

**Title of Lesson: *Working in Birmingham's Iron Industry***

*(Suggested grade level: 4)*

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**Background Information:**

Background information for teacher:

- [The Sloss Story](#) - Provides background information about Sloss, its founding, its relationship to Birmingham, and Sloss' workers.
- [James Withers Sloss and Birmingham's "Great Iron Boom," 1871-1890](#) - Provides background information about the man who started Sloss Furnaces and about Birmingham being the railroad center. (Copy also attached as PDF file.)
- The Encyclopedia of Alabama provides excellent articles about the [Sloss Furnaces](#) and [Birmingham](#).
- Suggested reading:  
Davis, Christopher. "The Role of the Elyton Land Company in Birmingham During the Depression of 1873 to 1879 ." Samford University, Copyright 2001. Web. 6 Jul 2010.  
<<http://www4.samford.edu/schools/artsci/scs/davis.html>>.

**Overview of lesson:** Students will use primary sources to gain a perspective of the living and working conditions in Birmingham in the late 1800s, especially as they relate to working in the iron industry. Students will explore the role of the iron industry with regard to the initial fast growth rate of Birmingham and how this growth was the result of location, transportation, and resources.

**Content Standards**

[Alabama Course of Study: Social Studies](#) (Bulletin 2004, No. 18)

Fourth Grade: Standard 10, p.32

[Alabama Course of Study: English Language Arts](#) (Bulletin 1999, No. 17)

Fourth Grade: Standard 3, p.26

Fourth Grade: Standard 8, p.27

Fourth Grade: Standard 9, p.27

[National Standards for History, 1996](#)

Standards of Historical Thinking for Grades K-4 (p. 15)

Standard 1 – The student thinks chronologically.

1A – Distinguish between past, present, and future time

Standard 4 – The student conducts historical research

4B – Obtain historical data

Standard 5 – The student engages in historical issues-analysis and decision-making.

5A – Identify problems and dilemmas in the past

5B – Analyze the interests and values of the various people involved

Standards in History for Grades K-4 (p. 29)

Topic 2, Standard 3 – The people, events, problems, and ideas that created the history of their state  
3E – The student understands the ideas that were significant in the development of the state and that helped to forge its unique identity.

*National Curriculum Standards for Social Studies*, (Bulletin 111, 2010)

Chapter 4 Learning Expectations: Early Grades

Standard 2 – Time, Continuity, and Change, p. 70

**Primary Learning Objective(s):**

Using primary source documents – images of making steel and iron, of working in the pig-iron furnaces, and of the housing for some of these workers – students will:

- Make comparisons;
- Develop reasonable explanations;
- Make inferences and draw conclusions;
- Construct meaning;
- Gain an understanding of what it was like to live and work in Birmingham in the late 1800s and early 1900s;
- Explore perspectives and express an understanding of the living and working conditions, culture, and attitudes of the time; and
- Learn to empathize with people from the past.

**Time allotted:** 30 minutes

**Materials and Equipment:**

- Iron Industry and Sloss Images (attached as a PDF)– contains images of creating iron, and steel, a pig-iron furnace, iron workers at Sloss Furnace, and Sloss low-cost housing.
  - Creating Iron
  - Creating Steel
  - Pig-iron Furnace
  - Iron Workers at Sloss Furnace
  - Sloss Low-cost Housing

Also attached as PDF documents:

- Creating Iron and Steel – Photos with Information
- Image-based Questions
- Footprint Activity Sheet – one copy per student (attached)
- 
- Oral history video clip: [Sloss Video: Like It Ain't Never Passed](#)
- Wall map of Alabama or the southeastern United States
- Colored pencils or crayons – enough for all students

**Technological Resources:**

- Computer with internet access
- Digital projector

## Background/Preparation:

The students should be able to define and use the following vocabulary words:

- peer – people who are equal with regard to such aspects as age, education, or social class
- wealth – the abundance of valuable resources or material possessions
- El Dorado – Spanish for “the golden one”
- personification – the attribution of human characteristics to inanimate objects

## Procedures/Activities:

### Engagement/Motivation Activity:

Show the first three-and-a-half minutes of the [Sloss Video: Like It Ain't Never Passed](#) – The video begins with an elderly gentleman reminiscing about ‘the old days’ at Sloss.

