markets in the decade of the 1910's.

There is no question of the First World War's market domination of the period 1915 to 1919, but the first four to five years of the decade saw the industry maintain a rather steady development. Established markets continued to grow in both size and complexity, and this growth made continued demands upon the steel casting industry.

Industrial castings continued to make demands upon the industry. Larger, stronger, smaller, harder, lighter were all watchwords of development. A record in terms of size was established when the Hubbard Steel Foundry in East Chicago, Indiana, cast a 70-ton boom shearing machine housing. The housing had an overall length of 18 feet 5 inches, was 12 feet 7 inches high, and had a 9-foot width. It was the largest steel casting a western foundry had attempted to produce.

Another record in size was accomplished with the casting of an unusually large 3-Y water pipe. Not only was this the largest water pipe ever cast, it was also one of the most difficult castings poured successfully of steel. Unusually large, the pipe was over 5½ feet in diameter. Three openings at the opposite end of the pipe connected it to the smaller pipes. Six cylinders traversed the main part of the pipe and these cylinders were used to bolt the pipe to anchoring platforms. Weighing 21,390 pounds and being fully 2½ inches thick, the casting had been designed especially for the high pressure fire system of Pittsburgh. The pipe had been made by a large foundry in Chester, Pennsylvania, which specialized in high pressure steel castings. Made of plain carbon steel and annealed, the casting was advertised as illustrating the high degree of skill of the modern foundry worker.

The railroad industry which in 1893 was purchasing complete locomotive frames from German foundries, had come to accept American production. Although by 1896 locomotive frames were being produced, by 1917 foundries were turning out 34-foot locomotive frames of complex design. These frames weighed up to 14,000 pounds, and the percentage of loss in a good foundry would not exceed four. At the same time the truck superstructure of freight cars, passenger cars, and locomotives, were almost exclusively composed of steel castings. The castings proved reliable when they were produced according to practice and the specifications which prevailed.

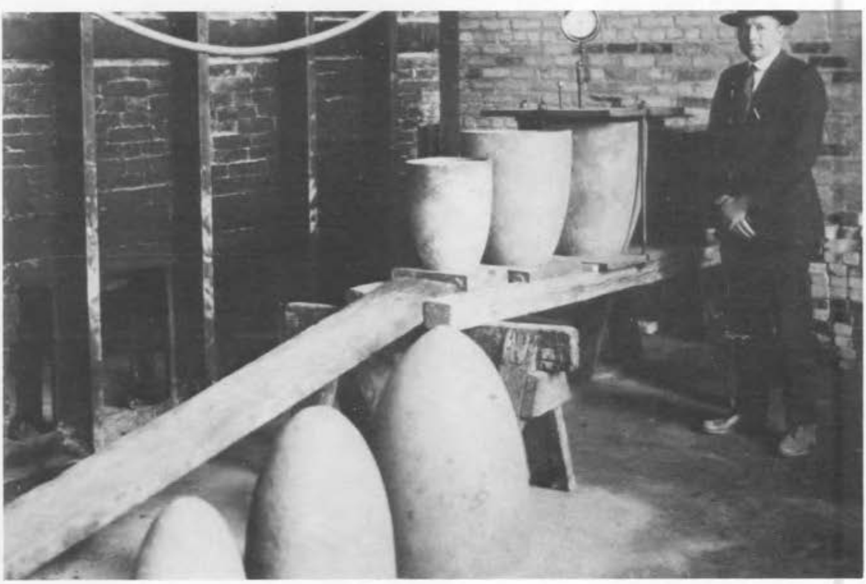
The production of a sound casting had been the founders' primary goal from the industry's inception. Beyond this was the extension of soundness to the entire product line. However, the problem of maintaining one foundry's quality was compounded geometrically when applied to the industry as a whole. The cooperation engendered by the technical societies, schools, and technical publications all served to bring this dream closer to reality. Instrumental in this was the development of increasingly sophisticated specifications and quality control measures.

Naturally the concern of sound castings was shared by the industry's customers. But, serving as an impediment to this was the variety of specifications set by the customers. A study of the problem undertaken by Edwin F. Cone of *Iron Age* served to point out the varying specifications put forth by customers within a given industry. Questioning 27 railroads, he found the specifications for their castings ranging from a simple tensile strength requirement of 56,000 pounds and a 17 percent elongation in 2 inches, to an elastic limit of 32,000 pounds minimum, a tensile strength minimum of 70,000 pounds, and elongation of 18 percent in 2 inches and a 25 percent reduction of area.

The same was to hold true in industrial and marine casting specifications. Here they were to range from a simple tensile strength requirement of 60,000 to 70,000 pounds minimum with an elongation of 15 percent in 2 inches, to a minimum elastic limit of 27,000 pounds, a tensile strength of 60,000 pounds minimum, an elongation of 22 percent in 2 inches and a 30 percent reduction of area. As a solution, Cone suggested the adoption of a set of universal standards for each industry. Typical standards for industrial and marine castings would call for and elastic limit of one-half the tensile strength, a tensile strength of 65,000 pounds minimum, and elongation of 22 percent in 2 inches, a 40 percent reduction of area, and a cold bend of 120 degrees minimum. For railroads the specifications

High pressure testing and the industry's contribution to the war effort are illustrated in these two photos of Maynard Electric Steel Casting Co. Below, Mr. Frank Wabiszewski stands next to the testing apparatus and the "aeroplane bomb shell noses."

Courtesy: Maynard Steel Casting Company



could include elastic limit of one-half the tensile strength, a tensile strength of 60,000 pounds minimum, and a 25 percent elongation in 2 inches with a reduction of area of 40 percent. This standardization would help to insure the quality and reliability of castings and serve to prevent tragedies such as the Quebec Bridge disaster.

The critics of steel castings were put to degrade the industry's performance in the First World War. Meeting rigid specifications in terms of casting quality and speed of delivery, the industry established itself as an integral part of the modern wartive industrial community. This performance revolved around the production of materials for both ordnance and naval construction. Ordnance production met a host of demands ranging from cast shells and the carriages which held the guns that fired them, to a role in the production of treads for tanks.

But it was in the field of naval construction that the industry faced its greatest task. By 1915, four very large and important steel castings were required for modern battleship construction. These included the stern frame, the stem, the rudder frame, and the struts. As the size of battleships has increased, so had the size of the castings required in their construction. Not only the size, but the design had changed and most of them presented unusual problems and difficulties in molding and casting. Battleships such as the *Arizona*, *Mississippi*, and *California* required about 343 gross tons of steel castings. This was a considerable increase over ships built a few years earlier, such as the *Kentucky*, which had required only 123 tons.

Producing these castings under pressure was not new to the industry, but was uncommon. In April 1911 the steamship *Princess Irene* went aground on the shore of Long Island. Obviously the steamship company was anxious to get the vessel back into service as soon as possible. But this could only be accomplished when a new sectional stern frame had been cast and installed. Faced with this problem, the steamship company offered a liberal bonus for the completion of a new frame in less time than was usually taken for such a casting. In this case the frame was cast in 11 days—and the bonus earned was almost equal to the price of the casting.

The early work of John Roach, William Chandler, and William Hunt had provided a firm base for the development of a modern navy. But the fleet with which the United States entered World War I suddenly appeared wholly inadequate. The war demands were considerably greater than any faced thus far. Under what could be termed a "sort of selective draft" General Goethals of Panama Canal construction fame was recalled to government service as supervisor of ship construction. As he entered into this service he discovered plans being made to produce 3 million tons of wooden ships in 18 months. Although contracts had been promised in all directions, Goethals soon found that no specifications existed and the wood planned for the construction was still standing in forests. With this discovery, he turned to the steel industry.

President Farrell of the United States Steel Corporation promised that enough steel would be available, and Goethals turned to Washington to find the money to pay for the ships. It had been planned to finance the ships' construction by selling Panama Canal bonds, but no steps had been taken to sell the bonds. As General Goethals put it: "Money is necessary in shipbuilding as in everything. Boards I have always regarded as long, narrow and wooden — I appealed to the House of Representatives Committee on Appropriations which is now discussing the matter. It has promised that in ten days or two weeks I shall get the money. I had another talk with Mr. Farrell and, depending on the promises which he made, I believe that I can say that we can build 3 million tons of ships in 18 months."

Construction of these ships began immediately. In one ship, the *Pennsylvania*, a stern post or stern frame was cast and its total weight was 59,826 pounds. It was cast in two pieces with the larger section accounting for 37,990 pounds. Its length was nearly 35 feet.

Turbine driven ships had developed a need for cast steel turbine wheels, both very large and intricate. They called for all the ingenuity of the industry's skilled labor. Other important castings for both the hull and engine included cross pipes, bent plates, and pistons. All of these required annealing, physical tests, and exacting surface inspection before the government would accept them.

The tremendous increase in shipbuilding brought about another casting development. Less conspicuous, but equally as important as the above, was the production of chain to anchor the dreadnoughts. To this time the market had belonged to the forgers. But the excessive demand imposed by the war prompted the casting industry to undertake the production. Casting a link chain had not before been undertaken. But after months of painstaking experimentation, the riddle was solved by National Malleable and Steel Castings Company of Cleveland. The company had for some time been engaged in the manufacture of car coupler knuckles and noted a resemblance between the shock and buff that the knuckles were required to withstand in hauling freight trains, and the shock and stress which an anchor chain would be subject to. The real problem though was how does one cast a chain. The answer was found in casting single links in advance and assembling these in molds into which steel was poured to produce a connecting link.

The incredible demands imposed by the war occasioned the government's first real attempts to control the economy's production. In this attempt Federal agencies, which were a composite of military and industrial personnel, were brought together and allocated powers by the government. Among their concerns were increases in productive capacity, standardization (e.q., automatic railroad car couplers were standardized in 1916), the simplification of products and processes, and scientific management. The creation of the War Industries Board, which was one of these agencies, has been proposed as the precursor of the military-industrial complex of the 1960's.

The Army Appropriations Act of August 1916 provided for a Council of National Defense which was to consist of six cabinet members and serve as the President's advisory body on the mobilization of the economy. Assisting this body was a National Defense Advisory Commission. It was this commission which brought together the businessmen of the nation. In many cases they served for a dollar a year or without compensation, and surrendered neither their positions nor incomes as private citizens.

With the nation's declaration of war this commission was faced with the challenge of bringing about full-scale mobilization. In July 1917 a more effective agency, the War Industries Board, took over the functions of the NDAC. Until March 1918 neither of the agencies had legal authority to enforce their decisions; both were subordinate to the Council of National Defense, and it, in turn, could only give advice to the President.

Yet, during 1917 these businessmen perfected the mobilization agencies and brought about the means for curtailing civilian production and converting industry to wartime production. In addition they developed their price, priority, allocation and other economic controls. By the end of the year the War Industries Board had created the organization and controls which were essential for regulating a wartime economy.

In an era fought with regulation and control it is hard to imagine the enormity of these men's accomplishments. For the first time the government had exercised control of the nation's economy. And, in overcoming the obstacles they faced, the NDAC and WIB layed the groundwork for future attempts to deal with large-scale national emergencies.

CHAPTER 7—The 1920's

The Great War was over. "The war to end all wars" had produced few physical scars on the United States. We had gained far more than we had lost. Fewer than 100,000 men died in battle, less than the number who died of influenza. The U.S. economy in general, and industry in specific had flourished in our attempt to "make the world safe for democracy."

Mentally, however, the U.S. emerged from the war with not a few scars. Although she could advance a claim as the most powerful nation on earth, she chose to retreat to a traditional, isolationist position. A generation of intellectuals became "lost." A moralistic Congress passed the 18th Amendment, and the word "dry" took on a whole, new connotation.

Strangely prophetic was Harry Donaldson's 1919 hit, "How You Going To Keep Them Down on the Farm after They've Seen Paree?". The answer quite simply was: you weren't. America was an urban industrial nation. The city had supplanted the farm—and that was clear to any who cared to think about it.

The "roaring" aspect of the '20's stemmed from the social scene. Prohibition did not stand in the way of people's enjoyment. Rather, it enhanced it. The speakeasy added romance and intrigue to the simple act of drinking.

Women had gained the vote, but their emancipation was to go far beyond this. With boyish hair and figure, the flapper appeared and joined men in their drinking, smoking, games, and jobs.

The U.S. turned its back on the military. Appropriations were slasked as the armed forces fell into a peace time disregard.

Politically the '20's were to belong to the Republicans. Warren G. Harding took the Presidency from the Democrats with his promise to "return to normalcy." Harding's political savoir-faire was as lacking as his vocabulary, yet it aroused no great stir. In the wake of the Teapot Dome Scandal, Warren Harding died in office and was mourned by the nation at large. Harding's successor, Calvin Coolidge, stood as a social foil to the departed President. Spurning drink and frivolity, Coolidge stood as the incarnation of sobriety. But, "the business of America was business" according to Coolidge, and this acknowledgment won him a second term. Herbert Hoover took office in 1929 and finished both the decade and the Republican occupancy of the Presidency.

The Coolidge attitude toward business was espoused and maintained by all three Presidents and contributed much to the prosperity of the decade. 1920-21 saw a period of sharp deflation and recession. But, by late 1922 recovery was underway, and superficially, it would last until the stock market crash of 1929. Sustaining the recovery was a conspicuous demand/supply of consumer's durable goods. The manufacturers of automobiles, washing machines, and refrigerators, etc., expanded their production, extended credit and enjoyed brisk sales. The construction and real estate industries boomed. The business of America was business — and business was good.

Consumer expenditures dropped in 1927, but the boom continued. Securities speculation fed the economy, and drove prices up. This was to continue until 1929 when the European economic decline was reflected in the American stock quotations. The United States and the rest of the world joined in discovering the true meaning of a depressed economy.

The transition to a peacetime economy is traditionally approached with a great deal of trepidation. Fortunately this apprehension, while definitely not to be discredited, has in many cases been unwarranted. The transition from the World War I economy to the peacetime economy of the early '20's offers a good example of this.

The cessation of hostilities on November 11, 1918, signaled the end of the war boom. Yet, the transition took place rapidly and the economy suffered a sharp but brief letdown. People, denied consumer goods because of war production priority, readily entered the retail markets as goods became available. Prosperity generated by sales restored the economy, and to a lesser extent, the steel casting industry through the last year of the 1910's to 1921 period. However, 1921 saw yet another economic letdown. While resembling the immediate post war downturn in its brevity, the 1921 fall was more severe.

These waves of letdown, boom, and letdown can be studied in a series of comparison statistics relating to orders, production, and prices of steel castings. Orders fell from a record 1,133,910 tons in 1918 to a low of 435,066 tons in 1919. The next year saw a peacetime boom of 997,358 tons booked, while 1921 saw the disastrous drop to 392,165 tons, the lowest since 1913.

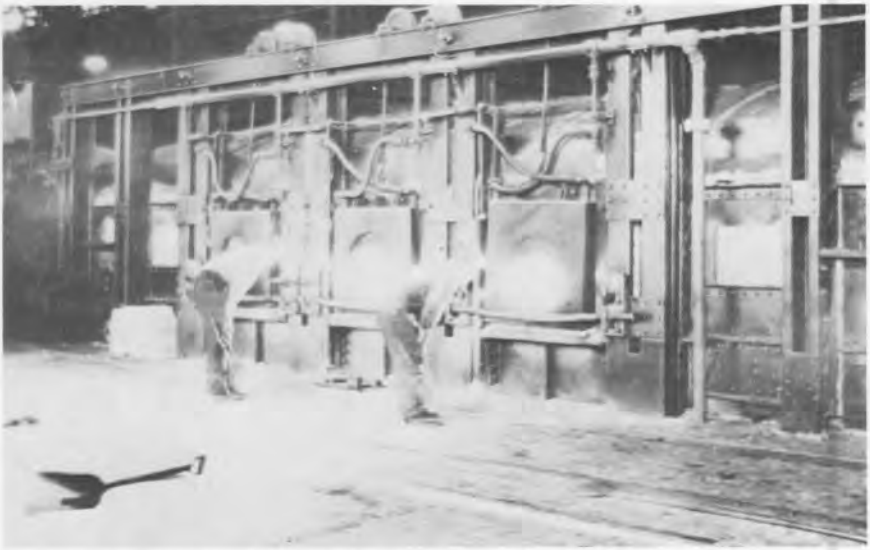
Actual production revealed the difference in intensity of letdowns. Total tonnage produced in 1919 was 825,485 tons; production in 1921 was 464,762 tons.

The price fluctuations of 1922 reveal the industry's attempts to recover. To stimulate sales, American Steel Foundries published a new price list on February 22, 1922, announcing general price reductions on all castings, with lighter castings leading. By late June the market had firmed up and prices rose. ASF (effective July 1) raised prices (by means of discounts) by about 5 percent.

Meanwhile, the number of steel foundries had grown. The third edition of the SFSA's *List of Manufacturers* published in 1922 records 237 foundries producing steel castings. These foundries were now spread over 36 separate states in the following manner:

Alabama	2	Kentucky	1	Oklahoma	2
Alaska	1	Louisiana	3	Oregon	2
Arkansas	1	Massachusetts	9	Panama Canal	1
California	12	Maryland	1	Pennsylvania	52
Colorado	2	Michigan	13	Rhode Island	1
Connecticut	3	Minnesota	6	Tennessee	2
Delaware	2	Missouri	4	Texas	3
D.C.	1	Nebraska	1	Utah	2
Georgia	1	New Hampshire	1	Virginia	3
Illinois	13	New Jersey	4	Washington	10
Indiana	6	New York	13	West Virginia	2
Iowa	6	Ohio	31	Wisconsin	20

Statistics, though not presenting the entire picture, do show the remaining years of the decade maintained the 1923 recovery. The Commerce Department's *Census of Manufacturers* showed 1923's



The enormous capacity of the open-hearth accounted for its high percentage of total steel castings production. Above, two melters follow the heat's progress.

Courtesy: Foundry

production to be 1,254,410 net tons; 1925 at 1,128,863 tons; 1927 at 1,100,907 tons; and by 1929 the production had risen to 1,531,040 tons. However, the increase in the number of foundries served to decrease the amount of castings produced per foundry and forecasted an alarming situation.

This "prosperity" can also be appreciated when average yearly production figures for the 1920's are compared with those of the pre World War I years. The years 1913, 1914, and 1915 had an average of 479,991.3 tons. If the production for 1916 (when war production began to affect the states) is included, the average rises to 625,343.25 tons. The eleven postwar years 1919 to 1929 showed a total production of 10,279,482 tons and a yearly average of 934,498.36 tons. Depending upon the statistical base of the prewar years, the '20's average yearly production is 149.4 percent to 194.7 percent above those of the prewar years.

The gross production statistics do not tell the whole story. Internally the industry was beginning to feel pinched. Production was increasing, but not as rapidly as did the number of foundries. As a result, the difference between capacity and production continually widened. Quite simply the industry was overexpanding. From the end of World War I to 1928, no more than 74 percent of the industry's capacity was utilized in any one year. By early 1927 less than 60 percent was used—late 1927 less than 50 percent. The number of companies had increased to 267, with 293 individual plants being operated.

Reacting to the situation, W. J. Corbett, Secretary/Manager of SFSA declared in June 1928: "In the public interest further expansion in the facilities for manufacturing steel castings should be delayed until a greater percentage of the present capacity of the steel foundries can be utilized to meet consumer's needs." The realization was there, but it was too late. This situation applied to the American economy in general, and no moratorium would avert the impending crisis.

