

2.1 Detail of Massachusetts Bay Charter, 1629. The Massachusetts Bay Colony was formed in England as a joint-stock company. (Courtesy of The Salem Athenæum)

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Hammersmith Through the Historical Texts

Janet Regan and Curtis White

Operating in what was considered the “dessart Wildernesse” of the New World, the ironworks at Saugus was a large-scale manufacturing venture using the most advanced production methods of the seventeenth century.¹ The Saugus ironworks worked in concert with an earlier but less sophisticated plant located in Braintree (now Quincy), Massachusetts, about fifteen miles south of Saugus by boat. Both plants were owned by a consortium of twenty English and four Massachusetts Bay Colony investors who called themselves *The Company of Undertakers of the Iron Works in New England*. The Company’s complex investment organization provided a glimpse of the modern corporation to come. As historian E. Neal Hartley stated, “They were big business and heavy industry. In the Bible Commonwealth they stood out as atypical, anachronistic and wonderful.”²

The heart of the Saugus ironworks contained a blast furnace, a forge, and a rolling and slitting mill, one of only a dozen such mills in the seventeenth-century world. The industrial yard also included two blacksmith shops, a coal house, a warehouse and dock, and sundry ancillary buildings. Workers built an elaborate water-power system, beginning with the construction of a great dam upstream on the Saugus River. The dam measured at least one hundred feet long by 18 feet high and 76 feet wide and was “faced with stone on the waterside from top to bottom.”³

From the dam, water was channeled through a sixteen-hundred-foot-long canal to a holding pond and on to sluiceways, which fed waterwheels that powered equipment in each of the three main iron-making buildings. Company boats carried the iron products to a Boston warehouse, where a company clerk coordinated their sale and shipment to various domestic and international ports, including London and Barbados. The cast- and wrought-iron goods produced at the ironworks were crucial commodities for the developing economy of the young Massachusetts Bay Colony. Originally called the “iron works at Linn or Hammersmith,” the Saugus facility operated from 1646 to about 1670, when mismanagement and litigation brought production to a halt. With the ironwork’s closure, skilled workers dispersed across the northeast, building new ironworks and giving rise to America’s iron and steel industry.

Because the seventeenth-century Massachusetts Bay Colony was a highly litigious place, the ironworks’ bankruptcy is well documented. Surviving court records and other source materials include depositions, correspondence, ironworks inventories, and accounting records. The most notable collection is

But these forsooke a fruitfull Land, stately Buildings, goodly Gardens, Orchards, yea, deare Friends, and neere relations, to goe to a desart Wildernesse, thousands of leagues by Sea.

Edward Johnson, *Wonder-Working Providences of Sion’s Saviour in New-England*, p. A2.

Lynn Iron Works Collection, housed at Harvard University's Baker Library.⁴ These documents provide invaluable information on early iron-making products and processes. They chronicle the activities of individual workers, agents, investors, and public officials involved in the project and offer descriptions of landscapes at the seventeenth-century ironworks. Professor E. Neal Hartley of the Massachusetts Institute of Technology published a comprehensive study of the ironworks based on documentary sources.⁵ Hartley's research, together with the archeological discoveries of Roland Robbins and consultation with world-renown specialists, informed a full-scale reconstruction of the heart of the colonial ironworks plant. The eight-acre site on the Saugus River, was opened to the public in 1954 as the "Saugus Ironworks Restoration." In 1968 the site became a unit of the National Park Service and is known today as Saugus Iron Works National Historic Site.

The ironworks' story is intimately bound to the history of the Massachusetts Bay Colony. The colony was born out of religious and political discontent in England, where dissenters sought to eradicate Catholic influences in the Anglican Church and challenged King Charles I's inflated assertion of royal authority. In 1630, nearly one thousand English Puritan dissenters departed England, and what they believed was the moral corruption of the Old World, and arrived in Massachusetts. Led by the colony's first governor, John Winthrop, the Puritans saw New England's wilderness as an opportunity to build a new society where their religious convictions and political ideals would guide a pure and righteous community. They believed that their holy commonwealth would serve as a model for the world to emulate: "for wee must Consider that wee shall be as a City upon a Hill, the eies of all people are upon us; soe that if wee shall deale falsely with our god in this worke wee have undertaken and soe cause him to withdrawe his present help from us, wee shall be made a story and a by-word through the world."⁶ Puritans interpreted the devastation of Massachusetts' native population by European contagious diseases as a sign that their mission was divinely ordained. "For the natives, they are neere all dead of the small Poxe, so as the Lord hath cleared our title to what we possess."⁷

Throughout the 1630s, ships brought English Puritans to New England's shores in seemingly endless waves. A "Great Migration" had begun and the colony's population swelled to twenty thousand in less than a dozen years. Along with passengers, these ships brought much needed supplies to the colony. New immigrants were encouraged to bring "... all manner of carpenter's tools, and a good deal of iron & steel ... and glass for windows and many other things."⁸ The colony suffered an economic crisis when civil war erupted in England and Puritans planning emigration to the colony chose to stay in England to fight against the king. The "Great Migration" dried up and ships bringing needed commodities came to port far less frequently. Iron, in particular, came to be in critically short supply, effectively halting the growth of the colony.

Our Civill Government is mixt: the freemen choose the magistrats everye year (and for the present they have chosen Tho. Dudley, esqr. Governour) and at 4 Courts in the yeare 3 out of each towne (there being 8 in all) doe assist the magistrates in making of lawes, imposing taxes, and disposing of lands: our Juries are chosen by the freemen of every towne. Our Churches are governed by Pastors, Teachers ruling Elders and Deacons, yet the power lies in the wholl Congregation and not in the Presbirrye further then for order and precedency.

John Winthrop to Sir Nathaniel Rich, *Winthrop Papers*, Vol. III, p. 167.



2.2 Portrait of John Winthrop, by an unknown English artist. John Winthrop, the first Governor of the Massachusetts Bay Colony, provided tax relief and other inducements to promote an ironworks in New England. (Courtesy of Massachusetts Archives.)

