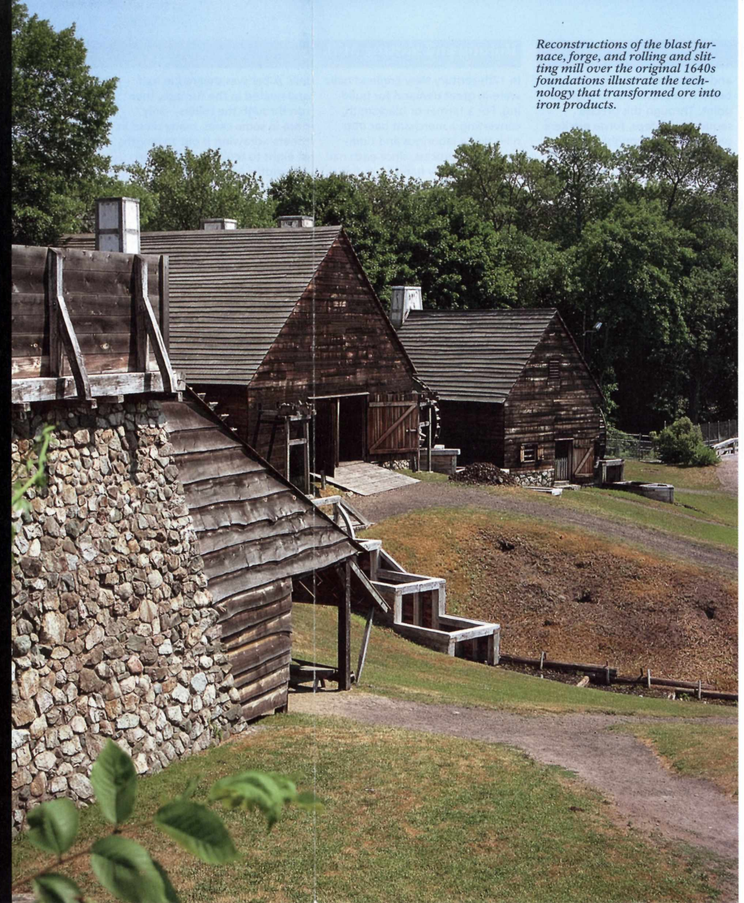
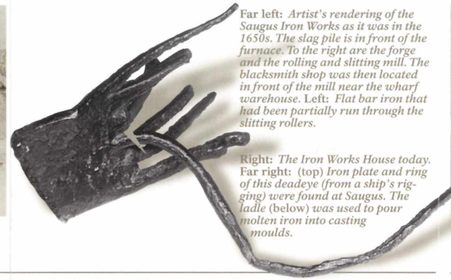
Saugus Iron Works

National Park Service
U.S. Department of the Interior

National Historic Site
Massachusetts

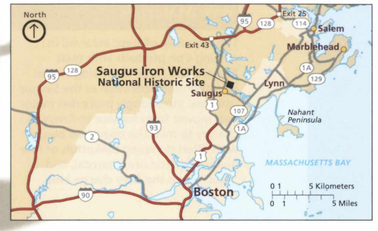


Reconstructions of the blast furnace, forge, and rolling and slitting mill over the original 1640s foundations illustrate the technology that transformed ore into iron products.



Far left: *Artist's rendering of the Saugus Iron Works as it was in the 1650s. The slag pile is 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:** *Flat bar iron that had been partially run through the slitting rollers.*

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

Saugus is the site of 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 near Boston, the Massachusetts government offered him incentives 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 a first effort at Braintree failed (excepting the forge), Richard Leader replaced John Winthrop. He chose the Saugus River site for its water power, water transport, woodlands, and raw materials. By 1646, employing technology equal to that used in Europe at the time, the Saugus works was making iron products for Massachusetts and England.

In the early 1650s financial problems beset the iron works. It never recovered. The last recorded blast was in 1668. Despite its short life, the Saugus works introduced a complex, demanding technology into a rough-hewn world.

The people who worked at Saugus were not Puritan settlers, but artisans brought from England and Wales to Massachusetts as indentured servants. Most were young men with families. Many 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—strenuous, hot, noisy, and dangerous. Heavy machinery threatened life and limb. Splashing molten metal caused severe burns. But moisture was his worst enemy. In the words of a contemporary: "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."