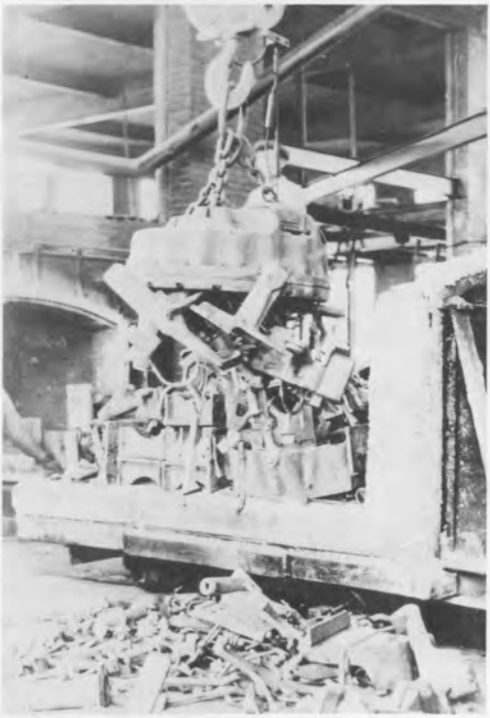
Technology was changing steel founding from an art to a science. But the art mystique continued to plague to the industry, due in no small part to the men who were then in control. The Bull of the Woods still considered steel casting an art—that statement often began and ended any discussion of the subject.

Molders considered their work an art. The following molders' formula appeared in a 1923 *Foundry* article on steel casting trends. Using high grade silica sand, facings were made as follows:

Four wheelbarrows of washed green sand
Four wheelbarrows of dry green sand

Two shovels of compound
One bucket of molasses water (one to twenty-five)
One gallon crude oil
This is ground in a mill and the pattern is coated with about one-half inch of facing where finish is required. The flask is then filled up with a backing made up as follows:
Two wheelbarrows of green sand
Six wheelbarrows of burnt sand
Two shovels of compound
One bucket of molasses water
One gallon of crude oil
Ground and mixed as was the facing.

However, technological advances continued to bring the industry closer to science. Although the art aspect would not disappear from the foundry, it would never again regain its former place.



A 36" electromagnet in use during the early 1920's.
Courtesy: Maynard Steel Casting Company

The teen years of the century had seen a surge in the acceptance of electric furnaces. While production in 1909 had been less than 2 percent of the steel casting total, by 1923 the percentage had grown to 16.17 percent. Output had increased over 800 fold. Of the 237 foundries contained in the 3rd edition of the Steel Founders' *List of Manufacturers*, 121 utilized electric furnaces either wholly or partially.

The advantages of the electric furnace were numerous and accounted for its rapid adoption. It was particularly well suited for jobbing foundries called upon to produce a variety of steels and an even greater variety of amounts. Beyond the actual advantages which had convinced founders to adopt the furnace, there loomed a vast potential. Technology in the 20's was to a large degree to revolve around exporing this potential.

Organized exploration of the potential was the driving force behind the Electric Steel Founders' Research Group which was formed in 1921. For the next ten years this group would undertake cooperative research in a variety of fields—but research which would be of value to all. By pooling their limited resources, the members directed their efforts in the following broad categories: lessening production costs through the elimination of waste; improvements of present products and processes while developing new ones; standardization of manufacturing operations, product quality and control and anaylsis methods; sales engineering, or the development of new uses for known products; and the development of new, efficient merchandising methods. Five foundries formed the core of the research group; Michigan Steel Casting Company, Detroit; Fort Pitt Steel Casting Company, Pittsburgh; Lebanon Steel Foundry, Lebanon, Pennsylvania; Nugent Steel Castings Company, Chicago; and Sivyer Steel Casting Company, Milwaukee. Research subjects were approved by the group and experiments carried out at one or more of the foundries.

The investigation of molding and core sands was carried out by Sivyer and Fort Pitt. Concentrating on the sand necessary in the production of small castings with thin sections, the two foundries amassed a considerable amount of information. This ranged from analysis of raw sand through mixing, moisture content, bonding ingredients, and the daily analysis and control of sand mixtures in the foundry.

Heat treating was the property of Michigan Steel Castings. Consumers were just beginning to realize the importance of the subject, and the research group expressed the necessity of establishing an optimum standard. Michigan began experiments in data collection and arrived at optimum annealing temperatures, stoking times, and cooling methods. In all, they has "conclusively determined the best practice to follow."

Lebanon Steel Foundry undertook the investigation of slag in castings, and their findings presented newcomers with methods to minimize the presence of occluded slag.

Research on the use of aluminum in steel casting production led to the conclusion that there was a definite maximum amount of the metal per ton of steel that could be employed without deleting the steel's ductility. If the amount were not exceeded, the aluminum's presence would have no effect on the physical properties of the steel casting other than the positive effect of deoxidation.

Technology was by no means the only concern of the research group. A 1921 Federal Trade Commission study of 30,000 manufacturing establishments in the U.S. had revealed only 10 percent had adequate knowledge of costs. The general example of foundry cost practices was the concept of an average monthly cost per ton of good castings. A $300 per ton average though would not point out that some castings had cost $150 per ton, while others had cost $1,000 per ton. Reacting to this misuse of elaborate cost summaries which foundries were using to determine costs, and therefore prices, the group pushed for more accurate and complete statistical records. Areas such as production control systems, development of new uses for products, education of salesmen, as well as technology continued to be investigated by them.

The Electric Steel Founders' Research Group did not limit the scope of its research efforts to its membership only, but co-operated with other organizations in ventures on a larger scale. Under research director, R. A. Bull, the group joined with AFA and SFSA members (100 foundries in all) to investigate the effects of phosphorous in steel. The industry as a whole was coming to appreciate the efforts of cooperation.

However, by 1931 the members found themselves confronted with economic circumstances which no amount of research on their part could alleviate. And, in such a position the group fell victim to the depression of the thirties.

Advances were not limited to multi-foundry research efforts. Striking evidence of this can be found in alloy developments of the decade. The first molybdenum steel rolls were cast in 1921. The roll as a cast steel product had undergone a succession of alloy improvements which culminated in the present state. The 1800's had seen the casting of the first nickel rolls; later manganese rolls were created.

Alloy steels by 1928 were being touted as producing advantages in three main areas. They were steels of high physical properties such as tensile strength, ductility, and resistance to impact, abrasion, distortion and fatigue. They possessed extraordinary properties in their resistance to corrosion and magnetic permeability. And finally, they were extremely resistant to heat.

As an industry, alloy steel dates back to 1909. At that time the production ratio of total steel to alloy steel was over 130 to 1: one hundred and thirty tons of ingots and steel castings for every ton of alloy steel. Prior alloys were produced in limited quantities with little being done on a commercial scale. The exception, of course, was high speed steels which did not run in large quantities.

In contrast to the size of the open-hearth is this small ½ ton per hour circular arc electric furnace installed in 1928 by Lebanon Steel Foundry for the production of stainless steel castings.
Courtesy: Lebanon Steel Foundry

By 1913 the 130 to 1 ratio had dropped to 36.3 to 1, and by 1924 it stood at 18.7 to 1. With alloy steel being applied to an ever-growing number of situations, Sir Robert Hadfield, an eminent British metallurgist, declared the alloy steel industry "a new age in metallurgy."

Alloy steel castings had been one of the more remarkable stories spawned by the new industry. The combination of the electric furnace and the alloys resulted in a growth almost unmatched in casting history. While only 8 gross tons of alloy castings were produced in 1910, the figure had grown to 6,057 by 1919. The next year saw production take off, and the figure climbed to 11,710 gross tons. The 67,866 gross tons produced in 1923-24 almost equaled the total of all previous years (1910 to 1922).

The proportion of alloy steels used in castings, as opposed to other uses, shows an even more remarkable growth. 245,272 gross tons of alloy steel were produced in 1920. The 11,710 tons used for castings was 4.77 percent of this total. 4.77 percent was also the highest percentage to date. But the next year, 1921, saw the percentage climb to 15.94 percent! Succeeding years to 1924 saw an average of 15 percent maintained.

Perfecting of castings continued to gain importance. The X-rays developed during the teens saw increasing use as nondestructive testing became a casting selling point. Between 1920 and 1921 an active and successful campaign to merchandise inspections took place. Testing facilities and personnel were improved and customers could now expect to save time, trouble and money when purchasing steel castings. Products passing under such inspection could arrive at the customer's business in a sounder and more true to pattern state than had been the case in the past.

Traditional markets such as the railroads, shipbuilding, machinery, mining, and dredging continued to act as the main outlets for steel castings production. But new applications on a mass scale partic-

A scene from the cleaning room shows two chippers and one of Maynard electric's first large gear castings.

Courtesy: Maynard Steel Casting Co.

ularly in the production of consumers' durable goods such as appliances and automobiles, added impetus to the rise in castings demand. During the 1920's these markets combined to call for an ever-increasing amount of castings.

The German ship, *Vaterland*, built in 1914 was the pride of Germany's merchant fleet. Interred and subsequently used by the U.S. as a troop carrier during World War I, the ship had turned in an admirable performance in its eight-year existence. But by 1922, it was suffering from extensive use and inadequate repair. The 33,000-pound steel anchors had damaged the cast iron hawse pipes beyond repair, and their replacement received high priority in the ship's 1922 major overhaul. It was determined that the new pipes should be of cast steel, but the absence of original drawings much less of patterns, made the task seemingly impossible. However, the Sterling Steel Foundry, Braddock, Pennsylvania, took on the job. Their patternmakers constructed templates and took their measurements from the damaged pipes of the ship. From these they produced two patterns weighing 900 pounds each and using 1500 feet of lumber. The patterns were shipped to Norfolk and checked with the hull before the casting was poured. When the 9-ton, 18-foot long casting was sent to the shipyard and hoisted into place, the match was almost perfect.

Naval deck ring castings were being produced for 8-inch gun turret mounts. Once thought impossible to cast, these rings were 23 feet in diameter, weighed 10,000 pounds each, and had a constantly changing section with the sheer and camber matching the variations of the deck. Finally it was necessary to cast and anneal the rings to within one-quarter inch of a true circle.

The movement of gases and liquids through pipes was not new to the 1920's, but the decade did see a dramatic widening of the field as more and larger and stronger castings were called for. The Pittsburgh Valve Foundry and Construction Company responded to this increased use in high pressure lines by building a steel foundry specifically for the market.

An attempt to harness the power of the Susquehanna River occasioned the construction of the Conowingo Dam near the Pennsylvania-Maryland border. Entering into the construction were steel castings wheels, wickets, and butterfly valves which at that time were the largest ever built for water power control. Sharing in the castings were The Falk Corporation, Milwaukee; Otis Steel Company, Cleveland; and the Wheeling Mold and Foundry Company, Wheeling, West Virginia.

The oil industry in the Southwest had been producing since the discovery of the Spindle-top fields in 1901. By 1921 the oil industry's demand for castings prompted the establishment of steel foundries such as Oklahoma Steel Casting Company, Tulsa, Oklahoma; and Texas Electric.

Castings for the oil industry could be produced anywhere in the U.S., and many times they were. But southwestern foundries' unique geographic position enabled them to keep in close touch with the field men, watch the performance of their castings, and learn firsthand the needs of the industry. And these needs were varied. Oil fields called for a multitude of shapes and sizes—each in a varying amount and analysis of steel. As a result, a company such as Oklahoma Steel Castings, which at this time produced exclusively for the oil industry, was in a unique and often uncomfortable position. Moreover their position was tied solely and securely to that of the oil industry. If oil production dropped, so did casting production. There was no room for orders from other markets to offset such a decline.

Consumer durable goods comprised a good portion of the '20's casting market, and the rise of durable goods production affected to a large degree the increase in castings production. The suspension system alone for one 1926 light truck contained six steel castings. Ironically these particular castings were produced by the Nutmeg Crucible Steel Company, Stony Brook, Connecticut. One of the latest castings' applications kept the oldest form of melting in operation.

In keeping with the precept "the business of America is business," the 1920's saw the government taking an increasingly active role in collecting and reporting commerce statistics. These ranged from the reporting of orders and production to the hours and wages of labor. Though they relate to the foundry industry in general (with little differentiation between iron and steel, much less the more subtle differences of steel grades, they do provide a reliable view of the labor scene. Combining these statistics with reports issued by the NFA, a fairly complete picture of labor in the '20's is brought about.

Attempts to cure the 1921 slump had involved cuts in wages as well as prices. The NFA reported welders and core makers in union foundries in 25 different towns in an eleven state area all experienced a wage cut in 1922. Mansfield, Ohio saw the greatest cut—from \$6.00 to \$5.00 per day. On the other hand the decline in Kansas City, Missouri, was only 15 cents—from \$6.40 to \$6.25 for a day's work. The average decline in the eleven state area had been 53.6 cents per day.

Averages for the entire ferrous foundry industry based on census data was published by the government in 1925 and 1927. The study had broken foundry labor into 13 different classifications ranging from highly skilled to common labor situations. It included (1) chippers and rough grinders, (2) core makers, (3) crane operators, (4) cupola tenders, (5) laborers, (6) molders (hand-bench), (7) molders (hand-floor), (8) molders (machine), (9) molders' helpers (floor), (10) patternmakers, (11) rough carpenters, (12) sand blasters, (13) others.

Among these classifications the average wage was found to be 61.2 cents per hour in 1925 and by 1927 it had risen to 62.6 cents per hour. The highest paid positions were those of patternmakers who in 1925 earned 80 cents an hour, and in 1927 earned 83 cents an hour. Molders (hand-floor) rose from 80.2 cents per hour to 82 cents an hour. The low men on the labor floor were molders' helpers who were earning 46 cents an hour in 1925 and 48.4 cents per hour in 1927. And, lowest overall were female laborers whose earnings were 31.6 cents in 1925 and rose to 38.2 cents in 1927.

It was thinking such as this — the publication of statistics and, more important the use of these statistics by management — which signaled the end of a foundry era. The era of the superintendent was drawing to a close. Professional management was making continual inroads on his power and control. Known by a host of aliases ranging from plain "Super," "Old Man," "Bull of the Woods," to simply "Bull," these men had determined actual foundry operation from its inception.

His word was law, and he was the prime enforcer of that law. Traditionally his most important qualification was "I can lick any man on my crew." One example of such action on the part of the Bull occurred at Empire Steel Castings in Reading, Pennsylvania. Mr. Mac Moore, President of Empire, recalled a scene in the '20's. The melter's assistant was a young, strong, confident fellow who had boxed professionally for a couple years during an interim in the foundry. One day the super directed him to use a certain scrap in charging a particular heat. The assistant really didn't see the wisdom of this particular specification and made the mistake of letting the super know. His second mistake came in his reaction to the old man's reply: "Do what you're told." Having taken what he considered enough of the fat man's bullying — the young melter lead with his right. To his great surprise, and greater regret, the melter's first shot had been ducked, and his head was now rather ungently cradled between the super's right arm and side. To make matters worse, his backside was now being held against one of Empire's electric furnaces. The super's final triumph came when he released the young man and gave him a final word of advice: "Next time I'll take your pants down first!" That may

The presence of the "Bull of the Woods" was felt throughout the foundry. The photo above shows the "Bull" personally pouring a heat.

Courtesy: Maynard Steel Casting Company

have been learning the hard way, but the lesson was learned. The "Bull of the Woods" had not been given the name for nothing. The young melter recently retired from Empire after 40 years in the foundry.

The end of the Superintendent's reign in the steel foundry was not a sudden, overnight cessation. As late as 1950 Steve Dobos, Superintendent of the Newark Plant of ASF, required his subordinates to remain one step behind him as they walked through the foundry. Vince Tripodi was one of Dobos' subordinates at Newark. Beginning his employment in the late '30's and attending college at nights, Tripodi trained under Dobos for over eight years. Finally in 1952, as Dobos was nearing his retirement and Vince's education was complete, they walked abreast through the shop.

Dobos had received his early training in Budapest where, as a boy in the coreroom, he would be sent to neighboring stables for manure to use as binders. Even in the U.S., when confronted with a particularly difficult core, he would order someone from the foundry out to the streets and neighboring stables with wheelbarrow and shovel.

However, transition figures were beginning to fill the Super's role in the twenties. One of these men was Raymond E. Fisher, Sr., who during the mid-20's was Foundry Superintendent of Duquesne Steel, Corapolis, Pennsylvania. This position was one of a series which spanned over fifty years, and witnessed a rise from molder's apprentice to corporate president.

The son of John Fisher, Superintendent of Ohio Steel Foundry, Ray grew up in the industry. By 1923 he had married, and assumed the Super's job at Duquesne. In 1927 Harrison Hoblitzelle brought him to American Locomotive Steel Foundry, and the subsequent General Steel Castings Co., in Chester, Pennsylvania. A final move in 1935 found Fisher as Finishing Department Superintendent of the Bonney-Floyd Co., Columbus, Ohio. Within four years he was President of the company.

The positions of Superintendent, General Manager and President afforded Fisher the Opportunity to install the latest equipment and employ more progressive methods. During the twenties his companies would be among the first to benefit from radiography and tackle large, complex valve and turbine castings. In opposition to the old school thought of men such as Dobos, Fisher would become active in informal management training programs as a new generation of foundrymen were being readied. No fewer than seven men would pass under his influence and eventually become presidents of other steel foundries.

The superintendent's role extended well beyond the foundry floor. In an address to the SFA's 30th T & O Conference, Mr. Charles Stull of Pelton Casteel, Milwaukee, accorded the superintendent, one of two most important roles in the steel casting industry—from 1861 to 1940 the most important role. Professing technical training gained through experience, the super was master molder and core maker. He directly supervised all pattern and core equipment, all heading and gating, all production in making the heats. He was a traveling management team. His fights with owners were legendary. The early metallurgists were his fair game—and eventually his undoing. Though some are still around, his race had been rapidly vanishing since the Second World War. Unions frowned on backsides being shoved against furnaces, and metallurgists on gauging melting by the color of the molten metal.

CHAPTER 8—The 1930's

Just as wars had dominated earlier decades, so the Great Depression dominated the '30's. Gone were the carefree days of the '20's. In their place had come the days which would epitomize the phrase, "hard times." One-quarter of the population was out of work; two-thirds would occasionally feel hunger. The glorious and opulent days celebrated by Fitzgerald had succumbed to the harsh and stark reality of Steinbeck.

Herbert Hoover, perhaps the ablest of the three Presidents of the '20's, would unjustly bear much of the blame for the depression. Elected in 1928 and inaugurated in March of 1929, he would be in office a little over seven months when Black Friday would dawn on Wall Street, and ultimately, $50 billion in paper valuation would disappear. At the time there was no way of accurately gauging the situation; much less any hope of remedying it. The measures taken by Hoover, seen with the advantage of hindsight, can be summed up as: "Too little, too late."

Roosevelt's election in November 1932 ended Republican control of the White House and began a 20-year Democratic tenure.

The economic situation following the crash of 1929 worsened despite credit extension and the easing of the money market. By Inauguration Day, March 4, 1933, deteriorated the depths had been reached: the banking crisis deteriorated and "bank holidays" were widespread; unemployment stood at about 15 million; industrial output was only half that of 1929; and one-third of the nation's railway mileage was bankrupt.

Franklin Roosevelt, adopting Hoover's relief programs as his own, further initiated one of the most controversial periods in American legislative history. With the objectives of relief, recovery, and reform, the country moved into its first New Deal and into the new era of national centralization.

Deficit financing on an increasing scale contributed to economic recovery between 1933 and 1937, though the recovery was by no means even or sustained. An acute recession in 1937 was met with renewed deficit spending and recovery began again. However, unemployment in August of 1939 still stood at 10 million, and relief from the depression came only from a national emergency of another sort—the Second World War.

The economic loss of the decade was staggering. The years 1930 to 1938 alone had seen a loss of national income totaling $132,600,000,000.

