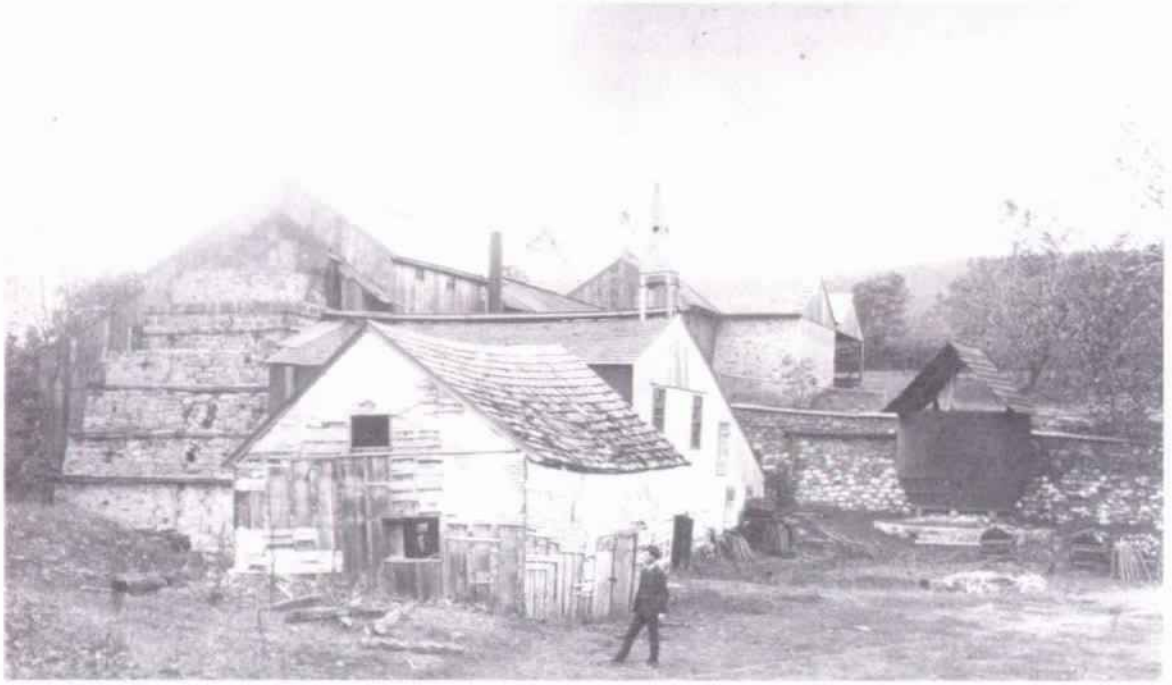

Historic Furnishings Report

Cast House

Hopewell Furnace National Historic Site/Pennsylvania

U.S. Department of the Interior/National Park Service

H3019 (HFC-MD)
HOFU

November 6, 2003

Memorandum

To: Superintendent, Hopewell Furnace National Historic Site

From: Deputy Associate Manager, Media Development

Subject: Distribution of Cast House Historic Furnishings Report

Please find enclosed 10 copies of the Historic Furnishings Report for the Cast House at Hopewell Furnace National Historic Site. All requested revisions have been incorporated in this report.

Thank you for the opportunity to provide historic furnishings services for Hopewell Furnace. We especially appreciate the many contributions made by you and your staff.

John P. Brucksch

Enclosure

cc: Regional Director, Northeast Region

bcc: HFC-IP
HFC-MD
HFC-PR park file
Park Historic Architecture Division, WASO (w/c enc.)
Technical Information Center, DSC (w/c enc.)
HFC Library/NPS History Collection (w/c enc.)

HISTORIC FURNISHINGS REPORT

CAST HOUSE

Hopewell Furnace National Historic Site
Elverson, Pennsylvania

by

John Demer
Staff Curator

Department of Historic Furnishings
Harpers Ferry Center
National Park Service
2003

APPROVED BY:

William A. Sanders
Superintendent, Hopewell Furnace National Historic Site
February 21, 2003

Contents

(**Contents,** *continued*)

Acknowledgments

Credit for this Historic Furnishings Report must go to many who have made it possible. Foremost among these is the late Earl Heydinger, Hopewell Furnace's historian, whose passion for the site is seen in the many programs he developed that have survived him. Others at Hopewell Furnace today whose advice and comments have been invaluable include Superintendent Bill Sanders, who kept the project focused and on track; Museum Curator Becky Ross and Historian Frank Hebblethwaite, both of whom always followed up on any question posed; and Park Ranger Steve Schorr. For their many years demonstrating the casting process, credit goes to Walt Malewicz, Jim Boyce, and Mike Bukowski. They have the skills and experience actually doing what this report only tries to describe. A Hopewell volunteer, the late Robert Foresman, did much to interpret patternmaking, especially to young audiences, and all-too-brief references to this complex trade are in his memory.

Special thanks to Chief of Interpretation and Resource Management Jeffrey Collins who answered my questions accurately, thoroughly, and quickly, and who has proven a major supporter of this work and to its subsequent implementation.

For his collections evaluation, mechanical abilities, and technical knowledge of historical trades, tools, and materials, thanks to Staff Curator Duncan Hay of the Northeast Regional Office.

At the Harpers Ferry Center credit must go to Staff Curator John Brucksch, who has always pressed for documentation and who is an unparalled source for objects to be acquired. Staff Curator Andy Chamberlain had probing questions and has helped acquire many objects critical to the exhibit. Staff Curator Mary Grassick developed a parallel report on Tenant House 2 and provided great depth to the people of Hopewell Furnace in the 1830s. With a background in the history of technology, Staff Curator Sarah Heald answered questions and pointed out sources. Staff Curator William L. Brown III and Exhibit Specialist Dave McLean visited Hopewell to suggest ways of engaging visitors to the Cast House. Thanks also to Teresa Vazquez, chief of Graphics Research, for providing illustrations in the most pleasant and helpful manner.

Although her strength is in developing historic furnishings reports and implementing them through installation, Staff Curator Carol Petravage has proven an insatiable publisher and editor of this and other reports within the office. That this report has reached this stage is a credit to her leadership and persistence.

Where this report is clear, accurate, well organized, and well written, credit is due its editor, Patressa Smelser, whose command of language and attention to detail is unsurpassed. Thank you Trese. Where the report is otherwise is wholly my responsibility for which I apologize.

Administrative Information

In 1935, the United States bought about 6,000 acres of land near Elverson, Pennsylvania, from A. Louise Brooke (a descendant of the owners of Hopewell Furnace) and others. The federal government acquired the land "for use as a public park and recreational area, for the restoration of structures of historic interest...and to provide public facilities for the project." The government developed a Civilian Conservation Corps encampment of 400 men to develop a park and restore the remains of the historic structures.[1]

On August 3, 1938, an Executive Order of the Acting Secretary of the Interior established the site's surviving structures as Hopewell Village National Historic Site to help represent "the colonial history of the United States."[2] The initial phase of restoration and stabilization of structures continued from 1935 to the late 1960s. The site currently represents a 19th-century iron plantation as surviving structures primarily date from the 19th century. Congress renamed the site Hopewell Furnace National Historic Site on September 19, 1985.

The Cast House is included on the National Register of Historic Places in the Register's inclusive listing for Hopewell Furnace National Historic Site, Berks County, Pennsylvania. Hopewell Furnace's National registration number is 66000645.[3]

The rehabilitation program of the National Park Service authorizes the historic furnishings report for the Cast House; the historic furnishings report supplements a thorough report on the Cast House done in 1967 by Park Historian Earl Heydinger. Hopewell Furnace National Historic Site states a need for a report in its long range interpretive plan.[4]

Interpretive Objectives

In the Cast House at Hopewell Furnace National Historic Site, workers first transformed raw materials to iron, and then transformed the molten iron into stove plates, plowshares, cook pots, weights, shot and other products indispensable to life in 19th-century America. The park's themes are clearly stated in its Long Range Interpretive Plan:

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[1] Joseph E. Walker, *Hopewell Village: A Social and Economic History of an Iron-Making Community* (Philadelphia: University of Pennsylvania, 1966), 70.
[2] Hopewell Furnace National Historic Site, Long Range Interpretive Plan for Hopewell Furnace National Historic Site (Elverson, PA: Hopewell Furnace National Historic Site, National Park Service, U.S. Department of the Interior, 1993), 2.
[3] U.S. Department of the Interior, National Register of Historic Places, 1966 to 1994 (Washington, DC: National Park Service, The Preservation Press of the National Trust for Historic Preservation, National Conference of State Historic Preservation Officers, 1994) (hereafter, National Register, 1966 to 1994).
[4] Hopewell Furnace NHS, Long Range Interpretive Plan, 33.

Overall Themes

1. Hopewell Furnace exemplifies the state of the iron-making industry in the nascent United States – an industry that was central to the growth of the nation.

The 112 years of Hopewell's operational and business history are a microcosm of the social, political, economic, and technological developments in America from the colonial period to the post-Civil War era.

Sub-themes

1. Changes at Hopewell reflect the continuing developments in ironmaking technology and the Industrial Revolution in America.
2. Hopewell provided its employees and owners with a demanding and sometimes difficult life, yet offered prosperity and independence for the successful worker.
3. An evolving transportation system economically tied the Hopewell to both the immediate area and distant markets.
4. Dependence of the iron-making process on the raw materials of limestone, iron ore, hardwood forests, and water power dictated the location of iron plantations and altered the natural environment.
5. Both the furnace work force and the general populace of the village were diverse, with African-Americans and women making significant contributions to life at Hopewell.
6. Hopewell Furnace played an important role in the American Revolution through the production of armaments for the Continental forces.

Following the recommendations in the long range interpretive plan for Hopewell Furnace, this report focuses on the 20-year period of 1820-40.

A reinterpretation of historical information disproves the assumption that Hopewell Furnace produced iron using only cold-blast technology. Stuart Wells cites evidence that as early as 1838, Clement Brooke, ironmaster at Hopewell Furnace, used a hot-blast method to make cast iron from ore, flux and charcoal.[5] Hot-blast technology – the use of ambient air preheated by the furnace – greatly reduces the quantity of fuel needed to make cast iron. Whether Hopewell

[5] Stuart W. Wells, "Hopewell Furnace National Historic Site: Historic Scene Report, Core Village Area and Big House Grounds" (Typescript at Hopewell Furnace National Historic Site, Elverson, Pennsylvania, 1995) (hereafter Wells, Hopewell Village Historic Scene Report), 1-7; Duncan Hay, "Hopewell Furnace Collections Management Plan (hereafter Hay, "HOFU Collections Management Plan")," typescript in park files (Elverson, Pennsylvania, 1998), 54.

Furnace used cold- or hot-blast technology is ultimately important to the site's interpretation, but the method of blast is probably not central to a visitor's enjoyment of the site.

Further reinterpreting historical information, Staff Curator Duncan Hay of the Northeast Museum Services Center recommends a casting floor of burned and green molding sand; installing a cupola furnace; installing a small pit to hold molten iron beneath the tap; substituting a chain for rope in the cranes; more flasks; a pattern loft, and use of iron instead of aluminum as a casting medium.[6] Some of these ideas can be implemented easily, others cannot. Those that can are recommended. Unfortunately, at least one of Hay's recommendations might be difficult to carry out. For example, a friable sand molding floor would fairly quickly become compacted and rigid from visitors trampling on it. Maintaining a friable floor would require considerable expense of staff time and materials.

Operating Plan

The first-time visitor will arrive by car or bus, stop at the visitor center, be greeted by the ranger at the entrance desk, view the orientation slide show and exhibit, pick up a park folder, and enter the historic village.

Eventually, a visitor will likely stop at the Cast House, the focus of the village. At the Cast House, the visitor will learn more about the process of making iron using charcoal cold-blast furnace technology.

From the Cast House, the visitor can continue a tour of the remainder of the furnace complex: Store, Barn, Ironmaster's House, and Tenant Houses.

Prior Planning Documents

Walker, Joseph E. 1966. *Hopewell Village: A Social and Economic History of an Iron-Making Community.* Philadelphia: University of Pennsylvania.

Heydinger, Earl. 1967. Cast House Furnishing Plan for Hopewell Village NHS. Elverson, Pennsylvania: Hopewell Furnace NHS.

Park Historian Earl Heydinger completed a detailed Historic Furnishing Plan for the Cast House in 1967.[7] Based on his plan, the Cast House contains what a visitor would expect

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[6] Hay, "HOFU Collections Management Plan," 53-57.

[7] Earl Heydinger, Cast House Furnishing Plan for Hopewell Village National Historic Site (Elverson, Pennsylvania: Hopewell Furnace National Historic Site, 1967 (hereafter Heydinger, Furnishing Plan). See also Statement for

to find in a cast house: molding benches, flasks, riddles, and other molding tools and equipment.

Heydinger, park historian for many years, was conversant in furnace technology. His plan reflects that knowledge. He interviewed men and women who lived at Hopewell while it was an active furnace (though by the 1960s most had been young children when they lived in the village). He interviewed moulders who knew traditional methods, and he invited them to demonstrate techniques of molding.

The Heydinger plan examines the process and technology of iron casting, particularly as those processes relate to the site. The plan describes in some detail how to demonstrate iron casting to visitors. By describing iron furnace work, Heydinger's focus satisfies one of two primary themes of interpretation at Hopewell Furnace. This historic furnishings report will focus on reinterpreting the Heydinger plan, particularly by illustrating materials and equipment needed to show an annual production of several thousand stoves. This re-interpretation is necessary as many components of the Heydinger plan were never implemented.

Crownover, Donald Allen. 1970. Manufacturing and Marketing of Iron Stoves at Hopewell Furnace: 1835-1844. Washington, DC: National Park Service, Division of History, Office of Archeology and Historic Preservation.

Crownover identifies names of moulders, numbers of stoves they molded, wages paid them, and total weight of stoves cast. His work is important in defining the production of moulders and of clarifying misleading single-day production figures cited in business records.