|               |   |
|---------------|---|
| <b>Step 1</b> | The teacher will use a document camera, computer, and projector to show the photos of making iron and of making steel and will use image-based questions (attached) to solicit observations and inferences about these photos. (Attached: Iron Industry and Sloss Images)   |
| <b>Step 2</b> | The teacher will show images of workers in a pig-iron furnace (with the title of the image covered up), and of workers going to lunch. The teacher will use image-based questions to solicit observations and inferences about the photos.  |
| <b>Step 3</b> | The teacher will show the photo of Sloss housing and will use image-based questions to solicit observations and inferences about this photo.  |
| <b>Step 4</b> | <p>The teacher will ask the students:</p> <ul style="list-style-type: none"><li>• How do these pictures help us get a better understanding of the working conditions for the people we see?</li><li>• How do we know that the production of iron was important?</li><li>• For what was iron used? (Try to tie this back to transportation.)</li></ul> <p>If time permits, add the following to the class discussion:</p> <ul style="list-style-type: none"><li>• This was said about Birmingham by Colonel James R. Powell, the first president of Elyton Land Co., in the late 1800s: ‘This magic little city of ours has no peer in the rapidity of its growth...its permanent mountains groaning to be delivered of their wealth...the El Dorado of iron masters.’<ul style="list-style-type: none"><li>○ Discuss the meaning of this statement.</li></ul></li></ul> <p>Discuss the use of personification. (Definitions of key words are provided in the background/preparation section.)</p> |
| <b>Step 5</b> | The teacher will explain the footprint activity. (Refer to assessment/strategies box.) The students will then complete this assessment activity and will share and display their footprints.  |

## Assessment Strategies:

**Footprint activity:** What was a day like in the life of an American pig-iron furnace worker in the late 1800s? Step back in time. Then use the Footprint Activity Sheet (attached) to create two footprints:

1. On one footprint, draw five pictures that represent important or significant aspects of a person’s daily life.
2. On the other footprint, use words to describe issues, events, and feelings that tell about this person’s life. These may be bulleted; they do not need to be written in complete sentences.

(Scoring guidelines: Each picture is worth ten points and each word response is worth ten points. These may be displayed under the title ‘Walk a Mile in My Footsteps.’)

**Extension:**

View videos or virtual tours online and have students write a paragraph of reflection – like telling how it made them feel. Videos or virtual tours to extend lessons:

**Title of Video:** [Like It Ain't Never Passed](#) (a segment of this video was viewed at beginning of the lesson)

**URL:** [http://www.slossfurnaces.com/images/stories/learning/lessons/like\\_it\\_aint.mov](http://www.slossfurnaces.com/images/stories/learning/lessons/like_it_aint.mov)

**Annotation:** This video begins with a gentleman reminiscing about his days working at the Sloss Furnace and takes you through the history of Sloss Furnace. Pictures tell the story of how Birmingham went from a small country town to a bustling city that grew up around the furnaces.

**Title of Video:** [Virtual Tour of Sloss Furnaces](#)

**URL:** [http://www.alabama360.com/sloss/Tourviewer\\_sloss.html](http://www.alabama360.com/sloss/Tourviewer_sloss.html)

**Annotation:** Good background information about Sloss, its founding, its relationship to Birmingham, and Sloss' workers.

**Title:** [Cast in Iron: Days of Sloss](#)

**URL:** [http://www.slossfurnaces.com/images/stories/learning/lessons/cast\\_in\\_iron.mov](http://www.slossfurnaces.com/images/stories/learning/lessons/cast_in_iron.mov)

**Annotation:** Documentary created by The Alabama Experience; touches on a variety of aspects of Sloss – from manual labor to why the product produced was called pig iron.

**Remediation:**

Provide the student with a footprint activity sheet that shows a completed example of the assignment, including a picture and a written response.

**Accommodation:**

- Do not count off for spelling.  
Allow the student to complete fewer written responses and illustrations.

