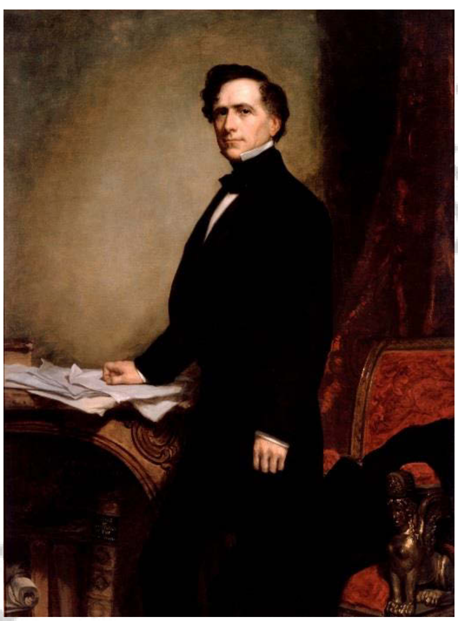
Abstract

This chapter uses the rise of Carnegie Steel as a case study to explore the social and economic context of materials. In the nineteenth-century United States, steel became a vital element of industrial growth, and Andrew Carnegie revolutionized its production through a system of "hard driving" at his steel mills outside of Pittsburgh, Pennsylvania. This is an example of the economic theory of "creative destruction," in which innovation in technology and the organization of the shop floor replaces longstanding institutions and practices in the production of materials. As a result, there are both gains to society—in this case cheap steel for the construction of things like buildings and railroads—but also drawbacks for workers and companies that tried to compete with Carnegie. In sum, innovation in the manufacture of materials can be a double-edged sword.

Carnegie, Creative Destruction, and American Steel

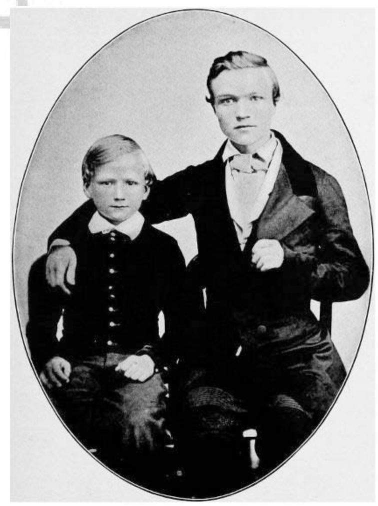
1. The President and the Weaver's Son



President Franklin Pierce (Wikipedia)

Franklin Pierce should have been celebrating his inauguration as President of the United States in early 1853; instead he was mourning. The New Hampshire Democrat had just won 86% of the electoral vote in the presidential election, even though he was a long shot to even win the nomination. Franklin, his wife Jane, and their beloved son Benny boarded a train on January 6, 1853 in Andover, Massachusetts. Less than one mile into the journey, a coupling snapped and the passenger car rolled down an embankment. Jane and Franklin suffered only slight injuries, but Benny was not so lucky. The Pierces watched horrified as the wreckage from the crash decapitated their only living son. Both parents would never be the same again; Jane brooded over the accident and even wrote a letter of apology to her deceased Benny, while Franklin never displayed the political vigor needed to unite a county rapidly coming undone over the issue of slavery. Although they felt their tragedy intensely, as every grieving parent would, the Pierces were not in rare company. From 1850 to 1852, over 900 Americans died in railroad accidents in New York State alone. Deficient parts—like the coupling that failed in January of 1853—and worn out iron rails signaled more than a technological challenge for American railroads: they could be quite deadly.[1]

At the same time that the Pierces mourned, young Andrew Carnegie had his own problems. His father, Will Carnegie, had been a skilled weaver in Scotland. But when a steam-powered loom opened in his home town of Dumferline, the elder Carnegie struggled to find steady work. "Andra," he confided in 1847, "I can get nae mair work." The next year the Carnegies were on their way to America, where Will still could not find a good job. In 1855, while a gloomy President Franklin Pierce presided over Washington, Will Carnegie died, leaving Andrew to tend to his mother and fend for himself.[2]



Young Andy Carnegie and brother Thomas, ca. 1851 (Wikipedia)

On the surface, the lives of Franklin Pierce and Andrew Carnegie appear very different. What could unite the 14th President of the United States and the immigrant son of an underemployed weaver? As it turns out, we can use steel to forge a link between these two stories; in fact, steel tells a great deal of the story of Industrial America. Think of it this way: had Andrew Carnegie's steel been around in 1853, the history of the Pierce family might be quite different. But even as cheap and durable steel made railroad travel safer during Carnegie's time, the societal cost—particularly to workers and Carnegie's competitors—took an altogether different toll on the United States. How this connection between steel and nineteenth-century Americans took hold is the focus of this chapter. And by understanding the context in which steel emerged as an essential material for industrialization, hopefully we can appreciate the ways in which new materials enrich our own generation. Steel here is a case study; one that provides a kind of blueprint for anticipating how the integration of new materials into our society can generate both positive and negative results.

