HISTORIC AMERICAN ENGINEERING RECORD

[redacted]

Sloss-Sheffield Steel & Iron Company
Furnaces, 1902, 1927-31, 1942-64
First Avenue North Viaduct at 32nd Street
Birmingham
Jefferson County
Alabama

AL-3

HAER,
ALA,
37-BIRM,
4-

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

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Sloss-Sheffield Steel & Iron Company Furnaces,
1902, 1927-31, 1942-64

AL-3

Location: Birmingham, Alabama
UTM: 16.5793450.3708875
Quad: North Birmingham

Date of Construction: 1881-1931

Present Owner: City of Birmingham

Present Use: Interpretive recreation center

Significance: The Sloss Company's city furnaces, built in what is now the center of Birmingham, Alabama, in 1881-1882, produced pig iron for the foundry market until their close in 1970.

Historian: Gary B. Kulik, Summer, 1976.

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I could not have provided specific dates for the erection of buildings and the installation of machinery without the assistance of the Jim Walter Corporation, Birmingham office. I wish to thank them for opening the Property Account Books of the Sloss-Sheffield Steel & Iron Company to me, for allowing me to use the company publication, Pig Iron Rough Notes, and for making available a number of Sloss-Sheffield's Annual Reports and engineering drawings.

A number of individuals provided assistance, information, and thereby helped to strengthen the final report. I wish to especially thank Daniel E. Watkins, Joseph B. Oliver, George Brown, Raymond Rowell, Robert S. Crowder, Dr. Marvin Whiting, James Y. Hunt, Helen Mabry, Grosbeck Parham, Dr. John E. Bryan, and Rucker Agee. None, however, bears responsibility for my interpretation.

Gary B. Kulik
Pawtucket, R.I.

INTRODUCTION

The Sloss Company's city furnaces, built in what is now the center of Birmingham, Alabama, in 1881-2, produced pig iron for the foundry market until their close in 1970. The furnaces, rebuilt most recently in 1927-8, stand today in disrepair, threatened by neglect and possible demolition. They remain a central element of Birmingham's skyline, a visual reminder of its past. Only six years ago, the slag and iron runs lit up the night sky, illuminating the workers who kept the furnaces fired twenty-four hours a day, seven days a week. The location of the furnaces brought home the spectacle of iron making to the entire population - from the motorists who drove along side, and the workers who lived along side, to the fashionable young middle-class of an earlier period whose entertainments consisted of Sunday afternoon "furnace party" picnics. [1]

The history of the furnaces parallels that of Birmingham an industrial "boom-town" whose rapid and tumuluous growth was spurred by the iron industry and underwritten by the area's rich mineral resources. The Sloss Furnaces mirror the major themes of Birmingham's economic history from 1880 to 1930: rapid but unstable growth; increasing reliance on Northern capital; artificially high transportation cost and slow development of regional markets; the strengths and limits of the area's mineral base; and the existence of an independent, and at times militant working class.

The site is important primarily for the insight it offers into the pace and extent of technological change in the Southern pig-iron industry. The most striking feature of the site is that its major operating equipment - blast furnaces, charging and casting machinery - was installed between 1927 and 1931. These five years mark the high point of technological change. Between 1927 and 1928, the two furnaces at the site were rebuilt, enlarged, and refitted with mechanical charging apparatus. Prior to that change, both furnaces had been hand-filled. In the same years, the company first installed pneumatic devices for opening and closing the iron notch, (the opening at the base of the furnace from which the molten iron ran), work previously done by hand under hot and onerous conditions. In 1931, the company installed a pig casting machine at the site. The machine, recently dismantled and sold, replaced the older, heavily labor-intensive, methods of sand-casting. All of these changes were labor saving, not primarily in the sense that they reduced individual human toil (though in fact they did), but because they made it possible to hire far fewer workers.[2]

In this concentrated program of modernization Sloss adopted systems which had been in widespread use for twenty to thirty years. The mechanical charging of furnaces was the central feature of the "Duquesne Revolution" which drastically altered blast furnace practice in the mid-1890's.

Pneumatic and electric drills and mud guns were used to open and close furnaces by 1900. Ironically, the first successful pig casting machine was invented in the mid-1890's by Sloss furnace superintendent Edward A. Uehling. Uehling, who never installed the machine at Sloss, eventually moved north and sold his patent rights to Carnegia. By the the late-1890's his invention was in place at three major furnaces in the Pittsburgh district: the Lucy, the Duquesne, and the Edgar Thompson. It was not installed at the Sloss city furnaces for over thirty years. (3)

In attempting to account for this delay in technological change, we may begin by dismissing two propositions; first, the Southern iron and steel industry was generally backward in its acceptance of new technology, and second, the Sloss Company was a marginal producer unable to afford costly innovation. The first proposition is easily refuted. The Ensley Furnaces, built in 1886, bought out by Tennessee Coal & Iron in 1888-9, and later swallowed up by U.S. Steel in a 1907 merger requiring the tacit approval of President Theodore Roosevelt, were the South's technological pacesetter. Located just west of Birmingham, the furnaces were the site of the South's first commercially successful effort at steel making. By 1909, they were equipped with both pig casting machines and mechanical charging devices. Ensley was also the location for 120 by-product coke ovens built in 1897-8 by the Solvay Process Company of Syracuse, N.Y. These were the first by-product ovens built in the South, and were one of the first four installations in the U.S. Thus, there was no shortage in the district of best-practice technology or innovative example. (4)

Second, Sloss was not a marginal company. By 1900 it was one of the South's major merchant pig iron companies (companiest which produced only pig iron and sold it directly to the foundry market), and the second largest iron producer in the Birmingham district. At one point the company operated seven blast furnaces and owned almost 120,000 acres of coal and ore land. Throughout their history, the Sloss Company invested in capital improvements - new boilers, the new steam blowing engines, hot-blast stoves, and gas cleaning equipment. None of these were direct labor-saving improvements. For a company as technologically advanced as any, and which constantly improved much of its operating machinery, the failure to innovate in labor-saving equipment is all the more striking. (5)

It will be argued that the Sloss Company did not innovate in the late-19th century because sufficient labor was available to perform the arduous work necessary to sand-casting and hand-filling, because some foundrymen retained a prejudice in favor of sand-cast iron, and because the demands of merchant pig iron production did nor require extensive mechanization. It will also be argued that the company innovated primarily as a result of the large-scale migration of blacks from the South during and after World War I. By the 1920's it was increasingly difficult to fill the hot and heavy jobs at Southern blast furnaces, and mechanization became the only recourse.

The paper is orgainzed in the following way: the first part is a discussion of the process of iron making and an overview of technological change, with particular attention paid to the tasks of workers; second, there is a brief section on the area's mineral base; third, an introduction to the history of Birmingham's development as it was influenced by James Withers Sloss, the founder of the Sloss Company; and fourth, a narrative of the companys history from 1881 to the 1930's. The narrative focuses on three issues, the "problem" of labor and labor supply, technological change at the city furnaces site, and the economics of the pig iron industry, both national and regional. A brief conclusion carries the company's history to the closing of the furnaces in 1970.

PROCESS AND TECHNOLOGY

A. The Furnace

The furnace is the key element in the process of iron making. (See Process drwg, part 2). Modern furnaces, large cylindrical stacks of sheet metal and fire brick construction, came into widespread use in the last third of the 19th century replacing smaller stone furnaces. Within the furnace, iron ore, coke, and a fluxing material - usually limestone or dolomite - are combined with hot air blown into the furnace through openings called tuyeres. The combination of ore, coke, flux, and heat produces molten iron. Coke, a high carbon residue of refined bituminous coal, is the primary blast furnace fuel. Its combustion produces CO, which acts on the iron ore as a reducing agent to produce metallic and CO^2. The fluxing material combines with non-metallic ore properties and coke ash to produce slag which, because it is lighter than iron and floats on top, can be easily separated. Iron and slag leave the furnace through separate notches - the iron to be cast, either in sand or by machine the slag to be either dumped, hauled away, or more recently, processed for use as cement aggregate, railroad ballast, or soil conditioner. (6)

B. The Cast House

If sand-cast, the iron ran in channels formed in the sand floor of the casting shed. These channels resembled a series of large combs on either side of a central channel. (They also resembled pigs suckling at the sow - hence the term pig iron.) The central channel carried the molten iron directly from the furnace and distributed it first, to narrower channels, and then to the sand molds. (See Figure 1), (7)

Work in the casting shed was physically arduous, intense, and hot. The sand molds were formed by hand as were the sand dams used to skim excess slag from the molten iron. The opening of the iron notch at the base of the furnace required six to eight men working with hand drills and sledges from ten to sixty minutes. Because of the heat, the men at the notch had to be relieved every two to three minutes. Closing the notch was also done by hand - a process employing clay balls and a ram, or stopping hook, that might take fifteen to twenty-five minutes. But the heaviest, most disagreeable work of all was breaking and loading the pig iron. In the South, the iron was generally allowed to cool first. This reduced the intensity of the heat, but made the iron harder to break. Heavy sledges and crowbars were used, and the men worked under intense time pressure for the furnace was continually charged, and could be expected to make its next iron run within four to six hours of its last. (See Figure 2) (8)

The iron carriers were unskilled laborers who occupied a crucial point in the production process and acquired a reputation for independence. One early 20th century furnace manual claimed that:

> The entire plant depended upon iron carriers, since the furnace could not be operated unless the iron were carried out, not any time but within a very limited period, so as to permit the beds to be made ready for the next cast. These conditions had the result of making this class of labor extremely hard to handle. (9)