Wells, Stuart. 1995. "Hopewell Furnace NHS: Historic Scene Report, Core Village Area and Big House Grounds." Typescript at Hopewell Furnace NHS, Elverson, PA.

Stuart Wells proposes that as early as 1838 Hopewell's furnace was hot blast rather than cold blast.[8] A hot blast furnace supplied preheated air to the tuyere. Bellows pumped cold air into a heavy iron pipe. The pipe ran up the stack, across the top, and down the stack to the tuyere. Air passing through the pipe drew heat from the stack. This hot air (now 500 degrees, Fahrenheit) then entered the tuyere. It burned more efficiently than cold air. Today we call this system a heat exchanger. Newspaper advertisements of 1838 claim a

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Management, Hopewell Furnace National Historic Site (Elverson, Pennsylvania: Hopewell Furnace National Historic Site), 5.

[8] Wells, "Hopewell Village Historic Scene Report," 1-7.

furnace could save forty percent in fuel costs through use of hot blast. We could depict a hot blast system, but the report does not support such a restoration at this time due to the difficulties of restoration and maintenance.

Hay, Duncan. 1998. Hopewell Furnace Collections Management Plan. Typescript in park files, Hopewell Furnace NHS, Elverson, PA.

A more recent perspective is a typescript report prepared by Duncan Hay, senior curator at the Northeast Museum Services Center, National Park Service, and a specialist in early technology.[9] Hay's report is included in the collection management plan (February 1998) for Hopewell Furnace, and examines all areas at Hopewell Furnace. He focuses on historical accuracy. He suggests elements absent from the historical scene and points out historical inaccuracies. In the Cast House, for example, Hay feels the casting floor should be "a mixture of burned and green molding sand."[10] The cost of maintaining such a floor, however, is currently beyond the resources of the park. Further, Hay feels the Cast House should exhibit considerably more tools and equipment to illustrate an active stove manufactory.

Hay questions the use of the Cleaning Annex to interpret cleaning of castings. Hay asserts that archeologists recovered little Albany sand (casting sand) and nearly no iron filings in this area.[11] This lack of evidence suggests that moulders historically cleaned castings elsewhere, and that the National Park Service misleads visitors by asserting that cleaning took place in the Cleaning Annex.

This report will incorporate these and other recommendations of Hay.

Long Range Interpretive Plan for Hopewell Furnace National Historic Site. 1993. Elverson, PA: Hopewell Furnace NHS, NPS.

The impetus for this project is the Long Range Interpretive Plan (LRIP) for Hopewell Furnace National Historic Site, developed by the site, completed and approved in 1993.[12] The Long Range Interpretive Plan includes recommendations for media ("The Plan" section), essential interpretive needs (the "Base Interpretive Program" section), research needs, staffing, and other needs.

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[9] Hay, "HOFU Collections Management Plan."
[10] Hay, "HOFU Collections Management Plan," 11.
[11] Hay, "HOFU Collections Management Plan," 57, 58.
[12] Hopewell Furnace National Historic Site, Long Range Interpretive Plan for Hopewell Furnace NHS.

Among the needs stated is a historic furnishing plan for the Cast House. The need exists because the "historic furnace operation lacks any real sense of industry. It should be a work place, filled with tools of the trade. Even when no interpreters are available, visitors should be able to envision workers toiling to create Hopewell products."[13]

[13] Hopewell Furnace National Historic Site, Long Range Interpretive Plan for Hopewell Furnace NHS, 33.

Historical Information

This section is a history of interior spaces, their appearance, and their historical uses. It consists of the documentation for recommended furnishings and a resource for interpretation by other media and by staff on site. The section also briefly summarizes the importance of the Cast House and the reasons for developing it. Material evidence of area use is restricted to archeological remains and to entries in furnace records. The latter were particularly useful.

The story of ironcasting at Hopewell Furnace is well told by Joseph Walker (1966),[14] Earl Heydinger (1967),[15] Donald Crownover (1970),[16] and the *Handbook for Hopewell Furnace* developed by the National Park Service (1983).[17]

A Note on Sources

This report examines known primary and secondary sources. These sources are adequate in the information they provide. In the absence of new research contrary to Heydinger, this report accepts major parts of the Heydinger plan. It also recommends accepting ideas proposed by Hay in the Collections Management Plan.

Joseph Walker,[18] Earl Heydinger,[19] Donald Crownover,[20] David Lewis,[21] and Walter Hugins[22] are important secondary sources on the historical occupancy of the Cast House. These secondary sources (and other primary and secondary sources) are easily accessed at the site. The National Park Service *Handbook on Hopewell Furnace* (hereafter, "Handbook"),[23] to which Lewis and Hugins are the principal contributors, is available beyond the site through either the Government Printing Office or Eastern National (formerly Eastern National Parks and Monuments Association). Information in this section is taken principally from these sources.

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[14] Walker, Hopewell Village.
[15] Heydinger, Cast House Furnishing Plan.
[16] Crownover, Iron Stoves at Hopewell Furnace.
[17] Walter Hugins, "Hopewell Furnace: The Story of a Nineteenth-Century Ironmaking Community," in Hopewell Furnace: Official National Park Handbook, ed. National Park Service (Washington: Division of Publications, National Park Service, 1983), 22-73.
[18] Walker, Hopewell Village.
[19] Heydinger, Cast House Furnishing Plan.
[20] Crownover, Iron Stoves at Hopewell Furnace.
[21] W. David Lewis, "Ironmaking in Early America," in Hopewell Furnace: Official National Park Handbook, ed. National Park Service (Washington: Division of Publications, National Park Service, 1983), 4-21.
[22] Hugins, "Hopewell Furnace."
[23] Hugins, "Hopewell Furnace."

It's important to insert a word of caution here: any approach to industrial history can inadvertently shortchange the role of women, children and minorities. Workers and their relationships do not fit into a neat, rigid organizational chart. To his credit, Joseph Walker seems fair in assessing the social aspects of life at Hopewell by including chapters on blacks, women and children.[24]

This report attempts to include research from the broader perspective of social history. It benefits from recent work by Julie Berebitsky, Christine Devine, Mary Grassick and Stuart Wells.[25] Of particular relevance is new research into the role of women in a furnace operation. Julie Berebitsky[26] and Christine Devine[27] help enlighten us on the contributions of women and minorities to the operation of a furnace.

A researcher chooses what information appears in a report. Not all information can, or should, appear. As Brooke Hindle, one of America's premier historians of technology notes, "society's needs change and require different histories."[28] Although considerable research at Hopewell Furnace dates to the 1960s — a period of social upheaval in America — little of Hopewell's research captures the malaise of that period. Instead, research at Hopewell Furnace during the 1960s focuses principally on technology and commerce, with our primary researcher, Joseph Walker being a notable exception. Today, social history encompasses technology and commerce in a broader net with such other issues as diversity. This broader perspective calls for a fresh look at how the Cast House is interpreted.

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[24] Walker, Hopewell Village, See chapters 15, 16, and 17.
[25] Julie Berebitsky, "Biographical Notes on Four Women at Hopewell Furnace: Jane Clemons, Margaret Painter, Elizabeth Mervine (or Merwine), and Phebe Shaner (Widow Shaner)" (Typescript (draft) at Hopewell Furnace National Historic Site, 1996); Christine Styrna Devine, "Women of Iron: The Impact of Class, Technology, and Gender on the Industrial Village," Paper presented at Hopewell Furnace National Historic Site March 31, 1996 (Typescript at Hopewell Furnace National Historic Site, 1996); Mary K. Grassick, Hopewell Furnace National Historic Site: Historic Furnishings Report for Tenant House #2. (Elverson, Pennsylvania: Hopewell Furnace National Historic Site, 2003); Wells, "Hopewell Furnace Historic Scene Report."
[26] Berebitsky, "Four Women at Hopewell."
[27] Devine, "Women of Iron."
[28] Brooke Hindle, " 'The Exhilaration of Early American Technology': A New Look," in The History of American Technology: Exhilaration or Discontent? ed. David A. Hounshell (Greenville, Delaware: Hagley Museum, 1984), 8.

Analysis of Historic Occupancy

The Furnace and Smelting Iron

In 1770 or 1771 Mark Bird (1739-1816) built an iron furnace in Union Township, Berks County, Pennsylvania. He named it "Hopewell," perhaps because he came from Hopewell, New Jersey, and "Hopewell" was a popular name in the 1770s. The furnace operated, though not continuously, until 1883. Bird was the first of at least 22 owners.[29] Though his furnace proved successful during the Revolutionary War, eventually imported iron, bad weather, and a depressed market forced him to declare bankruptcy and move to North Carolina, where he died.[30]

Mark Bird built his furnace against a hillside that would facilitate loading iron ore, limestone and charcoal. The design copied others that had proven successful elsewhere. The height of the furnace is about thirty feet. It is about twelve feet deep and twelve feet wide. It has an upper-tapering interior chamber, an interior pipe (tuyere) to supply a blast of air, and a small hole at the base to allow molten iron to pass.

Bird built his furnace of heavy limestone blocks lined with refractory sandstone. The interior of the furnace was narrow at the top, widened toward the base, then narrowed again. This design allowed molten iron to collect and workers to draw it off. The furnace is designated a blast furnace because the tuyere fed a stream of cold air to accelerate combustion and increase the temperature inside the furnace.[31] Bellows run by a waterwheel supplied the stream of air to the tuyere. The bellows system was converted to blowing tubes by 1822.

Converting ore to iron took time. The ore, limestone (as a flux added to fuse with the impurities in the ore), and charcoal had to be heated to between 2,600 degrees and 3,000 degrees Fahrenheit. These temperatures cause a chemical reaction: iron oxide ore gives up its oxygen atoms to carbon monoxide produced by the heated charcoal. The combination of intense heat and the presence of carbon monoxide "reduces" the iron oxide ore to iron. One definition of the word "reduce" is "to give up oxygen." Carbon monoxide picked up the surplus oxygen molecule in the iron oxide to become carbon dioxide. A simple example of a chemical formula reflecting the change that occurs during the blast is $Fe_2O_3+3CO= 3CO_2+2Fe$. Carbon dioxide produced by the chemical change vented itself through the top of the furnace.

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[29] Walker, Hopewell Village, p. 412. Not all owners were sole proprietors as was Bird. During the furnace's history as many as six partners controlled operations.

[30] Walker, Hopewell Village, 34.

[31] Wells, "Hopewell Furnace Historic Scene Report," 2-7. Documentation of Wells asserts that Clement Brooke used a hot-air blast. A hot-air blast required less charcoal than a cold-air blast and thus presumably saved fuel.

Casting Iron

About every twelve hours the founder tapped the hole at the base of the furnace to release the molten iron. Using ladles, the moulders poured the iron into several sand molds (flasks) they had prepared. Moulders allowed the iron to cool and solidify. They then disassembled the flasks, removed the castings, and reused the casting sand.

Moulders repeated this process, shift after shift, continuously, as long as the furnace was in blast. According to Heydinger, "A single circular stove consisted of nine outside and three oven plates, plus three doors (each with separate cast latches), and two standplates (or dovetailed feet)."[32] Heydinger deduces that moulders formed and poured no fewer than 75,000 flasks to make 5,000 stoves.

Preparing Molds

We find illustrations of the steps necessary to make a sand mold, or flask, in Crownover (pp. 54 to 65) and Hugins (pp. 50 and 51), and described thoroughly in Overman ("Moulding"). Moulders used the green-sand process for stove plates and other small articles. Workers made larger castings using dry-sand or loam. *The Moulder's and Founder's Pocket Guide* (1872) summarizes the green-sand process:

> The pattern is put on a flat board, which is laid perfectly level.... Upon this board the pattern is laid with its smooth side on the board.... The drag-box is put down.... The first layer of sand (facing sand) upon the board (fresh sand from the pit which is [*sic*] never before been in a mold) is to be worked through a fine sieve.... After the facing is properly secured, common moulding-sand is thrown into the box through a coarse riddle, flush with the box. This sand is rammed down, cautiously and uniformly, with the wooden and edged stamper. When this first box-full of sand is secured ...the box may be filled again by throwing in sand from the pile.... The coarse, or last, sand is rammed with the round iron stamper, the superfluous sand is stricken off by running an edge rule over the box, so as to make the sand perfectly flush with the box.... the sand, after being leveled, is covered with a board and the whole, box and board, turned over, so the former bottom is now the top of the box....After the bottom is removed, the upper surface of the sand-parting is smoothed down.... The parting-surface is thinly covered with parting-sand, gently sprinkled, just enough to prevent adhesion of the moulding sand....
>
> The upper box is then laid in its proper place...the facing-sand is put on; after which the common sand is stamped in; in short, the same operation is performed as previously described for the lower box.... Immediately after the face-sand is put in the upper box, and before the second layer is thrown in, preparations are made for the *gits*, gates, or passages for the metal. This is done by setting in wooden pins, very much tapered, of a sufficient length to reach above the edge of the

[32] Heydinger, Cast House Furnishing Plan, B-4, B-5.

> upper box.... In proportion as the surface increases or the pattern is thinner, the number of passages is to be increased.... [33]

For accuracy, interior spaces of the Cast House should show troughs and channels for pig iron, benches for molding, molds in different stages of assembly, uncleaned castings, cleaned castings, and reproduction shipping crates (hypothetically) containing finished stoves awaiting shipment. These images would represent different stages of production and the products produced. Earl Heydinger describes the casting process at Hopewell Furnace in some detail.

[33] Frederick Overman, *The Moulder's and Founder's Pocket Guide* (Philadelphia: Henry Carey Baird, 1872), 31-36.

Duties at Hopewell Furnace

Ironmaster

In 1837 and 1838 employees representing different skills worked in the Cast House. The most important person was the ironmaster. He (all ironmasters at Hopewell were male) needed the technical skills of a structural engineer, chemist and metallurgist; he also needed the managerial skills of a planner, recruiter, trainer and work supervisor. He influenced the quality of metal produced and had much to do with the efficiency of the furnace operation.[34] Often the ironmaster was a principal investor in his furnace; he thus had a compelling incentive for the furnace to succeed.