2. Iron and Steel

Iron is the second-most common element on Earth and humans have worked it into tools, weapons, and other goods for millennia. The process for converting iron ore into metal at various levels of toughness and flexibility is simple and straightforward: cook the impurities away from the ore, leaving the base metal behind. Steel requires a bit more work to make, as it needs a particular amount of carbon—usually between 1 and 2% by weight—and this kind of precision requires more care than basic iron smelting.

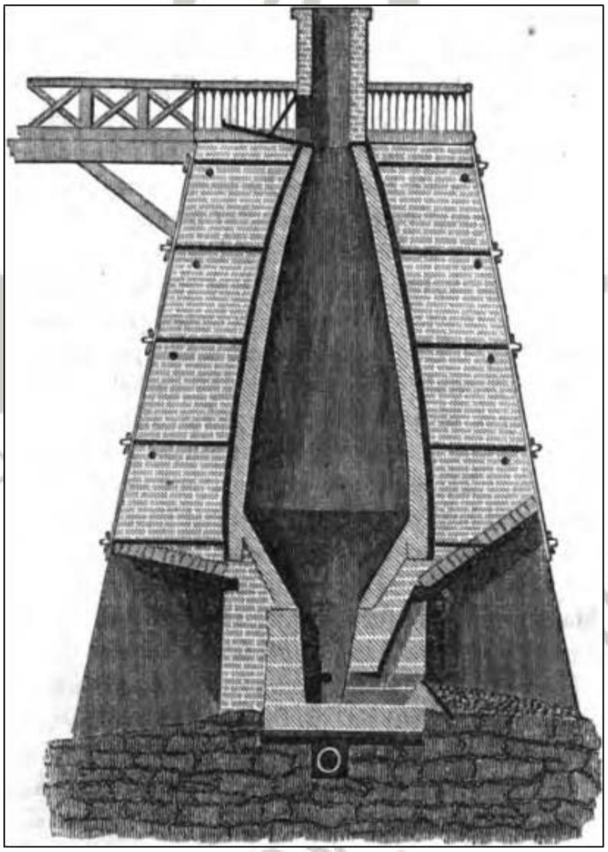
The relationship between humans and iron remained relatively stable over those thousands of years until a distinct time in the 19th century, when innovations in production techniques and changes in consumption patterns accelerated the knowledge and practice of iron metallurgy quite suddenly. In fact, these changes occurred so rapidly, we refer to the period as one of an "industrial revolution" and iron and steel played an absolutely central role in that phenomenon, particularly in the United States. American became connected to steel in so many ways, that by the advent of the 20th century, they didn't think twice about its presence in their lives.

3. Why Steel?

In order to understand why steel is so important, we first have to dive a bit into the history of iron. After all, steel is simply an alloy of iron and carbon, but since the common definition of steel is that it contains up to 2% carbon by weight, its history is closely related to iron. Essentially, iron's properties that make it a desirable product is its toughness—an iron plow tears the soil much more effectively than a wood one, for example—but at very high purity levels, iron can be too rigid and break. Adding carbon to iron adds some strength, but keeps the product flexible. Steel can take an edge quite well, which is why it has been a popular material for making swords for centuries. But making steel was a difficult, labor-intensive process for most of human history.

Iron, on the other hand, was relatively easy to manufacture. Iron smelting, the manufacturing process that mixed iron ore, a carbon-based fuel like charcoal or coal, and a stabilizing agent such as limestone, had been around for thousands of years. Small furnaces appeared in ancient China, Mesopotamia, and Rome. Although iron reaches a liquid state at temperatures of 1500^{o} C, ancient furnaces struggled to reach that temperature, and so they produced a product called "blooms," which then had to be heated and hammered in order to remove impurities. This labor-intensive process meant that iron was a useful material for weapons, small tools, and decorative item; large-scale manufacturing simply wasn't possible.