Governor Winthrop recognized that iron was essential to the continued commercial success of the colony's farming, fishing, timbering, and shipbuilding industries. For Winthrop, dependence on English iron was a barrier to his vision of religious and political self-determination. Historian Bernard Baylin writes:

A sense of destiny weighed on the Puritan leaders. They viewed their great adventure as a holy procession into the future, a deliverance from the corruption of the Old World. Trade, any sort of overseas commerce, for all its advantages, was not only replete with moral dangers but also drew the new commonwealth back into close relations with the homeland. Debts to English merchants represented to them a mortgage on their hopes for a free life in the New World. If the harsh demands of economic reality could have been silenced by decree of the Puritan magistrates, New England's economy would have been as independent as its churches and government.⁹

Winthrop resolved that the time had come to develop the colony's native resources. "We acknowledge with yow, yt such a staple comodity as iron is a great meanes to inrich ye place where it is, both by furnishing this place with yt comodity at reasonable rates, & by bringing in other necessary comodities in exchange of iron exported. . . ."¹⁰ In 1641, Winthrop issued an ordinance "for the encouragement of . . . the discovery of mines" to induce private-sector investment by offering public-sector benefits to prospective adventurers.¹¹ To begin such a difficult venture, capital investment, specialized materials, and technically skilled workers would need to come from abroad:

mynes . . . require the assistance of manie ingenious heads hands and full purces, min-
erall matters being slow in growth and heavy in managing, And all necessaries as men
skillfull in finding mynes, contriving watercources stamping mills, ingens for drawing
water, refynings, washings etc.¹²

Winthrop's son, the distinguished scientist John Winthrop, Jr., undertook the job of bringing iron-making technology from the Old World to New England. In 1643, Winthrop, Jr., recruited workers from England's woodlands, where deforestation had severely impacted the iron-smelting industry. Faced with work shortages, English ironworkers saw America as an economic opportunity for themselves and their families. Similarly, English ironmasters and merchants came to see New England's vast timber reserves as an excellent business prospect. Winthrop, Jr., brought together investors to form the Company of Undertakers of the Iron Works in New England. The venture was organized as a joint-stock company with shareholders investing varying amounts, from £50 to £2,000, in transferable shares. The largest investor was one of England's foremost iron manufacturers, John Becx, who held power of attorney for the company. The Company raised the extraordinary sum of £15,000 in capital to establish an ironworks in the Massachusetts Bay Colony. As colonial historian Edward Johnson writes: "The Land [in New England]

*[B]ut as wee use to say, if a man lives
where an oxe is worth but 12d, yet it is
neu the cheaper to him who cannot gett
12d to buy one, so if your iron may not be
had heere without ready mony, wt advan-
tage will yt be to us, if wee have no mony
to purchase it?*

Massachusetts Records, Vol. III, p. 92.



2.3 Nahant gabbro quarry. Gabbro was a key ingredient in iron production. (Photograph 698 by Richard Merrill, 1952.)

affording very good iron stone, diverse persons of good rank and quality in England were stirred up by the provident hand of the Lord to venture their estates upon an iron works.”¹³

The Company appointed John Winthrop, Jr., as the managing agent. Governor Winthrop and the Court of Assistants (up to 18 ‘godly’ men who along with the governor formed the General Court) granted the Company a 21-year monopoly on iron making and issued generous land grants and exemptions from taxes and militia duty. However, the agreement clearly stipulated that local needs were to be met before any iron could be exported and it set price limits at £20 per ton of iron. Governor Winthrop, thereby, insured that Company profits were subordinate to the well being of the commonwealth. A local ironworks was to provide Massachusetts’ major producers—shipyards, sawmills, fishing fleets, and farms—with a ready supply of iron. With the new operation, the Colony would shift from a dependent consumer to a producer of heavy industrial commodities. Moreover, Governor Winthrop’s ironworks monopoly agreement dictated the building of an integrated ironworks, containing both furnaces and forges rather than “bloomaryes only,” which transformed ore into wrought iron in one step.¹⁴ Bloomery operations produce no cast goods and Governor Winthrop intended that the ironworks should provide a full range of iron products for the young colony. The ability to make furnace-cast wares, like pots and kettles, would help to maintain the standard of living to which English immigrants were accustomed. Additionally, it would allow for the production of salt pans; salt was critical for preserving fish for the fishing industry and an essential commodity for the physical health of the Colony.

The ironworks agreement actually permitted the establishment of multiple ironworks in the Colony. John Winthrop, Jr., built a plant in Braintree in 1644, but the site lacked sufficient ore and waterpower and was a disappointment to the investors. In the summer of 1645, Winthrop, Jr., resigned his position as ironworks’ agent to pursue other ventures. The Braintree forge became a secondary operation after the large-scale ironworks at Saugus was built in 1646.

Winthrop Jr.’s, successor, Richard Leader, designed the Saugus plant. Leader had been “formerly employed in Ireland about mynes [and] . . . hath skill in mynes, and tryall of mettalls.”¹⁵ His contract with the company was described in a letter to John Winthrop, Jr.: “he hath covenanted to serve them 7 years, his wages is 100 li per annum he is to have passage for himselfe, his wife, 2 Children, 3 servants, an howse to be built for him, and ground to be allowed him for his horses and a few Cowes.”¹⁶

Leader’s 600-acre Saugus site contained ideal topographic features and plentiful natural resources to supply the era’s most ambitious manufacturing venture. The setting provided a navigable river and a natural terrace that dropped precipitously to a flood plain below. The steep escarpment gave sufficient elevation to power waterwheels and to provide access to the tall stack of the blast furnace from above. Raw materials were shipped in and finished iron was shipped out with the high tides, while the river’s

. . . that the undertakers, their agents and assigns, are hereby granted the sole priviledge and benefit of making Iron and managing of all iron mines and work . . . for the term of twenty-one years . . . that the inhabitants of this jurisdiction be furnished with bar iron of all sorts for their use for . . . setting up . . . of forges or furnaces and not bloomaryes only; that what iron is made more than the inhabitants need, they should have liberty to ship to other parts of the world for sale, provided they sell it not to any person or state in actual hostility with us.

“Iron Works Monopoly Agreement,”
Massachusetts Records, Vol. III, p. 60.

The 4th of June 1645.

