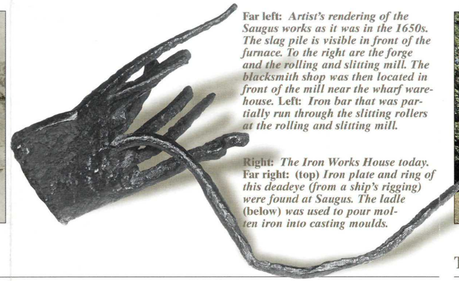
Saugus Iron Works

National Historic Site
Massachusetts
National Park Service
U.S. Department of the Interior

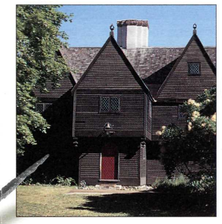
Official Map and Guide

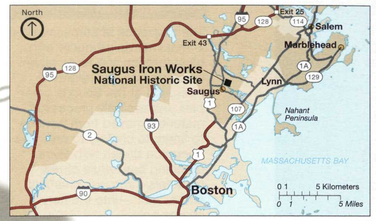
Reconstructions of the blast furnace, forge, and rolling & slitting mill over the original 1640s foundations illustrate the technology that transformed ore into iron products.



Far left: *Artist's rendering of the Saugus works as it was in the 1650s. The slag pile is visible in front of the furnace. To the right are the forge and the rolling and slitting mill. The blacksmith shop was then located in front of the mill near the wharf warehouse.* **Left:** *Iron bar that was partially run through the slitting rollers at the rolling and slitting mill.*

Right: *The Iron Works House today.* **Far right: (top)** *Iron plate and ring of this deadeye (from a ship's rigging) were found at Saugus. The ladle* **(below)** *was used to pour molten iron into casting moulds.*





The People of Hammersmith

Here was built the first successful plant for the integrated production of cast and wrought iron in the new world. When John Winthrop, Jr., a student of metallurgy, found significant ore deposits in the Boston area, he was offered incentives by the Massachusetts government to establish an iron works. He sailed to England in 1641 to form the Company of Undertakers of the Iron Works in New England. After an initial effort at Braintree failed (excepting the forge), Winthrop was replaced by Richard Leader, who chose the site on the Saugus River for its waterpower, water transport, woodlands, and raw materials. At a level of technology equaling anything in 17th-century Europe, the Saugus works was by 1646 producing iron products for Massachusetts and England. But in the early 1650s it was beset by financial problems from which it never recovered. The last recorded blast was in 1668. Despite its short life, the Saugus works introduced a complex and demanding technology into what was still a roughhewn world.

The people who worked at Saugus were not Puritan settlers, but artisans from England and Wales, brought to Massachusetts as indentured servants to staff the iron works. For the most part they were young men with families, many of whom lived in company housing. They named their community Hammersmith, after a small town near London.

When the furnace was in full blast, an ironworker's job was demanding—hot, noisy, physically hard, and dangerous. The heavy machinery threatened life and limb. Splashing molten metal caused severe burns. But moisture was his worst enemy. In the words of a 17th-century commentator: "Should the least drop of water come into the Metall, it would blow up the furnace, and the Metall would fly about the Workmens ears."

Due to the nature of the job and their specialized skills, the artisans fared well for indentured workers. The terms of their contracts depended on their bargaining power. The most highly sought were offered incentives, such as a shorter period of service than unskilled bonded servants and in some cases payment for their work. After working off their contracts, usually in seven years, they became independent workers who could negotiate their terms of employment.

Independent workers, however, should not be confused with freemen, the class of citizen with voting privileges. Becoming a freeman was a good indicator of assimilation, but apparently only a few full-time ironworkers attained such status. It required membership in the church, which required a believable declaration of conversion. The ironworkers' reasons for being here were financial, not religious. Since many of them did not share the religious enthusiasm of their Puritan neighbors, few of the first generation seem to have been truly assimilated.

The rarity of assimilation was also due to the natural tensions that arose between the Puritans and the ironworkers. The Puritan settlers lived by a strict social contract enforced by a theocratic government. The ironworkers played hard and sometimes fought hard when they were not working. They were called before the magistrates for such offenses as drunkenness, absence from church, "common swearing," domestic violence, physical assault, "verbal assault," and breaking of the sumptuary laws, whereby only the upper classes were allowed to display such finery as silver lace and high boots.