The work was so demanding, according to Edward Uehling, that "the extraordinary muscular exertion required bars four-fifths of the laboring class from standing up under the strain at all..."(10). Bars of iron, weighing 100 to 125 lbs., had to be carried six to then paces over "loose hot sand" and loaded onto a railroad car. This process was repeated 250 to 300 times in four to six hours. Uehling interpreted the work succinctly:

> The task of breaking and carrying out the iron from the casting beds of even a moderate sized furnace is not a fit one for human beings. If it were possible to employ horses, mules, or oxen to perform this work, the Society for the Prevention of Cruelty to Dumb Beasts would have interfered long ago, and rightfully so. (11)

For the large Northern furnaces, the increased rate of production in the 1890's made it almost impossible for the men to keep pace. It became harder to maintain full work crews, even with increased wages, and the men, growing more conscious of their critical role, became more difficult to "handle." As a direct result, labor-saving expedients including the Killeen Skimmer, which replaced the hand-made dams used to divert excess slag; cast iron molds, which eliminated the need for hand-formed sand molds; and pig breakers and cranes, which eliminated a large number of iron carriers were introduced. The latter two innovations were less effective than the major breakthrough of the period, the Uehling casting machine. (12)

In its original from, the machine consisted of two endless chains arranged in tandum (Figures 3 and 4). The first carried the molds into which the hot iron was poured. (A ladle car transported the iron from the furnace to the pig machine.) The molds were cooled by immersion in water, and the solidified iron was then discharged to a second chain, which also ran under water, before it delivered its product to a waiting railroad car. As the molds returned for the next pour, they were cooled and coated with lime to keep the iron from sticking. A later modification elimnated the need for two chains by merging their functions into one. (13)

In addition to reducing the labor from forty or fifty men to five, the pig machine provided a cleaner, more uniform product than before. It was a decided advantage not to have sand adhere to the iron, and it was much easier to maintain chemical consistency if the iron were thoroughly mixed in a ladle car rather than running freely from the furnace to the sand molds. It was a manifestly superior process, but one which the Sloss Company did not adopt until labor scarcity made it necessary. (14)

C. Charging

The work of charging the furnace with its burden of ore, coke, and flux was also done by hand until the mid-1890's. The earlier stone furnaces were generally built into the side of hills to facilitate top loading. The first metal-plate furnaces employed steam-driven vertical hoists (Figure 5). Loading at the bottom, and unloading at the top, however, were purely manual. The top loaders job was more dangerous and more responsible. Gas leaks, which inevitable, were a constant cause for wariness, as well as a potential cause of serious occupational illness. The job required attentive and responsible workers to circle the furnace rim while charging. If the stock were unevenly distributed in the furnace, it would not reduce evenly. One furnace manual stated, "slight variations in dumping more than any other cause, derange the works of the furnace." (15)

Particularly when the furnace was "driving" the top fillers might be tempted to dump all the stock on one side in an effort to "keeping-up."(16)

The industry responded by introducing automatic charging devices consisting of inclined, steam-driven skip-hoists which carried stock from the stock bins to the furnace top with a minimum of human labor. (Figure 6 and process dwrg, part 2). Improved stock bins were the key element in the system. The bins discharged their stock by gravity feed to traveling scale cars installed in a tunnel below the bins. The scale cars were designed to automatically weigh the stock and then dump it into one of the skip cars operating on the inclined hoist. The car traveled up the hoist and mechanically deposited its stock into the furnace. The system was in use by the mid-1890's as part of the new era in furnace building inaugerated at Duquesne in the Pittsburgh district. It allowed for a reduction in labor from twenty men to three. (17)

With automatic charging and the replacement of top fillers came a need for a new furnace tops with would effectively distribute the stock (Process dwrg, part 2). These generally consisted of a double bell and hopper arrangement. The two inverted cone-shaped bells were designed to provide a gas seal and a method of distribution. The McKee top came to be the one "almost universally used." In its improved form, the McKee top consisted of a stationary receiving hopper and revolving small bell, placed directly over the large bell. The small bell would receive the stock, discharge it to the bell below, and rotate sixty degrees before it received the next charge. In this was, the stock would be evenly distributed on the large bell before being discharged to the furnace. The two bells functioned as a gas seal by operating in series. One of then was always closed at any given time. (18)

D. Gas Cleaning

The operating furnace produced three products: iron, slag, and gas. In the older stone furnaces the gas was allowed to escape into the atmosphere. But with the introduction of improved gas cleaning devices, it was possible to recirculate the gas and use it to fuel the boilers and hot-blast stoves.(process dwrg, part 3). The gas was cleaned in two stages. It was first drawn off from the top of the furnace and carried in a pipe called the downcomer. The downcomer introduced the gas into a large cylindrical tank suspended vertically above the ground. The tank, called a dust catcher, was designed to reduce the velocity of the gas, by increasing the larger dust particles to settle at the bottom.(19)

With the larger particles removed, the gas then passed to the washers. Many different types of existed: stationary, either vertical or horizontal, revolving, and some operating on centrifugal force. Most washers contained vertical chambers fitted with water sprays. The water cleaned the gas of the remaining coke ash and ore dust, making it suitable for use in the boilers and stoves. Uncleaned gas would have clogged boiler flues and the interior brick work of the stoves. After 1900, new types of gas cleaners, using electrodes to remove suspended matter, came into increasing use. (20)

E. Boilers and Blowing Engines

The boilers, operating with coal and natural gas as well as furnace gas, provided steam for the blowing engines (process drawing, part 4). They also provided steam for the skip hoist elevator, the revolving furnace tops, and an assortment of water pumps. Because of the demands of blast furnace operation, large, high-pressure water tube boilers were a necessity. The types in most common use were the Cahall, the Sterling, and the Babcock & Wilcox. The Rust boiler, invented by E. G. Rust of the Colorado Fuel & Iron Company, found increasing favor by the early 20th century. This was a boiler with straight, vertical tubes, and was consequently easier to clean - a clear advantage for a continuously used boiler (Figure 7).[21]

The boiler-fed blowing engines propelled air through the hot-blast stoves into the furnace. These engines replaced earlier water-powered bellows. In the late 19th century they gradually increased in size and capacity. The years 1880-1905 marked the greatest development of these reciprocating steam blowing engines. Most of the engines used were vertical, though a few were horizontal or combined vertical and horizontal properties. The three types most commonly used were the "long-crosshead," with a flywheel on either side; the single flywheel, cross-compound, which because of its height became known as the steeple engine; and the single flywheel, "quarter-crank" with its steam and air cylinders placed on separate pedestals. The "long-crosshead" was probably the most widely used. It achieved prominence in the 1880's as the first of the modern blowing engines, and continued in use into the 20th century (Figure 8). Steam blowers were supplemented, or replaced, during the first quarter of the 20th century, by gas driven blowers or turbo-blowers. The latter, operated by air drawn to the center of "rotating impellers" and discharged by centrifugal force, gradually came into prominence by mid-century (process drawing, part 1).[22]

F. Hot-Blast Stoves

The hot-blast stoves were tall cylinders, with spherical caps, constructed of metal plate and firebrick. The interiors consisted of a large combustion chamber either in the middle or on one side, running the height of the stove (process drawing, part 6). Arranged around the semi-circular combustion chamber were networks of brick checkerwork partitions designed for heat retention. Stoves were classified as two, three, or four pass, depending on the number of partitions. A two pass stove consisted of a combustion chamber and one set of brick checkers; a three-pass, a combustion chamber and two sets of brick checkers; etc.

Each type operated on the principle of heat regeneration. Blast furnace gas entered at the bottom of the stove where it was immediately subject to combustion through the action of a gas burner. The products of combustion passed up the chamber and down and over the brick partitions, imparting heat to the brick checkers. Waste gases passed out of the stove through the chimney valve. The gas main was closed, and the cold blast main was opened. The cold air, driven by the blowing engines was heated as it passed through the stove, after which it was propelled through the hot blast main to the furnace. A stove of this type was patented by the English engineer, E. A. Cowper, in 1857. The basic technology was brought to the U. S. by Cowper's associate, Thomas Whitwell, in the 1870's. Regenerating stoves replaced earlier iron pipe stoves, which had provided the first successful method of heating the blast. Prior to the use of pre-heating stoves, the blast was introduced to the furnace cold.[23]

Furnace companies employed from three to six stoves per furnace. Extra stoves were necessary because a certain number were always heating, or "on heat, while one, and sometimes two, were "on blast" — giving up their heat to the furnace. Generally, the number of stoves used per furnace increased over the 20th century. The additional stoves functioned as spares, helped to reduce the wear, and when operated in conjunction with others, assisted in equalizing blast temperature.[24]

The tending of stoves, blowing engines, gas cleaning equipment, and boilers was not subject to extensive labor-saving innovation. In general, jobs in these areas were more desirable (though the cleaning of boilers and stoves could be both disagreeable and hazardous) and better paid than work in the cast house or stock bins. Stove tenders and blowers clearly perceived cast house labor as low status. One blower at a northern furnace around 1920 commented that "only Hunkies" (Poles and other Slovakian immigrants) worked in the cast house. The jobs, he said, were "too damn dirty and too damn hot for a 'white" man."[25]