At a Generall Court att
 beinge holden, and hie in the name of the said Court
 in New England

Supimus That the undertaker, their Agents
 from mines, and works y^e now are or shall bee, discovered and found
 herof. Provided that the said Undertaker, their Agents or a
 for many of the said works that the Inhabitants of this Juris-
 of Court to bee paid to the said Undertaker, in ready money
 Adventure with the Undertaker, if by the first day of
 Pounds wth allowance to the Adventure, for the Stock of C

2 Item The Court doth hereby grant to the said
 Court or person, of the said Undertaker their Agents or also
 own^e discretions have and take all manner of Wood, and
 to offer all manner of earth, stones, turf, Clay and other
 to bee built or for making or mending of all manner of Gun
 digg and carry away of all manner of stone from Ore and
 granted to the said Undertaker their Agents or a signe
 of Pools, dams, water courses, sluices, ponds for water in all way
 built not appropriated to any Court or person, during just

3 Item The Court doth hereby further grant to
 that the said Undertaker their Agents or a signe shall have fr
 or from Ore and to make and by all convenient wayes and m
 service of the said works through all the said grounds that are or
 of for the time being as three indifferent men shall adudge n
 Undertaker their Agents or a signe shall make or by any of t

2.4 Agreement between the General Court and the agent for the ironworks, 1645. (Massachusetts Archives, microfilm, manuscript, vol. 59, Manufactures 1639-1773, 14. Courtesy of Massachusetts Archives).

freshwater flow was dammed and channeled through a sophisticated system of canals and watercourses. Rich deposits of bog ore were easily accessible. Additionally, Lynn township was able to provide a non-skilled workforce to help meet the labor demands of the ironworks.

Located on land east of the Saugus River, Hammersmith village housed a community of skilled ironworkers and their families. The village contained “workmen’s houses and gardens, orchard and field of English grass adjoining the orchard.”¹⁷ Hammersmith was a forerunner of America’s mill towns built exclusively for the families of an industrial working class. Theirs were modest dwellings valued at between two and twelve pounds, except for a long house with four tenements that was valued at £20. The company paid for maintenance on and improvements to the workers’ homes, which sheltered single families and extended families with married adult children. Families often boarded bachelor workers and were reimbursed by the company for providing meals. References to fourteen houses indicate that they were generally clapboarded, probably with thatched or shingled roofs, and that some had cellars and some lean-tos. Many workers raised vegetable gardens, as well as sheep or goats. Four workers, John Vinton, John Francis, John Hardman, and Ralph Russell, were each granted their own two-acre plots of land. Since several workmen were in debt to the company in 1653, it is very possible that workers’ families bought goods from the company’s storehouse, as did workers of many nineteenth- and twentieth-century factory towns.

The company agent’s house, valued at eighty pounds on a 1653 inventory, was situated on a bluff to the west of the river, probably overlooking the plant. Also on the west bank was Dexter’s farm, containing the farmhouse, stable, fences, and barns of the land’s previous owner. The farm held “28 acres of plow land and marsh” where workers cultivated corn and hay and grazed “fifty or sixty head” of cows.¹⁸ In 1653, “a new ox howse” and a “new Chamber to lodge Corne in ye great barne” were added to the farm.¹⁹ Livestock included horses, oxen, cows, goats, and sheep. The marsh lining both sides of the river was regularly mowed to feed livestock. A vast forest of massive trees stretched to the west of the plant.

The ironworks employed about 35 skilled workers, while as many as 185 individuals were paid for part-time or occasional work at both plants throughout the ironworks’ operation.²⁰ Local farmers, tradesmen, and boatmen provided the bulk of part-time help. Accounting records also include payments to women for washing, mending, and providing medical attention for workers and to two Native Americans for cutting wood. The ironworks may have manufactured iron goods for trade with Native Americans; objects that closely resemble items made at the ironworks, such as pots and kettles, forged iron axes, and a brass ornament, are among trade items found at Native American contact sites.²¹

Iron making was hard, dirty, and dangerous labor and many of the English ironworkers were coarse and unruly. Their inclinations and rough behavior made them outsiders in the staunchly Puritan colony.

The farm work was done by the Scotchmen and Daniel Salmon, and deponent saw two men hilling Indian corn in the orchard that year; the Scotchmen kept Gifford’s and the people’s cattle, fifty or sixty head, two summers, for which they were to pay 5s. p. cow to the keeper.

“Deposition of William Emery Sworn,”
Records of Essex Courts, Vol. II, p. 96.

2.5 A spade (SAIR 2912) found during excavation. (Photograph by William Griswold.)



While many ironworkers were regularly brought before the court for profanity, Sabbath-breaking, drunkenness, and brawling, others kept the courts busy with far more serious infractions: “John Turner, living at the iron works in Lin, [is] presented [to the court] for stabbing Sara Turner”; “Quentin Pray for striking Nicholas Penion with a staff, having an iron two feet long on the end of it and breaking his head”; “Nicholas Pinnion . . . [for] beat[ing] [his wife] . . . and caus[ing] a miscarriage”; and “Richard Prey for beating his wife. . .” [and saying] “if he had trouble [with the courts] about abusing his wife, he would cripple her . . .”²² English investors wrote with regret that “we have bin necessitated to send some for whose civilitie we cannot under take [to guarantee,] who yet we hope by the good example, and discipline of your Country, with your good assistance may in time be cured of their distempers.”²³ Governor Winthrop anticipated the difficulty of introducing these unruly workers into his sainted community and lobbied for the Company to provide the workers with religious instruction. The Company, however, refused his request and Winthrop eventually withdrew this demand from the monopoly agreement. For Puritan leaders who conceived of the ironworks as a deliberate and indispensable step toward establishing a permanent and self-sufficient economy, tolerating unruly ironworkers was a necessary evil.

Many ironworkers were indentured servants who agreed to work without wages for a period of years to pay off the cost of their transport to Saugus. Because skilled workers were in demand, however, several of the most proficient ironworkers bargained for and received high wages. Tensions grew in the Colony as ironworkers and other laborers began to display a degree of their newfound wealth. Puritan authorities reacted with restrictions such as the 1651 Sumptuary Law, which prohibited the wearing of costly clothing and fined violators ten shillings.²⁴ For example, an ironworker was charged as an early violator of the Sumptuary Law for wearing great boots. The upward mobility of the laboring class was not part of Puritan authorities’ plan for their holy commonwealth.