Foundry operation reflected the worst of the general industrial economic conditions. The very nature of the industry tied it to the extreme variations in durable goods production. As the manufacturers of automobiles, machinery, building supplies, railroad equipment, and household appliances continued to expand, casting production grew with it. In 1929 production of steel castings stood at 1,531,040 tons — the highest in the industry's history.

With the onset of the Great Depression, the steel casting as well as the rest of the foundry industry was extremely hard hit. Unable to earn profits, many foundries shut down completely with no definite reopening scheduled, and 10 more were listed as "going out of business."

Statistics reveal the industry as a whole operating at only 25.6 percent of its rated capacity during 1931. During 1930 production had accounted for only 47.9 percent of capacity. Foundries which did not close became extremely cost conscious, with cost cutting being the primary means of fighting for life. Consequently, little was left for luxuries such as capital improvement and upkeep.

The next edition of the Commerce Department's biennial *Census of Manufacturers* showed steel castings' 1931 production had fallen to 514,417 tons. Production was to decline even further to a 1933 low of 312,225 tons, before a revival took place in 1937. The '37 production was 1,315,837 tons (over four times that of '33, and two and a half times that of '35.).

The recovery, however, was partial with an inordinate share of the production belonging to captive foundries. However, jobbing foundries did see an increase in orders from customers in the machine tool and refrigeration industries among others. But many that did receive orders found they were ill prepared to meet the requirements. The effect of seven years of depression had taken its toll on capital.

The economic recovery proved to be as short lived as it was uneven. By 1939 production had fallen back to 613,719 tons, less than one-half the 1937 level. Only the German military aggressions and eventual declaration of war generated an emergency strong enough to bring the industry, and the economy in general, back to its productive capacity.

During dark days of the deepening depression, founders made several attempts to mitigate its ravages. One of the earliest was simple economizing. Cost cutting worked initially only when work was at hand.

Walter Buchen of the Buchen Company, Chicago, offered as solutions three possible options. First, the industry could continue its cost cutting/price reducing course, which Buchen claimed had only created an unsavory "dog-eat-dog" standard. The second, rather quickly dismissed, was that of more sensible competition through regulation. Finally, Buchen suggested: "For such steel castings plants as are in a position to do it, to integrate with other metal parts plants, especially in selling and merchandising." Under this plan a steel foundry, gray iron foundry, forging plant, and possibly a die casting plant would utilize a common sales organization owned by all of them. To Buchen, "the only feasible remedy is for the specialist to enlarge his specialization by selling a live product for the same assembly, to the same contacts, in the same organization."

A by product of this last plan was "pooling". This topic was discussed at a national meeting of the SFSA on May 18, 1932. Here it was reported that Milwaukee foundries were actively considering the "feasibility of concentrating their orders in one plant and keeping that one plant running at a satisfactory rate."

Meanwhile the price of castings continued to fall as founders attempted to keep their plants in operation. By October 1932, Arthur Simonson of The Falk Corporation, Milwaukee, and SFSA President was led to remark: "The price obtained for castings has declined to a point where it not only represents a terrific loss under present conditions but makes profit impossible if operating at full capacity." The price of castings had to equal cost plus profit! Simonson went on to urge no further price cuts — such would only further cripple the ailing industry.

Reporting on these early days of the depression, Col. Merrill G. Baker in 1934 would give the following description of the industry's situation. "In common with most of the durable goods industries, it has suffered greatly from the burden of the depression. From a volume in excess of $200,000,000 in 1929, its sales dropped to a little more than $25,000,000 in 1932 when it operated at about 11 percent of capacity with an average loss of approximately $50.00 per ton on every ton produced during that year. Gradual improvement has been noted but even today (May 1934) the industry is only operating at about 30 percent of capacity and the industry as a whole is still 'in the red'.

"Four years of merciless competition has practically exhausted the resources of this industry."

The result of this competition was a completely demoralized price structure. Analyzing this, Baker would not blame any one segment of the industry. Rather, he would list as its causes: a rapidly diminishing demand for steel castings; the tactics of unscrupulous producers; and the pressure exerted by dishonest buyers. "The cumulative effect of all these factors had resulted in a condition where not even the most efficient producer could meet the competition created, without sustaining heavy losses. Despair was in the hearts of all."

Such was the state of the industry, and the economy in general. Simonson's cry had been made one month prior to the election of Franklin Delano Roosevelt. Yet the period between his election (November 1932) and inauguration (March 1933) saw conditions only worsen. And, by the time the National Industrial Recovery Act was drawn up in the spring of '33, Congress had seen fit to determine: "A national emergency productive of widespread unemployment and disorganization of industry, which burdens interstate and foreign commerce, affects the public welfare and undermines the standards of living of the American people is hereby declared to exist."

As he signed the NIRA into law on June 16, 1933, President Roosevelt declared: "History probably will record the NIRA as the most important and far-reaching legislation ever enacted by the American Congress." Though he may have overstated the law's importance, it certainly ranks as one of the most far-reaching and controversial pieces of U.S. legislation. The scope of the act itself was tremendous. It established as Congressional policy the following ten goals:

> "To remove the obstructions to the free flow of interstate and foreign commerce which tend to diminish the amount thereof;
>
> To provide for the general welfare by promoting the organization of industry for the purpose of co-operative action among trade groups;
>
> To induce and maintain united action of labor and management under adequate governmental sanctions and supervision;
>
> To eliminate unfair competitive practices;
>
> To promote the fullest possible utilization of the present productive capacity of industry;
>
> To avoid undue restriction of production (except as may be temporarily required);
>
> To increase the consumption of industrial and agricultural products by increasing purchasing power;
>
> To reduce and relieve unemployment;

To improve standards of labor;

And to otherwise rehabilitate the industry and to conserve natural resources."

The Steel Founders' Society had suffered with the industry, and by 1933 was about to fall victim to the depression. But the passage of the NIRA and the Society's subsequent assumption of the role of the Code of Fair Competition Authority was soon to thrust it into a premier position.

Chauncey Belknap of Curtis Fordick & Belknap had been retained by Harrison Hoblitzelle as counsel for General Steel Castings Corporation. With the passage of the NIRA, Hoblitzelle approached Mr. Belknap and suggested that he should review the Society's current position and assist in drafting a Code of Fair Competition.

The following is Mr. Belknap's description of the state of the Society in July 1933 and the subsequent reorganization brought about by himself, Mr. Hoblitzelle, and Mr. Lorenz, acting with other members of the Society's Board of Directors. "When I looked into the picture of the existing incorporated Society, I found that it had a little office here in New York where there had recently been an embezzlement by one of its officers which had practically stripped the Society of all of its funds, which didn't amount to much anyway. What I discovered was that the incorporated Society was insolvent, and its bank account was practically zero. It couldn't pay its rent; the salaries of its employees, who I think were only three in number, were in arrears; and it was in a state of complete disorganization. To make a long story short, I advised Hoblitzelle and his associates to dissolve the incorporated Society to make a fresh start with an unincorporated Society, which I told them would be a much more effective instrument as the trade association of the industry and as the proposed Code Authority. I pointed out that if they used the old corporation, they would have to comply with the corporation laws of the state of New York under which it was organized in 1929; whereas if they established an unincorporated organization, they would be free from the restrictions of state corporation laws and could adopt an extremely flexible organization. They were somewhat worried about the possibility of personal liability if they operated an unincorporated association, but I pointed out to them that all the trade unions were unincorporated organizations and a number of other trade associations were unincorporated. They asked me to go ahead and I prepared a Constitution and By-Laws for the new Society which took over the membership of the old incorporated Society and most of the personnel, and I helped them prepare a proposed Code of Fair Competition."

The application of the NIRA to the steel casting industry resulted in this Code of Fair Competition being drawn up. Largely the work of the SFSA's Board of Directors, spearheaded by Belknap, Lorenz, and Hoblitzelle, the Code complied with Title 1 of the Act and was approved by President Roosevelt on November 2, 1933.

Containing 13 articles and eight separate schedules, the Code was a model of succinct language. In printed form it comprised only 24 pages (22 of which contained actual text), yet it provided the operational framework for an entire industry. The articles dealt with the following:

I. Purpose—to effectuate the policies of the NIRA Title 1
II. Definition
III. Scope
IV. Participation
V. Administration
VI. Hours of Labor, Rates of Pay, and other Conditions of Employment
VII. General Provisions — these set up the agency's substructure
VIII. Amendments
IX. Cancellation or Modification — Under these provisions cancellation or modification could take place by Presidential action.
X. Violation — Any violation of the Code was an unfair trade practice and subject to penalties set forth in the NIRA (these were classified ad misdemeanors and subject to fines of not more than $500, though each day the violation continued was deemed a separate offense).
XI. Rights of the Members of the Industry — basically a right to be heard before any modification took place
XII. Duration — The Code took effect on the first Monday after the fourth day following the President's approval and was to continue in effect for 60 days after June 16, 1935 (or earliest date that the President or Congress proclaims this state of emergency as ended).
XIII. List of Unfair Trade Practices.

On the schedule attached to the Code were extensions of certain of the thirteen general articles. Schedule A was simply the form of letter which gave assent to the Code.

Schedules B and C related to the description of 21 wage districts and set forth a minimum rate of hourly pay for common laborers. These districts and rates were:

1. A. Eastern	.35	5. A. N. Ohio	.40	7. B. St. Louis	.37
2. A. Buffalo	.38	5. B. S. Ohio	.37	7. C. Midcontinent	.35
3. A. Southern	.25	6. A. Chicago	.40	8. A. Seattle	.38
3. B. Birmingham	.27	6. B. Ind. - Ill.	.37	8. B. San Francisco	.37
4. A. Johnstown	.37	6. C. Detroit	.40	8. C. Los Angeles	.35
4. B. Pittsburgh-Wheeling	.40	6. D. Michigan	.37	8. D. Utah	.39
4. C. West Virginia	.37	7. A. Colorado	.40	8. E. El Paso	.25

Schedules D, E, F, G, and H dealt with unfair trade practices as they applied to segments of the steel castings industry. While certain general prohibitions would be applied wholesale to the industry, the complexity and product diversity of the segments justified lists of specific prohibitions being drawn up and being applied individually. Schedules D through G accomplished this. Unfair practices were listed for D miscellaneous castings; E specialties; F draft gears; and G manganese steel castings.

Responding to a May 1934 request by Gen. Hugh Johnson, NRA Administrator, Merrill G. Baker, Executive Vice President of the Society, submitted a report outlining the Code's effectiveness in relation to the steel casting industry. According to Mr. Baker the consensus voiced without dissension at the April 19-21 General Meeting of the Society was "that the Code had been most beneficial."

The initial effects were largely psychological. Hope and confidence had been restored. But, as industry operation improved under the Code, tangible results began to appear and fall into four broad categories.

Labor had benefited from the minimum wage and the longer hours necessary to bring about production increases. 177 foundries reported 17,939 employees in December 1933. March 1934 saw 176 firms accounting for 22,143 employees. Between July of '33 and March of '34 a 132 percent increase in employment had been effected.

The elimination of unfair trade practices had been brought about. According to Mr. Baker: "The moral fibre of many members of the industry had deteriorated to a point where sharp practices of every conceivable character were being used. Most of these were corrected through a series of Unfair Trade Practices incorporated in the Code."

The loosely defined product classification system under which the industry had operated had been restructured on a more scientific basis. The result of this was a "comprehensive dictionary of clasifications" which clearly delineated the industry's products.

Finally, the "open price" provisions of the Code had spotlighted the "chiselers," and brought about price stabilization. "It has brought all prices into the open and almost entirely eliminated the vicious price-cutting previously prevailing." However, in May 1934 the industry's average prices were still approximately 13 percent lower than in 1926.

Ironically, at a time when the Steel Founders' Society had been most vulnerable, it assumed the most influential role it would ever play. In becoming the Industry's Code Authority it exercised a great deal of delegated governmental power. The Society would perform this function admirably and continue to do so until the NIRA was declared unconstitutional in May 1935. This, incidentally, came about as a result of the Supreme Court decision in the Schecter Poultry Corp. vs. the United States — a proceeding also known as the "Sick Chicken Case."

The Society, however, would emerge from the Code Authority experience greatly strengthened. The absence of direct governmental support could have hampered this transition, but the membership and leadership proved equal to the task. With renewed confidence it would channel all its efforts toward "the interests of the steel casting business."

One of the gentlemen responsible for this transition was Frederick A. Lorenz. Completing in 1909 a University of Illinois course in railway mechanical engineering, Mr. Lorenz accepted a position as a special motive power apprentice for the Chicago and North Western Railway. Shortly after this he became associated with American Steel Foundries. There he held a number of positions, including: Manager of Sales of "Davis" wheels; Assistant to the Fourth Vice President in Charge of Operations; Works Manager of the Indiana Harbor Plant; and in 1929, Assistant Vice President. By 1934 he was a Vice President of American Steel Foundries and would remain in that position until his death in 1938.

Fred Lorenz's first recorded service to the Steel Founders' Society came in 1931 when he was elected to the Board of Directors. In 1933 he was unanimously elected "Permanent Chairman" of the same Board. 1933 also saw the formation of an "Executive Committee" with positions held by President T. H. Harvey, Harrison Hoblitzelle and Frederick A. Lorenz. Following the term of President Harvey, Lorenz was elected Society President in 1934 and served in that capacity until his death in 1938.

To insure the effectiveness of the Code of Fair Competition, Lorenz dedicated his full energies to his Society position. Mr. Thomas H. Shartle, Chairman of Texas Electric Steel Casting Co., recalled those days and the frenzied activities of Lorenz and SFSA Executive Vice President Col. Baker; they "traveled the whole country plugging the blue book which set a floor on steel casting prices." The death of his father occurred during the October 24-27, 1933, Board of Directors Meeting in Cleveland. Yet, Lorenz would leave the meeting only after reading a statement from the Wage Committee Chairman of Division 6, and would return for the morning session on October 27.

His contributions to the industry were recognized and honored by the Steel Founders' Society. In 1938 the Society struck the first Frederick A. Lorenz Medal commemorating the outstanding and unselfish service to the industry rendered by Lorenz. This first medal was presented to his wife. During the 36 years between 1939 and 1975, 32 men would contribute in like manner and receive this award — one of the Society's two highest honors.

The depression's effects on labor were considerable, and for the most part, devastating. Of these effects, the most immediate was a drop in earnings brought about by a lessened wage and a reduction in working hours. Many foundries simply did not have the orders to warrant a full week's production. As a result workers would finish a shift with no knowledge of when they would be called in again. Compounding this problem were the effects of the price-cutting trend in the industry. These cuts had to be met with corresponding cost reductions — reductions which often struck the vulnerable wage of the worker.

The average foundryman in 1929 was earning $30.44 per week. To do this he worked 48.7 hours for 62½ cents an hour. In 1931 he was earning $21.30 for a week's work of 35½ hours at a rate of 60 cents an hour. By 1933 this average foundryman was working only 29.6 hours for an hourly wage of 48.2 cents. These men, who were among those lucky enough to be employed, received $14.27 for their efforts. Between 1929 and 1933 the average hourly wage had fallen 40 percent, and the number of hours worked reduced by one-third.

The plight of the common laborer was even more severe. The 46 cents an hour he was earning in 1931 had fallen to 37.8 cents by 1933. Combined with the reduction in hours, this wage brought the laborer $10.50 a week. Women on the other hand fared still worse. Though the number of women employed was quite small, they were receiving only 29.6 cents an hour and working 16.9 hours per week. At these rates their weekly earnings amounted to $5.00.

Prompted by the declining wages, and the state of the industries which paid them, Congress enacted legislation which would have tremendous effects on both. While the lots of the laborers in the remaining years of the '30's would by no means be good. he received a number of benefits through the new laws which improved it over its 1933 level and promised to be of inestimable value in the future.

Undeŕ the provisions of the NIRA's Code of Fair Competition the concept of a minimum wage was developed. Depending upon district, hourly wages were set between 25 to 40 cents. Moreover, in a move to spread work opportunity, maximum of 40 hours per week was established for each worker.

While guaranteeing the right of the open shop, Section 7A of the NIRA recognized labor's right to unionize, and thus relieved the laborer from inword pressure brought by the union and management regarding membership or non-membership in a union, and instructed employers participating in the NIRA program to comply with a minimum wage schedule and to observe a maximum hourly work week limitation.

The May 1935 Supreme Court decision in the Sick Chicken Case declared the NIRA unconstitutional. This decision aroused a great deal of fear in the workmen. Section 7A had promoted significant gains for labor — gains which were now in jeopardy. Governmental recognition of labor's right to organize had added impetus to the union movement. Union mebership had increased by 1 million between the years 1933 and 1935.

Labor's fears, however, were soon abated, for in August 1935 Congress passed the National Labor Relations Act (Wagner Act). The underlying philosophy of the law was the conviction that labor could not deal with management on an equal basis without the support of government. Not only did the law guarantee labor's right to form unions and bargain collectively, but it listed a series of unfair labor practices engaged in by management. Among these unfair practices were: the restraint or coercion of employees in their exercise of the right of collective bargaining; domination or interference with the formation of a labor organization; discouraging union membership by discrimination in regard to hiring or tenure of employment; and the refusal to participate in collective bargaining. As a final measure the law provided for the establishment of a National Labor Relations Board with broad investigative powers to insure compliance with the new legislation.

The passage of the Fair Labor Standards Act in June 1938 salvaged labor's gains under the NIRA. This act placed a floor under wages and a ceiling on hours. The minimum wage was set at 25 cents an hour with a sliding scale to 40 cents an hour. Maximum hours were set at 44 per week with an eventual goal of 40 hours per week. The law further prohibited child labor in firms involved in interstate trade.

But by the decade's end, labor had won, lost, and re-won a number of significant gains. Their right to bargain collectively had been guaranteed as were the principles of unemployment compensation, minimum wage, and maximum hours.

The poor competitive position which many jobbing foundries experienced by mid-decade rested to an extent upon technological backwardness. Six years of poor business had stifled the continual upgrading of equipment, etc., necessary to retain a competitive foothold. Larger, captive foundries had maintained the reinvestment level and found themselves in an enviable position when the 1936 recovery began. Though the recovery proved to be short lived, it did serve to point out the necessity of keeping up with improved technology in an increasingly competitive field.

Mechanization was being advocated as the key defense for foundries fighting to maintain this competitive edge. *Business Week*

An automatic "shake-up" machine raised and dropped a 20,000 lb. mold 83 times a minute to shake sand from castings.

Courtesy: Foundry

magazine heralded the trend. Stating that the old foundries relied too much upon guesswork, the editor stressed the fact that future markets would belong to the more exact, mechanized foundries. The old foundries were "rapidly being succeeded by the foundry which is highly mechanized, in some cases amounting to almost 100 percent." Areas such as sand handling, core making, metal and mold conveying systems, molding, cleaning, and other operations had all felt the thrust of mechanization.

The concept of centrifugal casting enjoyed its first success during the 1890's in the manufacture of manganese car wheels. The '30's saw this process successfully applied to the production of cannon. Such an achievement had eluded steel founders from their early attempts in the 1880's. Though guns were successfully cast in the late teens, they could not match the '30's product. Indeed the new process was producing a cannon superior to the forged guns of long-standing tradition.

The new process and equipment was developed at the Watertown Arsenal of the Army's Ordnance Department. Experiments were carried on in the late '20's with success finally being achieved in 1932. Using a determined amount of high grade alloy steel poured into chilled molds of cast iron, a cannon could be poured and solidified in 10 to 20 minutes.

The forging process had taken four days to produce a rough forging from molten metal. The molten steel had been cast as an ingot which had to cool for one day. It was then reheated for another day and soaked the heat for still another. Finally it was forged and by this time 35 percent of the original steel now was scrap. The advantages of the centrifugal casting process, therefore, were obvious. The Technological developments of the decade, however, many times went begging. Market conditions simply did not warrant their introduction.