**Modification:**

- Provide the student with an example of a partially completed set of footprints to use as a guide.
- Review Individualized Education Plans, 504 Plans, and Gifted or ELL Plans for instructional and assessment accommodations or modifications.
- Provide multiple opportunities for students to demonstrate comprehension and mastery of appropriate learning objectives.

James Withers Sloss and  
Birmingham's "Great Iron Boom," 1871-1890  
by  
Karen Utz  
Curator  
Sloss Furnaces National Historic Landmark

*This magic little city of ours has no peer in the rapidity of its growth....its permanent mountains groaning to be delivered of their wealth....the El Dorado of iron-masters.*

Following the Civil War, Alabama's economy began to shift away from the dominance of agriculture. In 1871, prominent Alabamians joined forces to form the city of Birmingham with the explicit function of exploiting the mineral resources of north-central Alabama, where every ingredient necessary for making iron could be found within a thirty-mile radius. One of these men was James Withers Sloss, a north Alabama merchant and railroad man.

Sloss was born of Scots-Irish descent in Mooresville, Alabama, in 1820. His father, Joseph, emigrated from County Deery, Ireland, to Lexington, Virginia, with his parents in 1803. He later moved to Tennessee where he eventually became a soldier and went on to fight in the War of 1812. Following the war he met and married Clarissa Wasson from Alabama and moved to Mooresville to farm and raise a family.

At fifteen his oldest son, James, became an apprentice bookkeeper for a local butcher. At the end of his seven-year term, he married a local girl, Mary Bigger, and used his savings to buy a small store in Athens, Alabama. By the 1850s, James Withers Sloss had extended his mercantile interests throughout northern Alabama and eventually evolved into one of the wealthiest merchant and plantation owners in the state.

In the early 1860s, realizing the need for the expansion of southern rail lines, Sloss became active in railroad construction. As Birmingham journalist Ethel Armes later noted in a 1910 newspaper article, "Sloss had a voice in county and state politics, and was taking up the fight for railroads with vigor, and that good Irish tongue of his to boot." In 1867, following years of negotiations, all rail lines between Nashville and the Tennessee River were consolidated into one company, the Nashville and Decatur, with James W. Sloss as its first president.

During this postwar period, Sloss not only promoted the development of southern rail lines, but became one of the chief proponents of Alabama's postwar industrial

development, most notably the area around present day Birmingham. Sloss was determined to develop ties with an enterprise that had emerged as the strongest railroad in the South; the Louisville and Nashville (L&N). He realized that the L&N had reached a critical stage in the South and greatly needed to find an outlet through Alabama to the Gulf of Mexico, where they wanted access to new markets and connections with Montgomery and Mobile, Alabama. Aware of this interest, Sloss seized the opportunity to forge an alliance between the L&N and the Elyton Land Company--the company responsible for developing the mineral district of Jones Valley and the city of Birmingham.

Sloss traveled to Louisville and presented the president of the L&N, Albert Fink, with a glowing picture of the mineral district and the future rail traffic it was capable of generating. He offered to lease the Nashville and Decatur to the L&N if that line would assume the Elyton Land Company's debts, pay interest on its bonds, and complete work on the gap between Decatur and Birmingham. If agreed upon, the L&N could run the combined system all the way from Nashville to Montgomery. Fink liked the idea, but his board did not. Following an intense meeting at a local hotel (and a round of whiskey!), Sloss and Fink were able to convince the directors of the L&N to endorse the plan.

Ultimately reaching the Gulf of Mexico, the L&N invested more than \$30 million in furnaces, mines, wharves, steamship lines, and other Alabama operations. By 1888 it was hauling annual tonnage of iron, coal, and other mineral products outweighing the nation's entire cotton crop. Sloss's decision to bring in the L&N transformed Birmingham from a squalid jumble of tents, shanties, and boxcars into a thriving community.