Ironmaster Richard Leader also got into trouble with the Massachusetts Bay Colony courts. Unhappy with his relationship with the investors, Leader resigned his position in 1650. “The Company,” he wrote, “are much discontented; and use me not as I have deserved.”²⁵ On a subsequent voyage to England, Leader gave vent to his bitterness: “. . . [he] threatened & in high degree reproached & slandrd, the Courts, magistrates, & government of the common weal & defamed the towne & church of Lin.”²⁶ The court fined Leader £250, a huge sum, but reversed his sentence when the legislature determined that it had no jurisdiction over remarks spoken while at sea.

In 1650, Leader was replaced by John Gifford, a clerk from a large English ironworks in the Forest of Dean that contained three furnaces and three forges. He was from a family of ironworks managers and was well acquainted with the business. Although he was paid less than Leader, he was charged with “the faithful care of the ironworks and their land and timber holdings and for seeking out new mines of iron, lead, tin, silver, and other minerals.”²⁷

[W]e canot but accoumpt it our duty to comend unto all sorts of persons a sober & moderate use of those blessings which, beyond our expectation, the Lord hath been pleased to afford unto us in this wildernes, & also to declare our utter detestation & dislike that men or women of meane condition, educations, & call-inges should take uppou them the barbe of gentlemen, by the wearing of gold or silver lace, or buttons, or poynts at their knees, to walke in great bootes; or women of the same ranke to weare silke or tiffany hoodes or scarfes, which though allowable to persons of greater estates, or more liberall education, yet we cannot but judge it intollerable in persons of such like conditions; its therefore ordered by this Court & the authoritie thereof, that no person within this jurisdiction, or any of their relations depending uppou them, whose visible estates, reall & personall, shall not excede the true & indeferent value of two hundred pounds, shall weare any gold or silver lace, or gold or silver buttons, or any bone lace above two shillings per yard, or silke hoodes or scarfes, uppou penalty of ten shillings for every such offence & every such delinquent to be presented by the graund jury.

Massachusetts Records, Vol. III, p. 243.



2.6 Replica pattern of the 1636 Leonard fireback. Richard Leonard, an English founder, is pictured at center surrounded by the tools of his trade. (Photograph by Dan Boivin.)

Gifford was to oversee the inclusion of another group of cultural outsiders in the Puritan colony, Scottish prisoners-of-war. These were Scottish soldiers who had been captured by Cromwell's forces at the battle of Dunbar in September 1650. Forced to march 118 miles out of Scotland with little food or water, about sixteen hundred of the Dunbar captives perished of starvation or dysentery on the journey. In England, the survivors were bound into indentured servitude to various enterprises, including the Company of the Undertakers of the Iron Works in New England. The Scots destined for the ironworks arrived in the New World in deplorable physical condition. One man named Davison apparently died en route along the Saugus River before reaching the works. Some of the Scots' indentures were sold to local settlers and by 1653 only 37 Scots were listed as company property on an ironworks inventory. Laboring for the most part at non-skilled jobs, such as woodcutting or farming, they received only food, clothing, and shelter for their efforts. It seems that even these were impinged upon.²⁸ In court testimony, William Emory testified that in addition to the 13 or more Scots lodged in a house built specifically for them, many other workers were crowded into the space and that their food and soap provisions were often skimmed by Gifford and others before reaching the Scots.²⁹

About 17 Scots were subcontracted to the colliers (charcoal makers) and other plant workers. Accounting records show that a few of the Scots received wages from the Company for skilled work. For example, James Adams was paid for managing ox teams, James Gourdan for mining, Thomas Kelton for mining and coaling, and Robert Meany for carpentry work. John Steward was paid as Gifford's house servant, until the investors learned of the arrangement, at which time Steward was "put forth as a smith."³⁰

The Iron Works Operation

Iron making was a multifaceted process requiring a complex set of specialized skilled employees and a myriad of support workers. Like other furnace operations, the Saugus plant smelted bog ore charged with charcoal fuel. Unique to the Company was the use of gabbro, an igneous rock, as a flux. Harvesting and processing each of these resources required a different set of skills.

Colliers were critical to the iron-making operation and at least nine men and their Scottish woodcutters worked regularly in this capacity. William Tingle, Henry Tucker, John Francis, Henry Stiche, Richard Green, John Hardman, Thomas Look, Richard Smith, and Richard Prey made charcoal in the nearby forests by burning cords of wood that had been carefully piled into rounded mounds and topped with earth, leaves, and dust. They erected hurdles (woven twig screens) around the mounds as a wind break. The collier lit a fire in the mound's center and thereafter worked to maintain a slow smoldering fire that would char the wood evenly. Danger from fire made this a very hazardous but well-paid job. Such hazard seemed to have little effect on the longevity or energy of Henry Stiche, whose court testimony reads:

Regular ironworkers, neighboring farmers and tradesmen, English and Scots indentured servants—these were the men who staffed America's first successful ironworks. Their jobs, wages, and living conditions outlined, we may turn to consider them as people. We have already mentioned their deviations from the prevailing Puritan standards, which posed problems for managers and magistrates. To the workers themselves such brushes with the law probably were counted as some of the costs of living with the all too godly Puritans, whose religious convictions they did not share.

E. Neal Hartley, *Ironworks on the Saugus*, p. 202.

George Thompson & Andrew Thompson
 James Smith & John Graham
 John Major & John Burges
 James Daniels & John Smith
 John Mackenzie & John Dugle
 James Marshall & John Smith
 John Clark & John Wright
 John Jordan & James Taylor
 James Thompson John Banks & John Pardo
 John Mackenzie & John Grant
 George Darling & James Liddle
 James Adams & William Macrae
 John Coish & William Downy
 John Mory & John Duxton
 John Tolson & Ingram Moody
 John Cowie & James Curdson
 John Stewart
 14 Bastard muskets wth 11
 of Bandoliers & 9 Swords
 one Haulband
 4 lb of powder & 1 lb of Maton
 1 lb of Bolles nashoe

2.7 The names of thirty-seven
 Scottish prisoners of war listed
 as company property on a 1653
 ironworks inventory. (Courtesy
 of the Baker Library, Historical
 Collections, Bloomberg Center,
 Harvard University Business
 School.)