The markets for steel castings expanded during the '30's, but the majority of foundries were not to benefit. This expansion took place in alloy castings and castings produced by captive foundries.

An example of expansion in both these fields occurred as steel castings gained greater acceptance in the automotive industry. *Business Week* noted this trend toward greater use of cast steel in a late 1935 article. Citing the recent construction of a $675,000 alloy steel casting department by Ford in its Dearborn foundry, *Business Week* went on to report the advantages of cast steel parts over forgings. With these advantages of production economy, certain superior physical characteristics, and applications for designs not possible with forgings, Ford was using steel castings for both Ford and Lincoln-Zephyr crank shafts, Ford cam shafts, Lincoln-Zephyr pistons, and a half dozen other parts in the Ford V-8."

Placer dredge buckets ready for shipment in the mid-1930's.
Courtesy: Columbia Steel Casting Company

The new Ford crank shaft was described as a "high carbon, high copper, chrome-silicon alloy" which possessed the characteristics of rigidity, good bearing surfaces, and resistance to shock." Moreover the production of the shaft presented a classic case of the casting versus forging in terms of economy. In the rough state the casting weighed 72 pounds; the forging 80 pounds. The weight in the shaft's finished state were 62.5 pounds and 65 pounds respectively. The cast steel shaft was 2½ pounds lighter and required removal of 9.5 pounds of excess metal as opposed to the forged shaft's 15 pounds. The time saved in the metal removal process by machining and grinding amounted to 20 minutes.

Foundry expansion in this field continued with the construction in 1936 of the first complete new foundry built since the early days of the depression. This was the foundry of the Kelsey-Hayes Wheel Corporation in Detroit, and its completion was heralded by *Business Week* as a part of the spectacular comeback of industry. Their heralding was premature though—the date was 1936 and the depression was to run the course of the decade.

The applications of alloys seemed endless, and indeed they were used in situations ranging from frivolous to practical to utmost necessity. Ford's use of alloy crank shafts may be termed practical. The lifesized bust of Katharine Cornell (star of "The Barretts of Wimpole Street") by New York sculptor Carl Delavas and cast in stainless steel may have been considered frivolous by those concerned with strict utility. But the Cooper Alloy Foundry Company, Elizabeth, New Jersey, felt it not only a contribution to art, but a tremendous advertisement for the beauty of stainless. Further, they made known the foundry would produce castings of a similar nature for interested artists.

Steel castings had won their place in naval construction, but diplomatic events of the '30's made their use in further construction an absolute necessity. Rear Admiral George H. Rock, Chief of Construction USN, made clear the importance of steel and steel alloy castings. "Having in mind the necessity for weight saving imposed by the Washington and London Treaties on limitation and reduction of naval armament, the importance of the use of steel castings is outstanding, and by the use of alloy steels greater strength and reliability can be secured."

The industrial machinery market had come to be a traditional source of orders for steel castings. But the depressed years of the '30's precluded much of the equipment upgrading by various industries and resulted in little demand for such castings. Moreover, when such castings were produced, they came from captive foundries. An example of this was the February 16, 1931, unveiling of "the largest steel casting in the world, having a weight of 460,000 pounds." The casting was a cylinder jacket for a 14,000 ton forging press in the Bethlehem Steel Company's Lehigh Plant and had been produced by the plant's foundry.

Size was an important part in castings produced and marketed. The construction of the Grand Coulie Dam included twelve, 30-ton cast steel impeller wheels in the pumps used to move water from Lake Roosevelt to the Grand Coulie Reservoir.

Finally, steel foundries could draw some consolation from "advances" made in the field of fabrication and weldments. A great deal of casting business had been lost to this field in industrial economy moves of the early '30's. Although they lacked the strength and a host of other casting qualities, weldments were cheap and could be produced quickly. But by 1936 the designers of welded assemblies were frequently calling for steel castings to be welded to rolled steel products, especially in positions of critical stress. But it was small consolation.

Co-operative efforts between the George Fischer Steel and Iron Works, Schaffhausen, Switzerland, and the Lebanon Steel Foundry, Lebanon, Pennsylvania, had taken W. H. Worrilow of Lebanon to Switzerland in 1938. During this visit Mr. Worrilow had several occasions to witness the advanced states of German armed forces. He particularly noted the advances the Germans had made in cast armor. Their tanks were streamlined with flat and riveted surfaces eliminated As such, they would deflect shells and decrease the tank's vulnerability.

In the late thirties concern with German armor advances and the U.S.'s defense preparedness sparked interest in cast armor production.

Courtesy: Lebanon Steel Foundry

Messrs. Worrilow and Quinn took this information to the War and Navy Departments in Washington. The officials, in turn, requested Lebanon Steel Foundry to begin research and experimentation programs. Working in conjunction with the Navy's Dahlgren Testing Grounds and the Army's Aberdeen Proving Grounds led to Lebanon's being one of the first plants converted to defense production.

This state of defense production had been seriously undermined by the isolation and depression of the '20's and '30's. Just one example of this was the lack of heat treating facilities available to cast armor producers. Because of this, heat treating was being done in high temperature pottery of brick kilns. Yet Continental Roll, American Steel Foundries, General Steel Castings Company, Symington-Gould. Pacific Car and Foundry, and Lebanon Steel Foundry would all undertake production of cast armor in these days as the industry and the nation girded themselves for the Second World War.

CHAPTER 9—The 1940's

Franklin Roosevelt was elected to an unprecedented third Presidential term in November 1940 as the United States was emerging from one national crisis and preparing for yet another.

Peace in Europe had lasted less than 20 years. The Treaty of Versailles, ending the First World War, had been signed by Germany on June 28, 1919. Twenty years, two months, and three days later, Germany invaded Poland and World War II began. The invasion of Poland was the last of a series of aggressive diplomatic moves on the part of Adolph Hitler. Great Britain and France had made their final concessions; with the invasion of Poland both countries issued declarations of war on September 3, 1939.

The evening of September third Franklin Roosevelt held another of his fireside chats. In its course he declared, "This nation will remain a neutral nation, but I cannot ask that every American remain neutral in thought as well." Two days later the U. S. issued its official proclamation of neutrality.

Having acknowledged that Americans were by no means neutral in their hearts, Roosevelt declared a state of limited national emergency to exist and asked Congress to go into a special session to repeal the arms embargo established by the Neutrality Act of 1937. On November 4 the Neutrality Act of 1939 was passed. It not only repealed the arms embargo, but authorized the "cash and carry" export of arms and munitions to warring nations. Thus, by the thirties' end the nation's role in the forties had been cast. War production was to stimulate industry and at the same time bring the nation ever closer to armed conflict.

1940 saw the invasion of Norway (April 9 through June 11), then followed Belgium and the Netherlands (May 10-June 4), France (June 5-July 10), the Battle of Britain (August 8-October 31), and the formation of the Axis on September 27. Through all of this, and until December of 1941, the United States would retain its neutral position. At the same time it would be supplying Britain and France with increasing amounts of war material, as well as preparing our own armed forces.

The Japanese attack on Pearl Harbor, December 7, 1941, marked the end of U. S. neutrality. The next day, December 8, Congress with only one dissenting vote, declared a state of war to exist between the U. S. and Japan. On December 11 Germany and Italy declared war on the U. S. —and the Axis-Allied conflict took final shape.

Three and one-half years later victory in Europe was formally achieved on May 8, 1945. German ratification of the surrender took place the next day. By June 5 an Allied Control Council was administering an occupied and divided Germany, and attention was focused on the Pacific theater. The end of the war in the Pacific was not long in coming. On August 6, less than two months after V. E. Day, an atomic bomb with an explosive force of 20,000 tons of TNT was dropped on the Japanese city of Hiroshima. Three days later a second bomb was dropped on Nagasaki. By August 10 the Japanese Cabinet had offered to surrender, and on August 14 they accepted the Allied terms.

The cost of the war had been exorbitant. Lend-Lease alone, terminated August 21, 1945, had amounted to over $50 billion. The war had claimed the lives of 321,999 servicemen, with 800,000 wounded, captured or missing. Enrollment in the armed forces had reached a height of 12,466,000.

Unlike its reaction following the First World War, the U.S. in 1945 assumed its proper place in global affairs. In October of that year the U. N. Charter went into effect with the United States playing a leading role. Beyond this stood U.S. participation in direct relief, an ever-increasing mechanism of our foreign policy. Eleven billion dollars was provided to Europe from V. E. Day to the spring of 1947. The Marshall Plan, unveiled June 5, 1947, declared U. S. policy to be against "hunger, poverty, desperation, and chaos." To implement such a policy President Truman submitted a $17 billion European Recovery Program to Congress.

Fed by heavy government spending, the domestic economy had boomed during the war years. By 1944 the index of industrial production had reached 235, and national income had increased two and one-half times.

Inflation, the traditional enemy of postwar reconversion, had begun even before the war's end. The price and wage controls adopted during the war had not been totally effective. Yielding to inflationary pressures, the consumer price index rose from 78.6 in 1940 to 105.8 by 1945. Increased inflationary pressure was felt with the war's end, and consequently the price index rose to 177.8 by June of 1950.

The outbreak of war in Europe in 1939 was to signal the end of the depression years in the United States. Though a proclaimed neutral, popular U. S. sentiment overwhelmingly favored Britain and France. In response to this, and the desperate need of the two countries, our neutrality policy contained provisions for the sale of military hardware on a cash and carry basis. But this was only the beginning. The year 1940 was to witness an unprecedented drive in preparedness and aid — and the spending to bring this about.

The overwhelming success of the Axis powers was putting strains on the neutrality of the United States; Washington began a ten figure spending program to prepare for what it saw as an impending crisis. In his annual budget request, January 3, 1940, Roosevelt asked Congress for $.18 billion for national defense. In the spring he asked for an additional $1.2 billion, and a program to produce 50,000 planes a year. May 31 brought his request for $1,277,741,170 to accelerate the preparation of the army and navy. When Prime Minister Churchill asked for military supplies, the War Department responded by releasing surplus stocks to Britain. In June 1940 alone over $43 million worth of aircraft, arms, and munitions were turned over to the British.

The Office of Production Management was created in December 1940 and placed under the direction of William F. Knudsen. With orders to co-ordinate the defense production of the U. S. and insure material aid to Britain, the office was envisioned as the control center of "the great arsenal of democracy." Just how great this arsenal was to become was only hinted at when Congress passed the Lend-Lease Act of March 11, 1941. Beginning with an initial appropriation of $7 billion, total lend-lease aid during the course of the war was to amount to $50,266,845,387.

This vast spending on the part of the government was directly responsible for the production increases enjoyed by the steel casting industry. In the depths of the depression, the 1935 production stood at only 388,988 tons of steel castings. Following the 1937 dramatic rise in production, the industry had dropped back to 613,719 tons in 1939. The 1940 production enjoyed a moderate increase as the total reached 797,947 tons.

By 1941, however, the government's spending began to be reflected in the industry's production. In 1941 production reached 1,316,027 tons and would remain above 1 million tons in each of the succeeding years of the decade. The production would fall no lower than the 1946 level of 1,043,358 tons, and would approach the 2 million mark in its 1943 production of 1,928,645 tons. The Bureau of Census chart, page 114 traces these high level statistics throughout the decade.

Year	Total	Railway Specialties	Miscellaneous
1940	797,947	290,255	507,692
1941	1,316,027	471,810	844,217
1942	1,679,178	309,352	1,369,826
1943	1,928,645	248,664	1,679,981
1944	1,843,388	338,077	1,505,379
1945	1,484,957	311,833	1,173,124
1946	1,043,358	286,131	757,277
1947	1,203,504	341,987	861,517
1948	1,760,894	442,258	839,143
1949	1,243,502	232,976	623,321
1950	1,461,089	261,897	1,199,732

The high levels of production and production quality achieved by steel foundries during the war were officially acknowledged by the government. This took the form of awarding individual foundries service flags recognizing their achievements. The results of a 1943 partial survey of the industry revealed 41 steel foundries having been awarded the Army-Navy "E" flag for excellence in production, and over half of these had been further honored with from one to four stars signaling continuous meritorious production records. The maritime "M" pennant had been awarded to 11 steel foundries, with most of the pennants containing added stars. Further acknowledgment was given with the awarding of three victory fleet flags, seven navy "E" flags, five all-navy burgees, two army ordnance banners, and a number of war bond "E" pennants and minutemen flags.

Production on this scale, however, was not without its difficulties. An acute labor shortage quickly developed and deepened as the war progressed. By 1944 quick surveys were reporting ferrous foundries operating at only 60 percent capacity from lack of manpower. Foundrymen were well aware of the situation, but were hindered by government controls. Therefore, they "were not displeased when W. P. B. Chairman, Donald Nelson, called their industry the number one bottleneck in both war and essential civilian production. They thought it was about time Washington learned the important facts of wartime life."

The demands of war required close to 100 percent of steel casting capacity to enter into war and essential civilian production. Even so, the number of different types of castings continued to expand. As warfare became increasingly mechanized, so did its reliance upon steel castings increase. As one of the basic industries upon which mechanization depended, the importance of steel castings rated an ever-increasing priority. The efforts of Donald Nelson to push for greater casting production would be based on his realization that "although castings and forgings comprise only 1 percent of the value of total American war production, they are the basic parts for fighting equipment many times the castings' value."

Steel castings were to make up 50 to 60 percent of the weight of the latest models of tanks and tank destroyers. Ordnance also called upon steel castings for gun mounts, cradles, and yokes.

A "TISCO" manganese steel tread for a medium tank ready for shipment in 1942.
Courtesy: Taylor-Wharton Iron and Steel Company

Naval uses included steel castings in the production of pump casings, reduction gear parts, propellers, turbine casings, valves, rudder frames, catapult mechanisms, and a host of other uses.

In the construction of military aircraft, steel castings were of limited use. However, they did serve an important function in their application to the landing gear of heavy bombers. Although some castings were used as structural components in experimental aircraft, the field would not be fully explored and appreciated until the next decade.

In the field of transportation, long a traditional market for steel castings, demands continued to be made. Military trucks required castings for rear axle housings and for hollow wheel spiders. Beyond

The U.S.S. Rock *launched in June 1943 used steel castings in all of its hatchways and fittings.*
Courtesy: Maynard Steel Casting Company

this were diesel engine frames and bases for the railroads, and crank shafts for jeeps and other military vehicles.

Machine parts such as worms, gears, racks and pinions formed the final category of military and essential civilian production of castings during the period of the Second World War.

These markets into which casting production was channeled were both limited and expanded by the government. The expansion stemmed from the increased mechanization of warfare and the high levels of government spending occasioned by supplying both our own forces and those of our allies with the mechanics of war. Meeting this challenge was to require close to 100 percent of our nation's industrial research and production capacity. By curtailing all non-essential civilian production the markets for steel castings were limited.

Determining and enforcing this production limitation were the responsibilities of the Office of Production Management. This agency organized 12 months before the U.S. officially entered the war, was under the direction of William F. Knudsen.

However, the mobilization of the entire economy was too great a task for any one agency, regardless of its power. Therefore, as the U.S. moved closer to and finally into war, a number of agencies were created to deal with various segments of the mobilization effort.

The nine-man War Manpower Commission (WMC) was created in April 1942 to bring about the most effective use of the country's resources. The commission's jurisdiction was to extend over Selective Service, the U.S. Employment Service, and other government recruiting and training agencies. In this role they were charged with carrying out Presidential orders such as the minimum work week of 48 hours (with time and a half for the extra 8 hours) designed to deal with the labor shortage apparent in February 1943, and the "hold the line" order of April 8, 1943, which froze over 27 million workers in their war production jobs.

Closely aligned in function, but acting as separate agencies, were the National Defense Mediation Board created in March 1941 and its successor, the 12-man National War Labor Board created January 12, 1942. Composed of representatives of the public, employers, and labor, the Board was given powers of investigation, mediation, and arbitration in dealing with labor disputes in defense plants. However, this work would become secondary to the task of restraining wage increases. The 15 percent cost of living increase between January 1, 1941, and July 1942 prompted the Board to authorize wage increases of like percentage. This "little steel formula" was to be applied to each union in an effort to limit the total wage increases to a 15 percent maximum for the period of the war.

The Office of Price Administration was created with the passage of the Emergency Price Control Act of January 30, 1942, in an attempt to fix price ceilings on all commodities except farm products. Replacing the earlier Offices of Price Administration and Civilian Supply, the OPA was administering 13 separate rationing programs at its peak, and by the war's end had held consumer prices to a 31 percent increase (one-half the increase experienced in World War I).

The Steel Casting Industry Advisory Committee provided the O. P. A. with a direct link to the nation's steel foundries, and vice versa. Throughout the war Tom Shartle, Frank Robbins, Bud Snowdon, Oliver Mount, Claude Harrell, Don Bakewell, Ted Harvey, Dick McBride, and other members met monthly with O. P. A. officials in an effective effort to determine realistic prices for both the industry and the consumer. However, the hard-line stand necessary to hold the 31 percent increase at this level was to create serious problems in terms of both labor and production.

Roosevelt's call for a 1942 production of 60,000 planes, 45,000 tanks, 20,000 anti-aircraft guns, and 8 million tons of shipping spurred the creation of the War Production Board. Headed by a former Sears Roebuck executive, Donald M. Nelson, the Board was

Col. Charles W. Briggs stands next to the Bochum Bell (one of the earliest steel castings) during a post-war inspection tour of the Bochum Works in Germany.

Courtesy: SFSA

given authority to mobilize the nation's resources for the war effort. In this capacity, it was to be the principal agency in the fields of production and supply.

One week after his appointment as Chairman, January 21, 1942, Nelson dissolved the Office of Production Management and the WPB absorbed its function. Non-essential residential and highway construction was halted by a WPB order on April 8, 1942. Not until August 14, 1944, was a limited reconversion to civilian production permitted by the Board.

Nelson resigned his post on September 30, 1944, and later that year went, as Roosevelt's personal representative, to organize war production in China. Meanwhile, the WPB continued its function under the direction of Julius A. Crew until it was terminated on October 4, 1945, and the responsibilities were passed to the Civilian Production Administration.

Co-ordination of the entire economy, including subagencies such as the WPB, the War Manpower Commission, etc., became the task of the Office of War Mobilization. Pressures to by-pass WPB orders were exerted by various factions upon Congress, pressure groups, and even the President himself. These pressures prompted the May 1943 creation of a new/higher authority which was embodied in the OWM and its Director, James F. Byrnes. The power given to and executed by Byrnes gave rise to his unofficial title of "Assistant President" as he attempted to carry out his super agency's mandates: "To develop unified programs and to establish policies with a maximum use of the nation's natural and industrial resources for military and civilian needs."

Life under these regulatory bodies was not as smooth as the theory which gave rise to them had forecast. From the onset of the war, the availability of foundry labor had been a problem. An initial surge of patriotism reduced the foundry labor force as enlistments ran high. Later, the Selective Service Act would further reduce the foundry rolls. By 1944 this problem had become acute. The agencies designed with the intention of maximizing production now stood in the way. Wage controls administered by the WMC blocked the traditional means of attracting labor. Moreover, the OPA was reluctant to authorize any price relief to secure the capital to make added benefits available.

The entire process was compounded by the government's publicity reports published by news agencies, which described foundry work as "dirty, hot, low paying, hazardous, and dangerous." *Business Week* reported the WPB Industry Advisory Committee's recommendation (in slightly more tactful language): "That the official war press shut up about forge and foundry manpower needs before they do any more harm."

The regulations of these various agencies converged on each steel foundry. On this individual level, foundrymen were encountering and overcoming obstacles which seemingly someone had gone out of his way to create. Mr. Ernie Marquardsen of Pacific Steel Casting Company, Berkeley, California, described these obtacles as he recounted some of his experiences in dealing with the priority allotments of World War II.