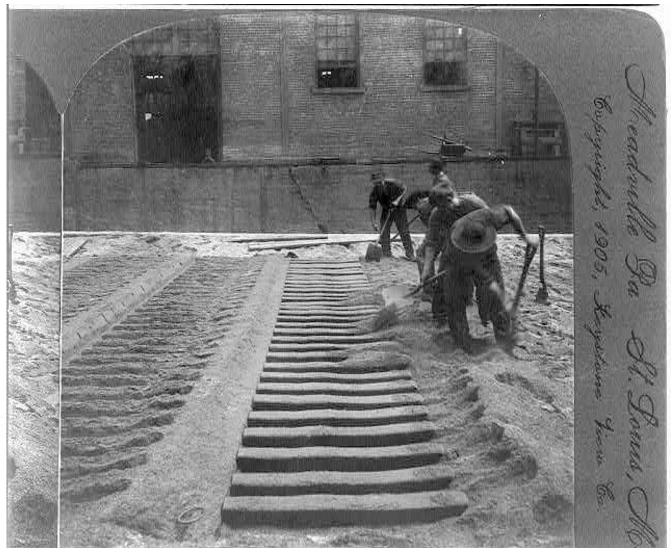
By the 1700s, Europeans were constructing large, tower-like "blast furnaces" that could run for months on end. Since these large-scale furnaces could reach well beyond the 1500^{0} F level, the iron liquefied at the bottom of the furnace while the impurities in the ore bonded with the limestone or other reactant. Once the ironmaker decided the batch was ready, workers tapped the furnace and skimmed the impurities, or "slag" off of the top. The molten iron flowed into troughs dug into the sand surrounding the furnace--workers eventually called the cooled iron "pigs" because they looked as if they were baby pigs suckling a large sow. The "pig iron" could then be reworked into iron tools, sash weights, cannonballs, plows, stoves, and other products by pouring, or "casting" the melted iron pigs into molds. Once the iron had been smelted, blacksmiths could also work it into steel by adding small amounts of carbon and then heating and hammering it to the right level. So, blast furnaces made larger iron products more affordable, but cheap steel still eluded furnace masters.[3]



Cutaway of a 19^{th} Century blast furnace

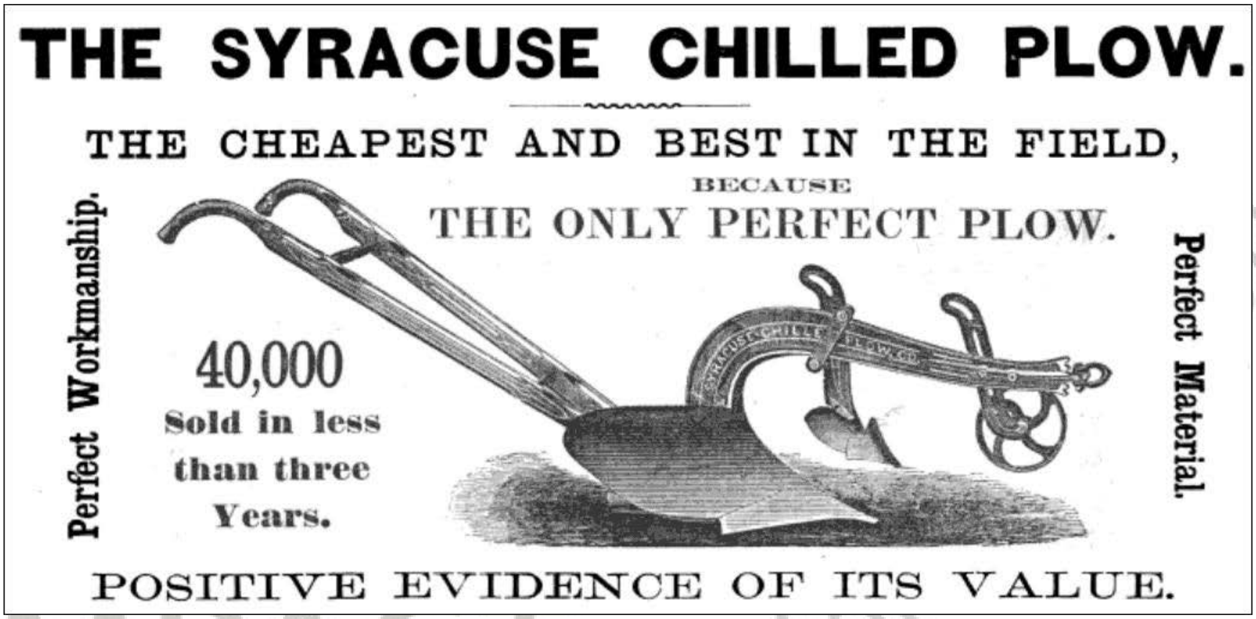
4. Iron in the American Context

Early American ironmakers built their furnaces in remote locations known commonly as "iron plantations," because they required close proximity to essential resources such as water power, iron ore, and wood for charcoal fuel. At full blast a good American furnace produced twenty-five to thirty tons of "pig iron" a week. This raw product made its way to specialized facilities like rolling mills, nailworks, and wireworks that produced more refined types of iron products.