“Henry Stiche, aged about one hundred and two years . . . testified that he was employed by Mr. John Gifford agent, in the mystery of coaling.”³¹ Six years prior to this deposition, Stiche had been charged with “. . . breaking the head of Rich. Bayly.”³²

Miners Charles Hook, John Gorham, and Richard Post and their Scottish assistants Thomas Kelton and James Gourdan used picks and shovels to extract bog ore from dry bogs and low-lying areas. Working from boats, they used floating shovels to harvest ore from lake and pond bottoms. Bog ore was mined throughout the Saugus area, as far north as Reading and as far south as Hingham and Weymouth. On the nearby Nahant peninsula, Robert Cootes, Hugh Alleye, and sometimes Charles Phillips mined gabbro by heating rock ledges, then dousing the rock with cold water to help split it into manageable sizes.

The Blast Furnace Operation

The area around the blast furnace was a hive of activity as ox-drawn carts, tip carts (called tumbrels) and coal carts (or wains) continually streamed into the plant, bringing charcoal, gabbro, and ore from the hinterlands. Tons of raw materials were heaped about the area or stored in nearby outbuildings. After an incident when the “Works [were] exposed to the Utmost danger of being all Burnt in one night When the coaleheape did fall on fier,” a stone house was built a few hundred feet from the furnace to safely store charcoal.³³ Iron ore was roasted, broken into small chunks, and sieved. The raw materials were then measured, carried across the furnace bridge, and dumped by the basketful into the furnace charging hole. To produce one ton of pig iron, or cast iron bars, the blast furnace consumed about three tons of bog ore, two tons of gabbro, and about 265 bushels of charcoal, roughly 36 cords of wood.³⁴

The blast furnace foreman, or founder, Roger Tyler, shouted orders to the furnace fillers Thomas Wiggins and Thomas Beale, who fed the charging hole at the top of the furnace stack. Most seventeenth-century illustrations of blast furnaces depict several feet of flame shooting up from the charging hole, which would have made the furnace filler’s task a dangerous and daunting one. The fillers used a gage, or rod, which was inserted into the charging hole as a kind of probe, to determine when more materials were needed. Beneath the charging bridge, Roger Tyler opened the sluice gate on the 16-foot waterwheel that drove a shaft to power the giant bellows. The furnace roared as the bellows’ blasts of air fanned the flame. The furnace became an awe-inspiring inferno, conjuring images of hell that would rouse any Puritan minister, “[God’s] breath is the bellows, which blows up the flame of hell forever.”³⁵ The giant bellows could produce three hundred cubic feet of air flow per minute, concentrated through a cone-shaped pipe called a tuyere.³⁶ As the air blasts raised the furnace temperatures to over twenty-five hundred degrees, a gaseous reaction with the carbon in the charcoal converted the bog ore to iron. As the ore and gabbro melted, impurities were drawn out of the ore in the form of slag. Both slag and liquid iron trickled down the stack into the crucible. Because the slag was lighter, it floated on the surface of

[T]he Works [were] exposed to the Utmost danger of being all Burnt in one night When the coaleheape did fall on fier but that it was by the spetial providence of God who kept them and little of yor care you being then at Boston with yor wife

Lynn Iron Works Collection. Baker Library Historical Collections, Harvard Business School, p. 34.



2.8 Detail of etching showing charcoal baskets and wheelbarrows. (Georgius Agricola's 1550 treatise on metallurgy, *De Re Metallica*, p. 389. Courtesy of Dover Publications, Inc. New York, [1950])

the iron. Workmen used iron rods called ringers to clear slag waste from the furnace fore-hearth. Cooled slag was carted in wheelbarrows to the river's edge and dumped onto the slag pile. Each ton of pig iron produced in the blast furnace created about four tons of slag.

Ore, charcoal, and air were managed by the founder to produce the particular grade of cast iron needed for a casting. Grey iron was used for pots and a mottled iron was preferred for bar iron.³⁷ Roger Tyler tapped the furnace once or twice a day. Using a great ringer, he broke the clay plug of the crucible's tap-hole and a stream of molten metal gushed into a channel that had been formed in the sand floor. The great ringer was about fifteen feet long, giving the founder enough reach to keep him away from the searing heat of the molten iron. The iron cooled and hardened in the channel, producing a sow bar. Cast-iron bars called pigs or sows were then weighed at the steelyard, a large scale or balance. The bars often ranged between two-hundred-fifty to three-hundred-pounds, with the occasional five-hundred-pound sow produced.³⁸

A furnace could be in blast for between thirty and forty weeks. In New England, it is likely that the furnace was blown out during the winter months, when freezing water would naturally halt operations. After each campaign, the furnace would be overhauled. Roger Tyler was paid "for breaking upp ye furnace hearth" and for "making ye furnace hearth of newe . . . and making cleane ye ffurnace."³⁹ Tyler would clear slag from the interior walls and chisel out and replace the heat-resistant sandstone lining; it is likely that this sandstone was imported from England and carried as ballast in ships.

At the blast furnace's casting shed, potters made molds into which the molten iron was ladled to make hollowware. A worker named John Divan probably served as the company's potter.⁴⁰ Period documents list pots, kettles, skillets, boxes, marmeleths (large kettles), mortars, stoves, and weights as some of the cast products; it is also possible that cannons were cast at Braintree. To cast firebacks, workers poured molten iron into molds made by pressing wooden patterns into the sand. To make thirteen-hundred-pound salt pans, molds were made from a mixture of clay and sand, and then buried in the sand floor of the casting shed to await the molten metal. Workers also cast iron replacement fittings for the iron-works plant, which were in constant demand. These important parts included large pieces such as five-hundred-pound hammerheads, gudgeons (large iron pins inserted into the end of shafts), anvils, cams, boytes (pillow blocks), and plates.⁴¹

The Forge Process

In the forge, cast-iron sow bars were reduced into more malleable wrought-iron bars in a demanding, dangerous, and deafening series of steps. The Saugus forge likely contained two finery hearths, a chafery hearth, and a five-hundred-pound trip-hammer mechanism.⁴²

Careful observation of the various signs enabled the founder to exert some influence in producing the kind of iron de-sired In the first of the above mentioned cases the iron produced would be white cast iron, so called since the fracture of it is white. The carbon contained in this type of iron . . . is intensely hard . . . but brittle. In the second case the iron produced would be grey cast iron, the fracture of which is grey. . . . It is softer and less brittle than white cast iron. At an intermediate state in which the grey and white kinds are visible in the fracture of the same iron, the cast iron was called mottled iron.