Some ironmasters succeeded, others did not. Mark Bird, Hopewell's founder and first ironmaster did not succeed. Clement Brooke, partner from 1827 to 1859, was the most successful ironmaster of the Furnace. He came to Hopewell in 1804 as clerk, became ironmaster in 1816, and continued to manage the Furnace until he retired in 1848.[35] Brooke was ironmaster during the period of greatest activity for the Furnace.

Founder and Keeper

If the ironmaster was responsible for overall operation of an iron furnace, the person responsible for actually producing pig iron was the founder. The founder determined timing and quantities of materials fed to the furnace. By examining molten output the founder varied materials for best product.

A founder could also be ironmaster as was Mark Bird. He may also have supplemented his income by being a moulder, but where founders were among the highest paid employees of furnaces, holding second jobs was rare.[36] Related to the founder in employment duties was the keeper. As Walker notes, the principal duty of a keeper was to serve as a substitute to the founder, most notably maintaining the furnace operation throughout the night. In 1803 Clement Brooke was a substitute keeper, a position of considerable responsibility for a young person.[37]

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[34] Walker, Hopewell Village, 165; Hugins, "Hopewell Furnace," 44.
[35] Walker, Hopewell Village, 172-74.
[36] Hugins, "Hopewell Furnace," 48.
[37] Walker, Hopewell Village, 172, 236.

Fillers

In blast a furnace required a constant supply of ore, charcoal, and limestone flux. Workers who poured wheelbarrow loads of these materials were called fillers. They worked day and night under the supervision of the founder and keeper. According to Walker, fillers often suffered burns and back injuries from the work they did. Important as their duties were, fillers comprised a small percentage of the furnace's workforce, less than two percent.[38]

Guttermen

Guttermen were responsible for scoring channels in the Albany sand to receive the molten iron by shaping troughs for pig iron billets.[39] This task was often performed by a boy whose father also worked at the furnace. In 1806 Edward Hughes hired his son, Isaac, as a gutterman, thus introducing the young person to an important element of iron casting.[40] With the founder, keeper, and fillers, a gutterman worked day shift and night shift when the furnace was in blast.

Furnace Clerk

According to Hugins, "second in importance to the ironmaster was the company clerk."[41] As the title 'clerk' implies, the furnace clerk kept company and store accounts. This activity alone was indispensable to furnace operations. Locally, clerks recorded all costs of labor and materials, payments to partners, and moneys owed the furnace. They kept worker accounts of moneys owed the store and they reconciled accounts when workers left the furnace.

Clerks had to review and honor incoming bank drafts. Receiving banks, in turn, honored drafts that Hopewell Furnace sent. The timing of these transfers was critical. Throughout its hundred-year history, Hopewell Furnace had chronic money problems, most of which stemmed from the Furnace's intermittent cash flow.

Beyond keeping accounts, furnace clerks also supervised operations of the furnace in the absence of the ironmaster. A furnace clerk was second in command to the ironmaster. Because clerks kept records, they knew the general operation of a furnace. Clerks were sometimes in training to become ironmasters.

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[38] Walker, Hopewell Furnace, 296-97, 425.
[39] Hugins, "Hopewell Furnace," 49.
[40] Walker, Hopewell Furnace, 276, 339.
[41] Hugins, "Hopewell Furnace," 45.

A market economy necessitated the need for detailed accounts. Time and space defined furnace markets, like any other commerce of the period. Commerce required the furnace to sell beyond its locale. In 1836, for example, Hopewell Furnace sold 2,974 stoves to Cornell & Cunningham in New York City.[42] This number represents 81 percent of Hopewell's production of 3,678 stoves for the year. Another buyer was Jonathan Morrison of Portsmouth, New Hampshire; Morrison bought 146 stoves.[43] Probably not of choice, the Furnace extended credit to buyers and the clerk had the task of keeping accounts.

Moulders

Moulders were among the most skilled group of workers. Using wooden or metal patterns, moulders made molds of sand to receive molten iron, poured molten iron into the molds and, after the molten iron cooled, cleaned their work by filing imperfections from the castings. Like ironmasters, moulders were also male. Drawing on records at the site, Heydinger lists moulders for the 1836 to 1837 long blast as: David Care, Nathan Care, Thomas Care, Sr.; Thomas Care, Jr.; Joseph Elliott, David Hart, Joseph Hart, Peter Hart, George North, Frederick Painter, John Painter, Jr.; Montgomery Painter, John Sheeler and Michael Walters.[44]

The name list suggests that in 1836 Hopewell's moulders were of Anglo or Anglo-American origin, and that some moulders were related, especially those who shared the common surnames of "Care," "Hart" and "Painter."

Cleaners

At Hopewell Furnace, the process of *cleaning* meant trimming surplus metal from castings. The most common surplus for removal was the gate, or 'sprue'. A *gate* is two things. First, it is the channel in the mold through which workers pour molten iron. A gate is also the conical piece of iron that solidifies and remains in the channel. Gates are unavoidable; cleaners simply removed them in the cleaning process. Cleaners trimmed with a chisel or sharp hammer.[45]

Occasionally a casting would include an unintended 'flash', or metal that oozed between seams of the mold during molding. Cleaners could remove flashing by filing. The process took time, but cleaning—removing excess metal—was preferable to an imperfect cast that contained voids intended for metal. Castings with voids were imperfect. The furnace could not sell profitably its

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[42] Crownover, Iron Stoves at Hopewell Furnace, 115.
[43] Crownover, Iron Stoves at Hopewell Furnace, 115.
[44] Heydinger, Cast House Furnishing Plan, C-3, C-4 (citing Hopewell Record SM 21, entries for 27 December 1836, and 9, 17, 18 and 19 January 1837).
[45] Overman, *Moulder's and Founder's Guide*, 220.

imperfect castings. The ironmaster either sold the imperfect castings as scrap metal or, when possible, re-melted the imperfect castings and recast them.

Although cleaning took less skill than molding, moulders cleaned as many castings as possible, especially those they had cast themselves. Some moulders hired someone to clean the remainder. According to Crownover these others included a minor child (the son of David Wynn in 1837), and in 1832, two widows, Margaret Painter and Elizabeth Mervine.[46] The year 1832 is the only reference Crownover makes for payment to women as cleaners. Research of Julie Berebitsky reveals that payment to women for cleaning was actually done by children rather than by the women themselves.

Cleaning castings was hard work. The cleaner had to remove gate metal, file flashings where metal had seeped, and remove sand stuck to the casting. Sand stuck to the casting could be removed with a wire brush. The cleaning process also allowed the cleaner to inspect the plate. A plate that showed only superficial defects could be used to make a stove and the stove would be sold. Hopewell Furnace called these "half-price stoves" and sold them for about two-thirds of the regular selling price.[47] The moulder got only half pay for defective plates.

Moulders paid cleaners by weight. The accepted rate for cleaning castings in 1836 was 75 cents per ton.

Apprentices

Apprentices worked with a skilled craftsman to learn a trade through practical experience.

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[46] Crownover, Iron Stoves at Hopewell Furnace, 76, 77.
[47] Crownover, Iron Stoves at Hopewell Furnace, 75.

FURNISHINGS PLAN

Furnishings Plan

The Interpretive Scene

The period of interpretation of the historic village is 1820 to 1840. The interpretive scene shall be as if workers had "gone to dinner."[48] This will help explain to visitors why the furnace is not staffed with a dozen moulders and other workers.

Recommendations for historic furnishings proposed in this report parallel those of Heydinger (1967), Crownover (1970), and Hay (1997). For consistency, area designations parallel those of Heydinger—Cast Arch, the Molding Rooms, the Loft, the Tuyere Arch, the Cleaning Annex, the loading area beneath the Cleaning Arch and the Cast House exterior.

Furnaces needed periodic maintenance. Sometime in August of 1836, the furnace was out of blast for two weeks. The two-week period allowed time for workers to replace worn refractory brick and the hearth stone. The furnace needed two days to cool sufficiently to allow workers to begin work on it. Removing and replacing the hearthstone and refractory brick took about a week. Fillers then had to recharge the furnace with ore, charcoal and limestone, fire the charge, and tend it until it reached smelting temperature. Wells is amazed this complicated process took only two weeks and not considerably longer.[49]

Issues for Consideration During Review

An interpretive challenge for the park is how to make Hopewell Furnace appear livelier. When in blast, Hopewell's furnace simmered, roared, and required tending by many workers. The furnace landscape had far fewer trees; workers had converted them to charcoal to feed the furnace. Hopewell village held about 260 people. They grew food, raised livestock, cooked and cleaned, and went to church. We cannot replicate most of these activities. The issue of lively interpretation seems a continuing problem at Hopewell Furnace. In 1941, for example, Superintendent Lon Garrison complained to NPS Director Newton Drury that Hopewell Furnace had "no more vitality than a dead fish."[50] Short of staffing the park with as many costumed interpreters as inhabitants in 1838, the site will inevitably seem quieter than during its heyday.

For safety concerns alone, the site cannot replicate its most focal activity, the furnace in blast. Interpreting Hopewell today, then, is a challenge. This plan recommends:

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[48] Heydinger, Cast House Furnishing Plan, E-3.
[49] Wells, "Hopewell Furnace Historic Scene Report," 10-12.
[50] Hay, "HOFU Collections Management Plan," 44.

(1) Interpreting to 1820 to 1840, the heyday of furnace operations. The surviving structures at Hopewell best reflect this period. (The longest blast, January 3, 1836 to April 10, 1837 was only a portion of this time period).
(2) Continued focus on live interpretation of the casting process in the Cast House. With current staffing, however, live interpretation is possible only during summer months.
(3) When possible, interpretation of other processes directly related to producing cast iron and shipping finished products from Hopewell Furnace. These processes may include patternmaking, making and repair of flasks, crate making, and packing disassembled stove plates in crates for shipment to distant markets. As with live interpretation of casting, any other demonstrations require staff, tools, and materials. These are in short supply. The park presently simulates workers as being present but just out of sight.

Architectural modifications recommended. This historic furnishings report recommends no significant architectural modifications. In keeping with Heydinger (1967) and Hay (1997), the report recommends the modification of the storage loft in the Cast House to allow display space for mold patterns. It also recommends replacing the compacted floor in front of the hearth with fresh Albany sand. (This recommendation may be impractical, however, because the cost of maintaining a friable floor is very high). If implemented, these recommendations will help ensure accuracy, and the effects of implementing the recommendations will be reversible. Presently Hopewell Furnace uses the loft to store security barriers during the off season. These wooden barriers can continue to be stored in the loft as long as they remain separate from patterns. Space needs change over time; storage of safety barriers and patterns in a loft area is compatible as long as they are not mixed.

Minor modifications are recommended for the cleaning shed. This plan recommends adapting the cleaning shed to interpret woodworking at Hopewell Furnace. A woodworking shop was indispensable to a furnace: flasks had to be made and repaired, shipping crates built, and wooden objects repaired.

Visitor accessibility. Revised furnishings at the Cast House should not impair visitor accessibility. Recommendations of this plan meet Guidelines for Interpretive Media: Programmatic Accessibility for Special Populations, version 2.1, dated September 1991, and included as an appendix to the site's Long Range Interpretive Plan.

Recommended Furnishings

The Cast Arch

This report recommends that the opening to the casting arch be closed except when live demonstrations are conducted.

Floor. The area in front of the Cast Arch will be a combination of burnt sand and green sand. This mixture would allow the casting of pig iron or such goods as window weights. A clay floor is not suitable for casting. Water in clay vaporizes on contact with molten iron. This vapor degrades the quality of the casting or, worse, explodes if confined.[51]

Hay also reminds us that Hopewell documents for 1817 and 1818 mention a cupola furnace. A cupola furnace has an elevated tap that allows workers to draw sufficient molten iron to cast the largest stove plate. Walker states that iron workers at Hopewell probably used a cupola furnace to reuse pig or scrap iron for moldings, but that the technique was not a success. Because a cupola furnace at Hopewell did not survive, was not part of the restoration of the 1960s, and is documented to an earlier period of interpretation than recommended, it is not recommended by this report.[52]

Hay states the two reproduction cranes at the casting arch are equipped with rope to lift heavy ladles of molten iron. Rope burns. Hay recommends replacing the rope with chain.[53] This suggestion is potentially valid but lacking support in the historic images. This report recommends retaining the use of rope.

Object Number	Object and Location	Documentation	Recommendation
1.	SASH WEIGHTS, flat cast near arch; show cooled	Heydinger retype 10 (SM8 11/8/1816; SM32 3/31/1849)	Acquire reproductions.

[51] Hay, "HOFU Collections Management Plan," 55.
[52] Hay, "HOFU Collections Management Plan," 56; Walker, Hopewell Village, 55.
[53] Hay, "HOFU Collections Management Plan," 56.

Cast Arch, ***continued***

Object Number	Object and Location	Documentation	Recommendation
2.	LAMPS, FAT (2)	Heydinger retype 10 (Long, 12)	Acquire reproductions of glazed redware[54] or metal betty lamps.
3.	CLAY, in IRON KETTLE, for taphole and lining ladles	Heydinger retype 10 (H2215 interview with Henry Johnson; Abel, 50)	Use site's historic iron kettle; fill with local clay.
4.	GREAT or LONG RINGER	Heydinger retype 10	Acquire reproduction.
5.	SMALL RINGER	Heydinger retype 10	Acquire reproduction.
6.	CINDER HOOK	Heydinger retype 11	Acquire reproduction.
7.	TUYERE HOOK	Heydinger retype 10	Acquire reproduction.
8.	PLACKET, to smooth clay around tuyere	Heydinger retype 10	Acquire reproduction.
9.	CINDER HOOKS (4). to move partially-cooled slag	Heydinger retype 11	Acquire reproductions.
10.	SHOVELS (4), to move partially-cooled slag	Heydinger retype 11	Acquire reproductions.
11.	WATER TROUGH to wet sand and cool tools	Heydinger retype 12 (H2215, Thomas Hoffman, 5)	Acquire reproduction.
12.	CHAIN for linking crane hook with crucible	Hay 56	Reproduce.
13.	WORKER COATS (2), on pegs		Reproduce.