Pacific Steel Casting was producing maritime work for the most part, and as such came under regulations regarding maritime work. Located in Oakland, the Kaiser Shipyards produced a tremendous amount of scrap in their production of naval vessels and had in the past formed a source of scrap for the Pacific foundry. Yet, when the allotments were determined by Washington, Pacific was forced to purchase its scrap from Los Angeles.

The use of aluminum as a deoxidizing agent necessitated the foundry's purchase of scrap aluminum. While a machine shop next to the foundry had tremendous stocks of this scrap, the foundry was forced to buy its aluminum in a processed form, although this made no difference in its use in the melting process.

Further, the priorities were based on prior usage, and initially there was no consideration for the amount of time foundries were producing. Prior to the war, Pacific was operating one 8-hour shift. With the war's step-up of production, they had moved to two 10-hour shifts, and consequently needed vast increases in the quantities of materials allocated to them.

When a Russian ship cracked a head off the coast of California, an order was processed through Pacific to produce a replacement. However an alloy different from their regular steel castings was needed. Production of such an alloy occasioned a $6,000 fine.

The attempts to determine the resources of the country pushed these regulatory agencies to demanding detailed inventories. At one point Pacific Steel Casting was asked to keep an inventory on the nails used as chills in molds.

The industry experienced a complete reversal in terms of employment. The '30's lack of work and consequent layoffs had created and maintained an oversupply of labor.

The size of the '30's labor force—including the men laid off or working part time—would not have been sufficient to handle the production increase engendered by the war. The increase of over 400 percent between the years 1938 and 1942 created a labor demand which the earlier force simply could not have satisfied.

The problem was compounded by even more direct demands made by the war upon the work force. Patriotism ran high in America's foundries and by July 1, 1943, over 20,000 workers had volunteered for armed service.

The combination of these two forces, tremendous production increases and the dwindling labor supply, was to bring about a crisis in the industry at a time when neither the industry nor the country could afford it.

The 1944 production bottleneck affecting the entire war production effort stemmed from a labor shortage in the foundries. "The only reason foundries cannot turn out more castings — steel, gray iron, malleable, and non-ferrous — than this country would know what to do with is that they cannot get the labor." The Steel Founders' Society statistics based on a survey of 277 foundries showed the current employment figures at 119,219 men in commercial foundries, and 23,462 in captive foundries. The War Production Board at the same time estimated that these figures were 7,100 employees short of the critical labor requirement.

Molders were in acute demand. *Business Week* reported "Many a foundry owner who learned the molders' trade is working at it today and letting his secretary run the office." Though wage and price controls were in effect, foundry owners upgraded work and added generous overtime in effort to compete for these skilled workers. As a result of the upgrading and overtime, the take-home pay of experienced molders was $5,000 or more per year. At the same time, the average wage including overtime in the steel foundry was about $1.11 and to $1.13 per hour.

Foundries in general were attempting to make employment more attractive. In a January 1945 report of foundry wages, the Monthly Labor Review remarked on the increasing benefits offered by foundries. According to the report, a substantial number of foundries were paying nonproduction bonuses in the form of profit sharing or Christmas bonuses. Two-thirds of all foundries were offering paid vacations for plant workers after one year's service, and insurance and pension plans were quite common.

Of further inducement to labor was the job security being predicted by foundry owners. Claiming to be able to shift to civilian production almost over night, over 74 percent of foundrymen felt that current levels of production could be maintained throughout the decade's remaining years.

The end of the war and consequent end of government control, gave organized labor its first real chance to take advantage of the legislative gains made during the depression. The average weekly earnings in 1946 were $48.45 for 38.8 hours of work. The average wage per hour was $1.25. The succeeding years of the decade saw the following increases:

Year	**Average Weekly Earnings**	**Average Weekly Hours**	**Average Hourly Wage**
1947	$53.94	39.6	$1.36
1948	59.93	40.8	1.48
1949	56.73	37.3	1.52
1950	65.43	41.1	1.59

The wage gains made by foundry workers were a part of an overall gain by labor. Wages in manufacturing increased from 95 cents per hour in 1945 to $1.39 in 1950. However, inflation in most cases nullified these gains. The average factory worker's paycheck in 1950 represented less actual purchasing power than a worker's in 1945.

The Labor-Management Act of 1947, known as the Taft-Hartley Act, came about in response to the power granted to unions during the New Deal and World War II periods. With wording not unlike the Wagner Act of 1935, the Taft-Hartley Act was to set forth a list of unfair labor practices on the part of labor. Strikes by Federal employees, the closed shop, jurisdictional strikes, and secondary boycotts were prohibited. The union shop was permitted only in absence of state laws to the contrary. Finally, the law prohibited striking workers from voting in bargaining elections if they had been replaced by other workers.

The law had effectively curtailed the power earlier granted to organized labor. It had done for management what the Wagner Act had done for labor.

A labor force diminished by the demands of war and greater production efficiency gave rise to the increased foundry mechanization. This process had been going on since the late 19th century, but during the '30's and '40's, it was approaching 100 percent. This fact, coupled with further rapid, important advances, established mechanization as one of the primary technological themes of the 1940's. Mechanization in the '30's was viewed as an efficiency movement, a move dictated by the cost cutting formula used to fight the depression. In the '40's mechanization was to be seen as a necessity occasioned by labor shortage and increased production demands.

In May 1946 *Business Week* reported foundries were "making increased use of mechanized handling, special machinery, automatic inspection, quality control." From these techniques they reaped double benefits: 1) reduced costs, higher output, better quality castings, fewer rejects; and 2) better working conditions to help solve the labor problem.

Certain foundry operations such as patternmaking did not lend themselves to mechanization. But operations such as melting, sand conditioning and handling, and the conveyance of material all readily fit into mechanization schemes. On top of this was the improvement of working conditions through dust control and ventilation; both were improved by mechanization.

The use of mechanization in sand handling and preparation was noted in the increased use of centralized sand systems. Central mullers cleaned sand and mixed it with binders. A conveying system delivered this sand to a series of molder locations throughout the plant. Here it entered, among others, sand slingers, where the sand was forced into the flasks around the patterns and tightly packed. Sand taken from the shakeout areas after the castings had been produced, dropped through gratings in the floor and onto a conveyor which returned it to the central sand station.

Mechanization of the melting process continued with the development of automatic chargers. This improvement enabled a stricter control of the melting process to take place, and resulted in increased benefits to the properties of the molten metal by eliminating guesswork and carelessness in preparing and placing the charge.

The advantages of mechanization ultimately reached the consumer. "All users of castings benefit, not only from stepped up production, but also because better castings mean less machining, closer tolerances, better physical properties." "Nobody loses when brains replace brawn" was the stand taken by *Business Week* as it heralded mechanization as one of the foremost trends in the casting industry. Mechanization would continue to play a leading role in the development of the steel casting industry from this point to the present day.

CHAPTER 10—The 1950's

Continuing American involvement in world affairs was to become a critical issue in U. S. postwar history. Coupled with participation in the U. N., American foreign policy was committed to the precepts of the Truman Doctrine, which was dedicated to the containment of Soviet imperialism and pledged U. S. military and economic aid wherever necessary to effect such containment. The upshot of this position would be the undertaking of a "Cold War"—an ongoing struggle between communism and democracy characterized by a lack of "hot" or large scale warfare.

On occasion the Cold War would heat up as military action was undertaken. But this limited military action would prove inconclusive. The Korean conflict begun in June 1950 and not officially halted until June 1953, brought this fact home to the American people. American involvement in South Vietnam, begun in 1955, and stepped up in the sixties, would demand still another instance of limited warfare.

The 20-year Democratic domination of the Presidency ended with the election of Dwight D. Eisenhower in 1952. Eisenhower's tenure of office would span the remaining years of the decade: years in which America's and the rest of the world's citizenry would attempt to cope with the problems of the nuclear age.

While the war in Korea was in progress it occupied the center of national attention. But the uneasy truce signed in July 1953 removed the war as a focal point and left the stage bared for a new attraction.

The U. S. public had not long to wait. Investigations of communist activities in the U. S. had been going on steadily since the "Red Scare" following World War II, and since the Truman Loyalty Order of 1947. But in 1953, Senator Joseph R. McCarthy, Chairman of the Senate Permanent Investigating Subcommittee, began a full scale series of hearings on the role of communism in government and other areas of American life. McCarthy's hearings unmatched in extent would continue until a Senate condemnation on December 2, 1954. Concern with communist infiltration, though, would not disappear with the McCarthy hearings, but would continue as the Cold War ran its course.

Civil rights resurfaced as a domestic issue in the mid '50's and signaled the rebirth of a movement which would build through the last years of the decade and become a major force in the 1960's. The first Civil Rights Act since 1875 was passed in 1957 as a part of this growing protest.

Eisenhower's re-election in the fall of 1956 came in the form of a landslide as he secured an electoral margin of 457 to 74, and close to a 10 million popular vote spread. The Cold War would continue to dominate the foreign affairs, while civil rights and nuclear control and disarmament, and a new national passion, the conquest of space, would be the concerns of America.

The Truman administration had actively participated in affairs of the business community, particularly in labor-management negotiations. However, interference was by no means restricted to this. Characteristic of this policy was the Employment Act of 1946 which "limited" the government's role to promoting "maximum employment, production and purchasing power" in the American economy.

In contrast, Eisenhower's administration would allow business a freer rein. With a general, low-keyed emphasis on price stability, foreign investment and safety, the administration's policy fell short of the sweeping goals of the past twenty Democratic years.

The traditional peaks and troughs of the nation's economy would reappear in the 1950's. American business entered the 1950's recovering from a recession which had bottomed out in October 1949. The recovery was sustained throughout the era of the Korean conflict and peak in July of 1953.

The decline in military expenditures, inventory liquidation, and an unemployment figure of 3.7 million by the spring of 1954 resulted in the gross national product dropping from 364.9 billion in 1953 to 356 billion in 1954. From August 1954 the economy began a steady recovery which would peak in July of 1957. A recession from this point until April of 1958 would result primarily from an overexpansion of capcity in durable goods production and a drop in exports. Recovery, however, was rapid and the U.S. finished the decade in a spurt of economic growth.

As a whole the fifties had been prosperous. They were a part of a growth period extending from World War II to the mid-sixties. During this span (1945-1965) the nation's Gross National Product, in constant dollars, would rise from $355 billion to $609 billion. Employment would rise, as would the standards of living and, eventually, inflation.

The production of 1,461,089 tons of steel castings in 1950 (as reported in *Iron Age*) was carried on in 352 steel foundries in 37 states and the District of Columbia. Counting only steel foundries employing 21 or more plant workers, *Iron Age's* basic marketing data revealed the following state breakdown.

Alabama	6	Kansas	3	Ohio	32
Arizona	1	Kentucky	1	Oklahoma	1
Arkansas	1	Louisiana	4	Oregon	7
California	29	Maryland	3	Pennsylvania	68
Colorado	4	Massachusetts	9	Rhode Island	2
Connecticut	6	Michigan	19	Tennessee	3
Delaware	3	Minnesota	5	Texas	12
D. C.	1	Missouri	8	Utah	1
Florida	1	Nebraska	1	Virginia	3
Georgia	4	New Hampshire	3	Washington	16
Illinois	25	New Jersey	10	West Virginia	4
Indiana	15	New York	21	Wisconsin	15
Iowa	4	North Carolina	1		

A number of foundries were still suffering from the inflation engendered by the demand of World War II. The transition to a peacetime economy had been smooth and short lived. Production remained high, never dropping below the 1,043,358-ton level hit in 1946. Consequently the number of foundries inflated during the war effort, continued in existence. But this continuance was subject to demand. If demand were to fall, the attrition rate would be high.

A situation reminiscent of the late '20's was developing. The number of foundries had been overextended and consequently, many individual foundries were producing at a low percentage of their capacity. As such, their existence was marginal.

Production in the '50's continued at a high level--the lowest year would be 1958, and, even then production would be 1,121,000 net tons. The high point in production was reached early in the decade, in 1951 when over 2 million tons of castings were shipped. This high point and subsequent years' production figures are listed below and based on the reports of the U. S. Bureau of Census.

Year	Production
1950	1,480,587
1951	2,050,054
1952	1,927,942
1953	1,834,197
1954	1,184,096
1955	1,530,694
1956	1,931,987
1957	1,766,191
1958	1,121,000
1959	1,412,885

The Cold War had slowed the traditional peacetime reconversion of industry and occasioned the reapplication of restrictions upon civilian production. 1952 saw the production of only two-thirds the number of automobiles turned out in 1951. However, the years were good for production as a whole. Iron and steel production (using 1935-39 as a base of 100) had risen to 208 in 1943, the highest of World War II. Yet 1951 saw the index level at approximately 260.

One of the few areas in which the Eisenhower administration exerted influence on the business community was the area of pollution abatement. Not until 1955 did the U. S. pass its first Federal legislation concerned with air pollution. Public law 84-159 was approved by the 84th Congress and authorized the Public Health Service to: 1) recommend research programs to devise air pollution control methods; 2) engender co-operation among all government levels; 3) collect and disseminate information regarding air pollution; 4) undertake research and methods for controlling and abating air pollution; 5) avail themselves to air pollution problems at the request of state and local agencies; and 6) administer grants to individuals, public and private agencies for surveys, training, research, and demonstration projects. Though later amended upward, the initial appropriation amounted to $5 million per year for five years and the University of Cincinnati's Robert A. Taft Sanitary Engineering Center, was chosen as a central site for air pollution research.

War imposed demands had added impetus to the loss of markets to fabrications. With casting production pushed to its limits, serviceable war material had been produced by the fabrication process. Now that the war had ended, the industry set out to regain its lost markets.

To this end the National Product Development Committee of the SFSA was reactivated in the spring of 1952. Outlining the committee's progress at the Society's annual Fall Meeting, Chairman Ross L. Gilmore, President, Superior and Malleable Castings Company, Michigan, stressed the goals of the committee. "Regain any business which may have been lost to fabrications; prevent further inroads by competing types of engineering structures; and generate new business for steel castings that will be of benefit to the entire industry."

Fruits of the committee's labor were already being enjoyed. The agricultural machinery industry noted cast weld assemblies as one of the outstanding developments in the use of steel castings. The cast-weld assemblies (casting to casting and casting to rolled steel products) replaced all cast parts for rolled steel weldments. Thus in addition to cost saving, many times the new products were stronger. Credit for the economies were given to the steel castings—"much of this work on the redesign of parts to permit cost savings in their production stems from a research and development program of the Steel Founders' Society of America."

The first clearly defined picture of the markets for steel castings appeared in October 1956 when the SFSA's recently established Marketing Research Committee published its first Market Research Report: "Distribution of Steel Castings Sales by End Use of Product." While government agencies had attempted to assemble statistical pictures of the industry, the reports had generally suffered from a confusion of limits which rendered them incomplete or useless. However, the report of the Market Research Committee had begun with a specific three-fold purpose: "to gather and disseminate information to enable steel foundries to gauge their markets more scientifically, to assist in selling, merchandising, and advertising efforts, and to provide a substantial base period on which to develop future market trends." To this end the initial study was begun in the late months of 1955 and continued through the first part of 1956.

Based on the responses of 142 steel foundries, the survey listed 13 general fields to which casting production had been directed during the period 1950 to 1954. (The survey also included 54 specific subdivisions which were distributed among the above 13.) The general markets and the proportion of castings production directed to them included: 1) railroad—37.9%; 2) rolling mill—8.6%; 3) power shovel and road building—8.5%; 4) ordnance—7.8%; 5) metal-working and other machinery—7.3%; 6) valve, piping, fitting and pump—6.2%; 7) mining, crushing—4.7%; 8) power equipment—4.5%; 9) automotive—4.5%; 10) agricultural—3.5%; 11) material handling—1.4%; 12) ship and marine—1.3%; and 13) all others—2.0%.

Succeeding reports were published in March 1958 covering the years 1955 through 1956, and February 1960 covering the years 1957 and 1958, and October 1960 covering 1959 sales and including 10-year comparative tables. The publication of the 1959 report included a newly adopted classification. Seventeen general headings now replaced the initial thirteen. These new headings with the 1959 market percentages and the averages for the ten-year period 1950 to 1959 included:

Title	Percentage 1959	Ten Years
Agricultural Equipment	1.08	.97
Motor Vehicle	7.28	4.17
Construction Machinery and Equipment	16.04	13.31
Construction (Structural Components)	1.00	.54
Mining and Crushing Machinery	6.37	5.26
Metal Shaping, Finishing, and Forming	3.18	3.62
Electrical Machinery and Equipment	2.08	2.99
Rubber Mill Castings	1.08	.83
Oil, Gas Field, Valves and Piping	5.99	6.15
Military	2.49	5.26
Railroad	27.86	35.33
Rolling Mill	11.94	10.56
Ship amd Marine	1.34	1.32
Material Handling	1.78	1.65
Special Machinery, Products and Components	4.68	4.53
Gear, Pinion and Worm	2.00	1.35
Unclassified	3.81	2.14

The railroad industry continued its tradition as the dominant steel casting market. By 1956 castings were used principally in frame, side frame, bolster, knuckle, and coupler construction. The weight of a 50-ton freight car included 7 tons of steel castings. Passenger cars required up to 10 tons while locomotive construction took place with 15 tons of steel castings as integral parts.

The Quebec Bridge disaster in 1917 had resulted from the failure of a steel casting. At the time construction engineers had shaken their heads—it was "the well known treachery of a steel casting." By the late 1950's completion of the Mackinac Bridge, however, the steel casting industry could point with pride to the use of steel castings. Castings had been used in bridge construction since the Quebec disaster, but the Mackinac completion marked castings' most trying application. Located on the straits between Lake Huron and Lake Michigan, the bridge was not only the world's longest suspension bridge, but also subject to some of the most severe climatic conditions of any bridge in the world. It would be subject to 120-mile per hour winds, high waves, and ice jams. To meet these demands steel castings were used as supports in the bridge's construction, supports which weighed as much as 34 tons each. The entire project had required more than a million pounds of steel castings.

Castings' potentials were further explored as the government shifted to a definitive defensive military posture with the onset of the Cold War. The development of supersonic aircraft, missiles, and nuclear energy provided new and glamorous markets for steel castings.

Steel castings had assumed an important, though limited, role in World War II aircraft construction. In fact, they were regarded as components of primary aircraft structure. However, high rejection rates forced the industry to abandon the market (and vice versa) following the wartime emergency. By the mid '50's the use of castings in aircraft construction was extremely limited. Some large sand castings were used as auxiliary structural parts, however "precision castings" from shell molding, ceramic and investment processes were enjoying a slight but serious application. Ranging from 8 to 30 pounds, these castings were applied to jet engines and air frames. Smaller precision castings were used for accessories, plumbing and hardware.

The government's desire to broaden the application of steel castings to the aircraft industry resulted in the formation of the "Panel on Precision Aircraft Castings." Under the Chairmanship of Clarence E. Sims, the 20-member panel included three representatives of the steel casting industry: Charles W. Briggs, SFSA; Walter Dunn, Pacific Alloy Engineering Corporation; and H. D. Phillips, Adirondack Foundries and Steel, Inc. The panel's conclusions and recommendations included: urging further and fuller co-operation between foundries and aircraft builders; a government developmental program necessary to establish the best applications of castings and methods of production; new quality standards developed; and the establishment of a co-ordinating body to insure implementation of the recommendations.

Pacific Alloy Engineering Corporation, El Cajon, California, was formed in 1954 by Pelton Steel Casting Company, Milwaukee. Buying the stainless foundry division of Solar Aircraft Company, San Diego, Pelton moved the operations to El Cajon, where it produced exclusively aircraft and missile quality castings.