H. R. Schubert, *History of the British Iron and Steel Industry from c. 450 B.C. to A.D. 1775*, p. 238.

2.9 Saugus crucible used to collect the molten iron from the furnace, which was then ladled out into various molds. (Photograph 1030a by Richard Merrill, 1953.)



Three waterwheels likely powered the three hearths' bellows, while another wheel worked the trip hammer. To improve production efficiency, an additional hammer may have been installed after 1652, although this conclusion is somewhat controversial. About ten men ran this complex operation. Among the most highly paid were finers John Turner and John Vinton. Other forge workers included John Francis, Nicholas Pinnion, Henry Leonard, James Leonard, Ralph Russell, Thomas Billington, Jonas Fairbanks, and Robert Crossman. Quentin Prey ran the forge at Braintree.⁴³

To begin the forging process, workers moved a sow bar into the finery hearth through a hole in the building. Here it melted slowly, trickling drops of molten iron through a layer of slag into the bottom of the hearth. The hearth was lined with cast-iron plates that could be positioned by the finer to control temperature. A 1653 inventory lists "27 plates at ye two finneries & at ye Chaffery."⁴⁴ Workers used a ringer to stir the iron and work it into a semi solid mass. After an alternating series of three heating sessions under the bellows and three cooking sessions at the cooler base of the hearth, workers kneaded the now pasty iron to form a ball called a "loop." Workers removed the loop from the hearth and placed it on a cast-iron plate on the forge floor, where they beat it with a sledge hammer to knock off charcoal and slag particles. Using heavy iron tongs, workers dragged the loop over a route of "9 [cast-iron] plates about ye forge fflower" to the five-hundred-pound trip hammer.⁴⁵ Here they beat the loop into a consolidated square shape and then cut it in half to form a half bloom. The half bloom traveled back to the finery to sweat out impurities then back to the trip hammer to be hammered into a dumbbell-shaped bar called an anchony. From this point the bar would be heated at the hotter chafer hearth and subject to repeated power-driven hammerings. Sparks cascaded from the iron with each blow of the hammer as workers arduously turned the bloom from one side to another. The blazing heat, the ear-splitting bang of the hammer, and the imminent danger of crushed limbs made this a very hazardous and demanding job. A mocket head bar was eventually formed as the hammer pounded out one side of the dumbbell-like end. Finally, an elongated merchant bar was produced as the other squared end was hammered out. The merchant bar was the primary product of the ironworks and sold to merchants or to local blacksmiths who would use it to fashion all manner of wrought-iron tools and implements.

The Slitting Mill Process

The operation of a slitting mill in the wilds of the Massachusetts Bay Colony at a time when so few operated in the Old World is testimony to the vision and ambition of The Company of Undertakers of the Iron Works in New England. About twelve percent of the wrought-iron stock produced at the forge traveled to the slitting mill where it would be heated for several hours.⁴⁶ Once pliable, a bar was drawn through a set of rollers to make flats, which were sold as stock for wheel rims, axes, saws, or scythes. Some flats were slit by large shears into nail rod, which was then bundled for sale to local blacksmiths and other settlers. The demand for nails in the young colony was enormous. Several forge workers were

The incorporation of the slitting mill in the plans for Hammersmith made perfect sense. The demand for nails in the building of the wooden houses and barns that became and remained standard in New England was enormous. The manufacture of nailer's rod by a drawing out of bar iron under the hammer was most expensive of time and labor. Product demand and industrial efficiency drove the men of Hammersmith to a machine which, while expensive, complicated, and difficult to keep in adjustment, might go a long way toward turning out the "raw material" from which farmers, working in off season by their firesides, and others, might make by hand the nails and spikes basic to frame building.

E. Neal Hartley, *Ironworks on the Saugus*, p. 180.

2.10 Costumed interpreters at forge hearth. (Photograph 1220 taken by Richard Merrill, 1954.)



paid for jobs in the slitting mill, including Joseph Jenks, John Vinton, Ralph Russell, and Nicholas Pinnion.

It appears that equipment replacement occurred regularly at the slitting mill. Accounting records show that in 1651 John Vinton was paid for “making 2 roullrs” and that cash was paid “for Steeleing ye Sheares” and for “mendeing the great Sheares”; in 1653, “a new Cogg wheele [was installed] for ye Slittin mill.”⁴⁷ It is likely that the cog wheel was paired with a lanternwheel to set the mill’s upper and lower rollers and slitters turning in opposite directions. The slitting mill was probably an ingenious bit of engineering.

Supporting Jobs

The great dam at Saugus impounded about 230 acres of water. Charles Phillips, one of the water drawers managing water levels at the dam testified that he “kept the water at the Iron works . . . low in order that it might not damage Mr. Haukes’ [a neighbor’s land]. This the deponent did, and gained the ill-will of the workmen, therby.”⁴⁸ Other workmen complained that the water was “so low that it caused a great deal of difference between the workmen and the water drawer.”⁴⁹

The ironworks operated its own blacksmith shop, located near the warehouse, to manufacture tools and repair iron mechanisms. Blacksmith Samuel Hart and his Scottish assistant John Clark likely produced tongs, ringers, smith’s shears, nails, hammers, coal rakes, shovels, cinder hooks, “ships” for making furrows in casting sand, agricultural tools for the farm, and hinges and other hardware for company houses and buildings.