G. Auxiliary Processes

In addition to the major blast furnace equipment, there were also important auxiliary processes. The maintenance of an initial adequate water supply, with its necessary pumping machinery, cooling ponds, and cooling and storage towers for recycling water, was imperative for cooling furnaces, boiler operation, and steam condensing. Even after electricity came into widespread use, steam machinery was retained for the operation of skip hoist elevators and furnace tops as a hedge against the disruptive consequences of electric power failure. Some furnaces were also fitted out with additional heating elements and iron pipe recuperators designed to pre-heat the cold blast before its introduction to the stoves. Other furnaces experimented with moisture control devices. These were essentially air-conditioning units whose purpose was to freeze the moisture out of the air before it was blown to the furnace. The process was first developed by James Gayley, c. 1890, but its utility remained a subject of controversy into the 20th century.[26]

THE RAW MATERIALS

Improved technology was a perquisite to large-scale iron production, and accelerated the exploitation of Alabama's mineral resources. The State's bituminous coal region encompassed an area of 6,400 square miles south of the Tennessee Valley. The Warrior, the region's largest field, was near Birmingham. Since coke constituted one-third of the furnace burden, and one-half the total cost of production, the low transport cost was a significant advantage.[27]

Two general types of iron ore were found in the district and were used in roughly equal proportions. Red iron ore, or hemitite, was mined on Red Mountain, east of Birmingham. The ore formation ran for 160 miles from north-central Alabama through the northeast corner of the State and into Georgia. 75 miles of it was workable. Red ore was classified as either hard or soft. The soft ore was rich in iron content and could be mined closer to the surface. The hard ore, however, consisted of 12% to 20% lime, and was therefore considered "self-fluxing." Since it reduced the amount of limestone or dolomite necessary for the furnace burden, the use of hard ore increased.[28]

The second type of ore found in Northern Alabama was limonite, or brown ore. Limonite was mined in four major fields: near Birmingham; Bessemer; Tuscaloosa; and in the northwest corner of the State near Muscle Shoals. Brown ore possessed certain advantages over red. It was higher in iron content, could be surface mined, and was more easily improved by washing or slow-burning - methods designed to raise iron content. However, brown ore was not found in extensive seams, as red ore was, nor did it contain "self-fluxing" properties. Each of the ores had its particular advantages, and each was generally mixed in the furnace according to tradition and experience. In the early period, particularly, little attention was paid to chemical analysis, and most manuals of the period noted this with dismay.[29]

The limestone or dolomite used as flux was quarried in the valley bordered by Red Mountain on the east and the Warrior coal field on the northwest. Prior to 1890, limestone was used exclusively. Gradually dolomite, a carbonate of lime and magnesia, came into increasing use. It possessed advantages over limestone because of its greater purity and regularity. 88 tones of dolomite could do the work of 102.19 tons of limestone.[30]

Raw materials were the major cost of production. In the mid-1890's they constituted no less than 70.9% of total annual production costs. Their plentiful supply, and the cheapness with which they could be moved to Birmingham furnaces, gave the area a strong initial advantage. But despite the ringing boosterism of the district's early publicists, there were serious problems. Local red and brown ores were high in phosphorus, an impurity which prevented the production of Bessemer steel and weakened castings made from high phosphorus pig iron. For iron to be converted to steel in the Bessemer process the ore could contain no more than .04% phosphorus to 50% iron. Alabama brown ore had a phosphorus content between .10 and .40, and red ore contained .30 to .40.[31]

Alabama was not alone in this problem. British, French, German, and Belgian ores also contained high amounts of phosphorus. Early efforts to eliminate phosphorus involved lining the converter with materials basic in chemical composition, such as lime or magnesia. The basic Bessemer process was eventually developed by Sidney Gilchrist Thomas between 1877 and 1879. Ironically, the process depended on ore of a higher phosphorus content than that of the Birmingham district. Experiments at Ensley attempted to increase the percentage of phosphorus by the addition of a phosphatic flux, but this was not a long-term solution. Efforts to produce a basic pig iron at the Alice experiments, the Birmingham Rolling Mills produced steel in two small open-hearth furnaces.

There were drawbacks to their success. The basic open-hearth process, superior in many ways to the Bessemer, could be economically operated with large amounts of iron and steel scrap. However, the Birmingham area did not have easy access to sufficient amounts for large-scale production. It was not until the development of the duplex process of steel-making, a process employing both Bessemer and open-hearth principles, that the district was finally able to cast off some of its competitive disadvantages. But the intractable nature of the district's ores left a permanent imprint. Steel production was seriously limited and Birmingham's challenge to the Northern iron and steel centers of Pittsburgh, Eastern Pennsylvania, and the Great Lakes districts was sharply hindered.[32]

Phosphorus content was not as serious a problem for the pig iron industry and saleable pig iron could be produced for foundries, rolling mills, and cast iron pipe works. There were certain disadvantages; phosphorus could not be eliminated in the blast furnace, and high phosphorus pig iron produced brittle castings and was not suitable for some cast iron products. In foundries where it was used, there is evidence it had to be mixed with low phosphorus pig iron to reduce impurities. In general, this was not a critical disadvantage, at least for the first half of the 20th century.[33]

Besides the problem created by a high percentage of phosphorus, Birmingham district ore was relatively low in iron content. As a result, more coke was necessary to reduce the ore. Since the district's coal had a high ash content, it produced excessive slag, which was destructive to hearth linings causing "frequent" break-outs of iron and slag, which raised production costs, lowered profits, and endangered workers.[34]

JAMES WITHERS SLOSS AND THE GROWTH OF BIRMINGHAM

Despite Birmingham's problem with phosphorus and low ore content its growth from 1880 to 1900 was impressive. Then blast furnaces were in place prior to 1885. By 1900, an additional 29 were put in blast, quadrupling production. Investment in Southern iron and steel doubled from 1880 to 1900, and over the same period, production trebled. Birmingham, as the center of Southern iron and steel, absorbed a major share of those increases. Growth hinged not only on raw materials, but on the construction of an effective rail line. A key figure in that effort was James Withers Sloss, merchant, planter, and railroad entrepreneur. (35)

Sloss, a farmer's son born in Limestone County, Alabama, in 1820, figured prominently in the early history of Birmingham. He had a major part in the successful completion, 24 September 1872, of the rail line connecting the Birmingham mineral district with Montgomery and Nashville. Sloss had been involved in efforts to build such a live since the 1850's. But his company's first efforts, like those of the state's antebellum iron industry, were laid to waste during the Civial War. When construction began again in the late 1860's, the live was threatened by capital scarcity and the duplicity of Chattanooga railroad interests. The history of the live was, in fact, marked by more than the usual rapacity and double-dealing characteristic of the "Gilded Age." At a critical point in 1871, when it appeared that the line would not be completed, Sloss helped to convince the Louisville & Nashville Railroad to provide capital, assume responsibility for the live, and to complete the final 67 miles from Birmingham to Decatur, Alabama. With the railroad forming the key transportation link, large-scale development of coal and iron became possible. (36)

It would be a mistake to view the developement of Birmingham as the simple and inevitable result of a mixture of raw material endowment, entrepreneurial foresight, and the railroad. The depression of 1873, an outbreak of cholera, and numerous law suits springing from a precipitous decline in the land company's stock almost destroyed the city and any dreams of future aggrandizement. In the long run, the city's growth was dependent, not only on transporation and raw materials, but upon technical experiments in iron making, recruiting skilled and unskilled industrial labor force, the continuing commitment of the Louisville & Nashville, and periodic infusions of Northern capital. Sloss had a hand in each of these processes. (37)

In the midst of the depression of 1873, Sloss joined with other local interests to form the Cooperative Experimental Coke and Iron Company. As one of three managers of the company, Sloss oversaw efforts to produce coke-fuled iron at the Oxmoor Furnace. The Oxmoor was originally built in 1862 on the side of Red Mountain. Destroyed in the Civil War, it was rebuilt in 1872 by the transplanted New Hampshireman, Daniel Pratt. Pratt was a leading spokemen for Southern industrialism and a manufacturer of cotton gins and cotton cloth. His attempt to revive Oxmoor failed in 1873.

The experiment with coke, however, proved successful February 28, 1876, and the furnace was rebuilt and put back in blast. 38

The ability to produce iron with coke fuel was critical to Birmingham's development. Charcoal produced high quality iron but was of limited usefulness in large-scale production; was expenisve to make, and had to be used in large quanities; its cellular structure resisted the effects of air, making it less combustible than coke; its use restricted furnace height because it was friable and could not support large amounts of ore and limestone; and it tended to deforest areas. 39

Oxmoor first produced coke in Belgian patent Shantle Reversible Bottom Ovens. Shantle himself supervised construction, but the ovens actually built by Dublin-born, Frank P. O'Brien later mayor of Birmingham - two examples among many of the importance of skilled European immigrants to Birmingham's industrial growth. Shantle's ovens were probably a type of bee-hive oven, so-called because of its shape. Long rows of bee-hive ovens, built of stone and fire-brick emmitting volumes of sulphurous smoke, became a characteristic feature of Alabama mines and furnaces. They were the primary means of converting Alabama bituminous coal to coke through the first decaded of the 20th century (See Fugure 9).[40]

Oxmoor also experimented with hot-blast stoves, presumably of iron pipe construction. These were rebuilt by the experienced Southern furnacemen, Levin S. Goodrich and John Veitch. The site, its equipment dismantled in 1928, was an important center of innovation for the district. Iron masters, furnacemen, and entrepreneurs, like Sloss learned and profited from its technical experiments. 41

With Oxmoor a technical success (it had yet to demonstrate that it could turn a profit), the old furnace company was rechartered and recapitalized. As a result, the Louisville & Nashville regained its interest in the district. The economic reversals of 1873 had made the railroad's expansion into Alabama appear foolhardy, which, in turn, may have resulted in the resignation of Albert Frank, the chief architect of the expansion.[42]

But with the events at Oxmoor and the personal intervention of Sloss, the L&N committed new capital, built special spur lines, and encouraged immigration.