Another southern entrepreneur crucial to the development of Birmingham's industrial district was Henry DeBardeleben, son of an Autauga County planter and son-in-law and heir to the Daniel Pratt fortune. In 1878, determined to tap the rich mineral areas surrounding Birmingham, DeBardeleben joined forces with Sloss and Truman Aldrich, a success mining engineer, to form the Pratt Coal and Coke Company, the first large coal company in Alabama. Pratt soon became the largest mining enterprise in the district. In 1882, the Pratt Company sold out to Memphis entrepreneur Enoch Ensley, who invested close to \$1.5 million and increased mining operations to a daily output of 2,500 tons. By 1885, Ensley's Pratt Company owned 70,000 acres of coal lands, 710 coke ovens and 30 miles of railway. With over a thousand free and convict laborers, the Pratt mines produced "first class coking coal" for pig iron furnaces throughout the Birmingham area. Tennessee Coal and Iron (TCI) acquired the company in 1886 and immediately added additional mines to the Pratt holdings. Since 1907 the mines have been the property of U.S. Steel.

In 1879, inspired by the success of the Pratt Company, DeBardeleben joined forces to create Alice Furnace (named after his oldest daughter), the first blast furnace designed to use coke. Sixty-three feet high and fifteen feet wide, it achieved an average daily production of fifty-three tons of pig iron. Birmingham's second furnace would be built by James Sloss. In 1880, tired of the constant bickering occurring at the Pratt Company, and with the backing of Henry DeBardeleben, James Sloss founded the Sloss Furnace Company. DeBardeleben agreed to supply Sloss with coking coal and Mark W. Potter, who owned red ore deposits on Red Mountain, agreed to supply the ore. Sloss took the contracts to

Louisville and won the financial backing of E.D. Standiford, president of the L&N. Following his return to Birmingham, Sloss and his sons, Maclin and Frederick, filed papers at the Jefferson County Court House in the spring of 1881 to incorporate the Sloss Furnace Company.

Construction of Sloss's new furnace began in June 1881, when ground was broken on a fifty-acre site that had been donated by the Elyton Land Company. Harry Hargreaves, a European-born engineer, was in charge of construction. Hargreaves had been a pupil of Thomas Whitwell, a British inventor who had designed the stoves that would supply the hot-air blast for the new furnace. Sixty feet high and eighteen feet in diameter, Sloss's new Whitwell stoves were the first of their type ever built in Birmingham and were comparable to similar equipment used in the North. Birmingham industrialists were impressed that much of the machinery used by Sloss's new furnace would be of Southern manufactured in the South. This machinery included two blowing engines and ten boilers, thirty feet long and forty-six inches in diameter. Driven by steam, the blowing engines were made in Birmingham at Linn Iron Works, an iron works company started in 1885 by a Finnish-born entrepreneur, Charles Linn. A local reporter described them as the "largest engines ever made south of Pittsburgh." Although the enormous boilers were too complex to be built in Birmingham, they too were made in the South. Walton & Company, located in Louisville, completed the task in time for the opening in 1882. After only its first year of operations, Sloss Furnace Company had sold 24,000 tons of iron. At the 1883 Louisville Exposition, the company won a bronze medal for "best pig iron."

James W. Sloss not only exported his iron, but managed to supply large amounts for local agricultural purposes....items such as traps, pipes, and stoves. The majority of Sloss pig iron, however, ended up in Cincinnati, Louisville, St. Louis, Nashville, Chicago, Detroit, and Cleveland. Pig-iron costs in Northern plants averaged \$18.30 per ton in 1884 while pig iron in the South could be produced for \$10-\$11 a ton.

The success of the Alice and Sloss Furnaces set off a mania of furnace construction that was later dubbed by local newspaperman as "The Great Birmingham Iron Boom." By the 1880s, pig iron production in Alabama grew from 68,995 to 706,629 gross tons in Jefferson County alone. Economically, the long financial depression that hit in the 1870s was finally over, and demand for industrial products was picking up throughout the nation. Birmingham was booming, and due to its rapid growth, had earned the nickname "The Magic City."

Town planners, railroad magnates, and industrialists such as James Sloss received, as one Alabama newspaper stated, "A degree of adulation previously reserved for military heroes." In November 1881, the Birmingham press touted Sloss as a possible candidate for governor:

"His excellent business qualifications, brilliant intellect, splendid character, and fine executive ability, all combined, make him the grandest man in Alabama today for our chief executive. He is the very personification of Christian manhood and integrity, possessing the qualifications of head and heart which we should emulate."