An example of both the industry's entry into the aerospace market, and the reclamation of a market previously held by weldments, was the 1958 production of stainless valve bodies for the Atlas ICBM. Meeting rigorous Air Force specifications at 70 percent of the weldments' cost, the steel castings offered increased efficiency in their greater resistance to shock, lack of seams, and, finally, better overall appearance. The castings proved satisfactory as they withstood temperature ranges of -65°F to 500°F, 2,000 vibrations per second, and stress equal to 15 times the pull of gravity.

"Atoms for Peace" or the non-military use of atomic energy became a central theme of the late 1950's. As had been the case with the early use of the atom, the alternative applications of nuclear energy would rely upon steel castings.

The large pressurized water reactor of Duquesne Light Company's Shippingport Atomic Power Station demanded the utilization of four cast 18-inch main stop valves and a large (8,000-pound) complex, double-volute pump casing. These castings, made of a stainless (ACI CF-8) alloy, met the rigid requirements of the ASME Power Boiler and Unfired Pressure Vessel Code.

The wide range of specifications for the components of nuclear power equipment stemmed from a number of sources. Military services, prime contractors and various standards bodies all took part in setting the specifications. Yet, these specifications notwithstanding, high-pressure, high-temperature plants were using stainless castings to an ever increasing extent. The success of the Shippingport Power Station had spurred the plans for larger water reactors in the Northeast. The Yankee Atomic Electric Co. at Rowe, Massachusetts, and the Consolidated Edison plant at Indian Point, New York, required pump casings of 15,000 pounds with a capacity of 24,000 gallons per minute.

America's first nuclear-powered merchant ship, the *N. S. Savannah* was launched July 21, 1959. Designed to steam for 3½ years on one fuel supply, the ship's structural and power components were chosen to complement its long life and efficiency. Among the power system's components were stainless steel impellers and volutes (castings) ranging from 52 pounds to 3150 pounds, respectively. In the reactor itself, 32 castings formed part of the transition assemblies connecting the fuel elements and grid plates. Cast fittings and valve bodies completed the casting application.

Three reasons lay behind the choice of stainless castings. One was the oft quoted economy inherent in castings. The second reason was the strength, heat and corrosion resistance of stainless steel. And finally, the castings could easily be designed with fillets and radii large enough to eliminate crevices which might trap radioactive particles.

The sophistication implied in casting applications reflected in part the increasing sophistication of the industry's technology. In this area during the 1950's U. S. foundrymen would witness revolutionary changes at an increasingly rapid rate.

Coremaking was an early beneficiary of such a revolution. In the decade's first year no-bake coremaking began in the U.S. While many founders continued to rely upon conventional coremaking methods, others readily accepted the innovations of the no-bake, silicate —CO_2, and hot box. The same principles would serve a second purpose as they were in turn applied to the field of molding.

Traditionally, foundry molds had been produced by ramming sand around a pattern. Evolution, and revolutions, in the field of molding had not touched this basic premise. You might vary the composition of the molding materials, spin the mold, bake it, whatever; but the sand was to be packed, and packed solidly. "Jarring," "jolting," and "ramming," had all come to demote mold production.

During the Second World War, German founders had broken with this tradition. In developing the "C" or "Croning" process, now known as shell molding, they had done away with the ramming and jamming. Rather, a heated metal pattern was applied to a sand-resin mixture and a thin, accurate shell was produced. The shell could then be used as a mold for molten metal.

The end of the war occasioned American foundrymen's first view of the process. But, it was not until the early fifties that they had adapted it to American production. The SFSA announced August 1, 1953, its sponsorship of a one year research project at the Massachusetts Institute of Technology. Aimed at discovering a means of producing good plain carbon and low alloy steel castings in shell molds, the research effort brought about three valuable findings, First, an improved casting surface condition and reduced carbon pickup by the metal could be brought about by adding manganese dioxide to the molding mixture. Second, further surface improvements stemmed from the use of chilling sands such as zircon, chrome ore, fosterite and olivine. And third, casting defects seemed to be due to an unfavorable time relationship between the casting's skin formation and the gas pressure buildup in the molds. Published in Research Report No. 34, these findings provided a firm footing for the shell molding process in the United States.

Once begun, however, the adaptation and foundry acceptance proceeded with remarkable speed. According to Susan L. Gibson, News Editor of *Foundry*, "A measure of shell molding growth can be seen in estimates of resins sold in the U.S., which jumped from ¼ million pounds in 1949 to 8 million pounds in 1954 and to more than 70 million pounds in 1970."

High pressure molding, on the other hand, accentuated the traditional "ramming and jamming." Introduced to the foundry world at the 1954 AFS Foundry Show, the process was described by Thomas E. Barlow as "a modification of existing knowledge using the most up to date information on pattern practice, sand practice and molding equipment." High pressure molding enjoyed a variety of applications — indeed its versatility was one of its selling points. Generally, though, the pressure molding was used to develop close tolerances, improved finish and detail in a modified green sand process. By altering sand, pressure and pattern, different degrees of precision could be attained.

The cleaning room had long resisted mechanization efforts and provided the greatest opportunity for technological advance. The sledge and chisel still remained as one of the primary tools of the cleaning room. But the contribution of arc welding and the components to successfully employ it in the foundry were to change this to a great degree. In the late '50's, Dale Hall, Oklahoma Steel Casting Co., perfected a nozzle assembly for the arc air process which insured its ready adoption to the cleaning room. The arc-air principle would so affect the industry that Charles Briggs would write in 1961: "So much progress has been made with the use of carbon arc-compressed air tools to remove defects and pads that many steel foundries have sev-

Physical testing for tensile strength measures elongation and breaking point.
Courtesy: Pelton Casteel, Inc.

eral units which, in a few cases, have supplanted the chipping hammer entirely."

Quality control and non-destructive testing had been regarded as important selling points in the 1920's. However, by the 1950's these fields formed an integral part of steel casting production. Consumers were demanding a battery of test results before castings would be accepted. While product liability had not yet assumed its later proportions, a casting's physical and chemical properties were checked and rechecked in efforts to assure a complete meeting of specifications.

Hardness was still determined by the Brinell test. Dye penetrants would point out surface discontinuities. But the hidden, internal defects which had haunted founders from the earliest days were the subjects of much of the increased scruntiny. Ultrasonics or high frequency vibrations also probed hidden defects. Radiography offered widespread, internal soundness checks. The betatron and isotopes such as cobalt 60 and iridium 192 were called upon to produce the pictures envisioned by G. E. researches in the days before World War I.

The necessity of improved quality control measures was emphasized by Harold E. Simmons in a 1956 *Foundry* article outlining the in-

Magnaflux testing for surface defects.
Courtesy: Pelton Casteel, Inc.

Brinell testing measures hardness, while below, X-Rays determine internal defects.
Courtesy: Pelton Casteel, Inc.

dustry's potential position in the aerospace field. As he urged founders to explore this developing field, he cautioned them against relying upon traditional testing procedures. "Begin thinking in terms of standards based on the current inspection techniques such as X-ray, flourescent penetrant, magnetic particle, ultrasonics and an influx of other methods which sometimes seem designed to reject rather than inspect castings."

Like castings designed for the aerospace industry, castings for nuclear service were subject to rigid specifications and the testing necessary to insure their compliance with these specifications. Primary pump volutes for the *N. S. Savannah* passed under the sophisticated eyes of the following testing/inspection methods: spectrographic, radiographic, dye penetrant, mass spectrometer, and ultrasonic.

As can be expected, the number of employees in the steel casting industry fluctuated with production. But with increasing mechanization and productivity, the number of employees required to turn out a level of production per year was decreasing. In 1947, 45,200 employees had produces 1,203,504 net tons of steel castings (roughly

Automation was a watchword of the fifties as foundries strove to increase production and efficiency. This 1956 photo shows molding machines and mold conveyors in the G.M. Development Center.

Courtesy: Foundry

The sandslinger had come to symbolize mechanized molding as it applied to larger castings.
Courtesy: SFSA

26.6 tons per man). Yet a production decline to 1,184,096 net tons in 1954 saw an even greater decline in employment. SFSA statistics showed 29,8000 employees in the steel casting industry in 1954, yielding 39.7 net tons per man. Further, in 1956 (the year in which American white collar workers outnumbered blue collar workers for the first time) production increased to 1,931,987 net tons and required the output of only 39,200 workers. The net tons per man had increased to 49.

The trend toward mechanization and higher productivity also brought about more formalized training of foundry personnel. *Business Week* had oversimplified the labor needs of a mechanized foundry. In praise of mechanization they gave the following description of the laborer's role: "to push buttons, watch the control panel warning lights, oil the mechanism." Yet a survey conducted by the Bureau of Labor Statistics in 1957 revealed 80 percent of production foundry employees, and 68 percent of jobbing foundry employees had received organized training to prepare them for their jobs. A 1952 survey had shown 60 percent of the hand molders and coremakers had learned their trade through participation in formal training.

Greater productivity, greater skills, and a host of other qualifications resulted in foundry wage gains. In 1959 the average steel foundry worker was earning $2.30 per hour with wages running from a high of $2.05 to a low of $1.97. A breakdown of wages by 26 job classifications is provided below.

Job Classification	Hourly Wage	Job Classification	Hourly Wage
Patternmaker, wood	$3.05	Melting department laborer	$2.12
Floor molder	2.16	Pourer	2.12
Bench molder	2.47	Shakeout	2.09
Rolover floor heavy machine molder	2.37	Blast cleaner, floor	2.22
Squeezer molder	2.37	Blast cleaner, machine	2.12
Sand slinger operator	2.37	Grinder	2.12
Shell machine operator	2.25	Chipper and finisher	2.22
Floor coremaker	INA	Welder	2.32
Bench coremaker	2.42	Crane operator	2.32
Machine coremaker	2.27	General laborer	1.97
Core assembler and finisher	2.17	Inspector	2.32
Cupola or furnace tender	INA	Electrician, maintenance	2.45
Electric furnace tender	2.42	Maintenance man	2.52

The above wages yielded an average of $2.30 per hour.

CHAPTER 11—The 1960's

The 1960's were to witness tremendous achievements in science and technology, achievements epitomized by the lunar landing in July 1969. Yet the decade would also be one of the most violent and divisive in our nation's history.

The decade's political history commenced with John F. Kennedy's victory in a close Presidential race with Richard Nixon. Kennedy's brief tenure would be characterized in retrospect as a period of "Camelot," a period in which Americans would rally to "do what they could for their country." The New Frontier being explored by Kennedy's administration had brought about an intellectual vigor reminiscent of the "Hundred Days" of F.D.R.'s first term. However, legislative gains were modest, with the most far reaching legislation awaiting the succeeding administration of Lyndon B. Johnson.

Kennedy's assassination in November 1963 brought Johnson to the White House. While the previous administration's policies continued to be carried out, Johnson added his personal touch as he declared his celebrated "War on Poverty" in 1964. His election in November of 1964 was a landslide in which he garnered 486 electoral votes and 61 percent of the popular vote. Viewing this as overwhelming support for himself and his programs, L.B.J. set about furthering Federal influence. In his inaugural address he called for a vast program bent on achieving "The Great Society," a society which would focus on crippling and killing diseases, poverty, civil rights, and education.

Opposition to the war in Vietnam and civil rights rioting contributed heavily to Johnson's decision not to run in the 1968 Presidential race. Richard Nixon won the election and fell heir to a country beset with national and international problems, many of which stemmed from U. S. involvement in Southeast Asia.

The roots of the United States' involvement in South Vietnam have been directly traced to 1955, but our initial concern goes back to 1946 and the turmoil following the days of World War II. Yet, as late as 1963, our military personnel were advising, and the average American had no idea of what or where South Vietnam was. However, by the decade's end few, if any, Americans had not seen or felt the effects of the war in this small country.

Large scale involvement in Vietnam did not begin until American vessels were attacked in the Gulf of Tonkin during 1964. Congressional adoption of the "Tonkin Resolution" gave the President the authority to send fighting forces to the region. By 1965 partial aid was no longer a question as American forces were openly engaging in combat. Demonstrations against the war, also begun in 1965, were to continue until peace accords were finally signed and the fighting officially ended January 27, 1973.

Despite the problems besetting the nation and the industry, steel casting production in the decade remained high. The low point would be reached early in the decade as 1961 saw a production of only 1,216,580 net tons. However, production would soar with the war induced prosperity of the mid-60's. In 1966, a record production level of 2,157,162 net tons would be shipped from American foundries. The figures below give a complete statistical production record of the decade.

Year	**Steel Casting Total**	**Steel Castings for Sale**
1959	1,412,885	1,112,668
1960	1,392,385	1,071,887
1961	1,216,580	936,877
1962	1,423,452	1,115,809
1963	1,503,762	1,197,216
1964	1,835,403	1,466,927
1965	1,961,246	1,569,782
1966	2,157,162	1,795,586
1967	1,857,485	1,555,297
1968	1,722,852	1,436,246
1969	1,899,558	1,582,587
1970	1,724,504	1,416,215

The "prosperity" of the decade can be appreciated by considering the above statistics. But production increases did not necessarily result in increased profits. Mr. Robert Schumo, President of SFSA, warned industry leaders at the Society's 1962 Fall Meeting that 1961 had been the worst year in terms of earnings since the early 1930's. Compounding this problem was a dangerous trend, centering on inadequate pricing, which was beginning to take shape. The 1962 price for a ton of miscellaneous castings was $647.97; a price which had risen over five years by $8.58 (1958 prices—$639.39). At the same time average hourly earnings of $2.64 plus $ .60 in fringe benefits put labor costs at $3.24 an hour in 1961. This indicated a rise of 32 cents per hour over the 1958 level. While prices had increased only 0.34 percent, labor costs had climbed almost 11 percent.

Yet labor costs were only one factor eating away at profits. The costs of producing an increasingly higher quality product had been high. However, a 0.34 percent rise in prices could hardly cover this. Compounding the price problem was the fact that the above were only average prices. With a number of foundries maintaining a marginal existence, it was possible in March 1962 to secure bids on a casting ranging from 15 cents per pound to $1.83 per pound.

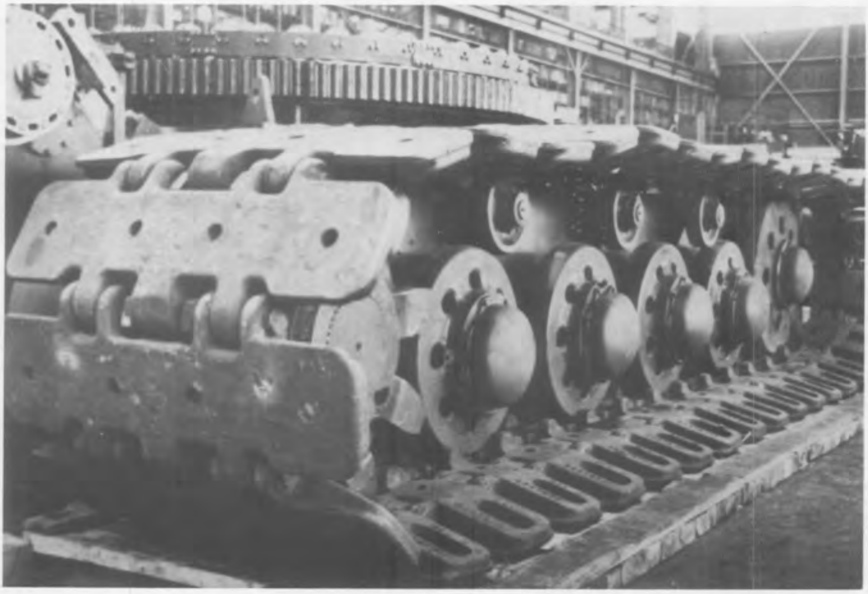
Reacting to this state of affairs the SFSA renewed its efforts in management research. The concept of 'management by objective" came into force. A committee headed by Mr. Charles Mellinger, Secretary-Treasurer of Lebanon Steel Foundry, developed a management accounting system designed as a single source of reference to permit a cost analysis of any particular job. Working through the mid-sixties and into the seventies, Mr. Mellinger's committee was faced with the added problem of tailoring its system to incorporate a growing number of casting applications.

During the '60's the Steel Founders' Society reported on the same general classifications of markets. The table below shows these general classifications and the percentage of the total market each captured in a given year.

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
A. Agricultural Equipment	1.06	.99	.96	.95	.72	.65	.66	.76	1.08	.53
B. Motor Vehicle	5.45	5.89	6.17	5.32	4.96	6.55	6.04	5.70	6.81	7.89
C. Construction Machinery and Equipment	14.68	17.16	17.16	16.31	15.93	16.40	13.96	11.63	13.28	14.39
D. Construction (Structural Components)	.65	.98	.74	.70	.31	.43	.83			
E. Mining and Crushing Machinery	5.76	9.17	7.65	7.08	7.00	6.70	7.84	7.97	7.83	6.30
F. Metal Shaping, Finishing and Forming	3.09	3.79	3.08	2.73	2.48	2.84	2.56	2.48	2.62	1.78
G. Electrical Machinery and Equipment	1.64	2.38	2.02	1.69	1.28	1.47	1.75	2.00	3.16	2.92
H. Rubber Mill Castings	1.20	.90	.86	.53	.58	.56	.54	.54	.68	.54
I. Oil, Gas Field, Valves and Piping	4.75	5.75	5.19	4.08	3.83	4.38	5.00	5.38	5.31	5.17
J. Military	2.25	3.90	4.08	3.47	1.81	1.51	1.59	2.69	2.39	1.27
K. Railroad	32.59	22.16	30.14	40.64	42.22	41.94	42.77	44.84	40.10	45.79
L. Rolling Mill	14.30	14.32	11.96	7.79	9.26	8.07	8.51	7.94	8.30	4.76
M. Ship amd Marine	1.34	1.80	1.33	1.06	.92	.56	.82	.65	.68	.55
N. Material Handling	1.66	1.85	1.51	1.62	2.58	1.46	1.32	1.26	1.36	1.36
O. Special Machinery, Products and Components	5.51	5.48	4.29	3.67	3.37	3.50	3.43	3.96	3.55	3.70
P. Gear, Pinion and Worm Castings	1.92	1.50	1.22	1.05	1.15	1.35	1.19	.86	.96	.81
Q. Unclassified	2.15	1.98	1.64	1.31	1.60	1.63	1.19	1.34	1.89	2.24

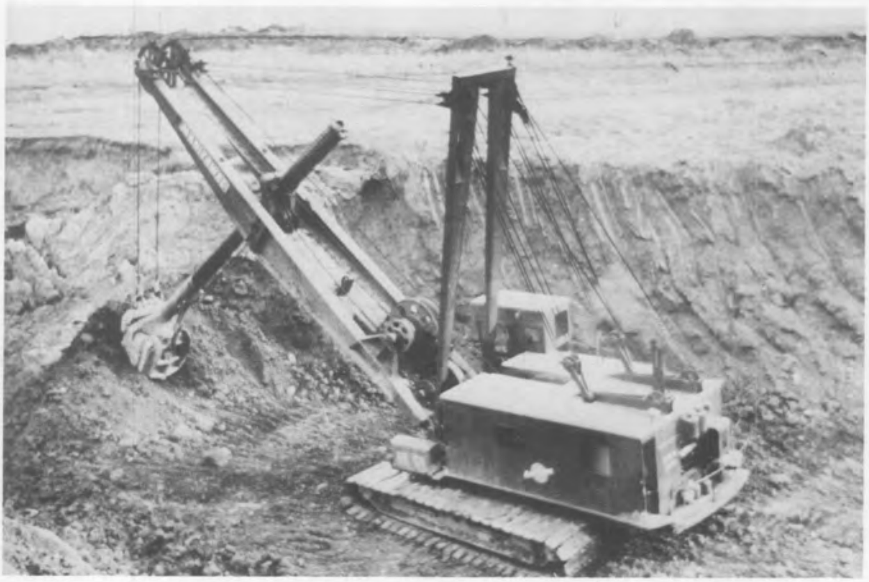
The glamour of the space race was enhanced for foundrymen as they watched an increasing number of steel castings gain aerospace acceptance.