Sloss played an important role in the reorganization of the Oxmoor company and retained his close connection to Louisville capital. In return for its capital the L&N received special treatment. One agreement between the L&N and the Warrior Coal Company, negotiated by Sloss, stipulated that the mine furnish the railroad with coal at fifty-cents per ton below market price. By 1876, the Louisville & Nashville owned one-half million acres in Alabama.[43]

Before Oxmoor could be deemed an economic success, it was necessary to find and extract good quality coking coal from local seams. In this effort, Sloss joined with Henry Fairchild DeBardeleben, Daniel Pratt's successor and the colorful descendent of an Hessian soldier, and New York-born mining engineer, Truman H. Aldrich. The seam was found in the coal lands of the Warrior basin, just northwest of Birmingham, in an area shortly to be known as Pratt City. In January, 1878, Sloss, DeBardeleben, and Aldrich formed the Pratt Coal and Coke Company. The presence and stability of the company, according to most historians of the district, marked a turning point. Within four years, it was followed by the Birmingham Rolling Mills; the Chaba Mining Company; the Alice Furnace; the Sloss Furnace Company; Pratt Coal and Iron; the Williamson Furnace; Woodward Iron and the Mary Pratt Furnace.[44]

Sloss resigned from the Pratt Company in 1879, and for a time assumed charge of the Oxmoor furnaces. Factional differences between Louisville and Cincinnati interests led to his resignation from Oxmoor in the spring of 1881. Because of a high demand for pig iron and with the encouragement of DeBardeleben - who oddered the Pratt Company coal for five years at cost plus ten percent, Sloss decided to form his own company. The L&N committed its support and its capital, and one of its directors, B.F. Guthrie, became the company vice-president. Sloss himself assumed the presidency, and his sons, Fred and Maclin, became secretary-treasurer and general manager, respectively.[45]

The new Sloss Furnace Company bought fifty acres of land between the tracks of the Alabama Great Southern and the L&N in an area then situated on the northeast border of the city. Furnace construction was supervised by Harry Hargreaves, a Swiss-English immigrant and an associate of the English inventor Thomas Whitwell. In the early 1970's Hargreaves in introduced the Whitwell recuperating hot blast stove at Cedar Point, N.Y. Raising Fawn, Georgia, and South Pittsburg, Tennesee. The Whitwell stoves he set up at the number one Sloss Furnace were the first installed in the Birmingham district.[46]

The first furnaces, 65x16 (the diameter is measured at the widest point - the bosh), was blown in 12 April 1882. The second furnace, 75x16½ was built in 1882 but was not blown in for more than a year due to a shortage of coke. The furnaces and their auxiliary equipment were generally considered the best, most advanced technology available.

The furnaces were of metal plate construction with vertical elevators used to handle raw material. There were six Whitwell stoves - three per-furnace. The two brick casting sheds and steam blowing engine house had large arched ventilation openings on the sides. Two 84" blowing engines, fed by ten boilers, provided air for the hot blast. Two-hundred forty-two bee-hive ovens supplied coke.

The stock bins were located on the south side of the site under a long, open-sided metal shed. The furnaces were hand-filled, and the iron was sand-cast. Although the basic symmetrical pattern of furnaces and supporting structures was repeated in subsequent construction, neither the original buildings or operating equipment survive. (Figure 10) [47]

Originally the company owned only a small percentage of its raw material. Coke was supplied by Pratt, and ore was supplied by a firm associated with Mark W. Potter. Sloss did own two limestone quarries, some sand deposits, and two small ore mine near Steele in St. Clair County and on Red Mountain. But the mines did not produce sufficient ore and contracts with independent companies were necessary.[48]

The company's growth hinged not only on capital, raw materials, and improved technology, but also on the physical labor necessary to mine the mineral fields and the keep the furnaces in blast. Skilled labor was scarace and was recruited in the North, often at rates higher than those customary in Northern iron and steel centers. Other skilled laborers came from England, Ireland, Scotland, and Wales. They not only brought needed furnace skills, but also supplied, by 1889, almost 20% of the state's mining labor. Additional immigrants from Southern and Eastern Europe joined them in the mines by the turn of the century. Southern whites constituted about 30% of the state's mining labor in 1889 and were important to the skilled iron and steel trades. The bulk of the district's labor, however, was black. Unlike the Southern textile industry, iron and steel in Birmingham was built on black labor. Significantly, the district's reliance on black labor increased over time. Constituting 41% of Birmingham's industrial work force in 1880, blacks made up more than half the city's wage earners by 1900. Their percentage in the iron steel industry was even higher, 65% in 1900 and 75% in 1910. [49]

At the blast furnaces the proportion of blacks to whites was extremely high. One observer commented that blacks outnumbered whites at Birmingham furnaces by ten to one. All the foremen, however, were white. For most blacks, this was their first exposure to industrial work, and like many other recent migrants to industrialism, they exhibited high levels of absenteeism and turnover.

In testimony given before the U.S. Senate's Committee on Labor and Capital at Birmingham session in the fall of 1883, James Sloss claimed that absenteeism was so high among black furnace workers that, in a typical month, he had to hire 565 men to do the work of 269. Sloss believed that a change in work habits would lower production costs by ten percent, but that he was "utterly powerless" to affect it:

> As long as they have a dollar in their pockets they feel independent and indisposed to work. Dismissing them from your services has no terrors to them.[50]

Even the raising or lowering of wage rates, Sloss asserted, would provide no leverage. It was "almost impossible," he believed, to keep his force at work after Saturday, and "not infrequently" his workers would be absent until Tuesday or Wednesday. Blacks worked well, Sloss claimed, while they were at work, ("the colored man likes the furnace business; he has a fondness for it."), 51 but their independence was clearly the company's most serious labor "problem." There is no reason to believe that Sloss was any less a racist than the average white American of the period, but his testimony ought not to be discounted for that reason. Other observers also noted high levels of absenteeism among turn-of-the-century black industrial workers. Like English hand-loom weavers, Irish canal diggers, and many first-generation migrants to industrial society, black furnace workers valued their free time more than additional wages.

In the early-20th century immigrant steelworkers at northern furuances also exhibited high levels of absenteeism, and had no difficulty in justifying it. After an unauthorized absence of three weeks, one Polish worker defended himself by simply exclaiming: "What the hell, work all time goddam job, what the hell."[52] In the face of a work schedule of twelve hours a day, seven days a week, under conditions of hot, intense, and exhausting labor, with a chance for upward mobility considerably less than white labors, the choice of time over money was hardly irrational.

Sloss attempted to resolve his problem by trying to attract family men, believing that they would provide a more stable work force than the young, unmarried, and "restless" blacks who, he claimed, made the bulk of the furnace workforce. He built forty-eight tenements at the city furnaces site as part of an effort to accomplish that end. But the short-run the only solution was the existence or an abundance of black labor. "I have got another set down-town," Sloss asserted, "that I can drum up whenever those who are at work leave."[53]

There is no evidence that Sloss, or other early furnace managers, attempted to employ white labor in sizable numbers. It is unlikely any such attempt would have been successful. White laborers was seen, by one of the district's early boosters, as "dignified." Reserving the heavy manual jobs for blacks prevented the development of class consciousness. The semi-privileged status of white labor was believed to excite "a sentiment of sympathy and equality on their part with the classes above them."[54]

And even if whites were successfully recruited for furnace jobs, at least one manager believed that the rate of absenteeism would remain unchanged.[55]

The success of the Sloss Company, therefore, hinged on the district's supply of black labor. As long as black workers were available to feed the boilers, charge the furnaces, and break and load pig iron, there was apparently little need for technological innovation. As early as 1900, one observer of Birmingham's labor noted the close relationship between black labor supply and technological change.

> In the Southern iron-works great numbers of negroes were employed with wheelbarrows to carry heavy loads of fuel or ore or metal from one place to another; but in the Carnegie Works in the Pittsburgh district there was a great network of overhead tracks, on which nearly everything could be shifted in any direction by steam.[56]

NEW OWNERSHIP AND THE DEPRESSION OF THE 1890'S

In the fall of 1886, with Sloss intending to retire, options to buy the company were extended to John W. Johnson, president of the Georgia Pacific Railroad, and to Joseph Forney Johnston, president of the Alabama National Bank and later Alabama Governor and U. S. Senator. Since sufficient capital to exercise the options could not be raised locally, the two men traveled to New York to see financier, J. C. Maben. Maben raised three million dollars from Wall Street sources, and in February 1887, the Sloss Iron and Steel Company was formed with J. F. Johnston as president. Northern capital, once again, helped to underwrite the district's development.[57]

With the additional capital, two furnaces were built in North Birmingham. The new company began to buy extensive coal land, an effort at vertical integration and self-sufficiency; acquired the Coalburg Coal and Coke Company, about eight miles from Birmingham; built 300 new coke ovens; and increased their total acreage to 38,000 acres. Under the handicap of a heavy mortgage caused by too rapid expansion, Johnston resigned after one year to begin his political career.[58]

The new president was Virginia-born, Thomas O. Seddon. Like Sloss, he was a railroad entrepreneur. Seddon remained president until his death on May 10, 1896. These were trying years for the company and the gragility of the district's industrialization was underscored. Efforts to stabilize the firm's shaky financial structure required reorganization and recapitalization. Those efforts, eventually successful, took place in the context of a national depression and a militant miners' strike.