Although appreciative, Sloss never ran for governor. Nonetheless, inspired by such rhetoric, Alabama industrialists eagerly embraced what was being called the “gospel of industrialism.”

The Sloss Furnace Company was born at a time when the despair of the postwar era was subsiding, and the South was feeling a measure of economic confidence for the first time since the opening years of the Civil War. The time was ripe for a resurgence of moves toward southern industrialization. Although agriculture was still the basis of Alabama’s economy, the demand for cotton on the world market had declined after the war and Alabama was worse off than most southern states. As a result, rural areas experienced a mass departure of ragged, malnourished people to Birmingham’s industrial district where employment was available at mines, mills, and blast furnaces. And however bad conditions might be, workers, primarily African-American, saw this type of work as preferable to the abject poverty they were experiencing in the countryside.

To James Sloss and other Birmingham industrialists, the use of an almost exclusively African-American labor force at mines and furnaces in the nineteenth century was simply a continuation of policies prevailing long before the Civil War. Partly because many Southern whites avoided manual labor, and also because white workers imported from outside the region did not seem to last, the industrial employment of black workers in transportation and industry was common. The use of African-Americans in skilled occupations was just as frequent as their employment at tasks requiring little or no training. Census figures indicate that the South had only 20,000 white tradesmen in 1865. By contrast, approximately 100,000 slaves were employed as blacksmiths, gunsmiths, cabinet makers, and shipbuilders.

Due to the prevailing belief that African-Americans were particularly well suited for hot and physical occupations, their use as ironworkers was common in the South during the antebellum period. And not surprising, the work required by laborers at blast furnaces like those built by Sloss later in the century also typified the labor Southern entrepreneurs thought particularly well suited for African-Americans. In an interview in 1883, Sloss stated that, “at our place, nearly all our labor is colored...except our skilled men; they are all white...the balance of the iron men, the coke men, the yard men, the furnace men, and some of the helpers and stock men are all colored.” James Sloss defended using African-American workers, saying they were best suited for his needs. He gave no economic arguments except to repeat a familiar antebellum theme by stating that blacks were less likely than whites to strike. Stressing his affection for African-Americans, a common stance among both prewar and plantation owners and postwar industrialists, he said that “the colored man likes the furnace business; he has a fondness for it.”

Sloss, however, admitted that using free blacks workers created difficulties that antebellum shareholders had not fully anticipated. The problems he was encountering were problems and issues being encountered by managers throughout the industrial nation. The the working class that was formed during the Gilded Age was made up of people who brought into industrial society ways of work and other habits and values not associated with industrial requirements and the industrial culture. This drawback was particularly true for

former Alabama field hands, who had to make difficult psychological adjustments in moving from rural plantations.

Sloss also complained about the transience of free black workers. His laborers came from all over the South, drawn to Birmingham by the lure of economic advances. "They are a moving, restless, migratory class, quite different from the farm or plantation Negroes." In 1882, because of high labor turnover and chronic absenteeism, Sloss had to employ 569 men to assure his company of the 269 workers that it actually needed.

Another reason why Sloss and other Birmingham industrialists clung to the almost exclusive use of black workers was due to their belief that social problems would result from trying to mix them on an equal basis with whites who might be willing to take on the difficult labor required in mines and furnaces. Local journalists even touted the virtues of using an all black labor force.

"The Negro of Birmingham fills the industrial position which elsewhere in great manufacturing towns is filled by a low class of whites. The Negro here is satisfied and contented; the low whites elsewhere are dissatisfied and turbulent. The white laboring classes here are separated from the Negroes...by an innate consciousness of race superiority."

It is clear from such statements that the rationale for relying on a predominately black labor force in Birmingham's primary industries was as much social as economic.

Sloss, as well as other industrialists throughout the South, did their best to devise ways of managing black workers that would preserve many of the traits of the old slave system. Like southern antebellum businessmen before him, Sloss was committed to using servile, low-paid labor as a key part of his strategy for controlling costs and believed it gave him a definite advantage over his northern competitors.