Steel castings played a major role in the 1964 construction of two 2,750-ton, crawler mounted transporters ordered by N.A.S.A. Designed to carry the space agency's Saturn V rocket and launcher-umbilical-tower 3 miles to a launch site, the transporters were built by Marion Power Shovel Co., Marion, Ohio. The treads alone called for 500 tons of steel castings. This, combined with a liberal use of castings in structural and machine situations, brought the total weight of

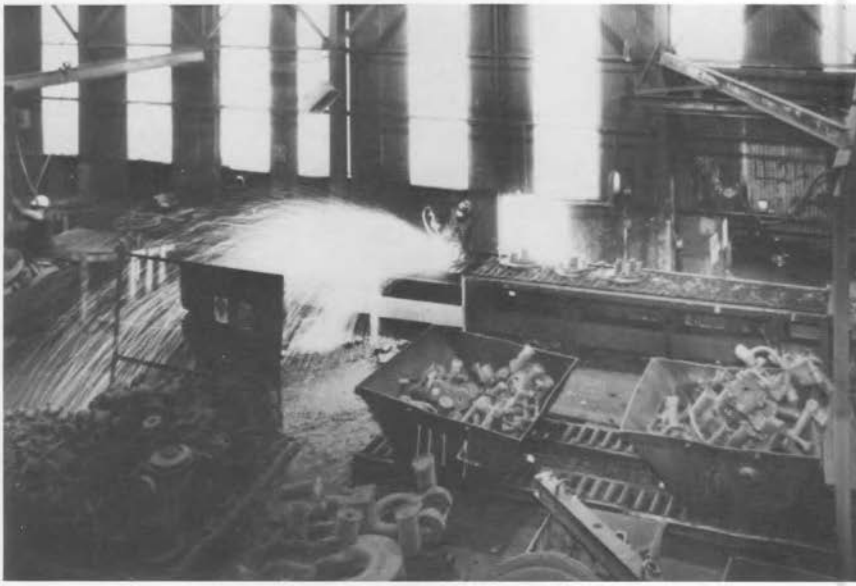


Modern construction machinery relies heavily upon steel castings. Gears, treads and bucket frames are all cast of steel.

Courtesy: SFSA and Maynard Steel Casting Company



utilized castings to 750 tons or over 27 percent of the transporter's weight.



Hand grinding and welding have cut the amount of time necessary to clean and repair castings.
Courtesy: SFSA

Wage increases reflected all the prosperity of the decade, light inflation, increased productivity, and the growing power of organized labor. The 27 traditional job classifications and corresponding hourly earnings for 1959, 1965, and 1970 are listed below and illustrate the extent of these increases.

Job Classification	Hourly Wage 1959	1965	1970
Pattermaker, wood	$3.05	$4.00	$3.95
Floor molder	2.62	2.87	3.65
Bench molder	2.47	2.87	3.45
Rollover or heavy machine molder	2.37	2.67	3.35
Squeezer molder	2.37	2.67	3.25
Sand slinger operator	2.37	2.67	3.55
Shell machine operator	2.25	2.57	3.55
Floor core maker	INA	2.87	3.65
Bench core maker	2.42	2.87	3.25
Machine core maker	2.27	2.85	3.55
Core assembler and finisher	2.17	2.57	3.05
Sand muller operator	INA	INA	3.05
Cupola or furnace tender	INA	2.77	3.75
Electric furnace tender	2.42	2.82	3.55
Melt department laborer	$2.12	$2.47	$2.77
Pourer	2.12	2.52	3.05
Shakeout	2.09	2.42	2.97
Blast cleaner, room	2.22	2.62	2.97
Blast cleaner, machine	2.12	2.42	2.97
Grinder	2.12	2.47	3.05
Chipper and finisher	2.22	2.57	3.15
Welder, gas or electric	2.32	2.92	3.45
Crane operator	2.32	2.72	3.25
General laborer	1.97	2.27	2.77
Inspector	2.32	2.82	3.45
Electrician, maintenance	2.45	2.97	3.75
Maintenance man	2.52	2.87	3.55
Average	2.30	2.68	3.33

Straight wage increases do not entirely reflect the situation. Corresponding increases in benefits have heightened the foundryman's labor costs and the consequent benefits enjoyed by labor.

The nation's growing concern with environmental pollution was to translate itself into a dramatic (and at the same time, unlooked for) addition to foundry operating costs. Air pollution legislation passed in 1955 was strengthened with the passage of the Clean Air Act of 1963. Like the '55 legislation, it authorized the Public Health Service of the United States Department of Health, Education and Welfare to conduct air pollution research, take corrective action in cases where air pollution was an interstate problem and administer grants to local agencies to initiate or expand their programs. While the '55 legislation appropriated $5 million per year, the legislation of 1963 slated $25 million for 1965; $30 million for 1966; and $35 million for 1967.

The Clean Air Act of 1963 was amended in 1965 with the addition of Title 2 of the act—the Motor Vehicle Air Pollution Control Act.

Amendments to the act which were to further directly affect the steel casting industry were passed in 1966. HEW was authorized to grant Federal funds to state and local agencies to assist in their maintenance of effective air pollution programs. As a part of these amendments, Federal budgeting was also increased with 1967 appropriations raised to $46 million. $66 million was authorized for 1968 spending and $74 million for 1969.

The Air Quality Act was passed in 1967 and designed to give order and increased power to the expanding air pollution control program. The act called for the establishment of regional standards and enforcement while strengthening the powers of local, state, and federal authorities. By the late '60's, protection of the environment had become so popular that both political parties had antipollution planks in their party platforms.

Charles W. Briggs, SFSA Vice President-Technology, issued in March 1963 a "state of the art" message in which he compared the research efforts of 14 countries on both sides of the Iron Curtain. With the Western countries clearly dominating the casting industry, Briggs gave a quick breakdown of research being carried on by leading nations.

Research areas of note in the U. S. included better steels relating to high strength, heat and abrasion resistance; improving the impact properties of carbon steel used in construction; ceramic molding; centrifugal casting; pouring procedure; lowering costs of precision metal patterns; reducing coremaking costs and improving the finishes of castings.

Financing and conducting U. S. research activity rested largely with the Steel Founders' Society, The Department of Defense (through the Naval Research Laboratory and the Watertown Arsenal) and "perhaps four major steel casting producers." The SFSA had averaged a yearly research expenditure of over $100,000 for the past 19 years. An estimate of the government's expenditures was set by Briggs at "probably less than $75,000 yearly prior to 1963." Private research, however, enjoyed the highest level of financing. "Expenditures at these four companies are upwards of 1 million dollars a year."

The large amounts being spent on research belie the role science had come to play in the steel casting industry. Yet, the "art" aspect of steel casting remained in the background, and would occasionally step forth and keep the industry mindful of its roots. The 1960's were no exception. This decade in many ways characterized by technology, saw the growth of a field dating back some 2500 years. The dual themes of art and science which run through the industry's history find no greater expression than in the investment molding process.

The "Lost Wax" process. It was responsible for some of the greatest treasures of the art world. Art historians have credited it with the Greek bronze "Portrait Head" cast in 80 B.C., "Myron's Discus Thrower," 440 B.C., and the "Equestrian Statue of Marcus Aurelius," 160-180 A.D., to name only a few. The casting method used in the creation of these works: "The actual modeling is done in wax over an earthen core, another layer of earth is firmly packed around the head, the hole is then heated to melt out the wax, and the molten bronze is poured into the hollowed form thus created." Cellini, 16th century mannerist sculptor had employed this same technique.

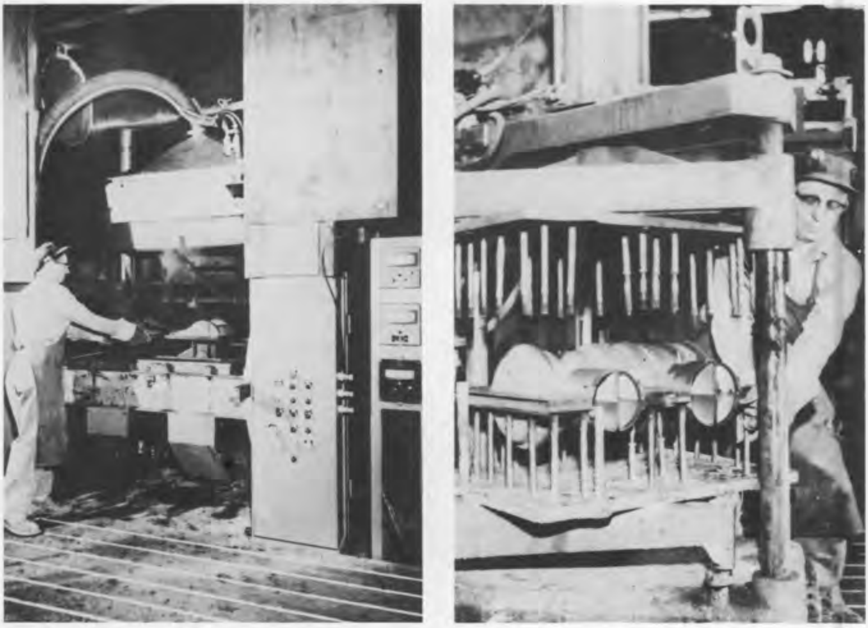
The precision manifest in these treasures stemmed from the process by which they were cast. Searching for the same qualities, steel founders adopted the process and by it turned out the investment castings of the 1960's. The 4th edition of the SFSA *Steel Castings Handbook* described investment molding as it was being employed by steel foundries. "A master mold must be prepared of the part to be cast. This mold is usually made from a low melting temperature refractory. The duplicate dispensable pattern used for each casting is made by pouring or extruding wax, or a low temperature plastic, into the master mold. After the wax pattern is made it is surrounded or covered by an investment refractory material. The molds are vibrated, thus allowing the investment to pack uniformly. The mold is heated, and the dispensable pattern is melted and poured out of the mold. The mold is fired and is then ready for filling with steel or any other metal.

Although extremely close tolerances are generally regarded as investment castings' primary advantage, they also possess smooth surfaces and low finish allowances. Beyond this, the most intricate pieces can be cast by the investment process.

The uniform structure with no directional effects enjoyed by investment castings posed an advantage over wrought alloys. And, while the castings elongation was only 75 percent of wrought alloys, the products were matched in strength values.

By the decade's end investment castings were being made of a wide variety of alloys. Among these were nickel, aluminum, magnesium, copper, iron and titanium. All of these, with the possible exception of titanium, could be cast to extremely close tolerances. These advantages meshed with the demands of the most sophisticated markets of the '60's and resulted in a 400 percent increase in the production of investment castings between the years 1959 and 1965. By the decade's end, the production of these castings which range up to 100 pounds, were averaging a little over 3,000 tons per year.

A demand for castings on a large scale brought about a dramatic increase in a second alternative molding process, that of shell molding. Like investment casting, the products of shell molding possess close tolerances and good surfaces. But, while these qualities are not equal to those of the investment castings, shell molding will accommodate castings up to 250 pounds. Beyond this, the process lends itself to mass production.



Shell molding gained increased acceptance during the 1960's as steel foundries competed with the weldments and forging industries. Left, the cope and drag for a valve are removed from a shell molding machine. Right, a shell mold for a track roller is bonded hydraulically.
Courtesy: Foundry *and* American Steel Foundries

Extended research into the problems of casting low carbon and low alloy steels in shell molds led to the development of the Chilmet Process. New developments in shell molding material, combined with a unique method of shell mold production, resulted in the process' 1961 unveiling.

Using a granular carbonate mixed with silica sand and resin, the resultant shell molds possessed desired chilling properties and improved temperature shock resistance. The molds were of composite construction with a thin facing of bonded refractory material backed by a carbonate-silica mixture.

The new process catered to better casting surfaces at a cost equivalent to the traditional molds employing zircon sand.

During the '60's the use of shell molding had increased rather steadily from a 1959 level to 10,000 tons to 30,000 tons in 1969.

In earlier chapters one or two men who, having achieved an outstanding impact on the industry, were acknowledged in their roles. The image of men such as William Hainsworth, Jim McRoberts, and Frederick Lorenz had all left an indelible mark on the steel casting industry. While playing important roles within private concerns, they had looked beyond their individual companies to the industry as a whole. The contributions that they made on this scale have set them apart.

The absence of such a character in the chapters relating to the past three decades does not deny his existence. For one man during those 30 years had maintained such an outstanding level of drive and achievement, that he might well have highlighted any of those decades. Indeed, in a 1975 address to the 30th Annual Technical and Operating Conference, Mr. Charles Stull of Pelton Casteel dubbed Charles Willers Briggs and the "Bull of the Woods" the two most important men in the history of the steel casting industry.

That Mr. Stull's address should take place at a T & O Conference was altogether fitting—Charles Briggs had initiated the first conference in 1946 and been responsible for each succeeding one until his retirement in 1968.

A native of the west coast, Briggs attended Stanford University and was granted a B. A. in metallurgy in 1926. Completing the requirements for D. Met. Engr. in 1928, Briggs accepted a position as a metallurgist in the Standard Oil Co. of California. After two years in this position, he moved in 1930 to Washington, D.C., and the U. S. Naval Research Laboratory. An eight year tenure at the Research Lab ended in 1938 when Briggs accepted the position of Technical and Research Director of the Steel Founders' Society.

A prolific writer, Briggs authored a number of works on all aspects of the technology of steel casting. Among these were: *The Flow of Steel into Molds; Fundamentals of Steel Foundry Sands; The Solidification of Steel Foundry Sands; The Solidification of Steel Castings; Fundamentals of Risering Steel Castings;* and *Core Sands and Binders.*

Drawing on his and fellow foundrymen's widespread expertise, he directed the 1941 publication of the *Steel Castings Handbook* and updated it in two later editions. In an editorial capacity he was also responsible for *The Manufacturer of Cast Armor During World War II* and the quarterly publication of the distinguished *Journal of Steel Castings Research*.

On a smaller, but no less prolific, scale was his publication of *Steel Casting Research Reports*. 1944 saw the publication of the first of these research reports: "Time and Temperature Transformation of

Charles W. Briggs

H. T. Curves." Working with Briggs on this project were the nine members of the first Technical Research Committee: Fred Milmoth, Frank Allison, Ray Gezelius, Charles Heater, Frank Hohn, Ed Hummel, Henry Phillips, H.A. Schwartz, and Paul Stuff. Work on a similar nature would be spearheaded by Briggs for the next 27 years and result in 67 separate published and copyrighted reports.

Charles Briggs was not content with a singular reliance upon the printed word. His lectures to various groups in the U. S. were innumerable, but did not deter him from expanding to foreign countries. During his tenure, lecture activity often took him to England and the British Steel Casting Research Association, the International Foundrymen's Congress in Holland, the German Foundry Industry in Dusseldorf, Germany, and the Centre de Technique, Paris, France.

His contemporaries described him as "a genius," and invariably added, "a controversial genius." Gifted with a tremendous amount of ability, he also had the drive and energy to fully exploit it. Foundrymen often found themselves hard pressed to keep up with him. He invited challenge and often met it with sarcasm. But, as Dale Hall of Oklahoma Steel Casting Co. maintained: "If he had been lovable, some big company would have hired him away."

However, the position of SFSA Technical and Research Director (changed in 1960 to Vice President-Technology) perfectly suited Briggs' ambitions and talents. In this position he was free from the restraints and myriad cares of an individual foundry. Moreover, he was free to move about and fully exploit his talents on an international scale. While serving in his SFSA capacity, Briggs maintained membership in a number of organizations. For ten years he served as a member of the U. S. Army Metallurgical Advisory Committee on Cast Armor. During World War II he was a member of the Technical Industrial Intelligence Committee Joint Chiefs of Staff. The work of this committee led to the introduction of shell molding in U. S. foundries. Membership in other organizations included: AIME, ASM, AFS, AWS, American Ordnance Association, American Society of Naval Engineers, NDT, ASTM, and IBF. He also served as Chairman of the Iron and Steel Division of the American Institute of Mining Metallurgical and Petroleum Engineers and a Board Member of the Metallurgical Society.

A concern with the future as well as the present was yet another facet of Charles Briggs' philosophy. Mr. Briggs recognized the key role which education played in the steel casting industry—a role which would become increasingly important. To bring about and maintain increasingly higher educational levels, he began the SFSA Educational Series. The "Green Books" would number four by the time of his 1968 retirement.

Pursuing the same objectives on a different level, Mr. Briggs instituted the position "Assistant to the Technical and Research Director." This program, begun in 1946, brought promising metallurgical students to the Society for a two-year residency upon completion of an undergraduate degree. Among the graduates of this program active in the industry today are: Harold Fraunhofer, President of K O Steel Castings; Charles Rowe, Grede Foundries; Dennis C. Harsch, Corporate Technical Director, Cast Metals Corporation; Jack D. McNaughton, Executive Vice President, SFSA; Rodman F. Duncan, Chief Metallurgist, ESCO; Paul Rudd and Dan Dutcher, both of K O Steel; and Edward M. Gall of Mid-Continent.

As he approached his retirement, Mr. Briggs looked to the future and forecast 13 avenues which the industry would do well to follow if it were to achieve maximum growth. These roads include: a rapid pattern formation; computerized steelmaking with swift, accurate control of chemistry, temperature and gases; ever thinner-faced molds and cores; rapid determination of risering and gating; automatic heat treating; a majority of production taken up by high strength, high toughness castings; repair welding done away with; chemical cleaning; rapid and easy removal of excess metal; electro slag assembly welding for large and complicated castings; maximization of customer demand and acceptance; and finally, an adequate plant with modern equipment and a low number of man hours per ton of castings produced.

This final road, the development of an adequate plant, with modern equipment and a low number of man hours per ton, Briggs considered to be "absolutely necessary to the attainment of all other technological goals." Ironically, it is this area which has been most affected by the crises of the seventies.

CHAPTER 12—The 1970's

The 1973 end of the Vietnam War marked a turning point in recent U. S. history. World affairs were blanketed under the unfamiliar term "detente" as U. S. attention focused on severe domestic problems relating to both politics and the economy.

Political scandals lent an air of distrust to the decade and the credibility of the nation's highest office was openly questioned. The financial affairs of Spiro Agnew led to his resignation from the office of Vice-President. However, this scandal was quickly forgotten as the 1973 Senate investigation of the Watergate break-in threatened to lead to the impeachment of a U. S. President. Richard Nixon's resignation in August 1974 highlighted, but did not end the national concern with investigation. The investigatory process continued to bring to light abuses of power ranging from the secretarial pool to covert CIA operation to the bribery of top officials by foreign governments.

Feeding and being fed by this political turmoil was the economic crisis of the seventies. The inflation of the early sixties continued and accelerated through the late sixties and early seventies. Coupled with this inflation was a recessionary tendency apparent in 1973, which produced a startling phenomenon dubbed "stagflation". Economists puzzled as both prices and unemployment continued to rise.

An energy crisis further compounded the nation's economic woes and Americans in 1974 faced gasoline rationing for the first time since World War II. The easing of the gasoline shortage only increased the impact of the next shortage, that of natural gas in 1976-77. Americans were thus faced with the triple economic threat of unemployment, rising prices, and shortages of basic energy sources—three seemingly incompatible phenomena according to traditional economic concepts.