Increasing Northern competition, marked by the "Duquesne Revolution" of the mid-1890's with its use of advanced and integrated technologies, accentuated two of the district's serious problems - high transportation costs and the lack of a local market. Sloss, while president, had shipped no iron to the East, although he had shipped to buyers in the Northwest, West, and South. He considered the development of a larger Southern market a high priority. As a railroad man, he did not believe freight rates were too high and recognized the need for more railroads. Sloss' successors, with fewer ties to railroad capital, would view the situation quite differently.[59]

The lack of applied scientific knowledge may have raised costs and reduced marketing potential.[60] Ore was bought without adequate checks on iron content, raw materials were mixed in the furnace without ehcmical analysis, and the grading system for pig iron was "illogical, cumbersome, and ridiculous."

There is also evidence that real labor costs were higher than most of the district's publicists wished to admit. This was true despite the reality that average hourly wages in the South were generally lower - 13 cents for blast furnace workers in 1907, compared to 13½ cents in the East, 15 cents in Pittsburgh, and 16 cents in the Great Lakes. However, average rates are deceptive. They tell us nothing about total labor costs. One expert, the author and chemist, William Battle Phillips, believed Alabama labor costs for late-19th century iron production were not as low as in competing states. High levels of absenteeism raised production costs and skilled labor had to be recruited at rates higher than those paid in the North. Other complaints occasionally surfaced in trade journals arguing that the district's labor was cheap but inefficient. Insofar as such comments were true, they reflected less on the district's workers than on the companies, like Sloss, whose continued reliance on manual labor retarded technological innovation.[61]

Southern textile promoters were known to advertise the cheapness and the docility of their labor. No one, however, argued the docility of steelworkers, miners, or blast furnace laborers. In 1894, an interracial miners' strike over wage reductions lasted four months, involved 4,000 miners, and was broken only by the intervention of the state. A strike by 1,200 miners at Sloss' Coalburg, Brookside, and Blossburg mines reduced production "far below" pre-strike levels. Striking miners were eventually ejected from company housing, and the mines were operated with 300 to 300 "blacklegs." At Coalburg, however, Sloss employed 589 convicts, 438 of them at jobs in the mine.[62]

The use of convict labor was one means to lower production costs. The Sloss Company seems to have had first bid on state convicts in January 1888. The company's bid was evidently too low, for an exclusive ten year contract was offered to the Tennessee Coal & Iron Company. There were county convicts available, and in 1891, Sloss contracted with Jefferson County (Birmingham) for the least of males at $9 to $10 per month , while simply providing food and shelter for convict men and boys. Sloss employed convict labor into the 1920's, as long as it was legally permissible

Sloss unquestionably benefitted from convict labor. In 1901, they found the capital necessary to build a "large new prison" at their Flat Top Mine. A few months after the prison was built, they reported to their stockholders that Flat Top "should prove the most profitable of the Company's coal mines."[63]

The survival of the convict lease system reflected an attitude toward labor contaminated by the virus of a slave society. The convict miners, subject to harsh and documented abuse, were an affront to the "free" miners, who vigorously organized against their use and who continuously raised the issue to the level of electoral debate. The "free" miners protest was sufficient reason for the Canadian government to ban the importation of Alabama pig iron from companies employing convict labor. The system was retained because it provided companies, like Sloss, with a cheap and regular labor supply, an inexpensive apprenticeship system, (it was estimated that 50% of the state's black coal miners were ex-convicts), and a critical resource during strikes or lock-outs.[64]

During the 1890's, the Sloss Company was so preoccupied with the effects of depression, the miners' strike, and its own internal difficulties, that it neglected to take advantage of an innovation of genuine importance - Uehling's pig casting machine. No records have been made available which would tell us precisely why both Uehling and his invention were allowed to slip away.

We have argued that as long as there was a plentiful supply of black labor, there was no reason to innovate, but in the 1890's there were at least three other factors which may have influenced the company's decision. First, unlike Northern steel plants, Sloss did not have a pressing need for integrated, high production technologies. When Northern furnaces were producing 300 to 400 tons of iron per day, a rate almost beyond the physical capacities of loaders and iron carriers, Sloss probably produced no more than 100 tons per day. Northern steel plants required rapid and consistent movement of molten pig iron to the converters or pig machines; Sloss produced only pig iron and could afford a less integrated system of technology.

Second, many southern foundrymen continued to prefer sand-cast iron. In a period when small-scale foundrymen could not afford, or did not wish to hire chemists, the grading of pig iron was done by fracture, not by analysis. Sand-cast iron cooled more slowly than machine-cast iron, and exhibited on fracture an open grain, large crystal configuration. This was a configuration valued by foundrymen, who did not like the close grain, small crystal iron produced by cast iron molds.

Third, the company may not have had sufficient capital to invest in labor-saving innovation. And even if they had, they might have been reluctant to invest it in an area where returns were not apt to be great. Despite the existence of labor costs relatively higher than previously believed, labor did not constitute a major cost of production. In the mid-1890's Phillips estimated it at no higher than 15% of total production cost. With a figure that low, an investment in labor saving machinery might not justify itself, since it could make itself felt only in a time of labor surplus. Once labor became scarce, the calculus of self-interest changed.[65]

RECOVERY

Recovery from depression, helped by the war boom of 1898, brought expansion, reorganization, and the rebuilding of the city furnace site. An aggressive expansion policy included buying three defunct North Alabama furnaces, the Lady Ensley, the Hattie Ensley, and the Philadelphia, all in the Florence-Sheffield area. High rail shipment rates drove them under during the economic crisis of the 1890's. Sloss also bought 20,000 acres of brown ore land in Franklin and Colbert Counties, and 20,000 acres of coal land in Walker County. In the process, the company bought out twelve smaller companies, (making it the second largest in the district, after Tennessee Coal & Iron), and reorganized as the Sloss-Sheffield Steel and Iron Company, incorporated in New Jersey in 1899.[66]

The company's drive for integration gave it a total of 63,603 acres of coal land and 48,000 acres of ore land by 1900. Sloss-Sheffield's five coal mines supported 1,100 bee-hive ovens and seven furnaces (six of which were in blast in 1900). Five McClanahan & Stone ore washers, five Robinson & Ramsey coal washers, all the necessary rolling stock, and a total of 1,400 worker tenements rounded out the firm's holdings.[67]

Once again rapid expansion produced a large debt and the need for additional capital. In 1902, after a succession of three presidents in a six year period, Wall Street financier John Campbell Mahan assumed the presidency. Maben, descended from a Richmond cotton and tobacco merchant, had played an active role in the company since 1886, when he raised a substantial sum of New York capital. Within three years he eliminated the company's floating indebtedness. The price for financial stability was increased Northern control; in 1902 eleven of the fourteen directors were from New York and only one from Birmingham.[68]

Maben presided over the company for fifteen years, during which the city furnaces were substantially rebuilt. There had been a few changes earlier. Four blowing engines built in Birmingham had been added while James Sloss still owned the company. In the mid-1890's, the number one furnace was rebuilt and two additional two-pass stoves were erected to complement the six already in place. In 1902, major changes occurred. A new brick blowing engine house was built and fitted out with three Allis-Chalmers blowing engines (Plan, Sheet 8 and Section, Sheet 14). The building and two of the blowing engines remain in place. The eight engines, 44x84x60 long cross-head types, are the oldest and most important pieces of surviving technology at the site. Most of them were built c. 1900, but were acquired by Sloss-Sheffield second-hand during the 1920's. They represent the first modern blowing engine used on a large scale by coke-fueled, metal plate blast furnaces.[69]

New stoves were added in the same period, raising to five the number used per furnace. These were stoves of Whitwell, or Gordon-Whitwell-Cowper, design. It is unlikely that any important elements of these c. 1900 stoves survive. The twelve current stoves, which include two built as spares in 1916 and 1971, have been thoroughly rebuilt since 1900. They have been relined, in some cases converted from four-pass to two-pass, raised in height, and probably replated. The major valves were replaced in 1927 and 1928 (Plan, Sheet 8 and Elevation, Sheet 13).[70]

By 1904, the number two furnace was rebuilt and a new steel casting shed was erected - both since removed. A battery of 400 hp capacity

Rust water-tube boilers was built between 1910 and 1911. These vertical, straight tube boilers, which remain in place, represented the latest development in boiler construction. Because they were designed for easier cleaning, they had advantages for companies in continuous operation (Plan, Sheet 8).[71]

By 1911, the first period of technological change at the city furnaces was over. None of the changes were directly labor saving and with the exception of the Rust boilers, none introduced new technology. It is clear, however, that the company was attentive to new technology, and that New York control did not mean capital investment at the site was to be neglected. Although constant relining and refitting of furnaces and auxliaries continued at the site, it would be almost twenty years before important technological changes occurred again.