Digging out the moulds for iron "pigs" at a blast furnace, 1905 (Library of Congress)

Iron production had ancient origins, but it began to change rapidly in the 19th century Atlantic World. In the 1820s, British ironmakers used coal in place of charcoal, which reduced their stocks of wood. This technology crossed the Atlantic to appear in American furnaces by the 1840s, the substitution of coal for charcoal reduced the cost of making a ton of pig iron by half. The use of coal also meant that iron furnaces and foundries (those smaller facilities that worked pig iron into useful tools and products) could be built closer to urban centers. As the nation grew, iron became an essential ingredient in American life. Farmers plowed their fields with an iron plow in the morning, cooked their meals in cast iron skillets at midday, stirred their fires with iron tongs to warm the chilly evening air, and then closed their windows at night using iron counterweights.



Plow advertisement from 1879 (Wikipedia)

5. Iron, Steel and Railroads

At the same time that coal became a common fuel in American furnaces and iron a common product in its households, the nation's expanding railroad network increased demand for steel. In the three decades before the Civil War, the American railroad network of the United States grew by a factor of ten; these railroads needed iron products such as rails, cars, and other railroad components. American iron producers struggled to meet this demand, and during this period of great expansion, many railroads imported their rails from Great Britain.

Some railroads tried to save on iron through other means. They laid down “strap” rails, in which thin iron strip sat on top of a wooden rail. Iron-starved companies could build a line quickly and cheaply in this fashion, but the strips of iron sometimes came loose and would fly upwards when a passing locomotive ran over them. These “snakehead” rails quite literally impaled some railroad passengers, and was part of the gruesome reality of early railroad travel. American railroads in the antebellum era also purchased iron products that were of uneven quality. Couplings, axles, and wheels were notorious for failing quickly—and sometimes disastrously—as the Pierce family found out so tragically on that January day. Castings made from pig iron were cheap, but the quality was uneven. And without the means of testing it for strength and flexibility, manufacturers made inferior products that often broke down at the most inopportune time.

A gruesome depiction of a railroad accident in 1856. Although human error sometimes caused them, accidents often were the result of faulty materials. (Library Company of Philadelphia)

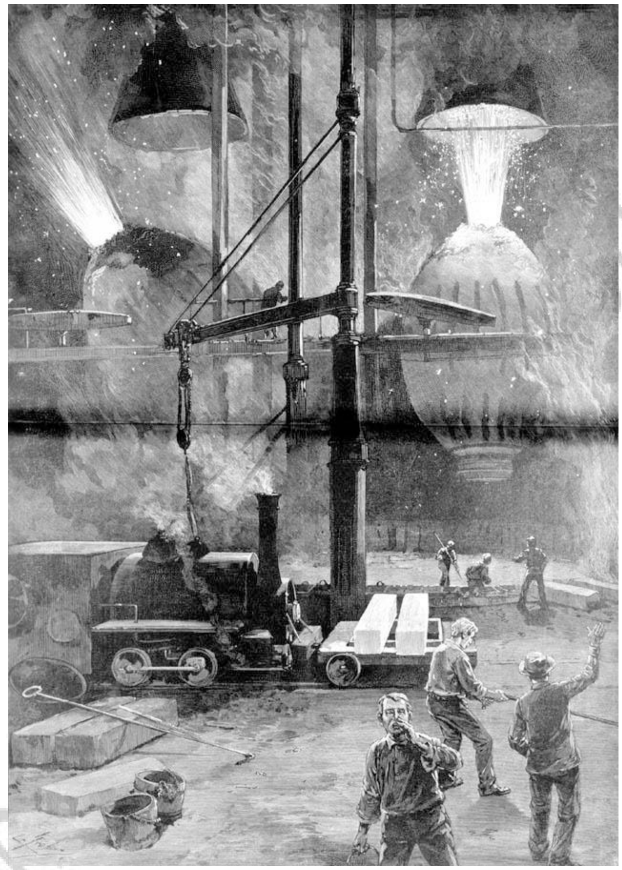
6. The Work of Making Steel

Could steel be the solution? Since steel is more flexible and stronger than cast or wrought iron it became the ideal material for making durable rails and other parts needed to run a railroad safely and efficiently. But at the time when the nation's rail network needed cheap steel, most of it was "blister steel," which required the repeated application of powdered carbon to superheated wrought iron. A skilled blacksmith then repeatedly hammered the carbon into the blade and dunked it into water to cool it rapidly. This ancient art of making high-quality steel was fine for razors or swords; but it was not feasible for the mass production of large industrial products like rails.


An iron puddler tapping steel from the furnace (Library of Congress)

Another method of making steel, which also drew upon a high level of skilled labor, was called "puddling." This method of refining involved melting pig iron from the heat of a coal fire in a furnace while an experienced "puddler" stirred the molten iron, thus burning off impurities while the purer iron formed a pool, or "puddled," in the furnace. Eventually the puddler added carbon to the iron and quite literally stirred up a batch of steel. As with blister steel, there was no inherent problem with this method of making steel, other than the amount of time and skilled labor it took. This necessarily raised the cost of production and gave workers a great deal of control over the process.