Owing to the job's nature and its requirement of specialized skills, indentured workers at Saugus fared well. Contracts reflected their bargaining power, offering incentives to the most highly sought workers. These included shorter periods of service than those given to unskilled bonded servants, or payment for their work. Most worked off their contracts in seven years. They then became independent workers and could negotiate their terms of employment.

Independent workers should not be confused with freemen, citizens with voting privileges. Becoming a freeman was a good indicator of assimilation, but only a few full-time ironworkers attained such status. It required membership in the church, based on a believable declaration of conversion. The ironworkers' reasons for being here were financial, not religious. Few seem to have become truly assimilated.

The rarity of assimilation was also owed to natural tensions between Puritans and 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 sumptuary laws that permitted only the upper classes to display finery such as silver lace or high boots.

But Puritans were not as strait-laced as the stereotype would have it, nor were the ironworkers all free-spirited rowdies. In time, workers' children moved elsewhere, achieved freeman status, and intermarried with Puritans. The ironworkers' eventual assimilation was an important part of their 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 only structure at the site that survives from the 1600s. The company agent may have lived in it while the iron works was in operation, but its date of construction is unknown. Its earliest recorded occupant, Samuel Appleton Jr., bought the Saugus works in 1676 (after it closed) and lived in the house from 1681 to 1688.

By the early 1800s the house had been greatly altered from its original state and was being used to house mill workers. Its rescue and restoration are owed to the efforts of Wallace Nutting, later known for his books on colonial houses and furniture. Nutting bought the house in 1915. Over the next year he restored it to what he believed was its original appearance, based on the work of architect Henry Charles Dean. Today several rooms with period and reproduction furnishings are open to the public.

Iron Works Reconstruction

Nutting's restoration of the house inspired later efforts to reconstruct the iron works. In 1943 community members formed the First Iron Works Association. With funding from the American Iron and Steel Institute, archeologist Roland Wells Robbins began digging in 1948. Over the next few years he and his team unearthed the remains of the blast furnace, a large section of a waterwheel, a 500-pound hammer head, and the principal structures' footprints.

By 1951 the Saugus Iron Works Reconstruction had begun, directed by the First Iron Works Association and funded by the American Iron and Steel Institute. Workers from civil engineers to leather artisans relied on archeological finds, documents, and materials describing and illustrating iron works in England in the 1600s. The project was completed and the site opened to the public in 1954. In 1968 Saugus Iron Works was transferred to the National Park Service and designated a National Historic Site.

About Your Visit

The park is open daily 9 am to 5 pm, spring through fall. Visit our website for the current months of operation.

Directions GPS: 244 Central St., Saugus, MA.
From I-95/MA 128 N or S take the Walnut St. exit east (no. 43); follow brown National Park Service signs for 3.5 miles. From US 1 N take the Main St. east (Saugus) exit; follow signs. From US 1 S take the Walnut St. exit east; follow signs for 1.5 miles.

Things To Do Take a free ranger-led tour, offered daily. • At the museum, view a film and many iron works artifacts. • A half-mile-long nature trail winds through woodland and tall-grass marsh overlooking the Saugus River. • Picnic tables are available. • For a self-guiding audio tour visit nps.gov/sair-audio.

Accessibility We strive to make our facilities, services, and programs accessible to all. For information go to a visitor center, ask a ranger, call, or check our website.

Regulations and Safety Do not climb on waterwheels or other machinery. • Slag and iron flakes can cause severe cuts. • Avoid poison ivy and bees. • Federal law prohibits removing natural or historic features. • For firearms regulations check the park website.

Emergencies call 911

Saugus Iron Works is one of over 400 parks in the National Park System. Learn about national parks at www.nps.gov.

More Information
Saugus Iron Works
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www.nps.gov/sair

National Park Foundation
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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 "flux"—into the fiery charge hole.

Blast Furnace

The blast furnace, developed in the late 1300s, 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 oxygen, the ore was converted to iron. The blast furnace was tall enough to allow the iron time to absorb carbon from the charcoal as it fell toward 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.

Water Power

Until the first practical steam engine was developed in the late 1700s, industry was powered by muscle (human or animal), wind, or water. In the ancient Middle East waterwheels lifted water for irrigation. The same principle was later used in milling, weaving, and many other technologies, including the making of iron. Water-powered operations required a constant source of fast-running water.

During a drought like the one that happened at Saugus in 1653, the waterwheels were still. And freezing temperatures could shut down water-powered operations until the spring thaw. Despite these limitations, by the mid-1600s the waterwheel was the most efficient power source and a common feature of the industrial landscape.

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.

