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Mystery of the Notched Bar at Saugus Iron Works

Saugus Iron Works National Historic Site is the birthplace of the U.S. iron industry. Called "the forerunner of America's industrial giants," the Works was a center of invention and innovation, serving as a training ground for colonial iron workers and influencing the development of other industries. The site, a reconstruction based on the archeological work of Roland W. Robbins between 1948 and 1953, includes a blast furnace, forge, and slitting mill with seven functioning water wheels. The site also has an archeological collection containing tools, hardware, and scrap iron left by colonial iron workers.

This view of Saugus Iron Works NHS, the birthplace of the American iron industry, was taken in 1995 by Richard Merrill. Photo courtesy Saugus NHS.

Because illiterate workers practiced iron making in the 17th century, there are few contemporary references to the craft. To understand the complexity of iron making at Saugus, interpreters are dependent on the evidence uncovered by Robbins and other archeologists.

One piece of evidence was an iron bar uncovered by Robbins in April 1949. As he noted in his diary, "found three sections of metal that originally was one piece. It is (altogether) three feet long, pointed on one end, larger and half circular at the other end and one side is notched." Over a dozen of these broken pieces were found, but their purpose was unknown. For years, the museum displayed the only complete notched bar in a museum case with a label reading "use of the notched bar in the case floor remains a mystery." This was the case until recent research uncovered an answer.

While constructing the Works in 1643, company agent John Winthrop Jr. described a type of Irish bog ore that "yielded great store of Iron and wrought very well and gently, in the furnasse, and would make both gray motly or white sowe Iron." A modern reference from G. Reginald Bashforth's *The Manufacture of Iron and Steel* (1964) hints at the purpose of the notched bar: "normally, pig iron is graded according to its fracture. The type of iron produced is dependent on three factors: the raw materials charged; the temperature at which the furnace is operated; and the type of slag formed."

Winthrop's quote suggests that founders could control the furnace fire with air, iron ore, and gabbro (a fluxing agent used to lower the melting temperature of the iron), producing varying grades of cast iron. Each grade of iron had its own application. Gray cast iron, which is soft and suitable for castings, results from the fusion of small graphite flakes with the iron. Gray iron castings made at Saugus included pots, kettles, skillets, firebacks (large iron plates behind fireplaces), and salt pans, which fishermen used to extract salt from seawater. Because large amounts of salt were used to preserve fish, these pans contributed to the development of New England's fishing industry.

White cast iron is lower in carbon and silicates, harder, and more difficult to work with hand tools. It was made into pig bars and later refined and forged into wrought iron bars. In mottled iron,

This photograph compares historic and modern notched bars. The two top bars were found near the Saugus blast furnace during archeological excavations. The two bottom bars are from a modern blast furnace. Photo courtesy Saugus NHS.

tled, and that which has the greatest volume is gray.

The iron was perhaps tested with a notched bar. The notched bar mold was made by pressing a wooden pattern into the open sand of the cast shed floor. The mold was then filled with molten iron. The notches tested the fluidity of the iron and its ability to take detail in a casting. They also created a weak point, making the bar easier to break. The tapered bar gave the founder variations in thickness. When the bar cooled, it was broken at a notch similar to the desired thickness of the proposed casting, thus indicating the grade of iron.

Workers at Saugus may have been unlettered, but their tools and products give us useful clues to their craft. On a recent trip to a modern blast furnace that produces more than 10,000 tons per day, I observed rooms of computers and other test equipment. On the plant manager's desk I noticed two small notched bars. When asked how they were used, he replied, "The old-timers use them. It gives them a quick accurate reference so they can make adjustments to the furnace." The Saugus legacy lives.

Archeological excavations of the 1646 blast furnace. Photo taken in 1950 by Richard Merrill, courtesy Saugus NHS.

some carbon occurred as graphite, while the rest combined with the iron. An 18th-century reference describes its resemblance to "the spots on a dogfish or trout." Mottled iron was also refined and forged to make wrought iron.

By describing the surfaces of the cast iron as either gray, mottled, or white, Winthrop revealed that iron was tested by fracture. Due to different cooling rates, the thickness of a casting at any given point also influenced the way iron retained carbon. A 1775 treatise by Pierre Grignon, reprinted in *Sources for the History of the Science of Steel 1532-1786*, outlines the effect of mold thickness on cast iron.

> When cast iron that is by nature gray is received in a cold, humid, compact body, it congeals precipitately and becomes white, hard, and brittle, so that if a piece is molded in such a manner as to make it unequal in its thickness, even though it is cast from the same drop of gray cast iron, the thinnest part is white, that which is a little thicker is mot-

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