But we should avoid oversimplifying these people or their relations. The Puritans were not as strait-laced as the stereotype would have it, nor were the ironworkers all free-spirited rowdies. In time, the workers' children moved to other places, became freemen, and intermarried with the Puritans. Indeed, that eventual assimilation was an important part of the ironworkers' achievement. They took the enormous risk of going to New England and creating a place in which their children could prosper.

The Iron Works House

The Iron Works House is the sole remaining 17th-century structure at Saugus. The company agent may have lived in the house while the furnace was in operation, but we cannot be certain, as the date of its construction is unknown. The records show only that the first known occupant, Samuel Appleton, bought the Saugus works in 1676 (after it shut down) and lived in the house from 1681 to 1688.

By the early 19th century the house had been much altered from its original state and was housing mill workers. Its rescue and restoration were due to the efforts of Wallace Nutting, later known for his books on colonial houses and furniture. Nutting bought the house in 1915 and over the next year restored it to its original appearance. In 1968 the house was transferred to the National Park Service. Today several rooms with authentic and reproduction furnishings are open to the public.

Iron Works Restoration

Wallace Nutting's 1916 restoration of the Iron Works House inspired efforts to restore the iron works site three decades later. Local citizens formed the First Iron Works Association in 1943. With funds from the Iron and Steel Institute, archeologist Roland Wells Robbins began digging in 1948. Over the next few years he and his team unearthed, among other things, the remains of the blast furnace, a 500-pound hammer head, a large section of a waterwheel, and the outlines of the principal structures.

By 1951, the project known as the Saugus Iron Works Restoration was underway. It was directed by the First Iron Works Association, again with Iron and Steel Institute funding. Workers, from civil engineers to leather craftsmen, relied on Robbins' archeological finds, colonial documents, and materials describing and illustrating 17th-century iron works in England. The restoration was completed and the site open to the public in 1954. In 1968 Saugus Iron Works was transferred to the National Park Service.

About Your Visit

Saugus Iron Works National Historic Site is a unit of the National Park System, one of more than 380 parks that are important examples of our natural and cultural heritage. Visit the National Park Service website at www.nps.gov. For information write Superintendent, Saugus Iron Works NHS, 244 Central St., Saugus MA 01906; 781-233-0050; www.nps.gov/sair. From I-95/Mass. 128 north or south take the Walnut St. exit (exit 43) in Lynnfield. Follow the brown National Park Service signs for 3.5 miles to the site. Driving north on U.S. 1, take the Main St. (Saugus) exit and follow the signs through Saugus Center. Driving south on U.S. 1, take the Walnut St. exit east and follow the signs for 1.5 miles to the site.

The site is open every day except Thanksgiving, December 25, and January 1. The museum offers a film and displays hundreds of artifacts found at the iron works. A half-mile nature trail winds through woodland and tall-grass marsh. Please do not pick flowers or disturb wildlife. Picnic tables are available. Wear comfortable shoes and seasonal clothing. *To help us preserve this site, please do not remove slag, pieces of iron, or other materials.*

Saugus Iron Works is a gateway to the Essex National Heritage Area. The area encompasses historic, cultural, and natural resources related to three stories: early settlement, maritime power, and industrial development.

Accessibility The museum, the first floor of the Iron Works House, and restrooms are accessible to those in a wheelchair. Some historic areas are accessible via a special route. A golf cart and wheelchair are available.

For Your Safety Do not climb on the waterwheels or other historic machinery. The slag and iron flakes can cause severe cuts. Be careful of poison ivy and bees.

The Transformation of Iron

Raw Materials

The sequence of steps involved in making iron products with blast furnace and forge technologies was an integrated operation at the Saugus complex. Increasingly processed materials moved from furnace to finery to chafery to mill. The operation began with fillers dumping basketfuls of raw materials—iron ore, charcoal, and a "flux"—into the fiery charge hole.

Bog iron (limonite) was the iron ore available to the Saugus works. Dug up in marshy areas or pond bottoms, it ranged in consistency from rocky to earthy.

Bog Iron

For the high temperatures needed to melt iron ore, the furnace burned charcoal rather than wood. Colliers slow-burned an earth-covered mound of wood to produce the charcoal.

Charcoal

Gabbro

The impurities in iron ore were removed by a calcium-rich flux, which combined with them and separated as slag. Limestone or seashells were often used as fluxes, but gabbro rock served this function at Saugus.