In 1856, however, Henry Bessemer invented a process of converting iron into steel which used the injection of a blast of air through molten iron. The "Bessemer Process" used an egg-shaped furnace that tilted once to accept the molten iron and the tilted upwards so that impurities could blow out the top of furnace. Bessemer steel came to the United States in upstate New York during the Civil War and in 1877 American steelmakers made 432,169 tons of steel rail; much more than the 332,540 tons of iron rails produced in the same year.[4]



Making Bessemer Steel in Pittsburgh, 1886 (Library of Congress)

7. Making Steel in the American Context

Railroad construction showed no signs of dropping off, which meant that iron and steel rails still commanded a large share of domestic consumption, and the application of steel beams to the construction of buildings and bridges dramatically increased the demand for steel in the United States. As its industrial economy expanded, the demand for steel in the United States seemed insatiable.

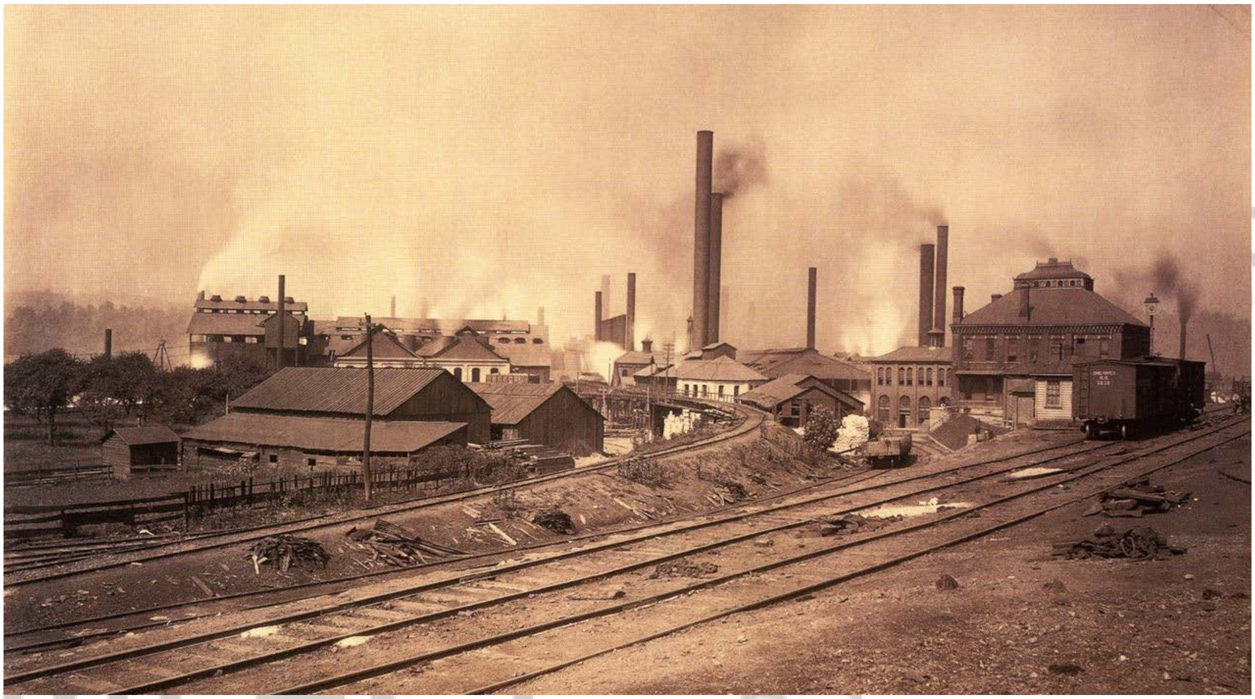
Politicians knew that steel was critical to their nation's success, and so American steel enjoyed a protective tariff for most of its rise, which meant that any imported iron had to pay a sizable duty. To insure this was the case, the American Iron and Steel Association, the industry's trade organization, teamed up with protectionists in the U.S. Congress like Pennsylvania's Rep. William "Pig Iron" Kelley. Their efforts insured that while tariff levels fluctuated in the years prior to 1900, they remained relatively high. Operating with strong tariff protection and utilizing new technologies such as the Bessemer process, the American iron and steel industry blossomed in the years after the Civil War.

8. Carnegie and Steel

Here is where Andrew Carnegie reenters the picture, because if you're going to talk about the rise of cheap steel in the American economy, you need to know the story of Andrew Carnegie. He was not the first person to make steel, nor would he be the last. But his method of doing so would change the course of the industrial economy forever.