A saw pit or mill produced boards for the construction and repair of buildings, sluiceways, tailraces, and carts. The location of the saw pit or mill is unknown. Sawyers Richard Hood and John Parker produced over 22,800 feet of oak and pine boards from 1651–1653. Several workers were paid for building carts and for weaving baskets and hurdles. The company’s carpenter Francis Perry, with help from Nicholas Pinnion and Charles Hook, maintained and replaced waterwheels, shafts, bellows, anvil bases, and other specialized wood structures. Harvesting and transporting large trees was an arduous task; it took “5 days fetching home ye furnace beame [shaft] with 12 oxen & 2 men.”⁵⁰ Preparing and installing large architectural members was also time consuming; Francis Perry and Roger Tyler were paid for “mackinge and fitteinge ye furnace beame [shaft] & placeing it being 4 Weeckes Worcke.”⁵¹

On the tailrace of the Saugus blast furnace, cutler Joseph Jenks established “a mill for the making of Sithes,” saw blades, and other edge tools for which he was granted a Massachusetts patent in 1646.⁵² Before emigrating to New England, Jenks had acquired skills at Hounslow, a town in Middlesex County, from exiled German swordsmiths in the mid-1630s, in an effort to develop a domestic sword-making

Counting employees at both plants, and including a few doubtful cases and clerks and managers who are not known to have had a financial stake in the ironworks, we find no more than thirty-five men who seem to qualify as full-time employees handling jobs directly related to the making of iron.

E. Neal Hartley, *Ironworks on the Saugus*, p. 187.



2.11 Detail of water powered hammer similar to the Jenks blacksmith hammer. (Georgius Agricola's 1550 treatise on metallurgy, *De Re Metallica*, p. 422. Courtesy of Dover Publications, Inc. New York, [1950])

industry in England.⁵³ In 1639, Jenks petitioned for a plot of ground in Isleworth to construct a “new invented engine or blade mill.”⁵⁴ After the death of his wife and daughter, Jenks brought his millwright and smithing skills to the banks of the Saugus River. There he forged, hardened, and tempered iron and steel into saw blades and axes for the ironworks.⁵⁵ Jenks also manufactured sawmill blades to support a developing timber industry, drew wire for the making of wool cards and fishhooks, and was called in to assess the value of a grist mill after the death of local miller Edmund Farrington in 1677.⁵⁶ After the bankruptcy of the Company of Undertakers in the mid-1650s, Jenks mortgaged his shop (for which he previously paid rent), the rolling and slitting mill, and a grist mill.⁵⁷ He imparted his blacksmithing skills to his son, Joseph Jenks, Jr., and apprentice William Curtis. Jenks, Jr., established a forge shop and sawmill in Pawtucket, Rhode Island. Iron tool manufacturing continued within this branch of the Jenks family well into the nineteenth century in Rhode Island. William Curtis brought his blacksmithing skills to John Winthrop, Jr.’s., new ironworks at New Haven, Connecticut.⁵⁸

Daniel Salmon and Scots James Adams, George Darling, Malcolm Maccallum, John Mackshane, and John Pardee ran the ironworks’ farming operation. “Daniell Salmon did plow & sow the ground with ye Scotts, & ye Scotts men did make hay & Labor about planting & getting in the Corne.”⁵⁹ The Scottish workers lived with the Salmon family in Dexter’s farmhouse. Providing food for the animals and the people employed by the ironworks was a critical part of the operation.

A warehouse (or iron house) located by the site’s dock stored finished iron products for shipment down the Saugus River. The Company owned several boats, including a “great boat.”⁶⁰ Six boatmen regularly sailed the Saugus River, typically with two men to a boat, carrying products to Boston and beyond. In 1653, Theophellos Bayly and John Lambarte were paid for “thare Severrall voyages with ye Companies boate to Boston, Brantrey, Waymouth and Hinghamm.”⁶¹ Although a massive wooden bulkhead held back soil at the dock and warehouse area, the boat basin was probably hand dug periodically to keep the water deep enough for boats to dock. In Boston, William Awbery and his staff of seventeen Scots managed a warehouse and pier to handle the sale and shipment of the iron products to local and overseas markets. Records indicate that Hammersmith iron went to Kittery and Portsmouth, Maine, Connecticut, Barbados, and England.

Several neighbors were paid for “findeinge . . . Bogg myne,” wood cutting, hauling timber and charcoal, building roads and bridges, and digging and carting ores, sand, and clay.⁶² Surprisingly, the top paid worker was a neighbor, Samuel Bennett. From 1651 to 1653, Bennett was paid £471 for a variety of services to the ironworks but mostly for the carting of charcoal and bog ore. Why Bennett was paid such large amounts for unskilled work is not clear. It is clear that Bennett was a close friend of John Gifford and sometimes received goods skimmed from the Scots’ account.

One ironmaking operation with indirect ties to Hammersmith appears to have left but few traces in published records. This was the forge at Pawtucket, Rhode Island, erected by Joseph Jenks, Jr., about 1672. His efforts with a sawmill and slitting mill at Concord clearly unsuccessful, this son of an able father removed to the younger colony in the latter part of 1668.

E. Neal Hartley, *Ironworks on the Saugus*, p. 303.



2.12 The bulkhead for the turning basin under excavation. (Photograph 745 by Richard Merrill, 1952.)

The Decline of Hammersmith

According to E. Neal Hartley, annual production at the ironworks during Gifford's management was 144 tons of pig iron, 20–25 tons of cast and hollow ware, 96 tons of bar iron, and 12 tons of rod iron.⁶³ Products were sold to at least 85 customers, including merchants, mariners, tradesmen, farmers, and blacksmiths.⁶⁴ Although production reached its peak under Gifford's management, debts mounted as he expended considerable amounts refurbishing structures and equipment to bring the works up to optimum condition. He built the coal house, replaced several waterwheels and bellows, “[built] up the End of the forge new,” added outbuildings for the farm operation, rehabilitated chimneys and hearths, made improvements to workers' houses, repaired the dam, raised the flume, made new sluiceways, constructed new rollers, shears, and wheels for the slitting mill, and purchased several parcels of land.⁶⁵

Concerns about Gifford's business practices prompted the Company's investors to elect four local commissioners, Robert Bridges, Joshua Foote, Henry Webb, and William Tyng, to supervise the operation. The latter three were given absolute power of attorney to act as “de facto owner-managers” of the ironworks and Gifford resented their oversight.⁶⁶ When asked to give a weekly or monthly accounting of his transactions, Gifford refused, saying: “he would not be ther Jack Boye.”⁶⁷ When he finally agreed to submit an account, there were differences between what Gifford reported and what was actually found in stock. “Ther was mor in bar Iron neer abut five or six ton more then the sayd mr Gefard had giun a Countt of to the Commisoners.”⁶⁸ It was also apparent that Gifford had no compunction about using Company servants, stock, and materials for his personal benefit.