[54] Rushlight Club, Early Lighting: A Pictorial Guide (Hartford, Connecticut: The Rushlight Club, 1972), Ill. 4-8.

Molding Rooms (North and South)

Because moulders were paid for what they produced by weight, Heydinger feels that "rows were necessary to keep every man's production separate (retype 12)." In the absence of documentation, he suggests 10 rows in the North and South Molding Rooms. This suggestion for 10 rows of molding frames with one bench per row remains valid.

We need to revisit Heydinger's 14 sequential stages of molding. Heydinger asserts the stages "must be depicted" in the molding rooms (retype 12). The advantage to the Heydinger approach is that (hypothetically) by walking from bench to bench, a visitor can view in sequence the steps moulders used in transforming a pattern to a casting. This approach requires the visitor to start at stage one and proceed, in order, to stage 14. It further requires either that the visitor knows what he is seeing, or alternatively, a series of labels at each bench describing each stage of the process. Finally, and most critical, the approach requires that the park ensure that each stage is accurately depicted as described in the label. This latter necessity is labor intensive for the park: someone has to make sure what we depict at each bench is not disturbed. In an open, outdoor setting without barriers (as the historic scene should be in the Cast House), this latter step requires constant vigilance by park staff. Unfortunately, the park does not have the staff to ensure the exhibits are not disturbed.

Historically, a visitor to Hopewell furnace did not see 14 stages of molding in sequence. Moulders knew the furnace would be tapped only about once in a 12-hour period. They worked to prepare as many molds as possible for the tap. They had to. The ironmaster paid them for the weight of castings produced. Moulders organized their shifts around the three functions of their foundry: preparing molds, casting and cleaning. They probably worked together: first preparing molds, then casting those molds, and finally, cleaning the molds they had cast that shift.

Therefore, since it is historically inaccurate to display the 14 steps of the molding process at the same time, and since without barriers the park staff will be unable to keep every element of the exhibit undisturbed, this report recommends showing the Cast House as if the employees were at dinner and would return within an hour.

Molding Area (South Room)

Object Number	Object and Location	Documentation	Recommendation
14.	BENCHES (14), for molding patterns	Overman	Acquire reproductions.

Molding Area (South Room), *continued*

Object Number	Object and Location	Documentation	Recommendation
15.	WOODEN and LEAD PATTERNS (14), at each bench, each representing a plate or piece of a number nine circular stove	Heydinger, retype 13; wooden patterns bound with wrought iron or wooden patterns faced with lead are needed per Crownover, 102-103	Acquire reproductions.
16.	FOLLOWBOARDS, WOODEN (170), at each bench;	Heydinger, retype 13	Acquire reproductions.
17.	FLASKS, WOODEN (170), 2 to 6 at each bench; both halves	Overman, 23; one flask on each bench to represent work in progress, others beside benches either empty or filled and ready to cast. Remainder stacked at tuyere waiting to be cast.	Acquire reproductions.
18.	RIDDLES (14, at each bench	Overman, 30	Acquire reproductions.
19.	RAMMERS, SINGLE HEAD (14), at each bench	Overman, 29	Acquire reproductions.
20.	RAMMERS, DOUBLE HEAD (18), distributed randomly	Heydinger, retype 13	Acquire reproductions
21.	SHOVELS, STRAIGHT-BOTTOM (18), one at each bench; others standing in sand piles	Overman, 30	Acquire reproductions.

Molding Area (South Room), *continued*

Object Number	Object and Location	Documentation	Recommendation
22.	LINEN BAGS (16), for parting charcoal; one at each bench—then should there be 14?	Overman, 30	Acquire reproductions.
23.	BELLOWS, SMALL (4), for removing surplus sand, distributed randomly	Overman, 30	Acquire reproductions.
24.	TROWELS (18), distributed randomly	Overman, 28	Acquire reproductions.
25.	IRON POTS (14), for holding parting sand at each bench	Overman, 30	Acquire reproductions.
26.	PAILS (14) for water at each bench	Overman, 30	Acquire reproductions.
27.	ROPE (1-inch tow) for TUFTS (8), distributed randomly	Overman, 30	Acquire reproductions.
28.	PIERCERS or PRICKERS (28), iron or brass needles, 6 inches to 10 inches long, tapered to a point	Overman, 30	Although prickers are a historically accurate tool, they are not recommended for safety reasons.
29.	SLATES (16), distributed randomly	Heydinger, retype 23; used to keep records until they could be transferred to account books	Acquire reproductions.

Castings Cleaning Area (North Room)

After moulders poured molten iron into the mold in the molding rooms, they allowed the casting to cool, opened the flask, and removed the casting. Moulders removed loose sand by simply "shaking out" the casting. Burnt sand covered the casting; the casting retained its gate, and perhaps it had small seam flanges. Cleaners could remove these accretions with a hammer and chisel or a file.

Cleaning completed the casting process. Cleaning entailed removing the gate, seam flanges or other minor imperfections, and burnt sand that covered the casting. A cleaned casting was free of its gate, burnt sand, and imperfections. It was gray in color. An eventual buyer could assemble this part into a finished stove.

Historically at Hopewell Furnace, cleaning occurred in an area apart from the molding room. According to Harker Long, a former employee of the furnace (reported by Heydinger), the historical cleaning shed was located in what became the wheelwright shop.[55] This building no longer stands. According to Crownover's interpretation of an interview with Mr. and Mrs. Sheridan Care, the historical cleaning shed was located across a road that ran through the village.[56] Citing the historical base map developed by archeologist Russel Apple, Wells places a building "a few feet south" of the Cast House.[57]

Fortunately, at least two photographs survive that show this building (see figures 3 and 4). The photos date to about 1890. Again cited in Wells, but not illustrated by him, one shows the east facade (Hopewell Furnace Photo Archives [HFPA] 101.03 Bull 1890), the other, the south facade (HFPA 125.01 Stokes 1889).[58] Wells feels the description "wheelwright shop" is misleading because the company did not add a wheelwright pit until 1848. This latter date is three years after Hopewell Furnace ceased making stoves. Further, the Furnace contracted wheelwrighting in 1837; these contracts are further evidence that the Furnace did not employ a wheelwright. For Wells, the term "carpenter shop" more accurately describes the structure (no longer standing) where cleaning and crating occurred.[59]

Cleaning of castings. A furnace paid moulders according to the weight of usable castings they produced. Even a perfect casting needed its sprues chiseled and its casting sand brushed off. The process of removing sprues and minor defects by chisel, file, and brush was called cleaning. At Hopewell Furnace, according to Heydinger, moulders moved uncleaned castings from the

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[55] Heydinger, Cast House Furnishing Plan, retype 23.
[56] Crownover, Iron Stoves at Hopewell Furnace, 77-78.
[57] Wells, "Hopewell Furnace Historic Scene Report," 20.
[58] Wells, "Hopewell Furnace Historic Scene Report," 20fn.
[59] Wells, "Hopewell Furnace Historic Scene Report," 20.

molding rooms to a cleaning area and piled them on wooden rails. However, as Heydinger readily concedes, the cleaning methods and the location of the cleaning area at Hopewell are unknown.[60]

To illustrate cleaning, the process that preceded crating, Hopewell Furnace presently uses the Cleaning Annex, a shed appended to the east side of the Cast House. Because the Cleaning Annex is not the historical location for cleaning castings, this report recommends that cleaning of castings be interpreted in what is now the south end of the Cast House.

Moulders generally cleaned their own castings, though sometimes they hired others to clean for them. In 1837, the prevailing rate that moulders paid others for cleaning was 75 cents a ton (but one cleaner earned $1 a ton).[61] Heydinger's research reveals that at least two women drew pay for cleaning in 1831, Elizabeth Merwine and Margaret Painter.[62] Margaret Painter was a widow; perhaps cleaning castings was one of many ways in which she earned money. Working different jobs seemed to be a source of income for the other female paid for cleaning castings, Elizabeth Merwine. Christine Devine reports that besides cleaning castings, Elizabeth Merwine also provided livestock to the furnace and worked as a seamstress.[63] Julie Berebitsky suggests Elizabeth Merwine, aged 42 in 1831, may have received the earnings on behalf of cleaning done by her two sons, ages 15 and 19.[64]

Castings Cleaning Area (North Room)

Object Number	Object and Location	Documentation	Recommendation
30.	RAILS, WOODEN, to support castings while they are being cleaned	Heydinger, retype 24; also Diderot (1959), Pl. 92	Fabricate and install reproductions.
31.	BRUSHES, CLEANING	Overman, 30	Acquire reproductions.
32.	BURNED MOLDING SAND, on floor	Overman, 30	Acquire from foundry.

[60] Heydinger, Cast House Furnishing Plan, D-28.
[61] Crownover, Iron Stoves at Hopewell Furnace, 75-76.
[62] Heydinger, Cast House Furnishing Plan, D-29.
[63] Devine, "Women of Iron," 4; Berebitsky, "Four Women at Hopewell," n.p., entries for "Elizabeth Merwine" and "Margaret Painter."
[64] Berebitsky, "Four Women at Hopewell," n.p., entry for "Elizabeth Merwine."

Castings Cleaning Area (North Room), *continued*

Object Number	Object and Location	Documentation	Recommendation
33.	CASTINGS (30~), shaken out but not cleaned	Historical practice	Acquire reproductions.
34.	CASTINGS (40), cleaned	Historical practice	Acquire reproductions.
35.	WHEELBARROW	Historical practice	Acquire reproduction.
36.	SEATING, worker; utilitarian stools or reproduction outdated chairs	Historical practice	Acquire reproductions. These should be strong enough for use.
37.	WOOD STOVE, Hopewell Furnace Number 9 circular	Heydinger, retype 26	Acquire reproduction.

Loft, Pattern Storage

As Heydinger states, wooden stove patterns cost a lot, and the furnace had to provide secure, dry storage for them.[65] Although few patterns survive, the furnace must have housed hundreds. In 1837, according to Crownover, the furnace had the capacity of molding 138 types of stoves.[66] If each stove required 10 unique patterns, the furnace (hypothetically) had at least 1,380 unique patterns. It probably had many more patterns than this. To fill orders the furnace needed more than one set of patterns for its most popular stoves.

We do not know for sure where the furnace stored its patterns. According to Crownover, archeologist Leland Abel discovered "several post holes near the furnace in the middle area of the South Molding Room." Norman Souder, the historical architect, park historian Heydinger, and archeologist Abel suggest these posts could have supported a stairway leading to a loft where the furnace stored patterns.[67] Because the use of these posts at this location is not adequately supported by documentary evidence, the park has not reconstructed a storage area for patterns in the South Molding Room. An unintended consequence is that the area appears underfurnished.

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[65] Heydinger, Cast House Furnishing Plan, retype 22.
[66] Crownover, Iron Stoves at Hopewell Furnace, 99. On page 47, Crownover states the furnace "made as many as 110 kinds of stoves in 1837." In spite of this minor inconsistency, Hopewell Furnace produced many different stove models.
[67] Crownover, Iron Stoves at Hopewell Furnace, 44 (figure 5), 47.

The plan recommends installing shelves in the loft above the South Molding Room. Shelves can exhibit the range of patterns the Furnace used, and the area probably held shelves. No stairs to the loft area should be installed, and by implication, no visitor access to the loft area will occur. The intent of this report is to exhibit a greater range and number of patterns.

Loft Pattern Storage

Object Number	Object and Location	Documentation	Recommendation
38.	SHELVES, installed above area	Heydinger, retype 26; Crownover	Install reproduction wooden shelving.
39.	WOODEN PATTERNS, bound with wrought iron, stored on shelves	Historical practice	Acquire reproductions.
40.	WOODEN PATTERNS, faced with lead, stored on shelves	Historical practice	Acquire reproductions.
41.	LEAD PATTERNS, stored on shelves	Historical practice	Acquire reproductions

Tuyere Arch Area

According to Heydinger, the area surrounding the tuyere arch historically contained molding benches.[68] The proximity of benches to the furnace made sense. In 1837 moulders did not want to carry heavy ladles of molten iron any farther than necessary. The more closely the mold was located to the tap hole, the better.

Today visitors want to look closely at the furnace and waterwheel, central elements of any 19th-century furnace, and the reason for the existence of Hopewell Furnace. Though historically accurate, molding benches near the tuyere arch would impede a visitor's view of the furnace and waterwheel. To accommodate visitor interest in these unique features, therefore, we do not recommend furnishing this area.

Loading area in cleaning annex. An area to depict how workers crated and shipped stoves is necessary to show a vital function of iron manufacture: transportation of finished goods to their market. We have not found documentation on where crating and preparing stoves for shipment occurred. Historically (and logically), crating and shipping probably occurred close to where castings were cleaned, possibly in a separate cleaning shed that is no longer standing but was located "across the road" according to Mr. and Mrs. Charles Sheridan Care.[69]

The historical location for crating and shipping no longer exists. The park could use the cleaning annex to depict this function. Records do not reveal what crates looked like or precisely how

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[68] Heydinger, Cast House Furnishing Plan, retype 18.
[69] Heydinger, Cast House Furnishing Plan, retype 23; Crownover, Iron Stoves at Hopewell Furnace, 77-78.

many stoves were packed in each box. According to Crownover, each crate cost the dealer 15 cents. He refers to Jacob Pleiss, of Philadelphia, receiving "thirty-two stoves and eleven sets of backs and jambs" in two boxes, and "thirteen stoves and seven sets of backs and jambs" in one box. The first shipment weighed three tons, the second, one ton.[70]

This exhibit area will include an open wooden crate and separately, the parts of 13 stoves and seven sets of backs and jambs. We recommend addressing the crate to a Furnace customer, "Jacob Pleiss, Philadelphia." Because each number four stove weighed about 175 pounds, the gross weight of the crate containing 13 number-four stoves was about one ton. Crownover claims the crate the Furnace shipped to Pleiss weighed about one ton.[71]

Workers first set empty shipping crates on wagon beds, then loaded the crates with stove parts. By using this method, workers did not have to raise to a wagon bed a crate containing as much as three tons weight. The area is not large enough to house a wagon. If we showed a crate filled with parts on the ground, we might mislead visitors. To avoid inaccuracy, we recommend showing the crate and its intended contents separate from each other.