Markets and Materials

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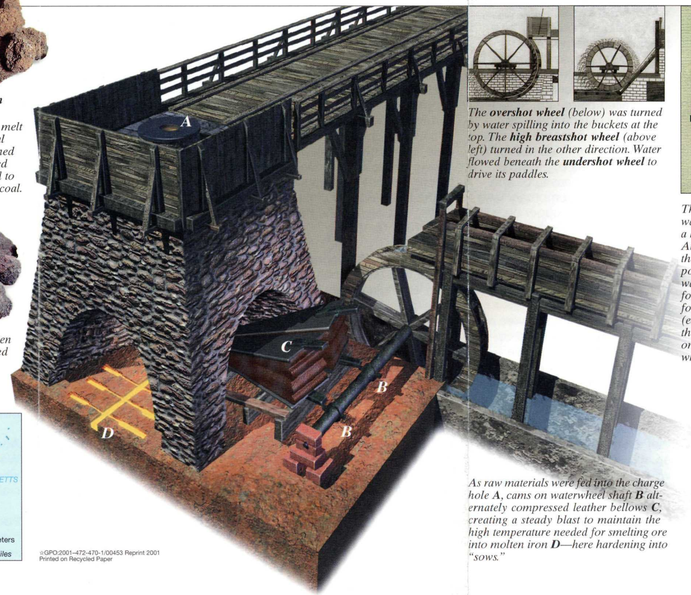
The Blast Furnace

The development of the blast furnace in the late 14th century introduced the principle behind modern ironmaking. Carbon from burning charcoal combined with oxygen in the ore to form carbon monoxide gas. With the removal of the oxygen, the ore was converted to iron. The blast furnace was tall enough that the iron had time to absorb carbon from the charcoal as it descended towards the hearth. This reduced its melting temperature, turning it to liquid by the time it reached the bottom. The molten iron could be cast directly into products or cast into sow bars, taken to a forge, and converted into wrought iron. The blast furnace, while "blowing," ran around the clock for 30 to 40 weeks until maintenance was needed.

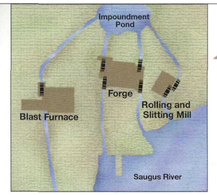


*As raw materials were fed into the charge hole **A**, cams on waterwheel shaft **B** alternately compressed leather bellows **C**, creating a steady blast to maintain the high temperature needed for smelting ore into molten iron **D**—here hardening into "sows."*

Water Power

Until the first practical steam engine was developed in the late 18th century, industry was powered by muscle—human or animal—wind, or water. Waterwheels were employed in the ancient Middle East to lift water for irrigation. The principle was applied in the following centuries to milling, weaving, and a number of other technologies—including the making of iron. A limitation of water power was that such an operation had to be near fast-running water. During a drought, as happened at Saugus in 1653, the waterwheels were still. And in places where water froze in the winter, everything was shut down until the spring thaw. Nevertheless, by the mid-17th century the waterwheel had developed into the most efficient power source and was a common feature of the industrial landscape.

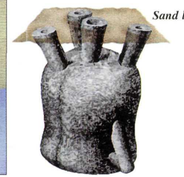
*The **overshot wheel** (below) was turned by water spilling into the buckets at the top. The **high breastshot wheel** (above left) turned in the other direction. Water flowed beneath the **undershot wheel** to drive its paddles.*



*The potential energy of slow-moving water was increased by impounding it at a higher elevation than the waterwheel. At Saugus, the river water was dammed, then released into the impoundment pond down the hill. From this pond water flowed at controlled rates down four wooden troughs called **races**: one for the blast furnace; two for the forge (each driving two wheels); and one for the rolling and slitting mill. Drop gates on each race regulated the speed of the wheels.*

Casting

When the founder determined that the furnace was ready to tap, he first raked slag off the molten iron. He then knocked out a clay plug in the dam to let the iron flow into trenches in the sand floor where it cooled and hardened into "sows." The iron could also be ladled from the furnace hearth and cast directly into products in buried moulds. The slag was carted away to the huge slag pile.