Symptomatic of the inflationary spiral of the 1970's is the foundry wage which has increased dramatically in the first six years of the decade. The NFA breakdown below reveals these increases in the specific 27 job classifications. However, the averages of the wages sufficiently illustrate the situation. The average wage climbed only 65c in the period between 1965 and 1970. Yet the six year period from 1970 to 1976 brought an increase of $1.58.

Job Classification	1965	1970	1976
1. Patternmaker, Wood	$4.00	$3.95	$6.15
2. Floor Molder	2.87	3.65	5.60
3. Bench Molder	2.87	3.45	4.80
4. Rollover or Heavy Machine Molder	2.67	3.35	4.80
5. Squeezer Molder	2.67	3.25	5.20
6. Sand Slinger Operator	2.67	3.55	4.30
7. Shell Machine Operator	2.57	3.55	5.00
8. Floor Coremaker	2.87	3.65	4.70
9. Bench Coremaker	2.87	3.25	5.18
10. Machine Coremaker	2.85	3.55	5.00
11. Core Assembler and Finisher	2.57	3.05	4.80
12. Sand Muller Operator	NA	3.05	4.70
13. Cupola or Furnace Tender	2.77	3.75	4.70
14. Electric Furnace Tender	2.82	3.55	5.00
15. Melt Department Laborer	2.47	2.77	5.10
16. Pourer	2.52	3.05	4.40
17. Shakeout	2.42	2.97	4.60
18. Blast Cleaner, Room	2.62	2.97	4.40
19. Blast Cleaner, Machine	2.42	2.97	4.50
20. Grinder	2.47	3.05	4.40
21. Chipper and Finisher	2.57	3.15	4.60
22. Welder, Gas or Electric	2.92	3.45	5.30
23. Crane Operator	2.72	3.25	5.00
24. General Laborer	2.27	2.77	4.30
25. Inspector	2.82	3.45	4.90
26. Electrician, Maintenance	2.97	3.75	5.60
27. Maintenance Man	2.87	3.55	5.50
Average	2.68	3.33	4.91

The problems wrought by inflation have been compounded for the steel castings industry by increasing governmental regulation. The trend toward centralized environmental control matured in the 1970's. Though providing increasing federal assistance, 1960's environmental control had been directed toward the development of local pollution control agencies. But in 1970 the President's Council on Environmental Quality (CEQ) was established for the purpose of consulting with and advising the President, a function similar to the President's Council of Economic Advisors. At the same time the Environmental Protection Agency was created to administer federal antipollution programs.

Legislation and the machinery to enforce it was in existence by 1972. However, it was only then becoming apparent just how expensive the process would be. In March 1972 the Environmental Protection Agency completed a study entitled "The Economic Impact of Pollution Control." The study indicated that enforcing the laws then on the books in just 14 industries would result in a total cost of $18.2 billion for air pollution alone. Moreover, the study predicted that from 200 to 300 of the 12,000 plants in the 14 industries would close, and between 50,000 and 125,000 workers would be out of jobs. The agency's conclusion, however, was that though the economic costs would be high, the U. S. economy could bear it.

A second base of governmental regulation was established with the 1970 passage of the Occupational Safety and Health Act which established the Occupational Safety and Health Administration. This small agency, a part of the Labor Department, has been assigned the following role which appears in the *United States Government Manual*. It . . .

> develops and promulgates occupational safety and health standards; develops and issues regulations; conducts investigations and inspections to determine the status of compliance with safety and health standards and regulations; and issues citations and proposes penalties for non-compliance with safety and health standards and regulations.

The agency's attempts to fulfill the above mandate has engendered a great deal of criticism. The most likely source of such criticism is businessmen and industrialists, but the agency had recently come under fire from government officials. Dr. Paul W. MacAvoy, a former member of the President's Council of Economic Advisers, gave the following comment on OSHA's effectiveness: "What OSHA had accomplished is to become the source of endless 'horror stories' which I guess may be inevitable when you attempt the mindless application of nationwide standards."

Foundrymen have been particularly hard hit by OSHA regulations, but most will concede the need for improved safety. Their main commplaints stem from regulations which they feel are inconsequential or are not enforced uniformly.

The period from 1945 to the present is regarded by many leaders of the steel castings industry as a period of high attrition. Competition, on which the capitalist system is based, accounts for a certain degree of attrition, but the inflated demand of the World War II years (and the resultant inflation of the number of steel foundries), increasingly sophisticated (and expensive) technology, labor demands, and most recently, the standards imposed by the EPA and OSHA, have forced many marginal foundries to close. Statistics compiled from the SFSA *Directory of Steel Foundries* show that between 1950 and

1965, 52 foundries ceased production. From 1965 to 1968 another 6 steel foundries closed. With the seventies and the added impact of high inflation, and OSHA and EPA requirements, the number of foundry closings has sharply increased. Between the summer of 1969 and the summer of 1971, 19 steel foundries closed. Another 27 foundries closed between the summers of 1971 and 1973.

However, the loss of 78 steel foundries in the seventies is only part of the problem. Expansion of many existing foundries has been forsaken as capital has become more expensive and less productive. But updating and expanding production facilities is, and has been, a prerequisite for the continued growth of the steel castings industry. Charles W. Briggs regarded it as "absolutely necessary" for continued technological growth.

Yet, the 1970's have seen this necessary expansion and upgrading seriously curtailed. Not only has inflation driven up the cost of such expansion, but the meeting of OSHA and EPA standards has drawn off the capital which would have met the inflated costs. A Cast Metals Federation study of capital expenditures between 1972 and 1976 found expenditures for compliance with OSHA and EPA requirements accounted for 38 to 45 percent of the total amount spent by smaller foundries. Larger foundries (foundries with more than $5 million in annual sales) directed 30 percent of their expenditures to meeting these requirements. And the problem is increasing with the adoption of stricter standards. As greater amounts of pollution must be abated, the cost suffers a disproportionate increase. For example, the removal of 98 percent of air pollutants requires seven times the expenditure necessary to remove 90 percent.

Steel castings production fluctuated during the first years of the seventies as the industry coped with economic and regulatory difficulties. The U.S. Bureau of Census production figures for the period 1966 to 1975 show the industry trying to regain the production level achieved in 1966.

Year	Steel Castings, Total	For Sale	For Own Use
1966	2,517,162 n.t.	1,795,586 n.t.	361,576 n.t.
1967	1,857,485	1,555,297	302,188
1968	1,722,852	1,436,246	286,606
1969	1,899,558	1,582,587	316,971
1970	1,724,000	1,416,000	308,000
1971	1,579,000	1,282,000	297,000
1972	1,584,000	1,296,000	288,000
1973	1,894,000	1,566,000	328,000
1974	2,091,000	1,739,000	352,000
1975	1,937,933	1,585,364	352,569

The production accomplished in this decade was channeled into markets the extent of which men such as O.P. Letchworth, William Hainsworth and John Roach could only dream. The Steel Founders' Society of America adopted the Standard Industrial Classification System in 1973 to report steel castings shipments. Using this system 20 major market areas have been defined and are ranked below in the order of the percentage of the total production each obtains. Though actual percentages remain confidential, this order presents an accurate picture of the end uses to which steel castings are put. Railroad Equipment ranks as the number one market for steel castings, followed by Construction Machinery and Equipment, and Mining Machinery and Equipment. These three markets account for approximately 75 percent of steel castings uses. Dividing the remaining production are, in order: Miscellaneous Fabricated Metal Products; Metalworking Machinery and Equipment; Other Construction, Mining and Materials Handling Machinery and Equipment; Motor Vehicles and Motor Vehicles Equipment; Special Industrial Machinery (Except Metalworking Machinery); Engines and Turbines; General Industrial Machinery and Equipment; Ordnance and Accessories N.E.C.; Farm Machinery and Equipment; Motors and Generators; Fabricated Structural Metal Products; Boat Building and Repairing; Miscellaneous Transportation Equipment; Aircraft and Parts; Refrigeration and Heating Equipment; Mobile Homes; and finally, All Others.

Steel foundries in the 1970's are offering their castings to an ever widening range of applications. This range necessitates an equally wide range of mechanical and physical properties to meet the specific demands of each application. In carbon and low alloy steels alone it is possible to produce a casting with a tensile strength from 60,000 to 128,000 pounds per square inch. The steel's elongation can be set between 4 and 40 percent. Hardness may range from 120 to 700 on the Brinnell scale. The casting will survive the Charpy V-notch impact test in a range from 5 to 65 foot pounds.

Greater meaning is given to these specifications when the demands of the castings' applications are considered. Aircraft frames and engines must be light, yet strong. Atomic energy reactors must be solid and secure. Turbines, valves and pumps must survive high pressures and operating temperatures ranging from 1,150 to -150 degrees Fahrenheit. Transportation, construction, earth moving, mill and mining equipment all must perform at high speeds under heavy loads.

Serving these markets are the 368 foundries of today's steel castings industry, an industry whose own growth has been matched by the growth of the problems which it must face. The industry's rise to its present state has been one of urgency, frustration, hardship, cooperation and success. Founders in the late ninteenth century turned to cooperation in response to technical backwardness and labor and governmental pressure. The formations of the American Foundrymen's Society, the National Foundry Association and the Steel Founders' Society of America took place as cooperation displaced secrecy. The industry's gains in terms of growth and acceptance rested to a large degree with these societies. Not surprisingly, the pressures of the late 1960's and 1970's have renewed the cooperative drive. Inter-society cooperation is a phenomenon of the recent period of increased pressures. In 1965 the Alloy Casting Institute merged with the Steel Founders' Society of America. Labor relations pressures occasioned the SFSA's adoption of their dual membership policy with the N.F.A. Under this 1971 program, membership in the Steel Founders' Society automatically included membership in the National Foundry Association.

The formation of the Cast Metals Federation in 1972 marked the latest and most extensive cooperative effort among founders. Recognizing the need for a "unified spokesman" for the casting industry, trade associations and other organizations united to form the CMF. The Iron Castings Society, the Steel Founders' Society and the National Foundry Association form the core of this organization's membership. In the past five years the Federation has represented the foundry industry in the fields of governmental relations, strategic raw materials conservation, environmental, health and safety programs.

Thus, the factors which have shaped the steel castings industry's 116 year development are in force today. As the industry reacts to these forces, further development will occur. The hardship, frustration, failure, cooperation and success will continue, as will the steel castings industry.

Conclusion

The steel castings industry in the United States has been developing for the past one hundred sixteen years. In this time it has risen from the uncertain sale of a railway casting to an industry serving twenty distinct major market areas with three billion dollars worth of castings per year. The 1875 production of steel in the United States amounted to only 390,000 tons, with steel castings accounting for only a slight fraction of this. One hundres years later steel castings alone accounted for 1,868,345 tons.

From its birth, adolesence and coming of age in the respective areas of Buffalo, Eastern Pennsylvania, California, Ohio, Wisconsin, Illinois and Michigan fill the top five positions with Illinois and Michigan sharing the fifth position. Texas is number six followed by Washington as seven and Alabama, Indiana, New York and Missouri tied for eighth. New Jersey and Oregon are numbers nine and ten.

Growth necessitates change, and changes have taken place in every area of the steel castings industry. "Can this piece be case of steel?" was once the overriding question put to founders. However, uncertain customers with no specifications but the casting "do the job" have given way to demanding customers with set specifications and rigid acceptance standards. The "steel doctor" of the early days has lost his place to the metallurgist. The crucible furnace for the most part has lost its place to the electric furnace. The castings themselves, once described as "equal parts of steel and holes" now are solid and must pass a battery of tests to verify this. Simple production has given way to production which must consider environmental and safety factors, product liability, equal opportunity, the most efficient use of resources, and still return a profit.

The "Bull of the Woods" might recognize today's foundries, but would hardly be comfortable in them. Management teams, scientific management and management by objective were simply not a part of his vocabulary or style. Changing demands have brought about the industry's development, and try as he might, the "Bull of the Woods" could not stop them.

The past one hundred sixteen years have seen an industry take shape. It, like the molten metal it deals with, has been cast to shape.

APPENDIX

1927
John E. Galvin
The Ohio Steel Foundry Company
Lima, Ohio

1928
Harry F. Wahr
Mesta Machine Company
Pittsburgh, Pennsylvania

1929-30
John E. McCauley
Birdsboro Steel Foundry and Machine Company
Birdsboro, Pennsylvania

1931
William H. Worrilow
Lebanon Steel Foundry
Lebanon, Pennsylvania

1932
Arthur Simonson
The Falk Corporation
Milwaukee, Wisconsin

1933
Theodore H. Harvey
The Ohio Steel Foundry Company
Lima, Ohio

1934-38
Frederick A. Lorenz, Jr.
American Steel Foundries
Chicago, Illinois

1938-39
Frank M. Robbins
Ross-Meehan Foundries
Chattanooga, Tennessee

1940-41
Donald C. Bakewell
Blaw Knox Company
Pittsburgh, Pennsylvania

1942-44
Oliver E. Mount
American Steel Foundries
Chicago, Illinois

1945
Alvin M. Andorn
Penn Steel Castings Company
Chester, Pennsylvania

1946-47
Edgar D. Flintermann
Michigan Steel Casting Company
Detroit, Michigan

1948
F. Kermit Donaldson
The Machined Steel Casting Company
Alliance, Ohio

1949-51
Thomas H. Shartle
Texas Electric Steel Casting Company
Houston, Texas

1952
Henning A. Forsberg
Continental Foundry & Machine Co.
East Chicago, Indiana

1953-55
A. J. McDonald
American Steel Foundries
Washington, D. C.

1956-57
Howard F. Park, Jr.
General Steel Castings Corporation
Granite City, Illinois

1958-59
Ross L. Gilmore
Superior Steel & Malleable Castings Co.
Benton Harbor, Michigan

1960-61
Wilson H. Moriarty
National Malleable & Steel Castings Co.
Cleveland, Ohio

1962-63
Robert M. Schumo
Pennsylvania Electric Steel Casting Co.
Hamburg, Pennsylvania

1964

I. Mindred Emery
The Massillon Steel Casting Company
Massillon, Ohio

1965

Allen M. Slichter
The Pelton Steel Casting Company
Milwaukee, Wisconsin

1966-68

Burleigh E. Jacobs
Grede Foundries, Inc.
Milwaukee, Wisconsin

1969-70

Harold C. Binge
The Massillon Steel Casting Company
Massillon, Ohio

1971-72
John M. Quinn
Lebanon Steel Foundry
Lebanon, Pennsylvania

1973-74
Richard A. McBride
Howmet Corporation
Crucible Steel Casting Division
Milwaukee, Wisconsin

1975-76
Lawrence S. Krueger
Pelton Casteel, Inc.
Milwaukee, Wisconsin

1977
C. E. Haney
ESCO Corporation
Portland, Oregon

Mr. Haney is currently SFSA President.

SFSA EXECUTIVE VICE PRESIDENTS[1]

C. C. Smith[2]	1902-1905
Thomas C. Pears	1905-1924
W. J. Corbett	1924-1929
Granville P. Rogers	1929-1933
Raymond L. Collier	1933
Col. Merrill G. Baker	1933-1946
Raymond L. Collier	1946-1947
Tullie V. Taylor (acting)	1947
Leslie C. Thellemann	1947-1949
F. Kermit Donaldson	1949-1965
Thomas E. Barlow	1965-1971
Jack McNaughton	1971-

1. Throughout SFSA's history the title of its chief executive officer has changed several times. Executive Vice President is in current use.

2. Mr. C. C. Smith was a steel foundryman and member of the SFSA Board at the time of its founding. He was given organizational and record keeping responsibility for the new association. Mr. T. C. Pears was the first full-time staff executive.

FREDERICK A. LORENZ MEMORIAL MEDALISTS

Commemorating the outstanding and unselfish service rendered to the Steel Castings Industry by Frederick A. Lorenz, this medal may be awarded by unanimous vote of the SFSA Board of Directors to an employee of a Society member "for outstanding service to the Industry."

1938	Mrs. Frederick A. Lorenz	1956	Allen M. Slichter
1939	Frank M. Robbins	1957	Howard F. Park, Jr.
1940	Lee C. Wilson	1958	Ben P. Hammond
1941	Donald C. Bakewell	1960	Jules D. Hagans
1942	Oliver E. Mount	1961	Wilson H. Moriarty
1943	Theodore H. Harvey	1963	Newman Ward
1944	Claude L. Harrell	1964	Robert M. Schumo
1945	Alvin M. Andorn	1966	Royal G. Parks
1946	Jack A. Sauer	1967	Edwin Walcher, Jr.
1947	Edgar D. Flintermann	1968	Robert C. Wood
1948	F. Kermit Donaldson	1969	Burleigh E. Jacobs
1949	A. J. McDonald	1970	Bradley B. Evans
1950	Thomas H. Shartle	1971	Harold C. Binge
1951	James Suttie	1973	John M. Quinn
1952	Henning A. Forsberg	1974	Dale L. Hall
1953	Clarence Tolan, Jr.	1975	Richard A. McBride
1954	Ross L. Gilmore	1976	Joe L. Long

Note: The Lorenz Medal was not awarded for 1955, 1959, 1962, 1965, and 1972.

CHARLES W. BRIGGS MEMORIAL TECHNICAL AND OPERATING MEDAL RECIPIENTS

Originally established as the Technical and Operating Medal in 1944, the award was renamed the Charles W. Briggs Memorial Technical and Operating Medal in recognition of the activities of Mr. Briggs. The medal is given by the unanimous vote of the SFSA Board of Directors to an employee of a Society member for an outstanding scientific or engineering contribution toward the advancement of the Industry.

1944	Edwin A. Walcher	1961	William D. Emmett
1945	John B. Caine	1962	William W. Heimberger
1946	Walter F. Wright	1963	Frank H. Allison, Jr.
1947	Charles L. Heater	1964	Charles E. Stull
1948	Roy A. Gezelius	1965	Charles Locke
1949	John F. Lacey	1966	P. James Neff
1950	Paul H. Stuff	1967	W. Kenneth Bock
1951	Luther A. Kleber	1968	Gail L. Stroppel
1952	Gustav A. Lillieqvist	1969	Alfred B. Steck
1953	Francis X. Hohn	1970	Arthur F. Gross
1955	Robert C. Wood	1971	Carter DeLaittre
1956	Henry D. Phillips	1972	Nino Davi
1957	Victor E. Zang	1973	Edward W. O'Brien
1958	I. Mindred Emery	1974	Arthur P. Guidi
1959	Clyde B. Jenni	1975	Benjamin J. Bergson
1960	Dale L. Hall	1976	Frederick K. Sutter

Note: The T & O Medal was not awarded for 1954.

THOMAS E. BARLOW AWARD OF HONOR RECIPIENTS

Established in 1961, the SFSA Award of Honor recognized distinguished contributions of persons outside the Steel Castings Industry. The award was renamed the Thomas E. Barlow Award of Honor in 1971 as a posthumous tribute to Mr. Barlow, Executive Vice President of the Steel Founders' Society of America, 1965-1971.

1961	Frank G. Steinbach, Publisher, Foundry Magazine
1962	Charles Willers Briggs, Consultant, SFSA
1964	I. Mindred Emery, President, SFSA
1966	F. Kermit Donaldson, Executive Vice President, SFSA
1967	John F. Wallace, Professor of Metallurgy, Case Western Reserve University
1969	Clarence Sims, Consultant, Battelle Memorial Institute
1970	Chauncey Belknap, Patterson, Belknap & Webb
1971	Thomas E. Barlow, Executive Vice President, SFSA
1972	Clyde B. Jenni, Washington Representative, SFSA
1975	Charles Sheehan, Executive Director, National Foundry Association
1976	Richard G. Moser, Patterson, Belknap, Webb & Tyler