By the time Andrew Carnegie migrated with his family to the United States in 1848, steel was still costly to make, and so his newly adopted country imported a great deal of it from Great Britain. While working as a telegraph operator with the Pennsylvania Railroad, young Andy saw firsthand the American railroad industry's huge appetite for high quality steel. After earning a small fortune in the stock market, Andy decided that he wanted to make something rather than just buy or sell things. That something was steel.

9. Hard-Driving



The Edgar Thompson Works outside of Pittsburgh, Pennsylvania in 1891 *(www.explorepahistory.com)*

When he finished construction on his Edgar Thomson Steel Works outside of Pittsburgh in 1873, Andrew Carnegie was employing two major business strategies. The first was a tactic called “hard-driving,” in which Carnegie worked his men and his machines to the limit. He used the newly improved Bessemer process for making steel, which required a massive furnace with a specialized lining—Carnegie’s employees wore them out constantly. But he didn’t care, so long as he continued to reduce the cost of steelmaking.

Carnegie Steel hired Alexander Holley to implement Bessemer steel technology—at the time the cutting edge technology in steelmaking—at his mills; eventually a new and more efficient process known as “open hearth” appeared. Carnegie simply scrapped the existing equipment and made the transition to the new system. Short-term costs were no object. For example, once a manager told Carnegie he knew of a rolling-mill design that could roll steel rails more efficiently. Andy ordered the existing rail mill—which was only three months old—ripped out and new one installed.

Carnegie's managers tinkered with the process constantly—finding more and more ways to cut the cost of labor and materials. If that meant adopting new techniques, Carnegie's managers did it quickly; if it meant breaking the power of skilled workers on the shop floor, Carnegie's managers did it brutally. In the end, "hard driving" worked: the first ton of Carnegie steel cost about $56 a ton to make; by 1900 the cost was down around $11.50.

Hard-driving is a great example of the more general concept of improving *throughput*: essentially a measure of the speed and volume that the flow of materials has through a single plant or works. A high rate of throughput—which managers usually measured in terms of units processed per day—became the critical criterion of mass production. It's an important measure of productivity that many businesses sought to emulate the success of steel.

10. The Carnegie Legend

By implementing new technology and cost accounting, Carnegie saw one blast furnace increase annual output from

Bessemer Steel

In 1856, Henry Bessemer introduced to London's Royal Academy of Science a revolutionary process of converting iron into steel which used the injection of a cold blast of air through molten iron in egg-shaped furnace—called a "converter"—that transformed iron into steel in a matter of minutes

Although accounts vary as to who actually "invented" the Bessemer process, we do know that the first working converter in the United States appeared in Troy, New York in 1864. Soon other firms like the Cambria Iron Works and the Bethlehem Iron Company quickly adapted Bessemer converters in their plants, and Carnegie Steel eventually turned the process into a finely tuned machine.

Since "hard-driving" made Carnegie obsessed with reducing costs via innovation and efficiency, his steel factory eventually ditched its Bessemer Converters for the open hearth process, which is more like the way that steel is made today.

There are only a few Bessemer converters remaining in the United States, and most of them are museum pieces.

Here is a video that shows the manufacture of a steel rail from a working Bessemer converter in England.

13,000 tons to 100,000 tons. British steelmakers, who had previously dominated the world market in steel rails, couldn't understand this process and considered it reckless. For example, Carnegie would hard-drive a furnace until the lining was completely shot, then he would simply replace his furnaces about once every three years. British furnaces, in contrast, lasted twelve years on average. One British visitor bragged to Carnegie that back home they had equipment they had been using for twenty years. Carnegie reportedly responded. "And that is what is the matter with the British steel trade." Carnegie streamlined the production process within the plant. Once the blast furnace formed the molten steel into ingots, they were rushed to the rolling mill and made into rails. Another British observer said that he would like to sit on an ingot for a week and watch that mill operate. A manager told him that if he wanted an ingot cool enough to sit on, he'd have to send to Britain for it. When steelmaking changed from the Bessemer system to open hearth production (a method of steelmaking that relies more upon chemistry), Carnegie ripped out the Bessemer converters and put in open hearth furnaces. The end result: Carnegie constantly slashed prices and undersold competitors.[5]

Andrew Carnegie, the Hard Driver, in 1878 (Wikipedia)

11. Vertical Integration

Making coal into coke in "beehive" ovens (Pennsylvania State Archives)

The second major strategy that Carnegie employed was something business historians called *vertical integration*. Rather than buy the ore, Carnegie bought mining land in Minnesota's rich Mesabi Iron Range, along with a small fleet of vessels to transport it to Pittsburgh. Rather than buy the best fuel for steelmaking—a refined version of coal called "coke"—Carnegie acquired vast coalfields, as well as the beehive ovens that made coke, when he brought in Henry Clay Frick, the ruthless coal baron, into Carnegie Steel. By 1900, his company controlled every aspect of steelmaking, from the time the ore left the ground to the time it returned in the form of a steel rail.