Another advantage Birmingham industrialists believed they had over their competitors was their close proximity to raw materials. As mentioned earlier, all the necessary ingredients needed to make pig iron—coal, limestone and iron ore—were located within a thirty-mile radius. And despite sagging prices that hit in the early 1880s, pig iron production in Alabama rose from 100,683 gross tons in 1882, to 253,445 in 1886. This success was also the result of the implementation of a smart business practice known as "vertical integration." In vertical integration, a company knew it could best expand by buying up its suppliers or its customers or both, thus controlling all the processes of production, from raw material through to the sale of the final product. Sloss, unfortunately, was not as successful as others in utilizing this business practice.

One Birmingham company that did succeed in vertical integration was Woodward Iron Company. Founded in late 1881, not long after James Sloss founded his own company, S.H. Woodward, a West Virginian who migrated to Alabama in 1867, not only controlled his own coal and ore mines, but purchased the rail lines linking these natural resources to his blast furnaces, thus avoiding freight costs.

Unlike Woodward, Sloss never controlled his coal supply. Instead, he obtained it under contract from another Birmingham company at rates much higher than what Woodward was paying. In addition to paying more for his coal, Sloss could not depend on regular deliveries since many of the local coal companies were often plagued by strikes, fires, and

other problems. When Sloss was preparing to open his second furnace in 1883, he had to delay it by months because he could not get enough coal to make coke for his furnaces. Another drawback in Sloss's operation was that he lacked his own railroad to deliver ore to his furnaces from one of the few mines he owned, his red ore mines. Instead, he had to rely on the Alabama Great Southern. And unfortunately, the penalty that Sloss paid for insufficient control over raw materials and the means by which they were transported to his furnaces was compounded by continual problems with poor equipment. Sloss's furnaces were designed by northern standards, meaning they were ill-suited to the specific characteristics of southern raw materials. As indicated in an 1884 *Iron Age* magazine article, "Constructing Southern furnaces without regard to the differences in fuel and ores from those worked by Northern furnaces, whose lines have been copied, had been, it seems, the great error of Southern iron-makers.

It was not that Sloss and other southern industrialists were technologically backwards, it was because they were only beginning to adapt to the deficiencies and oddities of Birmingham's raw materials. Sloss, as well as other furnace owners in the area, had not anticipated the high silica content of Birmingham's red ore, which resulted in the accumulation of deposits on the inner walls of the furnace and frequent repairs. Fortunately, by the end of 1885, Sloss was starting to adapt to the problem of the local minerals and able to make the necessary changes and adjustments. In the spring of 1886, Sloss's two furnaces produced 5,365 tons of pig iron, only slightly less than what DeBardeden's Alice Furnace produced.

Although James Sloss appeared to be recovering from his early operating problems, he started depending more and more on his sons to make the major managerial decisions. By late 1886, due to numerous labor, economic, and political problems, James Sloss decided to sell his company. In 1899 he sold out to a group of Virginia financiers for \$2 million who would successfully lead the Sloss Furnaces Company for the next three decades.

## Creating Iron

A worker covers the steel slag poured on the ground with sandy soil at a stainless steel factory.



"How Iron and Steel Work." *How Stuff Works*. Web. 25 Jun 2010.

<<http://science.howstuffworks.com/iron3.htm>>.

## Creating Steel

A ladle filled with molten iron approaches a blast furnace that will convert it to liquid steel.



"How Iron and Steel Work." *How Stuff Works*. Web. 25 Jun 2010.

<<http://science.howstuffworks.com/iron3.htm>>.

"The Great Industry of Birmingham, Alabama.--A Pig-Iron Furnace." March 26, 1887



File Name: Q10255

Collection or Series Title: Nineteenth-century periodical illustrations collection

Box Number: LPP86

Folder Title: 1880s-1890s and undated

Catalog Record: <http://216.226.178.202:81/vwebv/holdingsInfo?bibId=10539>

Repository : Alabama Department of Archives and History

## Iron Workers at Sloss Furnaces



The market for iron and steel was increased in the late 1930s due to World War II. This created jobs for Birmingham workers. America entered the war in 1941 when nearly half of the work force was employed by the iron, steel, and mining industries. More than two-thirds of these workers were AfricanAmerican.

"L & N Railroad ." *Sloss Furnaces National Historic Landmark*. Web. 25 Jun 2010.