Tuyere Arch Area

Object Number	Object and Location	Documentation	Recommendation
42.	Shipping crate, wood, addressed in painted handwriting, "Jacob Pleiss, Philadelphia"	Crownover 1970, 85ff	Reproduction; acquire.
43.	Stoves (13) No. 4, disassembled	Crownover 1970, 85ff	Reproduction; acquire.
44.	Stove backs and jambs (7), No. 4	Crownover 1970: p. 85ff	Reproduction; acquire.

[70] Crownover, Iron Stoves at Hopewell Furnace, 85ff.
[71] Crownover, Iron Stoves at Hopewell Furnace, 85ff.

Area Adjacent to the Cast House

To round out the historic scene, we recommend furnishing the area adjacent to the Cast House with reproductions of objects that were present in 1837. No graphic documentation survives of the historic scene in 1837.

According to Heydinger, the area adjacent to the Cast House would include "stacks of flasks, a pile of stacked pig iron, defective castings, flasks awaiting repair, and a pile of gate metal."[72] We recommend the same.

Object Number	Object and Location	Documentation	Recommendation
45.	Flasks (20), stacked	Heydinger, retype 31	Use worn flasks supplemented by reproductions.
46.	Pig iron billets (30), piled	Heydinger, retype 27	Reproduce in cast iron.
47.	Castings, defective (50)	Heydinger, retype 27	Reproduce in cast iron.
48.	Flasks awaiting repair (10)	Heydinger, retype 27	Use worn flasks supplemented by reproductions.
49.	Pile of gate metal (125)	Heydinger, retype 27	Reproduce in cast iron.

[72] Heydinger, Cast House Furnishing Plan, retype 27.

Associated Media

Associated media refers to the use of any of the following media in the historical context of the Cast House: wayside exhibits, interpretive panels, life-forms (high quality mannequins), audio stations, or audiovisuals.

The sentiment expressed by Superintendent Garrison in 1941 persists. "New attitudes on funding, staffing, and interpretive techniques must replace the old," reports the Long Range Interpretive Plan on page 7. This perception remains an enigma. In his e-mail memo of January 4, 1999, Hopewell Furnace Superintendent William Sanders states that the interpretive media at his site is of "vastly inferior quality" and "presented through outdated technology."[73]

In recent years, the technology of interpretive media at NPS sites has changed dramatically: audio programming on tape has given way to digital audio on a chip; film projection is being replaced by digital media on a television monitor or digital video projection; the Internet has allowed creation of a whole new medium, the park web page. Increased use of these media may help Hopewell Furnace interpret its many stories in a more lively manner.

Taking into consideration "the limitations of extensive reliance on personal services,"[74] this report recommends the following ideas to consider at the Cast House and throughout the rest of the site:

- Continued use of audiotape narration stations, upgrading them (if they have not been upgraded already) to digital quality
- An audio station to depict the sound of the waterwheel (when it is not running)
- An audio station to depict the din of the furnace (intermittently). However, doing so might be inaccurate and misleading because visitors might leave with the misimpression that a furnace could be turned on and off, much like a furnace in a home
- A mechanism to blow air as happens when the wheel runs and furnishes power to the bellows
- Updated wayside panels inside and outside the Cast House depicting the work that occurred there
- Audio stations throughout the village to depict the sounds of farm animals (dogs, swine, sheep, cattle, chickens, hens, horses)

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[73] William Sanders, bill_sanders@nps.gov, Memo on improving interpretive media in the National Park Service (Elverson, Pennsylvania: Hopewell Furnace NHS, 04/01 1999).
[74] Hopewell Furnace National Historic Site, Long Range Interpretive Plan for Hopewell Furnace NHS, 7.

- Wayside panels depicting the historic scene, perhaps using existing artwork from the park handbook
- Increased use of an already excellent park-developed site bulletin series to cover such topics in the Cast House as sand casting, products, and different trades
- An audiovisual production shown in the visitor center depicting the site in full operation. This would be a timely and accurate introduction to the site, and would allow a visitor to enter the present village with a fresh image of life at Hopewell Furnace in the 1830s.

Ideas proposed and rejected in earlier drafts included:

- Constant, deafeningly loud din of a furnace in blast. An audio recreating the din of a furnace in operation would be distracting to staff and visitors and would probably be turned off.
- Porcelain figures in fields and throughout representing different workers such as ironmaster, clerk, moulders, cleaner, patternmaker, and packer would seem contrived and would be costly, distracting, and difficult to maintain. This is the reaction of staff to the use of mannequins at Cornwall Iron Furnace, Pennsylvania. Though made of porcelain enamel baked on a base layer of steel, the porcelain figures would attract dust and dirt and would require constant (though simple) maintenance.
- Heat radiating from the furnace (impractical and wasteful of resources)
- Deforestation of woods around the site (not ecologically sound).

Any ideas for increased use of interpretive media are best addressed by a formal interpretive planning process outlining how current media (audio, video, waysides, publications, and exhibits) could be developed immediately and used to enliven interpretation at the site.

Although interpretive media can help supplement a lack of human activity at the site, the most powerful interpretation is the physical presence of humans depicting everyday life at the furnace. Lack of funding for such personal services is chronic; the site may well never be able to hire interpreters in period costume. The alternative is continued use and expansion of the popular park volunteer program. Another possibility is the use of increased weekend special events staffed by volunteers. Weekend special events have the advantage of attracting volunteers and visitors when they are most available.

As anyone who has administered a volunteer program will attest, however, volunteers need to be trained, scheduled, and supervised. Few volunteers are available all weekends during spring, summer, and fall months. An active volunteer program further requires considerable park resources, and these resources simply may not be available. Nonetheless, the increased used of weekend special programs using volunteers is an option. Even one special event a month does much to generate interest in the site by visitors and volunteers. The park could also investigate inviting independent, formally organized reenactor groups to give presentations on the weekends. These groups should be vetted for accuracy in their costume, gear, and interpretation.

Figures

List of Figures

Figure 1. Engraving, 1888. Interior of a foundry. *Scientific American.* The significance of this engraving is that it depicts different operations of a foundry used to cast large forms of iron. In the foreground, moulders carefully remove excess casting sand from mold before top and bottom of the molds are joined. In the left mid-ground, four workers hold the cope (top) of a two-part mold above the drag (bottom). They will carefully line up the two sections before pouring molten iron to make the casting. A worker at the far right mid-ground holds a riddle through which sand is sifted into the mold. Piles of sand and molds ready to be cast are located throughout the image. Source: Photo archives, Graphics Branch, Harpers Ferry Center, National Park Service, Harpers Ferry, West Virginia.

Figure 2 and Cover. Photograph, 1887. View of Cast House. This image postdates operations at Hopewell Furnace by four years; it postdates stove production at the furnace by about 43 years, if we accept that stove production ceased in 1844. Although Heydinger conceded that historians had not (and still have not) pinpointed the location where moulders cleaned castings, he proposed the wheelwright's shop would be rebuilt, but prospects for its reconstruction at the time of this report in 2003 are unlikely. Source: Photo Archives, Graphics Branch, Harpers Ferry Center, National Park Service, Harpers Ferry, West Virginia, image number 1932.

Figure 3. Line drawing by Norman Souder. 1964. Site plan of Cast House. (Drawing NHS – HV 3040, 1 of 8).

Figure 4. Line drawing by Norman Souder. 1964. Plan of Cast House. (Drawing NHS – HV 3040, sheet 2 of 8).

Figure 5. Line drawing by Norman Souder. 1964. Elevation of Cast House. (Drawing NHS – HV, sheet 5 of 8.).

Figure 6. Engraving, "The Inside of a Smelting House at Brosley, Shropshire, 1778." Wilson Lowery 1778. With permission of the Yale Center for British Art, Paul Mellon Collection.

This contemporary engraving helps substantiate the use of rope, block and tackle to lift a crucible of molten iron. Rope was cheaper than iron, easily replaced, and did not require an expensive, complicated chain hoist.

Figure 1. Engraving, 1888. Interior of a foundry. *Scientific American.* The significance of this engraving is that it depicts different operations of a foundry used to cast large forms of iron. In the foreground, moulders carefully remove excess casting sand from mold before top and bottom of the molds are joined. In the left mid-ground, four workers hold the cope (top) of a two-part mold above the drag (bottom). They will carefully line up the two sections before pouring molten iron to make the casting. A worker at the far right mid-ground holds a riddle through which sand is sifted into the mold. Piles of sand and molds ready to be cast are located throughout the image. Source: Photo archives, Graphics Branch, Harpers Ferry Center, National Park Service, Harpers Ferry, West Virginia.

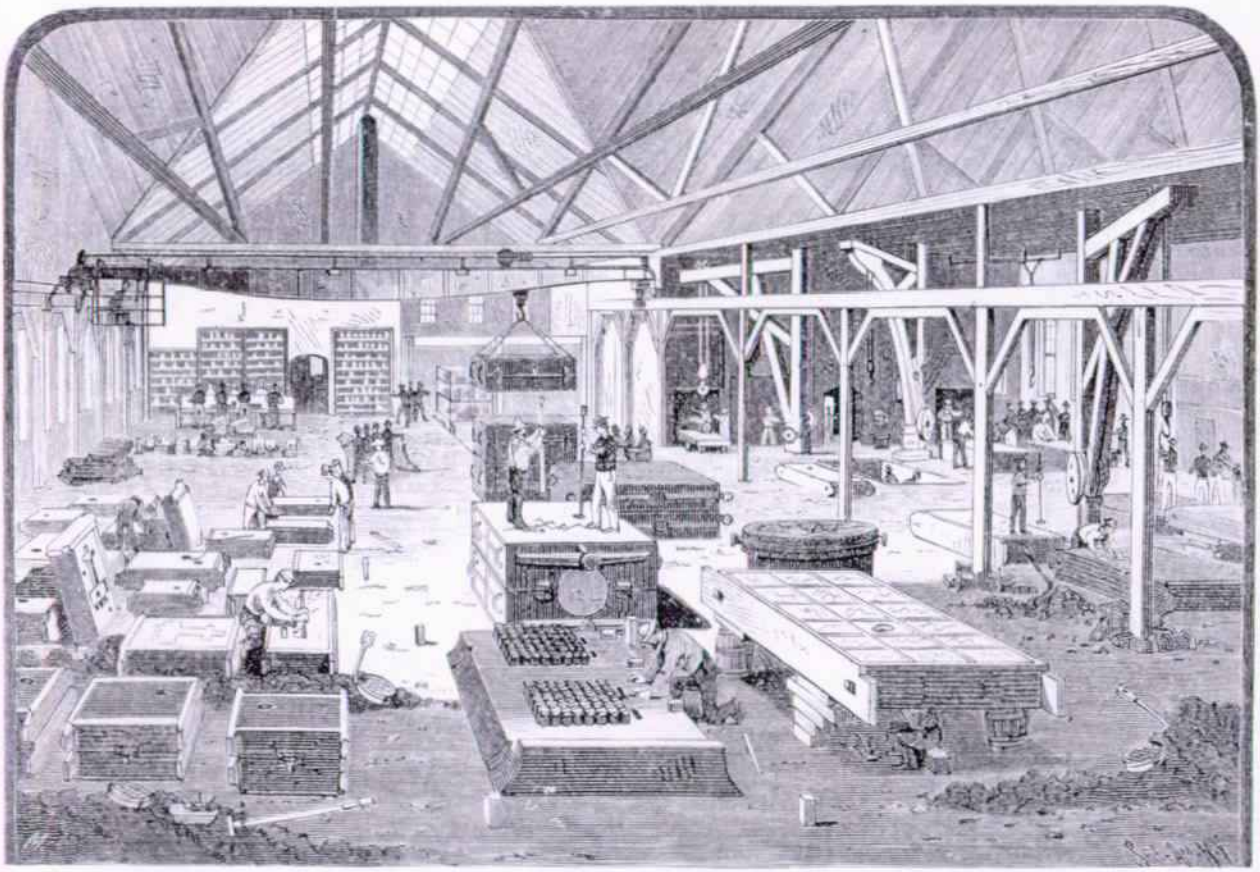
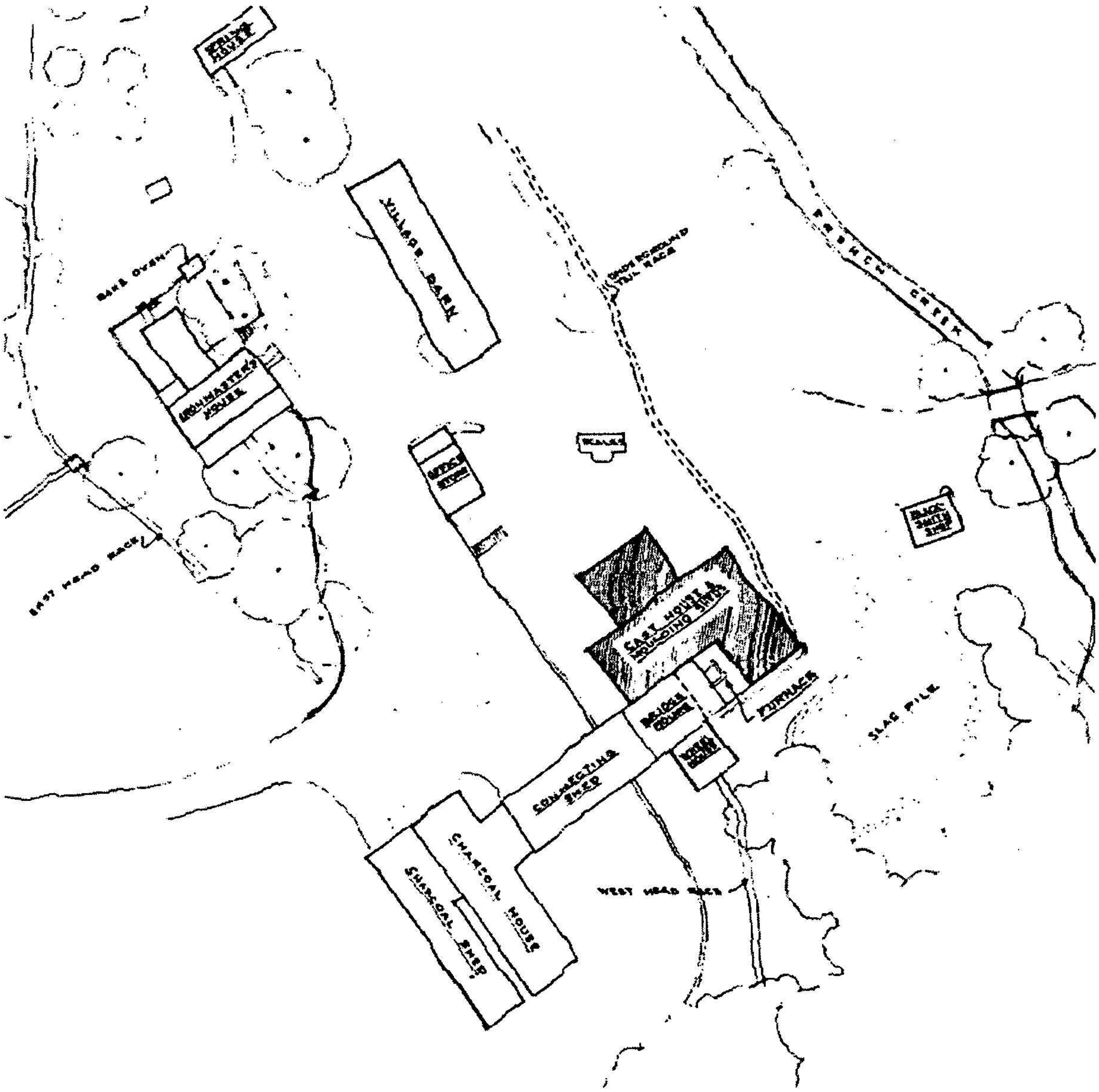