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 then a chafery, made hotter with blasts from water-driven bellows. Cams on a waterwheel shaft lifted the hammer. Its downward force came from the weight of the 500-pound iron hammer head and the rebound from a wooden beam it depressed at its highest point. Through this precise sequence of steps, forge workers produced the wrought iron merchant bar, the Saugus works' major product.

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 and time-consuming process, since each nail had to be cut by hand from flat iron. 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 here was moved to the mill. A bar was sheared in half and heated in the furnace, then run through the rollers—only once in some cases, many times in others—drawing it out to lengths of eight to ten feet 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. 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 the Saugus blacksmith cut some into nails for local use. He also forged merchant bars into commercial items like hinges, hoes, shovels, kettle hooks, andirons, latches, and tongs.

Iron nail

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

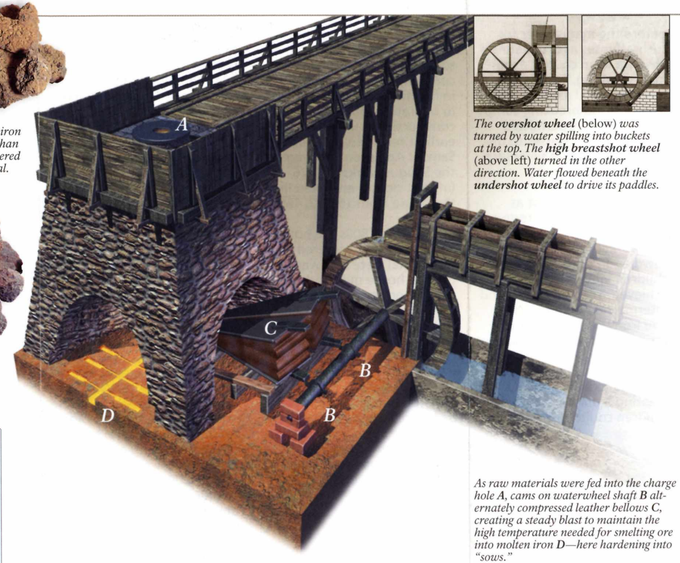
For the high temperatures needed to melt iron ore, the furnace burned charcoal rather than wood. Colliers slow-burned an earth-covered mound of wood to convert it into charcoal.

Charcoal

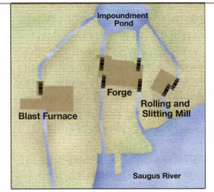
Gabbro

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

Markets and Materials



*The **overshot wheel** (below) was turned by water spilling into 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.*



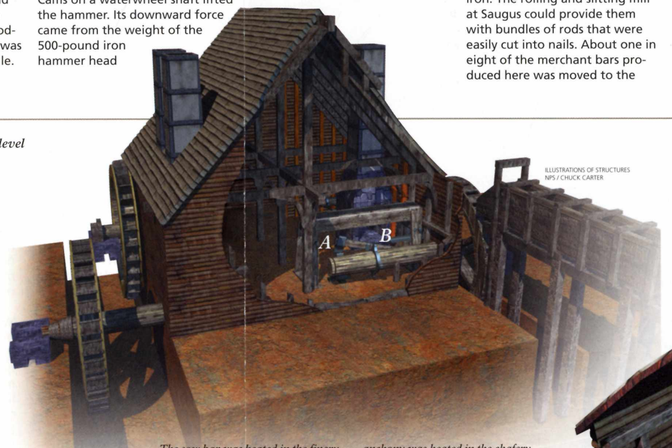
*The potential energy of slow-moving water was increased by impounding it at a higher elevation than the waterwheel. At Saugus, the river water was dammed, then released into the impoundment pond down the hill. From this pond water flowed at controlled rates down four wooden troughs called **races**: 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.*

*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."*

Sand level

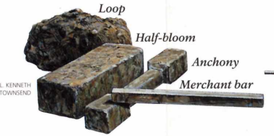
*Potters at Saugus made the clay moulds in which some **cast products** were formed. The moulds were buried beneath the sand floor of the casting house—except for several hollow tubes or sprues, through which the molten iron was poured, and the risers, which allowed hot gases and slag to escape. To cast 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' stock cast products.*

Fragments of pots cast at Saugus



ILLUSTRATIONS OF STRUCTURES NPS / 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 horseshoes, axe heads, saw blades, and other tools. Merchant bars were also basic stock for the rolling and slitting mill.*



ILLUSTRATIONS / L. KENNETH TOWNSEND

*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**.*