<<http://www.slossfurnaces.com/education/story.html>>.

Sloss Furnaces began building low-cost housing when Birmingham's population exploded in the late nineteenth century.



These 48 houses, called "the Quarters," were shotgun-style structures with two rooms and were specially designed for black workers. These houses provided a community setting for workers and their families, with neighborhood gatherings of watermelon cuttings, barbecues, chittlin suppers, dancing, and baseball games. There was land for flower and vegetable gardens, chickens, and hogs. Thomas Elementary School was nearby, so children had access to educational opportunities almost unheard of elsewhere in the 1930s and 40s.

"L & N Railroad ." *Sloss Furnaces National Historic Landmark*. Web. 25 Jun 2010.

<<http://www.slossfurnaces.com/education/story.html>>.

## Creating Iron

A worker covers the steel slag poured on the ground with sandy soil at a stainless steel factory.



The more advanced way to smelt iron is in a blast furnace. A blast furnace is charged with iron ore, charcoal or coke (coke is charcoal made from coal) and limestone ( $\text{CaCO}_3$ ). Huge quantities of air blast in at the bottom of the furnace, and the calcium in the limestone combines with the silicates to form slag. Liquid iron collects at the bottom of the blast furnace, underneath a layer of slag. The blacksmith periodically lets the liquid iron flow out and cool.

At this point, the liquid iron typically flows through a channel and into a bed of sand. Once it cools, this metal is known as **pig iron**. To create a ton of pig iron, you start with 2 tons (1.8 metric tons) of ore, 1 ton of coke (0.9 metric tons) and a half ton (0.45 metric tons) of limestone. The fire consumes 5 tons (4.5 metric tons) of air. The temperature at the core of the blast furnace reaches nearly 3,000 degrees F (about 1,600 degrees C).

Pig iron contains 4 to 5 percent carbon and is so hard and brittle that it's almost useless. If you want to do anything with it, you have three options. First, you can melt it, mix it with slag and hammer it out to eliminate most of the carbon (down to 0.3 percent) and create strong, malleable wrought iron. The second option is to melt the pig iron and combine it with scrap iron, smelt out impurities and add alloys to form **cast iron**. This metal contains 2 to 4 percent carbon, along with quantities of silicon, manganese and trace impurities. Cast iron, as the name implies, is typically cast into molds to form a wide variety of parts and products.

The third option for pig iron is to push the refining process even further and create **steel**.

## Creating Steel

A ladle filled with molten iron approaches a blast furnace that will convert it to liquid steel.



Steel is iron that has most of the impurities removed. Steel also has a consistent concentration of carbon throughout (0.5 to 1.5 percent). Impurities like silica, phosphorous and sulfur weaken steel tremendously, so they must be eliminated. The advantage of steel over iron is greatly improved strength.

The **open-hearth furnace** is one way to create steel from pig iron. The pig iron, limestone and iron ore go into an open-hearth furnace. It is heated to about 1,600 degrees F (871 degrees C). The limestone and ore form a slag that floats on the surface. Impurities, including carbon, are oxidized and float out of the iron into the slag. When the carbon content is right, you have carbon steel.

Another way to create steel from pig iron is the **Bessemer process**, which involves the oxidation of the impurities in the pig iron by blowing air through the molten iron in a **Bessemer converter**. The heat of oxidation raises the temperature and keeps the iron molten. As the air passes through the molten pig iron, impurities unite with the oxygen to form oxides. Carbon monoxide burns off and the other impurities form slag.

"How Iron and Steel Work." *How Stuff Works*. Web. 25 Jun 2010.

<<http://science.howstuffworks.com/iron3.htm>>.

## 'Walk a Mile in My Footsteps' Footprint Activity Sloss Furnace Workers

What was a day like in the life of a Sloss Furnace worker in the late 1800s or early 1900s? Step back in time. Then create two footprints:

1. On one footprint, draw five pictures that represent important or significant aspects of the person's daily life.
2. On the other footprint, use phrases to describe important or significant aspects of the person's daily life. These may be bulleted; they do not need to be written in complete sentences.
  - o Each picture or written response is worth ten points.