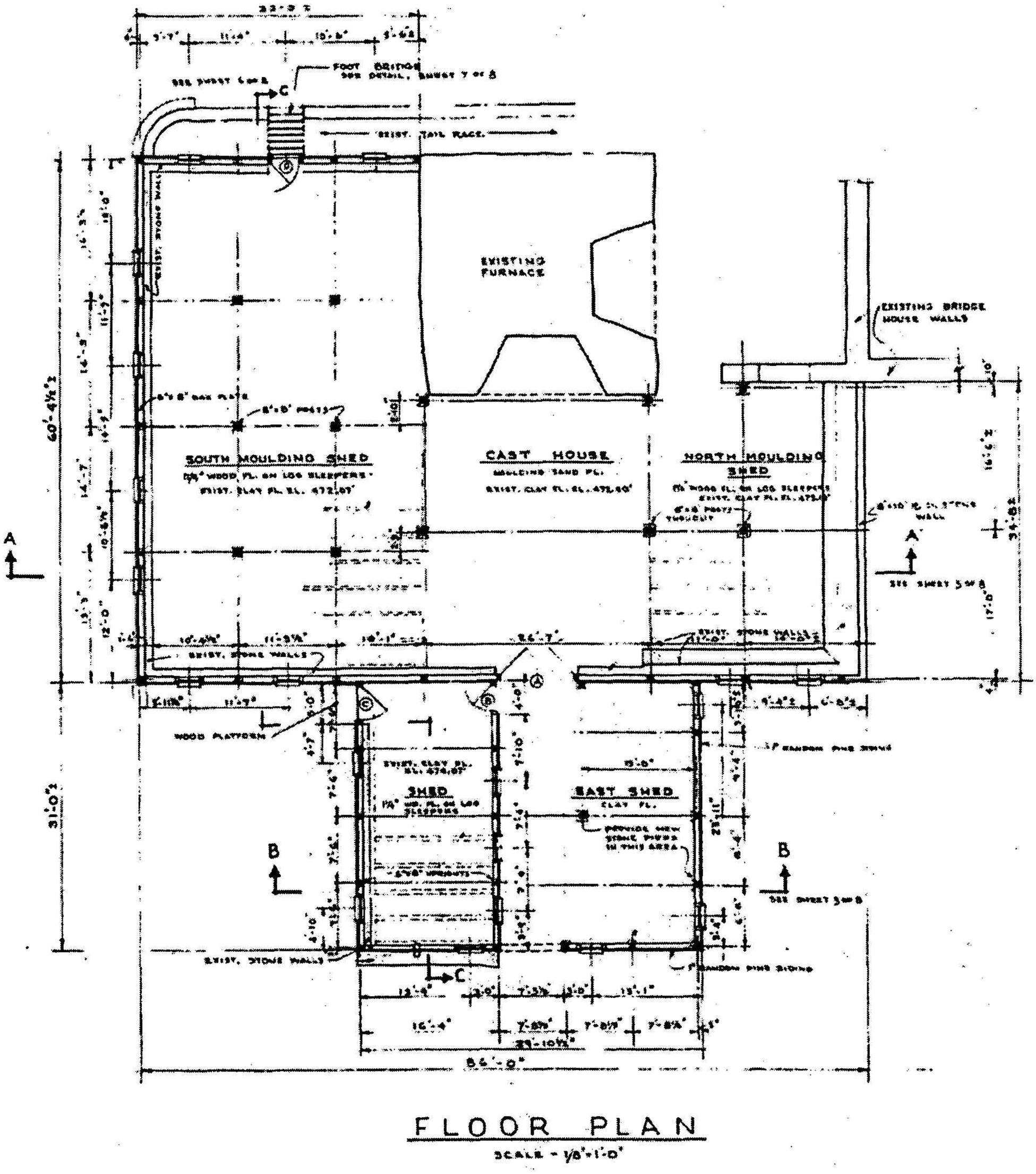
Figure 2. Photograph, 1887. View of Cast House. This image postdates operations at Hopewell Furnace by four years; it postdates stove production at the furnace by about 43 years, if we accept that stove production ceased in 1844. Although Heydinger conceded that historians had not (and still have not) pinpointed the location where moulders cleaned castings, he proposed the wheelwright's shop would be rebuilt, but prospects for its reconstruction at the time of this report in 2003 are unlikely. Source: Photo Archives, Graphics Branch, Harpers Ferry Center, National Park Service, Harpers Ferry, West Virginia, image number 1932.

Figure 3. Line drawing by Norman Souder. 1964. Site plan of Cast House. (Drawing NHS – HV 3040, 1 of 8).



VILLAGE BARN
IRONMASTER'S HOUSE
BAKE OVEN
EAST HEAD RACE
OFFICE STORE
FRENCH CREEK
CAST HOUSE & MOULDING SHED
FURNACE
BRIDGE HOUSE
CONNECTING SHED
CHARCOAL HOUSE
CHARCOAL SHED
WEST HEAD RACE
SLAG PILE

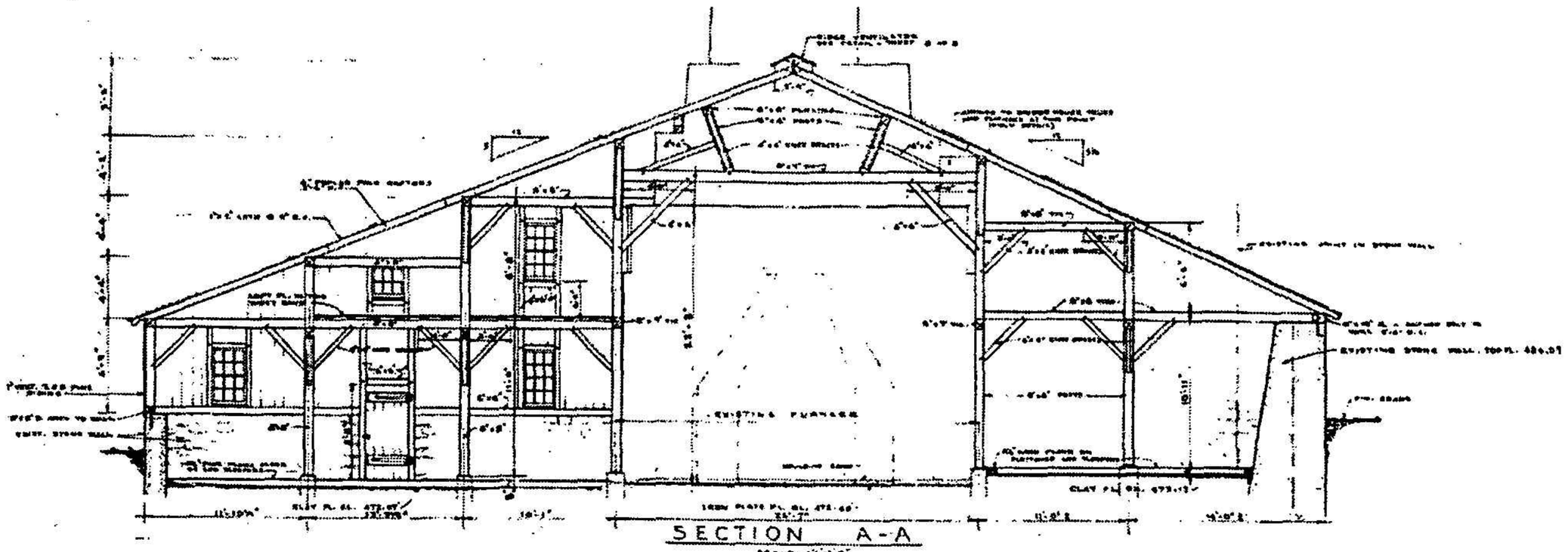
Figure 4. Line drawing by Norman Souder. 1964. Plan of Cast House. (Drawing NHS – HV 3040, sheet 2 of 8).



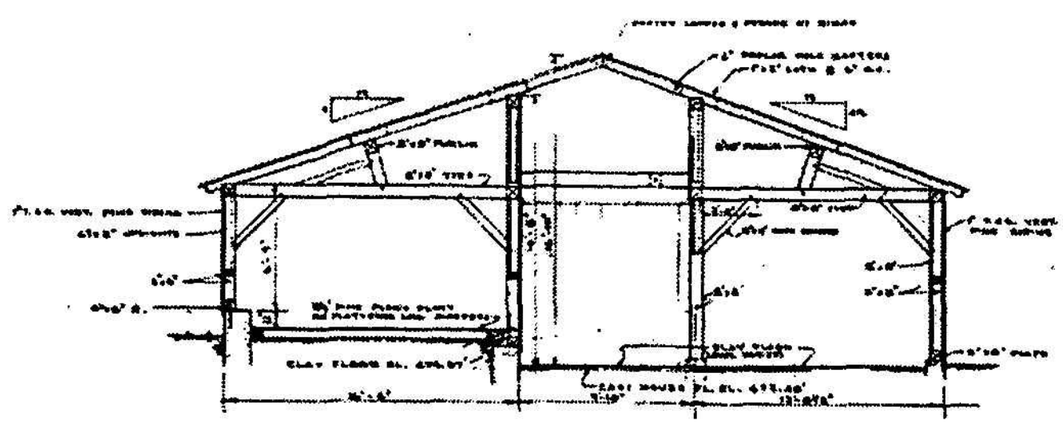
FLOOR PLAN

SCALE - ⅛"=1'-0"

Figure 5. Line drawing by Norman Souder. 1964. Elevation of Cast House. (Drawing NHS – HV, sheet 5 of 8.).



SECTION A-A



SECTION B-B

Figure 6. Engraving, "The Inside of a Smelting House at Brosley, Shropshire, 1778." Wilson Lowery 1778. With permission of the Yale Center for British Art, Paul Mellon Collection.

This contemporary engraving helps substantiate the use of rope, block and tackle to lift a crucible of molten iron. Rope was cheaper than iron, easily replaced, and did not require an expensive, complicated chain hoist.

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Appendix:

(Retype of original)

Cast House Furnishing Plan
for
Hopewell Village National Historic Site

by Earl Heydinger
1967

Appendix:
(retyped from original report)

Cast House Furnishing Plan

for

Hopewell Village National Historic Site

Elverson, Pennsylvania

by Earl Heydinger
1967

Contents

INTERPRETIVE OBJECTIVES

If the Furnace was Hopewell's heart and the red-hot iron its blood, the cast house complex was – in effect – its circulatory system. Here the molten iron produced by the furnace literally took shape in molded products either directly usable as "consumer goods," or indirectly usable (like bars of pig) in production of "wrought" iron goods at forges beyond the village area.

With the objective of "bringing alive" the historic scene in the reconstructed Cast House complex, it is proposed that it be refurbished (insofar as practicable) to illustrate an "operating" foundry of the period 1820 to 1840. Such refurnishing will reflect, particularly, the heavy emphasis at Hopewell in that period on stove production, but also the production of other products (pig iron, pots, pans, kettles – termed country casting – and plowshares) will also be suggested by furnishings and arrangements particular to their process.

Beyond illustrating the sheer "production process," the great bustle of activity, the clutter of production that centered in this building must somehow be suggested and interpreted. Necessary explanatory interpretive devices must, however, be kept to a minimum and be as unobtrusive as possible. Slate orders as in bridge house is one probability. Whenever possible, "living history" techniques must be employed: demonstrators in period dress, demonstrations particularly of molding techniques. Wherever possible, interpretation must be "personal," either by the demonstrators as they work or by National Park Service personnel describing the operation in progress.