LABOR SUPPLY IN THE EARLY 20TH CENTURY

Through the early 20th century, there is no evidence the company's workers were any more tractable or submissive and militant strikes in the mines continued. A strike in July, 1903 closed the Sloss-Sheffield mines for two months. They were reopened on the "open shop" basis, though the strike was not called off until August, 1905. During this period, production fell, labor scarcity was acute - "frequently sufficient labor could not be had to draw the ovens" - and violence included placing a bomb under the front door of President Maben's house.[72]

In 1908, a brief violent strike closed down every mine in the district. The strike was finally broken by state intervention and the militia. One result of the strike was the decision by U. S. Steel to introduce welfare and education programs, and to become actively involved in the design of worker communities. By 1910 plans were ready for the development of Corey (now Fairfield), a landscaped community built for U. S. Steel's workers. The company's "welfare work" was admittedly self-serving, designed to reduce labor turnover and to hold workers in the South - "a difficult thing in the past." As such, it represented the district's first concentrated effort to confront the labor supply problem, though it was directed primarily at holding white labor. The supply of black labor was not yet a problem.[73]

Despite the example of U. S. Steel, Sloss-Sheffield maintained a classic laissex-faire policy. The company's worker housing was described in 1912 by John Fitch, then doing research on steelworkers in The Survey:

> The village of the Sloss-Sheffield company in central Birmingham, with a slag dump for a rear view, blast furnaces and bee-hive coke ovens for a front view, railroad tracks in the street, and indecently built toilets in the back yards, is an abomination of desolation. The houses are unpainted, fences are tumbling down, a board is occasionally missing from the side of a house.

> Col. Maben, president of the company told me that he didn't believe in codding workmen.[74]

There was some improvement one year later when the city compelled Sloss-Sheffield to abandon use of approximately 300 coke ovens at the city plant. The ovens, closed because of excessive pollution, have since been destroyed or covered over.[75]

The company's labor policy was partly dictated by economic considerations. It is unlikely they had sufficient capital to underwrite extensive welfare programs. Holding to an older ideal of labor management keep the men working and drive them - Sloss-Sheffield was not involved in "welfare work."[76]

Though the furnace workers were generally less militant than the miners, they too continued to create special problems for the company. Absenteeism remained high, and evidence exists that Sloss-Sheffield was forced to continue carrying 50% more workers on the payroll than were needed at any one time. Blacks were said to have worked a four to five hour day.[77]

But the company was becoming more aware of the problem of maintaining an adequate labor supply. Local industrialists, including Sloss-Sheffield vice-president, J. W. McQueen, and the Birmingham Chamber of Commerce, actively opposed the continuence of a local legal system which supported itself by payming arrest fees to its officers. One middle-class reformer described it pointedly as a "cash-nexus for crime" and believed the system encouraged arrests, consequently driving away black labor. Using the same logic, Maben and McQueen opposed the prohibition of alcohol and prohibition laws would make it even more difficult to recruit and retain labor.[78]

These positions did not originate among local industrialists because of a simple desire for justice. Their primary concern, in supporting or opposing particular measures, was in maintaining an adequate labor supply. To this end, they were quite prepared to use the coercive power of the law. This was evident in their response to the "acute labor shortage" brought on by World War I. The war years marked a concentrated black exodus from the South. In 1918, a local vagrancy law was passed, with the support of Birmingham industrialists, which placed the burden of proof on anyone found "wandering or strolling about" on any working day. It was a clear and harsh response to a problem engendered, not only by migration, but by higher wartime wages which allowed blacks to work two or three days, and much to the consternation of the area's managers of labor, "still support themselves."[79]

TECHNOLOGICAL CHANGE AND THE CRISIS OF THE 1920"s

The history of the Sloss-Sheffield Company from the start of World War I through the 1920's was characterized by two sharp realities. First, the company found itself, like all merchant pig iron producers, in a deteriorating economic environment. Second, the company was faces with the problem of continuing black migration. Despite these pressures, the company survived and continued to produce pig iron. Their successful adaptation resulted from timely technological change, the development of a local market, and proximity to raw material.

The number of Alabama blast furnaces decreased from 49 to 35 between 1905 and 1925. By 1936, only 22 blast furnaces were left in the South, and only 15 of those were operating. Pressure on the merchant pig iron industry was particularly severe. The industry produced 42% of the total pig iron manufactured in the U.S. in 1903. By 1927, its share of the market had fallen to 23%. There were three reasons for this. First, steel plants were buying less pig iron in the open market. Instead, they were making extensive use of scrap and were producing more pig iron than they needed. Second, the excess pig iron was increasingly offered for sale in the foundry market. Third, advancing freight rates restricted markets and further undermined the merchant's furnaces' ability to compete with the large steel companies. The merchants were generally not part of the vast merger movements of the 1890's, nor were they a part of that inner circle of iron and steel magnates, under the leadership of U.S. Steel's Elbert Gary, which attempted to control markets and competition after the mergers failed to do so.[80]

The pig iron industry was weakest in the South. The number of companies active in the U.S. iron industry in 1929 was only 60% of what it was ten years earlier. In the South, over the same period it was only 47% of its former size. This was partly the result of inefficiencies induced by a slow technological change. As late as 1924, nine of twenty four blast furnaces in the Birmingham district were still hand-filled, and all the districts merchant furnaces continued to cast in sand. While blast furnace productivity in the nation doubled from 1912 to 1927, Southern furnaces showed an increase of only 50% for the period 1917-1927, and the gap between the two regions was widening during the first half of the 1920's.[81]

Though Southern furnaces were less mechanized than Northern ones in this period, the Southern furnaces' central problem was their distance from the large iron markets of the North and Mid-west. Efforts to establish a Southern market continued. In 1880, only 10% of Alabama iron remained in the South. By 1910, the percentage had doubled to 20%, and by 1914 it was 60-70%. The most important local outlet for pig iron was the cast iron pipe industry. works built between 1900 and 1914 were built in Alabama. The demand for soil and pressure pipe kept the furnaces operating. In 1914, the president of the Birmingham Chamber of Commerce stated that, without the pipe industry, "there would be no furnace in operation today on foundry iron in the South."[82]

With a part of the company's marketing problem solved, Sloss-Sheffield became a leader in the effort to restructure freight rates. Along with other Alabama and some Tennessee iron companies, they initiated a case before the Interstate Commerce Commission on November 7, 1912. The companies argued that current rates discriminated against the South. The ICC decided in their favor on July 7, 1914 and rates were reduced between 35 cents to 75 cents per ton. J. W. McQueen, Sloss-Sheffield vice-president, stated the new rates would increase Birmingham's competitiveness, but would not put the district on the same competitive footing as Pittsburgh. The company took advantage of the new rates and continued its efforts to market iron in the North. In 1920, they were selling enough in the North to justify establishing a permanent pig iron storage yard on the municipal wharf in Providence, Rhodes Island.[83]

Despite gaining some relief from the ICC, the district continued to operate at a geographical and manipulative disadavantage. The policy of "Pittsburgh Plus", initiated by the steel trust, severely discriminated against the South. The policy fixed the sale price of iron and steel based on rail shipment cost from Pittsburgh to the point of sale, regardless of where it was made. If Sloss-Sheffield shipped iron to the West, for example, the final price was determined by rail shipment costs from Pittsburgh, not from Birmingham. The policy sharply underlined Birmingham's position as a captive industrial center and an "outpost" of Northern capital. The full implications of "Pittsburgh Plus" have yet to be studied, but it appears the policy stiffled competition and retarded Birmingham's growth. With pressure from the Federal Trade Commission, and after the damage had been done, U.S. Steel ended the policy in the summer of 1924.[84]

Sloss-Sheffield made one particularly important economic and technical adapation in the years immediately after World War I. The company built 120 Semet-Solvay by-product coke ovens at their North Birmingham plant, and two years later added 30 Kopper ovens. The technology had been developed in Germany in 1881, and made its first appearance in the United States in 1893 at Syracuse, New York. Four years later, it was introduced to the Birmingham district. Despite initial objections, the new technology eventually replaced the bee-hive ovens. By expert accounts, by-product ovens produced higher yields of good quailty coke. The major advantage of the new ovens was that their by-products, gas, tar, and ammonia, could be sold. In some cases, the sale of by-product was sufficient to pay for the labor necessary to operate and maintain the ovens. By 1930 use of the ovens became so important that one furnace manual argued the by-product oven was the chief reason merchant furnaces were able to operate successfully. The ovens, still in place in North Birmingham, provided gas for the city; benzol, a gasoline additive; coal tar, used for creosote - a wood preservative; sulphate of ammonia, a fertilizing agent; solvent naphtha, a base for month balls and an ammonia base for household use.[85]

The introduction of by-product coke ovens did not significantly reduce the number of workers and was not motivated by any sense of the long-term effects of black migration. Black migration, however, continued "steadily and quietly." From 1922 to 1923, 90,000 blacks left the state of Alabama, because of the continuing crisis of Southern agriculture, industrial opportunites in the North, the revival of the Klu Klux Klun, and other public and private reasons. Although indices of internal migration have always been incomplete, it is clear the percentage of blacks living in the South declined from 85.2% in 1920 to 78.7% ten years later. This was the sharpest percentage decline yet recorded. In that same ten year period, the total number of Alabama blacks in the iron and steel workforce decreased by approximately 4,000.[86]

The exodus could no longer be ignored. In 1921, Sloss-Sheffield made its first technological response. In that year, James Pickering Dovel, the company's furnace manager, erected a pig iron breaker of his own design. The basic idea was not new. Pig iron breakers were in use as early as the 1890's and Dovel's design was a modification of earlier technology. The device, a heavy frame casting mounted on a track near the top of the casting shed, operated with an 8" air-driven piston. The piston, with a 15" stroke and a chisel-nosed hammer at its tip, was designed to break pigs from the sow, after the sow was lifted into place by an overhead crane. The pig breaker eliminated the need for iron carriers, but sand cutters and a loading crew were still necessary. It was not as labor-saving a technology as the pig casting machine, but its installation indicated the seriousness with which Sloss-Sheffield was beginning to face its problem of labor supply. Black migration from the South was finally forcing the mechanization of the Birmingham iron industry.[87]

