The Evolution of the United States Iron Industry between the Years 1750 and 1920 and the Economic Factors which Contributed to its Growth

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The revolution in the American iron industry between the years of 1750 and 1920 can be described as nothing short of amazing. In that time span the industry grew from a number of relatively small, independently owned furnaces, in the backwoods areas of the Eastern United States, that were capable of producing only small amounts of iron (i.e. the Callaway Furnace of old Pittsylvania County, Virginia only produced 600 tons of pig iron during the entire Revolutionary War)\(^1\), into the monolithic industrial giants, such as the United States Steel Corporation, that ruled the country's iron and steel production, and churned out phenomenal amounts of refined metal (U.S. Steel produced 28 million tons in 1910) from their massive plants in the major industrial cities of the United States.

The beginnings of the American iron industry can be traced all the way back to the Saugus Ironworks in Hammersmith, Massachusetts. The Saugus refining facilities, founded in 1641, are widely recognized as "the first successful furnace" in Colonial America.\(^2\) However, the industry did not take off immediately. The technology would not be available to exploit the country's wealth of iron ore for some time.

The early furnaces were at a great disadvantage because of a lack of a truly efficient transportation systems. The sheer weight of iron ore (it usually took three tons of ore to produce one ton of pig iron) prevented it from being shipped any considerable distance. This would change in the 19th Century when a canal system was put in place.

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\(^2\) Rutland 10.
in place and a large scale railway freight network developed.\(^3\) The furnaces also were heavily dependant on a vast, nearby fuel source, which means they were usually located away from cities in heavily forested areas where timber for charcoaling was readily available.

The crude technological manner of the furnaces themselves were a major handicap to the spread of the industry as well. These furnaces were enormous structures ranging in size from around thirty to sixty feet in height and twenty to forty feet in width. The cold-blast furnaces were the first of the effective furnaces. They consisted of an outer shell of rock mortared together, square in shape, sloping toward a smaller top, with abbesses cut in two of the sides out of which the molten iron and slag would pour. The interior of a large furnace (fifty feet high and thirty-eight feet wide) had at it's base an area roughly eight feet wide and eight feet high called the hearth, it is here that the liquid iron settles after it is removed from the ore. The interior would then slope outward for about ten feet, this area is called the boshes. The interior wall would then proceed upward and inward in an egg shaped curve, until at the top it was only about ten feet wide. The area between the inner lining and the outer wall would be filled with loose stone rubble to better support and insulate the furnace. On the side of the furnace there would be an opening (or openings) called a Tuyere hole through which the blast would be sent into the furnace. The blast would originate.

in a bellows that is driven by a water wheel, or in emergency cases, when the water flow is insufficient, manpower.4

With these primitive furnaces only charcoal, coke, or peat could be used (peat was only used in places such as Ireland where a ample supply of peat was available, but was probably never used in the United States). Both the coke and the charcoal took a tremendous amount of preparation, further retarding the ability of a furnace to produce pig iron efficiently. In order to produce the charcoal a thirty to forty foot circular area was completely cleared, cordwood was then stacked to form a triangular chimney, wood was then stacked around the chimney until the mound was ten to fourteen feet tall, and then the chimney was filled with kindling. The wood was then covered with turf, leaves and dust from the last coaling, and finally the kindling was lit. It would take roughly two weeks for the mound to completely cook, at which time holes would be dug on the edge of the mound to allow it to cool. Coke was made in roughly the same manner as the charcoal. It could be prepared under an earthen mound as well, but it was discovered that it was much more efficient and less time consuming if it was cooked in a close oven. Charcoal was preferred over coke if it could be obtained cheaply and in large quantities, it was purer than coke and much more combustible.5

The first recorded attempt at using coke as fuel in a blast furnace in the United States was believed to have happened at the

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5 Fairbain 38.
Bear Creek Furnace in Armstrong County, Pennsylvania in 1819. This first attempt failed because of a weak blast, but the potential this held attracted considerable attention in Pennsylvania because of the large deposits of bituminous coal that were scattered throughout the state. Due to the lack of suitable bituminous coal, or a way to transport it, this interest failed to grip the nation, however and the coking process would spread slowly, not reaching Virginia until 1874 when William Firmstone converted the old Lucy Silena charcoal Furnace of Alleghany County.

The invention of a practical steam engine facilitated the movement of the iron refining facilities away from the water sources that they were so long dependant on for power. The use of the steam engine to operate the bellows freed the furnace from being tied to streams and other bodies of moving water, and allowed it to move inland, closer to the ore, where production was more efficient because of the close proximity to the raw materials.

One of the most important developments in the iron and steel industry came in 1823 when J. Beaumont Neilson, an engineer from Glasgow, Scotland invented an "improved application of air to produce heat in fires, forges, furnaces, where bellows or blowing apparatus are required," he had just invented the first hot blast furnace. There was no difference in the actual furnace itself, the

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6 Coats and Robertson 98.  
7 Coats and Robertson 99.  
8 Upchurch, Thomas C., Two Ironmaster Families in Alleghany County Virginia: A Study of Jordan's Lucy Silena, and Australia Furnaces and the Firmstone's Longdale Furnaces Washington and Lee University, Anthropology Department, 8.  
9a Fairbain 59.  
9b Fairbain 63.
only change was that the air was not sent directly from the bellows into the furnaces, instead it was diverted into an oven or stove that would heat the air to between 600 and 800 degrees Fahrenheit. This invention was crucial to the expansion of the worldwide iron industry because in places such as Great Britain, where anthracite coal of good quality was readily available, the coking and charcoaling processes could be abandoned in favor of just using the more efficient anthracite for fuel (three to four times more coal was used in coking as it was if it was used directly as fuel, and the production of charcoal consumed enormous tracts of forest). However in the United States there was not a ample presence of the anthracite coal near major mining sites, except in western Pennsylvania and Ohio, so the invention was not important for that reason, but instead it was important because it was simply a more efficient way to produce iron.10