OPERATING PLAN

Operation of the furnished Cast House will present several challenges. Among those recognized at this time are visitor participation, personnel for efficient interpretation, moisture at cast arch, rust prevention, need for visitor space and paths, and the need for many cleaners' rows. Each is discussed below.

Participation

As part of the furnishings in one moulder's row, a slate at a pile of damp sand, perhaps on a moulder's bench invites the visitor: "Squeeze this damp moulding sand and then open your fist. The retention in sand of your finger impressions is part of the pattern-sand moulding process."

Personnel

Ideally, a retired moulder would "putter around" in the Cast House. One of his duties would include the "control" of visitors and the keeping of displays in constant top

quality. Actual melting and the pouring of red-hot aluminum (and iron, if experiments prove this feasible) into flasks on a cold, damp weekend is another potential benefit. The pouring of a quick-setting red plastic is yet another potential. Student pouring of this plastic under his supervision might produce a product suitable for classroom display or for sale by the site. Naturally, the castings produced of metal would have to be small, in flasks within the capability of the moulder to handle. Stove lids, trivets, stove doors and latches are in this category.

Moisture at Cast Arch

Movement of up to 2,400 degrees of heat out of the chimney built into the furnace at the cast arch historically prevented rain from falling into the cast arch area. Until heat moves sufficiently through this chimney to prevent rain entrance, some method of moisture control must be installed over this chimney.

Rust Prevention

The Cast House today is as cold and damp as it was once hot and dry. The prevention of rust on the products displayed in position (in and out of sand) is another unknown to be solved through experience. The very visible presence of charcoal dust on all new castings is both natural and a must. Spraying these castings with oil (after removing rust spots, if any) may keep them black and rust proof.

Castings displayed as "cleaned" and in-the-crate ready for shipment likewise need a spraying with lacquer, wax, or one of the epoxies tested at Hopewell on casting exposed to the weather for several years.[1] This treatment is necessary to make them constantly appear as just-cleaned gray iron. Gate and pig castings may be either black from burned moulding sand and charcoal dust, gray as cleaned, or rusted, depending on whether they're displayed inside or outside the building. Piled outside displays of these two products may be rusty at the bottom of the pile and black at the top.

How much snow will blow into the display section of the Cast House is another unknown, but if winter storms film castings with snow, plastic covers may be necessary. The storage of displays during the active snow season may become a preventive maintenance function. And an annual (or more frequent) cleaning of rust from displays may become necessary.

Should rusting become a major problem, castings of aluminum or of Ni-iron (as cast at Weatherly, Pennsylvania) may be necessary.[2] Naturally, this cost is unknown. However, casting demonstrations at the site, last sponsored by ENP&MA [Eastern National Parks & Monuments Association], produced castings of aluminum at the cost of ingots, about 25 cents a pound.

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[1] Polytok A-C mixture, an epoxy, proved most rust resistant for clean iron. *Report Iron Preservation* 25 July 1967.

[2] Letter, Grede Foundry, Milwaukee, Wisconsin, 20 October 1965.

Visitor Space
To include this topic in a furnishing plan is necessary. If space is not provided, the visitor will "make and take" space. Without doubt, most of the tuyère arch area, in front of the popular waterwheel, was once used for stove production. However, except for a stack of flasks to suggest this use, that area will be without furnishings.

Likewise, visitor space and passage must be provided within the Cast House, not only for ordinary visitation, but especially for demonstrations and at the observance of Establishment Day. As long as air pumped by the historic waterwheel is used to fire the metal-melting "cupola," space on those days at the cast arch will require hiding of displays otherwise visible. This means that the clay kettle, ladle pit, and the flask-clamp casting display will be hidden during demonstrations. Experience gained from setting up and operating the furnished Cast House will eventually determine the space needed for visitors. Safety is another factor. Stacked flasks, piles of gate metal, furnace tools and other furnishing items will suggest non-entrance at various points. Specific planned paths include an entrance to the waterwheel-tuyère arch area and a passage out of the rear (west) door of the Cast House. Naturally, there will be an entrance for the visitor into the sand floor section of the building.

Traffic will be kept out of the operating-display section of the cleaning annex by crate and other barriers.

Cleaning Annex & Moulders as Casting Cleaners
Every casting had to be cleaned to reveal defectives and to save shipping charges. The cleaning, packing, and shipping of castings had to keep pace with the furnace moulding output. Product had to move daily into and out of the cleaning annex, perhaps three times daily. (And until more space is available, *all* cleaning will have to be shown here.)

To report that 5,000 stoves passed through this cleaning process annually is understating the fact. For instance, the most common nine-plate circular stove consisted of nine outside and three oven plates, plus three doors (each with separately cast latches) and two stand plates (or dovetailed feet).[3] Some stoves consist of 20 plates, hence, 15 plates times 5,000 stoves is 75,000 flasks of moulders' work or stove plates annually.[4] This production is the reason for the huge 80' x 60' Cast House.

A partial list of 1831-37 castings cleaners includes 20 persons: a carpenter, a collier, a keeper, moulders, women, and at least four boys. Even the highest-paid furnace employee, founder Thomas Care, earned extra pay in this cleaning process. Paid cleaners varied annually from four to seven and moulder-cleaners from three to eight. Individual cleaner earnings found to date varied from $2.20 to $40.88. (Recall that an 1832 dollar at Hopewell bought 22½ pounds of beef before passing judgment on work value.)

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[3] Circular stoves were also in nine sizes with two different tops and at least three different weight bottoms for each size.
[4] *Hopewell Record*, SM 64, 6.

Need for Cleaning Space

No matter how many cleaners or moulders there were, there had to be a cleaning row for every moulder so that his output could be credited to him after cleaning and deliveries could be made with confidence and savings.

Not only did moulders earn 75 cents a ton by cleaning castings for their coworkers, but the absence of record entries implies that they cleaned their own production as well. That moulders here worked an eight-hour shift is based on record entries and tradition in the nearby moulders' union. Hence, Hopewell moulders worked extra time to clean their own and other moulders' production after working their own eight-hour moulding pouring day. That the furnace owners knew of this "moonlighting" is proven by the record entries, generally under each moulder's semi-annual production credit.

Furnace-founder Thomas Care is a prime example of such double-shift work. Sixty-one years old in 1836, he cleaned castings for other moulders, moulded, and by the absence of charges against himself or credits to others for this service, cleaned his own castings. Know-how of furnace activities was his skill. Responsible for furnace operation paid by the grade of iron he produced, Care did have two keeper-helpers, one for each 12-hour shift.[5] He paid these men. Moreover, one of his keepers, Barney Hart, also cleaned castings and "pounded" charcoal parting dust for moulders.[6]

Analysis of Historic Occupancy

The L-shaped Cast House was the center of activity for all those workmen involved in converting the molten iron produced in Hopewell Furnace into marketable, usable cast-iron products either directly into consumer goods (like pots and pans or plates for stoves) or into the bars of pig iron which (at an iron forge) could be shaped into wrought-iron consumer products. In the peak period of 1820 to 1840, this involved a work force (in addition to the founder who ran the furnace and tapped the molten iron his keepers, fillers and workers involved in crating and shipping) of 12 to 16 moulders on a three-shift basis and probably an equal number of casting cleaners.[7] In a typical year during the 1820 to 1840 period cast iron plates for as many as 5,000 stoves were produced in the Cast House, as many as 75,000 plates in addition to varying amounts of such items as pots, pans, kettles, sash weights, plow castings, street and window grates, ladles and flask clamps.[8] (Gate iron was a by-product of all flask casting.)

In terms of floor space, the principal activity in the Cast House was the making of moulds in box-like flasks, each moulder in the north and south moulding rooms (see floor plans) typically working a "row" consisting of a bench with moulding tools, a row-pile of moulding sand, a basket of wooden stove patterns, a stack of empty two-part flasks (each

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[5] *Hopewell Record* SM 14, 30 May 1829, 30b is an example.

[6] Ibid., SM21, 13 March 1834, 19 January 1835, 10 March 1836, and 18 January 1837 list payments to Hart. Two are over $20.

[7] *Hopewell Record*, SM 46M, 25 September 1825.

[8] Ibid., SM 39. In 1839 the furnace produced 5,112 stoves.

with a follow board), individual flasks in varying states of completion on bench or floor and individual completed flasks with funnel-like "gates" visible and lined up ready for the pouring of iron thereinto, plus flasks showing red-hot iron, just poured.[9]

The moulding process basically involved shaping (by wooden patterns and special tools) a hollow space inside sand-filled flask halves secured during pouring by iron clamps. This simplified description does not do justice to the great skill required in the clean shaping of the mold left by the pattern. Into the molded space inside the flasks red-hot iron was eventually poured through the funnel like "gate." Cooled, and shaken out of the sand, the result was a casting, nearly always in these peak years, a stove plate.

Typically – after "moulding up" during the most of his eight-hour shift – the moulder took his turn with the ladle under the tap hole in the front of the furnace cast arch, hurriedly carried therefrom his 50 pounds of red-hot molten iron back to his moulding row where he poured it piecemeal into the gated flasks that he had earlier prepared. Sometimes he and the man on the next row adjacent had to work together in the making and pouring of an extra-large flask. After being shaken out, the casting was still not ready for crating and shipping till it was degated and brush cleaned. This phase of the work was done in the cleaning room, again by moulder working rows. The process was particularly important in uncovering defective castings.

Naturally there had to be storage space for the many hundreds of patterns used in the casting of Hopewell's iron. Suggestive of the quantity is the fact that in 1837 Hopewell made castings for as many as 140 different types and varieties of stoves, and some stoves had as many as 15 plates.[10] Archeological and architectural evidence suggests a loft storage area over part of the south molding room, exact storage arrangements therein unknown, but most likely in bins.

On the north side of the east entranceway to the Cast House, an archeologically-uncovered area is tentatively identified as a probable loading space; construction of new moulding flasks, the repair of old flasks and shipping crate construction might have taken place here also.

Necessarily there would be clutter and mess everywhere in the Cast House complex discarded defective castings, gates (the holes in the flask through which molten iron flowed), slag at the hearth, stacks of pig iron (from the casting area in the sand floor in front of the casting arch), piles of castings, unrepaired flasks, lumber for crates, crates in process, etc.

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[9] Moulding in rows continues today in non-automated foundries. Being paid by the pound, the moulder's product had to be kept separate to properly pay him.

[10] The most common stove was the "Circular," also termed a "nine-plate" stove. It consisted of a top, bottom, two sides, three doors, a front, back, three oven plates, two base plates, plus three door latches. *Hopewell Record*, SM 64, 6 presents extreme cases of 18, 19, 20, and 25 castings to a stove.

Moulders
Moulders working during the long blast, January 3, 1836, to April 16, 1837, featured in museum displays were:[11]

Care, David
Hart, Peter
Care, Nathan
North, George
Care, Thomas Sr.
Painter, Frederick
Care, Thomas Jr.
Painter, John Jr.
Elliot, Joseph
Painter, Montgomery, a minor, as his father John Sr. collected his wages.
Hart, David
Sheeler, John
Hart, Joseph
Walters, Michael

Cleaning Annex, Moulders as Casting Cleaners
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To report that 5,000 stoves passed through this cleaning process annually is understating the fact. For instance, the most common nine-plate Circular stove consisted of nine outside and oven plates (3), plus three doors (each with separately cast latches) and two stand plates (or dovetailed feet). Some stoves consisted of 20 plates; hence 15 plates times 5,000 stoves is 75,000 flasks of moulders' work, or stove plates annually. This production is the reason for the huge 80'x 60' Cast House.

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Need for Cleaning Spacing
No matter how many cleaners or moulders [there were] there had to be a cleaning row for every moulder so that his output could be credited to him after cleaning and so that deliveries could be made with confidence and savings.

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[11] HR, SM 21, 27 December 1836; 9, 17, 18, and 19 January 1837. Records for the end of the blast did not survive.

Not only did moulders earn .75 ton by cleaning castings for their coworkers, but the absence of record entries implies that they cleaned their own production as well. That moulders here worked an eight-hour shift is based on record entries and tradition in the nearby moulders' union. Hence, Hopewell moulders worked extra time to clean their own and other moulders' production after working their own eight-hour moulding-pouring day. That the furnace owners knew of this "moonlighting" is proven by the record entries, generally under each moulder's semi-annual production credit.

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Evidence of Historical Furnishings

Apart from items relevant to the moulding of products other than stoves and items involved in the handling of molten iron and (cooled) slag at the furnace hearth, the annual production of 5,000 stoves visibly dominated the 1820-40 casting-house scene, in terms of equipment, work arrangements and output. Here, up to 16 moulders, working on a three-shift basis, poured liquid iron into 75,000 flasks in a year producing a single stove plate per flask. Evidence about pertinent 'furnishings is presented by area within the Cast House and its Annex.

Cast House Furnishings Areas

The furnishings required were used (and will be displayed) in seven locations: (I) the Cast Arch, (II) the Moulding Rooms, (III) the Cleaning Annex, (IV) the Loft, (V) the Tuyère Arch, (VI) the loading area of the Cleaning Annex, and (VII) piled around the Cast House exterior.

[Cast House Drawing was inserted here in Heydinger's original report. – ed.]

Cast Arch

The following equipment was historically used at the furnace cast arch:

Bed of just-cast clamps

Because most of Hopewell's iron went into finished product before 1840, an extensive pig bed was never present. Bed stove iron, known by a quick chill test, became pig. Another and yet more historic type of casting was that of flask clamps, a necessity for moulding, and flat-bed cast.[14] A small bed of these just-cast clamps, a series of smaller within larger, fits into the cast arch area. (If necessary, these can be removed or covered when casting demonstrations require this space.) An area only two feet square

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[12] Hopewell Record, SM 14, May 30, 1829, is an example.

[13] See FN 2, E-24

[14] Hopewell Record, SM 8, Nov. 8, 1816 and SM 32, Mar. 31, 1849.

accommodated this production. Iridescent red paint will give a hot appearance. A new MET sign at the furnace now calls visitors' attention to this bed of flask clamps.