Andrew Carnegie's many innovations make him a great example of an entrepreneur in America's Industrial Age. He revolutionized the process of making steel in order to undercut his competitors, increase his share of the steel rails and construction beam markets, and then drive any potential competition out of business. American as a whole benefited from Carnegie's cheap steel, but there were costs as well.

12. Who Bought Steel?

These innovations in production were made possible by an insatiable demand for steel in American economy of the late 19th century. After the Civil War, railroads grew at a spectacular rate, until by 1890 they linked the entire continental United States with 167,000 miles of rail; 150,000 miles had been laid since 1865. Every American lived and worked, on average, within ten miles of a rail line. This kind of a massive network required a constant influx of cheap steel, as new rail lines went in, old ones were replaced, and rolling stock like locomotives, freight cars, and passenger liners all employed steel parts for their durability and strength. This was no longer Franklin Pierce's kind of railroad.[6]

As American cities spread out across the continent, they also grew up in construction. The massive influx of immigrants to cities across the United States made urban areas in the Northeast and Midwest swell in size. From 1860 to 1880, New York City grew from 813,000 to 1.2 million; Chicago from about 112,000 to over 500,000. This kind of rapid growth over a few decades meant that urban infrastructure was stretched to its limits. In Chicago, a solution came with steel construction. Between 1885 and 1895, Chicago architects developed a close relationship with Pittsburgh steelmakers to develop a “steel-skeleton” design that allowed for individual buildings to double, even triple in height over the traditional brick and mason structures. When William Jenney’s Home Insurance Building was completed in 1884 with structural steel, it was the tallest building in the world at 138 feet. Fifteen years later New York’s Park Row Building’s 30 floors stretched 391 feet and helped coin a new phrase: “skyscraper.” As American cities slanted upwards, so did the demand for structural steel.[7]

The Park Row Building on the cover of Scientific American in 1898

<u>13. Creative Destruction</u>

As steel transformed the American landscape in both the city and the country, Andrew Carnegie reshaped both its method and marketing. What would be the impact of these changes? Why are they important?

In 1942, the economist Joseph Schumpeter coined the phrase *creative destruction* to describe the process of industrial change, particularly in the face of entrepreneurial activity and the incorporation of new technology. Schumpeter was trying to explain how the market economy drives change that benefits society, but at the same time can wreck established ways of doing things. In his book entitled *Capitalism, Socialism, and Democracy* he described a process of "industrial mutation" in which a new way of producing goods are "incessantly destroying the old one, incessantly creating a new one. This process of Creative Destruction is the essential fact about capitalism."[8]

14. Carnegie and Competition

Any firms who tried to cut into Carnegie's market found themselves in a tough spot—Carnegie would drive the price of steel low enough to put the upstarts out of business, only to raise the price back up once the coast was clear. So "creative destruction" certainly had its benefits—cheap steel rails and beams—but in rearranging the way America did business, Andrew Carnegie also left some wreckage in his wake.

Carnegie Steel's price leadership limited smaller firms to niche markets such as structural steel, wire, wire nails, rods, and hardware. So it is unfair to say that Andrew Carnegie enjoyed a monopoly on steel production; or even an oligopoly. Instead, he tended to drive out competitors in large industrial markets and focus on achieving *economies of scale*—that is, the reorganization and expansion of the production process so as to reduce costs. Doing this meant that Andrew Carnegie needed absolute control over the process of making steel, from the raw materials to the finished product.

15. The Impact of Creative Destruction on Workers

Take for example organized labor. Before Carnegie Steel, most of the power over the steelmaking process resided in the workers. This was reflected in both wages and working conditions. For example, in 1865 the Sons of Vulcan, an organization of iron puddlers, secured

Steelworkers at Carnegie Steel's Homestead Works, 1890 (www.explorepahistory.com) a "sliding scale" for their members in which wage rates were tied to the price of iron. However, as new techniques eroded the traditional power and prestige of puddlers and other skilled ironworkers, many employees sought to organize themselves into unions. In 1876, the Sons of Vulcan combined with a number of other trade unions to form the Amalgamated Association of Iron and Steel Workers in Pittsburgh. By 1891, the Amalgamated reached its peak membership of over 24,000 workers organized into 290 locals. They exerted a great deal of authority and helped organize what had been a fairly diffuse trade.[9]

The integration of new technologies like the Bessemer converter or the open hearth furnace threatened the Amalgamated's power. In prior labor conflicts, steelworkers had been able to gain some concessions from their employers like the sliding scale. But when faced with the system of "hard driving," the Amalgamated struggled to retain control over the shop floor. This all came to a head in Homestead, Pennsylvania during a famous strike in 1892.