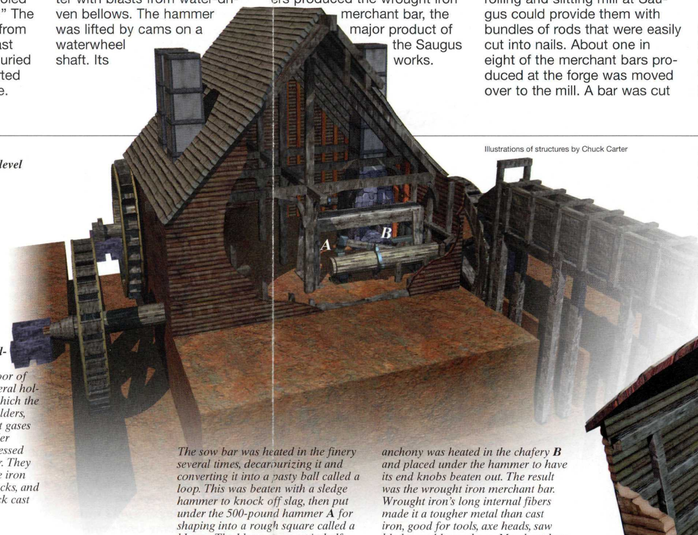
Sand level

*Potters at Saugus made the clay moulds in which some **cast products** were formed. The moulds were buried beneath the sand floor of the casting house, except for several hollow tubes—the sprue, through which the molten iron was poured by moulders, and the risers, which allowed hot gases and slag to escape. To cast simpler shapes, wooden moulds were pressed into the surface of the sand floor. They left an impression into which the iron was poured. Pots, weights, firebacks, and anvils were among Saugus's stock cast products.*

Fragments of pot cast at Saugus

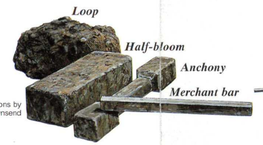
The Forge

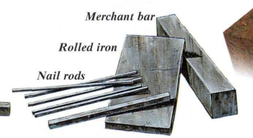
Most of the iron produced at the furnace was moved over to the forge, where sow bars were converted into wrought iron. Workers heated the iron in a finery and a chafery, made hotter with blasts from water-driven bellows. The hammer was lifted by cams on a waterwheel shaft. Its downward force came from the 500-pound weight of the iron head and the rebound from a wooden beam it depressed at its highest point. In a precise sequence of steps forge workers produced the wrought iron merchant bar, the major product of the Saugus works.



Illustrations of structures by Chuck Carter

*The sow bar was heated in the finery several times, decarburizing it and converting it into a pasty ball called a loop. This was beaten with a sledge hammer to knock off slag, then put under the 500-pound hammer **A** for shaping into a rough square called a bloom. The bloom was cut in half, and the half-bloom was again heated and beaten out into the anchony. The anchony was heated in the chafery **B** and placed under the hammer to have its end knobs beaten out. The result was the wrought iron merchant bar. Wrought iron's long internal fibers made it a tougher metal than cast iron, good for tools, axe heads, saw blades, and horseshoes. Merchant bars were also basic stock for the rolling and slitting mill.*





Illustrations by L. Kenneth Townsend

The Rolling and Slitting Mill

In 17th-century New England nails were in great demand for building. For a farmer or blacksmith, converting a merchant bar into nails was a laborious, time-consuming process. The rolling and slitting mill at Saugus could provide them with bundles of rods that were easily cut into nails. About one in eight of the merchant bars produced at the forge was moved over to the mill. A bar was cut in half by the shears and heated in the furnace, then run through the rollers—only once in some cases, many times in others—drawing it out to eight to ten feet long and to various widths and thicknesses.

Some of the rolled pieces were shipped as they were; farmers could turn them into iron tires for wagon wheels and other items. The others were passed back through the slitters, reducing them to thin rods. Most were bundled for shipment to Boston and other New England settlements, although some were cut into nails by the Saugus blacksmith for local use. The blacksmith also forged merchant bars into such commercial items as hinges, hoes, shovels, kettle hooks, andirons, latches, and tongs.

Iron nail

*At the mill, one waterwheel **A** drove a shaft containing the lower rollers and slitters **B**. The other wheel **C** drove a cog wheel **D** inside the mill. The cog wheel's teeth meshed with the rungs of a lantern wheel **E**, whose shaft turned the upper set of rollers and slitters **F** in the opposite direction from the bottom set. A cam mounted on the first shaft drove the cutting shears **G**.*