In 1653, the investors removed Gifford from his post. In his defense, Gifford wrote that his removal was coming at a critical juncture, when the ironworks was poised to generate much revenue.

The produse of such Stock at present is proper for my credit, the time when I was taken off from the Employment being in the very prime of all, when as ther was never such a Stock before to be rought out, the worcks fitted, Scotts Servants acquainted with the business by ther seaverall trades, many of the worckmen in debt, which would have helpt to worck out the Stock: I having spent a Compleate yeare at the worcks before I blowed for want of Stock and now having this reddie I was taken off in my prime which had I wrought out, I should have rendred my principals great gaine.⁶⁹

The investors sued Gifford for damages; he was arrested and jailed and his goods were attached. Multiple lawsuits ensued and while large creditors were paid, small creditors and workers were not. Workers petitioned the court for their back wages:

We fynde now such Things but that he hath his senses at Comand so that I feare more knavery then Malloncolly & and in yor Accotts you make noe mention of any thinge more then yor transactions & as if you know him not nor in what Capacity he was only you haue made vse of him to draw money for you soe that in the meane tyme the Company is well serued & yor Accotts are not such as the Company desired of you.

Lynn Iron Works Collection. Baker Library Historical Collections, Harvard Business School, p. 32.

2.13 Artist's conception of the ironworks in 1650 by Charles Overly. (Photograph 1076 by Richard Merrill, 1953.)



That wheras yor peticoner living by their labors and have wrought some time for the Iron workes whereby more wages is Groune due unto them than at present they can receive or are able to beare and that as wee are Informed the said workes are likely this day to be sentenced for the payment of divers Great Somes wherein your peticoner are not menconed nor related, but themselves theire wives & children are like to suffer greatly If your peticoner should not be paid theire wages so hardly earned; doe most humbly beseech this Honnored Court to be pleased (that before any Judgment be entred) yor peticoners maybe paid theire Just dues or such order taken that they may be paid in some short time.⁷⁰

All parties involved in the lawsuit were sympathetic to the workers' plight. Gifford noted that "the poore laboring men . . . for want of which pay some of them are in a Sadd Condition one at the gates of death."⁷¹ While Company commissioner Henry Webb stated that "there are manie poor workmen, country men mine carriers colliers & cole carters & other workmen do make a grievous complt for paymnt of their wages."⁷² The workmen's petition for payment languished, however, as a convoluted series of lawsuits and counter suits dragged through the courts. Hartley writes that eventually "certain workmen had acquired title to certain low value assets," but adds, "It is difficult to escape the conclusion that many of the small claims against the iron works were never satisfied."⁷³

A limited liability function of the Company protected Massachusetts commissioner Henry Webb from personal losses from creditors' lawsuits. John Gifford journeyed to England to plead his case to recover his salary in England's courts and was awarded more than £400. Finally, the ironworks itself was awarded to its major Massachusetts creditors, with Boston merchant Thomas Savage as a primary recipient. In 1658, entrepreneur William Paine bought two-thirds shares, with Thomas Savage retaining one-third share. Paine assumed management of the works, which rallied under his guidance. According to Hartley, the ironworks produced "143 tons of bar iron, nearly 15 of hollow ware, some 6 1/4 tons of solid castings, and wrought ware to the value of £290."⁷⁴ John Paine took control of the works upon his father's death in 1660. The ironworks faired less well under John Paine's management and production continued sporadically as Paine's agent, Oliver Purchase, tried valiantly to keep the ironworks running. In the latter half of the 1660s Paine's estate was beset by debt and the ironworks slowly ground to a halt.

The demise and failure of the Saugus ironworks caused the disbursal of the "many ingenious heads and hands" recruited in England by the Company of Undertakers and created a lineage of iron production facilities throughout the northeastern United States.⁷⁵ Generations of the Leonard family established iron mills throughout eastern Massachusetts and in New Jersey, John Winthrop, Jr., began a new iron-making venture in New Haven, and the Jenks family established its industrial presence on the Blackstone River in Pawtucket, Rhode Island. Each brought along displaced skilled workers from Saugus, includ-

You are required to atach the body & goods, of Mr John Giford to the valew of fifteen thousand pounds, with sufficient surety or suretyes, for his personall appearance, at the next County Court, to be held at Boston, on the 25th day of this instant October, then and there, to giue in a true weekly acompt of all the effects, both of sow Iron, rod Iron, barr iron, & all cast wares, that haue bin made & cast by him, & all other effects of the iron works, since he first came to his place, according to his covenants & Instructions to Captain Robert Bridges, Mr Henry Webb & Mr Joshua ffoote, as Comissionors & Aturneis of the vndertakers of the iron works; And so make a true return hereof vnder your hand dat 17 (8) 1653.

Lynn Iron Works Collection. Baker Library Historical Collections, Harvard Business School, p. 200.

2.14 Costumed interpreters at the blast furnace. (Photograph 1216 by Richard Merrill, unknown date.)



ing Scottish prisoners, and helped to spread specialized knowledge of ironworking to the new colonies. These new ventures formed the foundation of the American iron and steel industry. Historian Stephen Innes writes:

Ironworkers helped set the tone for what eventually became known as Yankee ingenuity. Their skills in metalworking and mechanical engineering spread and ramified throughout the province. In the region's growing number of iron-fabrication shops, hammer mills, and smithies, men with the names of Leonard, Pinnion, and Pray passed on to others the mystery of their craft. In doing so they helped provide the Massachusetts economy with one of its most notable features: its complex and diversified human and material infrastructure.⁷⁶

The ironwork's legacy is impressive; by the time of the Revolution, American iron manufacturing "produced some 30,000 tons of ironwares annually (one seventh of the world's yearly iron production)."⁷⁷ Its story chronicles the tensions, conflicts, and eventual assimilation of the early industrial working class. According to historian Hartley, the Company's large scale and organization on rudimentary corporate principles including price controls and limited liability, made it a forerunner of American big business.⁷⁸ With customers as far away as London and Barbados, the ironworks was one of the earliest exporters of American heavy industrial goods. The manufacture of finished products for local use and overseas trade allowed the Massachusetts Bay Colony to evade to some degree the system of dependency endemic to colonial possessions and helped Puritan leaders reach toward their vision of an economically viable, self-determined settlement.