16. The Homestead Strike

Because of his working-class background, Andrew Carnegie liked to portray himself as a friend of his workers. In 1889, his workers went on strike at his steel plant in Homestead (outside of Pittsburgh) and Carnegie settled by giving them a contract that set their wages higher than those at neighboring steel mills and negotiated with the union, the Amalgamated Association of Iron and Steel Workers. Homestead was huge—12 mills employing 3,800 men with a town if 11,000 surrounding it.[10]

In 1892, Carnegie left the country to travel to Scotland, and left the dirty work of union-busting to Henry Clay Frick. Frick announced that Carnegie Steel would only deal with men on a one-to-one basis, and the workers walked out. Frick then set up "Fort Frick" a 12 foot high fence topped with barbed wire—he also hired 300 Pinkerton Agency detectives as guards. On July 2 he shut Homestead down to lock out the union. When the Pinkerton guards

Frick and Homestead

Henry Clay Frick (1849-1919) had built a business empire in the coalfields of Southwestern Pennsylvania. Frick produced the best "coke," a fuel made by baking coal in beehive-shaped ovens. After consolidating his power in the coking fields of Pennsylvania, Frick joined Carnegie Steel as a partner in 1889.

Frick's iron-fisted tactics in breaking labor unions in his coking operations influenced his approach to striking workers at Carnegie's Homestead Works in 1892. He locked them out and prepared for a

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arrived on a barge on the Monongahela River on July 5, the workers--throwing rocks, firing guns, and employing a small cannon--met the Pinkertons. After 12 hours, nine strikers and seven detectives were killed. The National Guard was called out—the Pinkertons were allowed to leave and Homestead opened with non-union workers. The strike went on until November, when the Amalgamated finally gave up and called it off—the union leaders were fired from Homestead and Frick sent a wire to Carnegie in Scotland: “Our victory is now complete and most gratifying. Do not think we will ever have any serious labor trouble again.” In fact, the steel industry operated without organized labor for the next four decades.[11]

<u>17. U.S. Steel</u>

In 1900, the financier J.P. Morgan was tired of competing with Carnegie Steel—he had been involved in several steelmaking ventures which Carnegie always beat on price—and decided to buy him out. In order to do that, Morgan had to buy out Carnegie Steel and formed U.S. Steel, the world’s first corporation capitalized at over $1 billion—it was $1.4 billion to be precise. Andrew Carnegie’s personal take in the U.S. Steel deal was over $200 million—billions in today’s dollars—and he was perhaps the world’s wealthiest man. And he couldn’t have done it without creative destruction in the steel industry. That’s why Andrew Carnegie’s story is so fascinating—and important—to the rise of steel.

The Homestead Strike was front page news in America’s newspapers and magazines in 1892

<u>18. The Legacy</u>

What does this case study in steel tell us about materials? It tells us that innovation can be a double-edged sword. On the one hand, Carnegie’s cheap and durable steel made railroads more affordable and safer. The story of Franklin Pierce's tragic loss might have been quite different had Carnegie Steel been around a half-century earlier. On the other hand, Andrew Carnegie's rearrangement of the shop floor, his ruthless competitive ways, and his willingness to break the power of labor organizations like the Amalgamated shattered lives. His own father, Will Carnegie, found out the hard side of creative destruction right before moving his family to America. Steel changed the United States by allowing the nation to grow both outwards and upwards—quite literally. Yet, along the way, Americans like those workers at Homestead found out, paid a price for cheap steel.

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Discussion Questions

1. Do you think that Andrew Carnegie's firsthand experience with the mechanization of his father's workplace might have affected his strategy in steelmaking?

2. Do the benefits to society of having an Andrew Carnegie reshaping the steel industry outweigh the costs to workers and competitors?

3. Can you think of other examples in which "creative destruction" transformed the production of a material?

4. What materials might revolutionize contemporary life if they were suddenly made abundant and cheap?

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[4]S.H. Finch, "The Iron Industry in its Relation to Railways," *American Railroad Journal* 58 (February 1885): 353-354.
[5]Harold Livesay, *Andrew Carnegie and the Rise of Big Business* (Boston: Little, Brown & Company, 1975), 109-123.
[6] Walter Licht, *Industrializing America: The 19th Century* (Baltimore: Johns Hopkins, 1995), 82-83
[7]Thomas Misa, *A Nation of Steel: The Making of Modern America*, 1865-192545-89.
[8]Joseph Schumpeter, Capitalism, Socialism, and Democracy p. 83.
[9]David Brody, *Steelworkers in America: The Non-Union Era* (Urbana: University of Illinois Press, 1960), 50-57.
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