In 1924, the company machined casting for the first time. Between 1923 and 1924, Sloss-Sheffield acquired five additional North Alabama furnaces Two of these, the Etowah furnaces in Gadsden, were the most modern merchant furnaces in the state. They were bought from the Skip hoists revolving Brown furnace tops, electric scale cars, and a Pollock steam dump, self cleaning cinder car had been used as early as 1908. In 1921, a new and bigger furnace had been built. Its spray cooled hearth jacket was replaced with rolled steel and cooling plates. A new receiving hopper was added at the top, and the shape of the furnace was slightly altered. A storage trestel was built and a Heyl & Patterson, single-strand pig casting machine, the first at an Alabama merchant furnace, was put in place. The casting machine reduced the necessary manpower from 305 to 160.[88]

Sloss-Sheffield's expansion policy was ill-timed. The old inefficient North Alabama furnaces were too far from the coal fields. Isolated from large population centers, they may also have felt the crisis in labor supply before Birmingham. For these reasons, Sloss-Sheffield began to close its North Alamaba furnaces. By August, 1927, the company had shut down all its furnaces except the four in the city limits of Birmingham.[89]

While the North Alabama furnaces were being closed, the company decided to undertake major renovation of the city furnaces. Between 1927 and 1931, the two furnaces were rebuilt and upgraded, fully mechanizing furnaces operation. Since existing company records were not made available, we do not know the reasons the company offered for mechanizing in those years. Fortunately, we do have records of the Woodward Iron Company for the period from January 1924 to June 1926. Woodward Iron, located twelve miles southwest of Birmingham, was a merchant pig iron producer. Like Sloss-Sheffield, Woodward drew its labor from the Birmingham area. Woodward's monthly reports, for the mid-1920's indicate a pervasive and consistent concern for labor supply. The company had a paritcularly hard time in filling unskilled positions at its mines and furnaces. Iron carriers and sand cutters were in particularly short supply. It was becoming harder to find men willing to do the hot and strenuous work in non-mechanized blast furnace operation when other opportunities were available. The iron carriers, always a source of difficulty for furnace managers, became more independent and more conscious of their value under conditions of labor shortage. Woodward's president, Frank H. Crockard claimed in December, 1925 that iron carriers and sand cutters were "the most difficult class of labor with which we have to contend."90 The company saw no other choice but mechanization and in a statement of December, 1924, justifying their decision, they left no doubt about their reasons.

> The most laborious type of work around the blast furnace today is that of the pig iron carrier. As this type of workman is seemingly becoming extinct, in order to prevent serious decreases in production, arrangements are now being made to install mechanical means of handling the iron, which is now being handled by hand. 91

There is no reason to think Sloss-Sheffield's justification was any different. In December, 1926 they began dismantling the Number Two city furnace. The new furnace, 82x21, with a capacity of 400 tons per day, was completed July 25, 1927 (Figure 11). It was not only large than its 200 ton per day predecessor, it incorporated a seriers of improvements patented by James Dovel. The Dovel patents included an improved hearth and bosh jacket, a modified cooling system, and altered interior furnace lines. The interior was designed with fewer fire bricks and a larger surface area at the top, increasing the amount of stock which could be contained in the furnace. Dovel claimed the increase in stock helped to retain heat, thereby increasing furnace output and reducing coke consumption. Dovel also patented and erected a gas washer and a heat recuperator (See Elevation, Sheet 18). The latter, a large rectangular structure containing numerous iron heating pipes, was designed to preheat the cold blast prior to its introduction to the stove.(92)

The key features of the new furnace were a McKee automatic top and an inclined skip hoist for mechanical charging. (See Elevation 17 and Figure 12) The skip cars, which traveled up the hoist with their load of stock, were driven by a double-drum Otis steam elevator. The effectiveness of the skip hoist was dependent on radical changes in the stock bins. A concrete charging tunnel, 747 feet long and 10 feet 8 inches high, was built in 1927. New stock bins were constructed over it with doors opening down into the tunnel. Rail tracks were laid in the tunnel and on top of the bins. The system, described previously, was designed to fill the furnace using a minimum of human labor.93

In March, 1928 work began on furnace Number One. It was replaced by a furnace to the new Number Two. (See Elevation, Sheet 12 and 13) Each new furnace was fitted with electric mud guns, designed to automatically close the iron notch at the end of a pour work previonsly done by hand. (See Plan, Sheet 9).94

During the same years, the company upgraded other parts of the operation in 1927. A 68 foot water tank was moved from one of the company's deactivated furnaces in Florence, Alabama and installed adjacent to the southwest corner of the blowing engine house. One year later, a bank of 60hp capacity Casey-Hedges water-tube boilers, built in Chattanooga, Tennessee was installed to supplement the Rust boilers in place since 1911. A second-hand Allis-Chalmers blowing engine was moved from company property in Sheffield, Alabama and put in place in 1928. It operated along side eight other blowing engines, four of which were bought second-hand in South Chicago and Rising Fawn, Georgia between 1926 and 1927. The other four were originally installed at the site c1900. (See Plan, Sheet 8)95

The new Number Two furnace was put in blast on August 1, 1927 and the Number One in January, 1929. For a brief period the company continued to cast in sand. Its labor requirements were, however, much less. Not only was the company using pig iron breakers for the heavy work, but in January, 1929 a uni-pig machine was set up a machine designed to pre-mold the loose sand into which the iron was then cast. These devices were transitional expedients which reduced the companys reliance on manual labor and allowed them to continue casting in sand. Sloss-Sheffield was still selling to foundrymen who disliked machine cast iron. But the argument for smaller, cleaner, more uniform pigs was growing. Machine cast iorn gradually more acceptable as foundrymen learned to grade iron by chemical analysis instead of by fracture.96

In January, 1931, Sloss-Sheffield installed a Heyl & Patterson, single-strand pig casting machine. Even after it was set up some sand casting still continued. The machine, based directly on the patents of the company's former furnace superintendent made its first appearance at the site approximately thirty-five years after its invention. (See Plan, Sheet 9 and Figures 13 and 14). 97

CONCLUSION

The site strongly reflects the changes made from 1927 to 1931. The furnaces have been refitted, but their basic structure survives. The skip hoist, Otis elevators, gas cleaners, stock bins and charging tunnel, and Casey-Hedges boilers still survive. (See Plan, Sheet 8 and 9, Elevation, Sheets 17 and 18). An electrical power house, built in 1929 and a laboratory building built in 1930 also survive. (See Plan Sheets 4 and 5, Elevation, Sheet 13). The foundation and some of the framing for the pig casting machine are still in place, but the machine itself was sold in 1975. (See Plan, Sheet 9). The recuperators, once located between the furnaces and stoves, were dismantled in 1956, they were no longer necessary after the stoves were increased in height in the early 1940's. A few elements - the blowing engine house, some of the blowing engines, and the Rust boilers - remain from the early 20th century. The stoves built many times, relfect no particular period.

Some of the technology is recent. The de-humidification unit, behind the blowing engine house, was used during World War II to save on coke consumption. (See Plan, Sheet 4). The slag granulators, of Kinney and Osbourne design, were added in the late-1940's to process material previously wasted cement aggregate and railroad ballast. In 1949, a Kinney vertical gas washer was added at furnace Number One. (See Elevation, Sheets 13). In the same year the site's first turbo-blower was installed in an addition to the blowing engine house, and a second was put in place in 1951. (See Plan, Sheet 4). The two Ingersoll-Rand turbo-blowers operated in conjunction with the Marley redwood cooling towers at the eastern end of the site and replaced the vertical steam blowing engines. (See Plan, Sheet).[98]

The furnaces are now idle, but their survival evokes the past. Taking advantage of the area's rich mineral resources, the Sloss Furnaces were one of Birmingham's charter industries. They stand as symbols of the city and Southern industrialism. The history of the Sloss Furnaces is a history of black labor and the interaction between labor supply and technological change. Thirty years behind best practice technology, the company did not innovate until the late 1920's, when black migration from the South could no longer be ignored. This paper has implicitly argued the importance of approaching the history of technology in the broadest possible context, a context attentive to the material facts of technology, economics, and demographic change. No other approach can do justice to the complexites of social change.

ILLUSTRATIONS:

1. Sand-casting, from the cover of Scientific American, 22 December 1895.

2. "Making a sand cast from a blast furnace" and "Breaking up the pig-iron," from Cassier's Magazine, 24/2, (June, 1903), p. 116.

3. "The Uehling pig casting machine," from The Iron Age, 22 April 1897, p. 14.

4. Single-strand Uehling casting machine, from Cassier's Magazine, 24/2, (June, 1903), p. 124.

5. View of Sloss Furnace, North Birmingham, c1920, (vertical elevators can be seen on the far side of each furnace), Tutwiller Collection, Southern History Room, Birmingham Public Library.

6. "Vertical section of a modern blast furnace" with skip hoist on the left, from Cassier's Magazine, 24/2, (June, 1903), p. 115.

7. "Rust boiler in setting," from J.E. Johnson, Jr., Blast Furnace Construction in America, (N.Y., 1917).