It took several years for the Hot-Blast furnaces to take over the industry. Because furnaces were generally more productive during the winter months there was the general train of thought throughout the industry that the colder the air was the more effective the blast would be (the increased production was later attributed to the lower humidity of the winter months). This slowed down the expansion of the industry for a short time, but eventually the improved quality of the iron and the overall more efficient nature of the hot-blast furnace won out.11

10 Fairbain 63–64.
11 Fairbain 63.
Another technological innovation that added to the effectiveness of the iron ore smelting process was the advent of the use of the Siemens-Martin process in 1861.\textsuperscript{12} This process, commonly referred to as a regenerative gas furnace, took the gases expelled from the top of the furnace and sent them back through the tuyere holes. This was "by far the most successful and economical method of attaining higher temperatures"\textsuperscript{13} that had been discovered at that time.

In 1864 Kelley Bessemer created one of the most important developments in the history of the iron and steel industry. He discovered that if air was injected into the molten iron that the oxygen in the air would react with the impurities in the iron and burn them away. This created a much stronger steel that had many more practical uses. It was now strong enough that it could be used for many industrial reasons, opening the way for a much broader marketplace.\textsuperscript{14}

The railroad industry was the foundation on which the iron industry would spread. It provided not only an efficient mode of transportation for the raw materials to get to the refining facilities and a much faster way for the finished product to reach its final destination, but also it was the largest consumer of the iron products themselves.\textsuperscript{15} The creation of the large scale railway networks and canal systems, that were to make nearly every part of

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\textsuperscript{12} Coats and Robertson 50.  \\
\textsuperscript{13} Coats and Robertson 50.  \\
\textsuperscript{14} "Iron" World Book Encyclopedia, 82 ed. 353.  \\
\end{flushleft}
the country accessible, also facilitated the moving of the iron refining process into large cities. The movement of the industry into the cities was a crucial step in the move toward large scale production because a large full time work force was readily available in the form of the non-skilled immigrants that were pouring into the country in the middle and end of the 19th century. These immigrants were a reliable work force because they had no agrarian interests that could possibly affect their work in the furnaces and forges, as the workers in rural forges sometimes did.

The movement of the industry to urban centers was devastating to Southern steel production after the Civil War because with an absence of slaves the industry was basically devoid of a large percentage of its manual labor force. In addition to losing its slaves the South's iron industry was also hurt because the overwhelming amount of immigrants, that were to become the industries laborers, went to the industrial centers of the North such as New York, Boston, Philadelphia, and Baltimore where there was already an extended family of people of their own culture, leaving the South with no tangible work force for the iron industry.

The increased efficiency, and overall expansion of the iron industry, as well as the explosive growth of the entire United States manufacturing industry in general, combined to lower the cost of iron prices considerably. The price of producing iron using a charcoal furnace, at the Lycoming Iron and Coal Company of Pennsylvania in 1853, was estimated to be $6.38 per short ton of pig

16 North 167.
17 North 170.
iron, while production of iron in a coke furnace was only $2.10 per short ton. The radically lower prices achieved with the new technologies were a serious boon to the industry because for the first time iron products such as stoves and other cast and wrought iron materials were transportable, readily available and cheap enough to afford for a large section of the populace.19

Perhaps the most important step toward today's modern iron manufacturing industry was made by Andrew Carnigie in 1873. Carnigie set up the first large scale iron and steel production facility in the United States, The Edgar Thomson Works, in Braddock, Pennsylvania. The Edgar Thomson Works were the beginning of what was to become the huge conglomerate called The United States Steel Corporation, which was to dictate the industries prices, and effectively control the country's iron and steel production well into the twenties.20 Throughout the course of Carneige's life he built up an enormous quantity of iron and steel holdings that gave him a large percentage of the market share. Upon his retirement in 1901 he unloaded all of his iron and steel holdings on the great industrialist banker J.P. Morgan; Morgan then proceeded to combine Carneige's holdings with his own impressive properties and several other interests he purchased to form the enormous holding company, United States Steel Corporation. The Corporation, masterminded by Morgan and Elbert H. Gary, consisted of eleven constituent companies which controlled over 170 subsidiary companies. The actual capital

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19 Coats and Robertson 101.
of the new enterprise was valued at $1,402,846,000, an extraordinarily large amount of money at the time. The venture was so productive that every year, with the exception of three, from its inception until 1932 it paid dividends back on its common stock, making it one of the most successful of all the great consolidations.21

With the rise of the great consolidations in the 1880's and 1890's there became an even greater need for iron and steel.22 Corporations such as the United States Shipbuilding Company, and Standard Oil Company of Ohio, placed enormous demands on the iron and steel industry. The increased production capabilities of the industries represented by these corporations allowed for the even further expansion of the iron and steel industry because of the profit it was making supplying their needs.

The iron industry of the United States grew from a small independent industry with rural production facilities, with the intent of making primarily agrarian products,23 into an enormous centralized industry with massive production facilities in the major industrial cities of this country. By the start of the 1920's the switch away from rural production was almost complete as industrial giants such as the United States Steel Corporation and Bethlehem Steel Corporation ruled the country's iron and steel production. The United States steel industry had grown from a backwoods industry, that lagged behind the rest of the industrial

21 Faulkner 428-429.
22 Faulkner 428.
23 Coats and Robertson 106.
world's technology, into the world's foremost leader in production and innovation in less than 200 years.
Works Cited:


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