8. Mesta long-crosshead blowing engines, from Johnson, op. cit.

9. Bee-hive coke ovens, Birmingham, from Pig Iron Rough Notes, Sloss-Sheffield Steel & Iron Company, 50th Anniversary No., 1932.

10. "Sloss Furnace," earliest known view from John W. DuBose, Ed., Mineral Wealth of Alabama and Birmingham, Illustrated, (Birmingham, 1886).

11. Plan of No. 2 City Furnace, from J.P. Dovel, "Improved Furnace on Southern Ores, The Iron Age, 22 September 1927, p. 783.

12. Skip hoist in operation at the No. 1 City Furnace, from Pig Iron Rough Notes, op. cit.

13. Iron runs to ladle car at the No. 2 Sloss City Furnace, Pig Iron Rough Notes, op. cit.

14. Pig molds at Sloss City Furnace, Pig Iron Rough Notes, op. cit.

ENDNOTES:

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Addendum to:
Sloss-Sheffield Steel & Iron Company Furnaces
First Avenue North Viaduct @ 32nd Street
Birmingham
Jefferson County
Alabama

HAER No. AL-3

HAER
ALA,
37-BIRM,
4-

PHOTOGRAPHS

Historic American Engineering Record
National Park Service
Department of the Interior
Washington, DC 20240

ADDENDUM TO
SLOSS-SHEFFIELD STEEL & IRON CO.,
COKE WORKS-NORTH BIRMINGHAM
Birmingham Industrial District
3500 35th Ave. North
Birmingham
Jefferson County
Alabama

HAER No. AL-56

HAER
ALA
37-BIRM,
44-

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ADDENDUM TO
SLOSS-SHEFFIELD STEEL & IRON CO. FURNACES
(Sloss Furnaces)
Birmingham Industrial District
First Avenue North
Viaduct Thirty-Second Street
Birmingham
Jefferson County
Alabama

HAER No. AL-3

HAER
ALA
37-BIRM,
4-

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SLOSS-SHEFFIELD STEEL & IRON CO. FURNACES
(Sloss Furnaces)

This report is an addendum to a 37 page report previously transmitted to the Library of Congress.

Location: Just east of the Birmingham city center along First Avenue North. The furnaces are generally bounded by the L. & N. (CSX) Railroad to the northwest, 32nd Street on the east, and the Southern (Norfolk Southern) Railroad right-of-way and other lines on the south. Birmingham, Jefferson County Alabama. The total site contains 32.66 acres. The furnace site is located on a 17.4 acre parcel located on the south side of 1st Avenue North. The remainder of the site, 15.26 acres, is located on the north side of First Avenue North. The First Avenue North viaduct and 32nd Street South serve as primary access routes for visitors to the site approaching from the city center and Southside areas. Visitors approaching from I 65/20 exit at the 31st Street North exit, proceed south along 31st Street to Fifth Avenue North, left on Fifth Avenue North one block under the L. & N. Overpass to 33rd Street, right on 33rd Street one block to Second Avenue North, right on Second Avenue North which enters the Sloss site. The route is circuitous due to necessity to cross the L. & N. right-of-way.

Date of Construction: 1882 to 1950s

Ownership: City of Birmingham

Builder/Architect/Engineer: Multiple

Significance: The Sloss Furnaces, the nucleus of an integrated ironmaking system which includes extensive surviving remnants of coal and iron ore mines, quarries, and coke ovens, are the most visible symbol of the Birmingham District's role as the nation's leading foundry iron producer from the late-19th century until the 1960s. The blast furnaces, stoves, boilers and other structures represent the highest expression of American merchant pig iron furnace practice and design of the late 1920s. Other features such as vertical blowing engines and sand casting beds chart technological evolution at the turn of the century.

Project Information: This report is based upon written documentation donated by the Birmingham Historical Society, reformatted to HABS/HAER guidelines.

DESCRIPTION

The Sloss Furnaces site contains two blast furnaces, steam boilers, a powerhouse, blowing engine rooms, hot blast stoves, expanded slag machine, slag pits, cast houses, office, cooling towers, spray pond, gas washing equipment, storage bins, bathhouse and railroad tracks. These structures and buildings still contain much of their original equipment and machinery. Also contained on the site are the buried archaeological remains of a battery of over 200 coke ovens and the possible remains of the first Lurhig jig coal washing plant in the United States.

Components of the Site
Two Blast Furnaces and Casting Sheds
Stock House-Charging Trestle and Tunnel
Loading Gear
Stoves
Blowing Engine House with Turbo Blowers
Power House with Generators (now studio for artists work in large scale metal sculpture)
No. 1 Bath House (now Visitors Center)
Filling Station
Bucket Display
Slag Pit Shovels
Slag Pits
Cooling Towers
Spray Pond
Cast Shed (now an open-air Amphitheater)
Ladle Car (125-Ton)
Water Tanks
Slag Machine
Laboratory Foundation
Furnace Exhaust Stacks
Air Dehumidification Building
Skip Hoist Elevator Equipment Building
Pyronitor House (now Blacksmithing Shop)
Dust Catcher
Horizontal Gas Washer
Boilers
Vertical Gas Washer
Car Haul
Storage Building-Paint Shop
No. 2 Bath House
Coal Bin
Locomotive Water Tank
Settling Basin
Scales Building
Pig Machine Foundation
Beehive Coke Oven Site
Old General Office Site

Stairs to Viaduct Overpass
Domestic Coke Bins
Machine & Blacksmith Shop Foundation
Fuel Oil House Foundation
Oil House Foundation

Other Site Improvements

1. Pedestrian Circulation System
2. Stage Performance Area
3. No. 2 Cast Shed has been converted into an amphitheater.
4. Beehive coke ovens excavation has been completed.
5. Bath house has been converted into information center, museum meeting room and office.
6. The Duncan House has been relocated and restored on the site. It serves as an office for the Birmingham Historical Society.
7. A parking lot with landscaping has been developed.
8. The Power House has been converted into a sculpture/metal fabrication studio.
9. The Pyronitor House has been converted into a blacksmith shop.
10. Many structures on the site has been painted to prevent rusting.
11. New bathrooms have been constructed.

Other Improvements in Progress

1. The spray ponds are being converted into a visual fountain with an adjacent plaza area linking the pond into No. 2 Cast Shed.
2. The stock trestle tunnel complex will be renovated for interpretive purposes.
3. No. 2 Furnace is currently under renovation.

HISTORICAL OVERVIEW

The Sloss City Furnaces were erected in 1882 and 1883 on 50 acres of land near the crossing of the L. & N. and Southern Railroads, at the eastern edge of the Birmingham city center. They were extensively rebuilt and modernized in 1927 and 1928 (the dates of the present blast furnaces). The furnaces remained in operation until 1970 when the declining market for raw pig iron and the high cost of anti-pollution devices forced their closing. The Sloss Furnace Company (later Sloss-Sheffield Steel and Iron Company and U.S. Pipe) was one of major foundry-iron producers in the Birmingham District and contributed to the District's growth as a major regional industrial center. The company's founder, James Withers Sloss, was involved in almost every facet of

Birmingham life in the 1870s and 1880s and many significant individuals in Alabama's industrial history have been associated with the furnaces.

The furnaces were given to the City of Birmingham in the early 1970s. Several years and several plans passed before a decision by the Alabama Fair Park Authority to demolish the furnaces led to their recording in the summer of 1976 by the Historic American Engineering Record. This documentation brought national attention to the site. A tour of the site, intended to encourage public support for demolition, ironically led to the formation of the Sloss Furnace Association, a loosely-knit crew dedicated to preserving the furnaces. In 1980, SFA succeeded in recruiting support at the polls for the passage of a major City Bond issue authorizing funding for restoration of the furnaces as a city museum and community center. Portions of the furnace site opened to the public for the first time on Labor Day, 1984. City and federal appropriations have funded successive restoration of historic fabric. The Furnaces, now a museum of the City of Birmingham, have become a national and international center for the pouring and smithing of metals (with artists working on the site), and exhibits, workshops and special programs.

Conditions at the site vary from excellent to poor. Throughout the 1980s, preservation efforts have been ongoing. Sloss Furnaces has pioneered techniques for the stabilization of large-scale industrial facilities no longer in use. Historic resources on the site that have been and are being stabilized include: Cast Shed No. 2, converted to an out-of-doors amphitheater; Bathhouse No. 1, converted to a visitor's center with meeting rooms, offices, gift shop and restrooms; Pyronitor House converted into a blacksmith shop; Furnace No. 1, stacks and stoves stabilized and painted to prevent rust; Furnace No. 2 stabilization currently underway; spray ponds currently being converted to function as a fountain with plaza area linking them to Cast Shed No. 1; use of the internal rail network as pathways for internal circulation; and renovation of the stock trestle tunnel for interpretation. There are many future conservation challenges on this immense site.

Sources Consulted

National Historic Landmark Nomination, 1981

Kulik, Gary B., "The Sloss Furnace Company, 1881-1951: Technological Change in the Southern Pig Iron Industry," Mimeographed Report for the Historic American Engineering Record, Birmingham, 1976.

National Register Nomination, 1972

Historic American Engineering Record, 1976

ADDENDUM TO:
SLOSS-SHEFFIELD STEEL & IRON
(Sloss Furnaces)
Birmingham Industrial District
First Avenue North Viaduct at Thirty-second Street
Birmingham
Jefferson County
Alabama

HAER AL-3
HAER ALA,37-BIRM,4-

COLOR TRANSPARENCIES

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
U.S. Department of the Interior
1849 C Street NW
Washington, DC 20240-0001