Lamps
At least one fat lamp was probably at the cast arch for lighting that area and for the founder's use at any area.[15]

Pig bed, created as needed
In the pre-1840 period most of Hopewell's iron became flask-cast stove plates. Therefore, it is probable that when iron quality was known to be inferior, (a quick chill-and-break test showed this) a bed for pigs was ready to receive this inferior iron.

On a typical day flask clamps and sash weights would be other flat-bed cast products.

Iron clay kettle and clay
Clay was the medium used to plug the damstone taphole and to line the iron ladles, which carried liquid iron to the flask. Hopewell's historic iron kettle, which held this clay was uncovered at the right side of the furnace cast arch during archeology and will return to the cast arch as the functioning wet-clay kettle.[16] This is the late period location; the earlier location is unknown. This kettle is probably a broken Hopewell-made butcher kettle. Local clay is without cost, except for labor.

Cast arch tools
No furnace control-operating tools used by the founder have been found to date in Hopewell Records and Documents. Such tools were fundamental. However, Diderot presents a drawing of this founder equipment[17] and English iron authority of Schubert, copied the Diderot illustration and presented a description of the five. Further, Schubert lists them as "the most important," and said about them: "These remained the same throughout the period in which the smelting of iron was carried out in charcoal blast furnaces."[18]

By name these tools were: (1) the great long ringer, up to 15 feet long and weighing from 36 to 44 pounds; (2) a smaller ringer about 12 feet long and weighing from 27 to 32 pounds; (3) the cinder hook of unstated size and weight, but illustrated with the other five tools; (4) the tuyère hook "considerably smaller than 3 inches" and of unstated length and weight; and (5) the placket, designed towel-like to shape and smooth the clay in which the tuyère was fixed. Again size and weight are absent.

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[15] H2215 Interview , Harker Long, 12. This late tradition placed a coal oil torch in the bridge house.
[16] H2215 Interview, Henry Johnson; Leland Abel, Archeological Excavations at Hopewell Furnace, March 6, 1964, 50, hereinafter cited as Abel.
[17] Diderot, Plate IX, "Forges, 2d section, Fourneau Ö fer, Couler la Gueuse." No [English] translation of Diderot is at the site.
[18] H.R. Schubert, History of the British Iron and Steel Industry from 450 B.C to 1775 (London, 1957) 239, 240;, the illustration presented is a duplicate of the above Diderot.

In addition, cinder hooks and shovels were necessary to move the partially cooled slag.[19]

A Cornwall Furnace drawing of an unstated date, but contemporary with Hopewell, shows that furnace's adaptation[20] to the French-English presentation of Schubert. Without doubt, every founder had his pet variation of these tools.

No cast arch tools survived at the site.

Slag

Along with the iron, slag flowed from the furnace at the cast arch three times daily. As the refined iron filled the interior furnace hearth, slag floating on the top of that iron automatically ran out of the hearth over the dam stone. At casting, the remaining slag was pulled off. Overmann recommended a pair of pits for the collection of this slag,[21] but tradition and documents at Hopewell are mute about pre-1840 slag handling.[22]

Probably on any pre-1840 day there was a pile of broken slag at the left hand side of the cast arch (near the water trough) awaiting movement to the outside slag pile. This slag, remaining from an earlier furnace tapping, probably moved to the slag pile in an animal-powered, two-wheeled cart. An appropriate cart is at the site.

Water supply and trough

Hopewell has three traditional accounts of water at the cast arch of the furnace. Two list the cooling of the furnace tools as the reason for trough and water.[23] The third ascribes the water use (without mentioning the trough) as "to wet the sand."[24] Both tool-cooling and sand-wetting need existed historically. Diderot does not show water at the cast arch. Archeology uncovered a lead water pipe at the cast arch. Archeologist Abel dated it by reporting [it was laid] "sometime after the (clay) floor was laid and probably after the building was abandoned."[25] This lead pipe waterline may date from the 1850 installation of a hydraulic ram or the present 1870 water system.[26]

The other traditional source presents a different and earlier water supply.[27] "An iron pipe (about one inch) ran from the east headrace trough along the west and south faces of the furnace and then into the casting house. Water (was) used to wet moulding sand." This

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[19] Ibid.

[20] Hopewell Photo 1959-441.

[21] Frederick Overmann, The Manufacture of Iron in All Its Various Branches, etc., 34d Edition, (Philadelphia, 1854), 206.

[22] H2215 Interview, Harker Long, 1, "hauled away by mule teams." This is post-1867.

[23] H2215 Interview, Thomas Hoffman, 5, and H2215 Interview, Sally Boone and Son David, II-2.

[24] H2215 Interview, Henry Johnson.

[25] Abel, 69.

[26] Hopewell Record, SM 31, Mar. 29, 1850. Lead-pipe soldering in 1854, in SM 65, Sept. 23, 1854, is the sole clue found to date on early lead-pipe. Today's system dates to 1870, SM 34, 209a, but lead-pipe is purchased in 1872, as well. (See SM 62M, Nov. 16, 1872).

[27] H2215 Interview, Harker Long, 12.

informant was evidently speaking of the cast house period before the lead-pipe installation.

Since archeology found no evidence of a drain, either water supply was most likely controlled by a valve.

A water-supply trough,[28] old-looking and burned near the size of the traditional trough is at the site of the cast arch.

Crane and Chain-Supported Tools
While portrayed by Overmann, there is neither documentary nor traditional evidence that a crane ever existed (or that chains suspended tools) at the cast arch. A two-man ladle carrier plus the half-dozen moulders constantly present, seemingly provided sufficient metal handling capacity.

Pig bed mosaic
The layer of stove plates and stones, uncovered archeologically[29] and used historically to cool pig iron more evenly, has been reburied under burned moulding sand. To show this mosaic would require electricity and a glass or plastic panel. With the ever-present sand neither plate would stay clear long. Historically, this mosaic was not visible.

Moulding Rooms
In the north and south moulding rooms, moulding equipment will be shown in moulder's rows.

Moulder's Production Rows
Moulder's rows were necessary to keep every man's production separate; each moulder was paid for his individual production. Records[30] list this production by the individual moulder.

Ten rows[31] probably existed in the two moulding rooms. In them, fourteen stages of moulding must be depicted. Every row contained flasks, sand, followboards, flask clamps, tools and a bench (with exceptions as noted.) Some must present castings protruding from the row sand. The actual number owned and used depended on the whim of the individual moulder

Nine historic steps show flask preparation before liquid iron is poured into them. These steps are:

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[28] H2215 Interview, Thomas Hoffman, 5.
[29] Abel, 51.
[30] Hopewell Records, SM 74 M, SM 22, SM 55 and SM 49 cover individual production for 1831, 1832, 1837 and 1839.
[31] Records, and tradition are mute about row numbers. Moulding rows also existed on the sand floor from the cast arch to the Loading Annex and at the Tuyère Arch, but most of these areas must be reserved for visitor use.

1. A wooden pattern is on a followboard in flask half, noticeably partly dusted with charcoal dust—a black cloth charcoal dusting bag is dropped on the pattern. If small, this flask half is on a bench; if large, on the floor.

2. Yellow Albany moulding sand is partially sifted over a dusted pattern in a flask half on a followboard. A riddle (sieve), partially filled with Albany sand, rests on the flask half.

3. Flask half is partially rammed with Albany sand; a shovel is in the sand of the "peaked" row underneath the bench. A hand rammer is in the flask and a long double-end rammer, one end on the floor, leans on the flask.

4. Flask half with rammed sand is partially "struck off" (evened) with the hand strike in position at the edge of sand in the unevened part of the flask.

5. A second followboard is clamped onto the flask-half and the first followboard with two flask clamps. This flask half is now ready for turning so that the second half of the flask may be worked on.

6. The pattern is re-exposed by the removal of the original followboard. The second flask half is now over the first. The opposite side of the pattern is charcoal dusted and partially riddle-sanded with Albany sand.

7. The complete flask is now shown filled with rammed sand and with the wooden gate pattern either in position (suggesting its removal) or removed and stop the flask.

8. Flask is opened at its "parting line" and lean-propped open by a long rammer from its rear. The "rapped" pattern has been lifted from the sand, which shows the pattern details very visibly. Newly cut molten metal feeders are vividly visible since charcoal dust makes a sharp contrast between the earlier moulding work and the recent feeder cuttings, new yellow sand against the black background.

9. A completed flask, ready to receive iron in its gates, secured with a pair of flask clamps is ready to be lifted from the bench to the floor, or is already on the floor if the flask is large.

These minimum nine steps present flasks in rows before metal pouring, "ready to pour." Five additional steps are required to present the just-poured flask and the iron stove plate just shaken out of the flask. These steps consist of:

1. Rows of completely "moulded" flasks in front of the benches (with the bench against the wall) or a row of all large floor flasks, ready to receive metal. All sand flask tops show open empty gates.

2. Rows of flasks with gates showing "hotness" iridescent red paint. These are just-poured flasks, containing hardening iron and nearly ready for "shake out."

3. Rows of empty flasks alongside a pile-row of sand with shaken-out castings protruding from the sand in a natural way, as they would fall from the flask. The exposed castings are charcoal dust and sand covered.

4. Rows of "peaked" sand and flasks with followboards and flask clamps alongside, ready for moulding. A charcoal basket of patterns is on the moulder's bench which is as distant from the wall as possible, at the very end of the moulder's row.

5. Same as #3, but with a pile of cast stove plates, some degated, at the sand edge of the floor. Gates are on piles alongside. The row shows the "missing" castings; the remaining row space has stove plates protruding from the sand pile. Their gates are visible.

These 14 moulding and pouring steps will be called to all visitors' attention by the inclusion in the Guide Literature, or by an attendant, if present. The following moulders' tools are to be appropriately placed in the moulding rows to create the 14 displays enumerated above. Not every row had every tool; moulders supplied themselves then, as now, with the tools each felt necessary to produce the most castings possible.

Bellows

These hand-powered tools, of unknown size and shape historically, possibly similar to those used at fireplaces today, were necessary to blow away any surplus sand from the pattern at the parting line of a nearly-completed flask. A second was used to remove surplus sand after the moulder had repaired a damaged portion of a sand pattern within the flask.

Two bellows are listed to an 1800 Hopewell Inventory and another one in an 1800 purchase.[32] No others have been located to date in records and documents. Seemingly, the furnace furnished this tool (as well as ladle carriers, ladles, shovels and cleaning brushes) to the moulders without cost.

Overmann in 1851 specifies "several small bellows" as necessary moulding equipment.[33]

Representative donated bellows are at the site in numbers sufficient to suggest their need and use and probably appear as historic bellows did.

Brush, moulder's

A moulder's brush enabled that craftsman to safely remove surplus sand from his work. Brushes, as items bought and sold at Hopewell, are many entries in the Records. However, few are specifically listed as a "moulder's brush." A "potter's brush" is in the 1800 Inventory and an 1816 entry mentions the purchase of a "moulder's brush" by an

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[32] Hopewell Document, X800320 and Record, SM 2, Feb. 17, 1803.

[33] Frederick Overmann, Moulders' and Founders' Pocket Guide, etc. (Philadelphia, 1872), copyrighted in 1850, 30. Hereafter cited as Overmann.

individual. Seemingly, as the bellows, etc., these brushes were furnace-furnished. Size and shape are unknown.

Overmann calls for a "piece of rope" in 1851, adding that for "tufts," paint brushes could be used.[34]

These brushes probably resembled the brushes used by moulders today.

Brush, cleaning
Records regularly show payments from moulders to casting cleaners,[35] but are without entry as to the type of brush used. Most likely the modern moulders' brush is similar to those used historically.

Casting stove-plate
Historically, stove-plates were the profuse product visible in mouldings rooms. These were visible in the sand of the row and piled at the rows' ends with their gates attached. On barrows, but without gates, they were en route to the cleaning annex for removal of sand and charcoal dust to determine the quality of the casting. A pile or barrow of gates was near the degated castings. Each moulder's product was kept separate for bookkeeping purposes. Hopewell made 140 kinds and types of stoves in 1837.[36] Degated castings cleaned (and appearing gray) and uncleaned (appearing black with charcoal dust and burned moulding sand), also were very prominent in the cleaning annex.

Clock
The sole reference to timekeeping in the Cast House is in a list made by the CCC Historian Jackson Kemper c. 1935, "Equipment, Trappings, etc., belong to or made at Hopewell at one time." This compilation reads, "Old clock which hung in the Moulding House. Property of Charles Care, Birdsboro, Pa."[37] No description of this clock exists in Hopewell Records or Documents, nor is the date of purchase known. Hence, there is no evidence for a pre-1840 clock here.

Chills and chaplets
Since the site has been unable to secure identification of archeological items thought to be chills – used in moulding within the sand of the flask to control the cooling rate of the iron cast – these rasps will be NOT be shown. The only identification offered to date suggested that they have been used in removing the core from cannon.[38] Mark Bird did cast cannon at Hopewell,[39] but broken "rasps" were found in profusion.

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[34] Overmann, 30.
[35] Hopewell Records, SM 41M, 24b, Apr. 20, 1784, to SM 21, 190b, Jan. 19, 1837 reflect these payments.
[36] Resume Card 1837, Store Research.
[37] French Creek Project, Mr. Kemper in File H2215 Interview, Harker Long.
The H2215 Interview, Mr. and Mrs. Charles Sheridan Care does not mention a cast-house clock. Mr. Lee Care, son of above, did not recall his parents owning this clock. Jan. 1969.
[38] Letter, Aug. 7, 1967, from Grede Foundries, Inc., Milwaukee, Wisc.
[39] Hopewell Record, SM 41 M Aug. 12, 1784 and Jan. 17, 1785, sells three cannon at pig iron prices.

Country castings, especially teakettles and kettles may have used core-supporting chaplets, but only proposed display of such production[40] suggested is that of defective pots, pans, skillets and kettles secured from modern manufacturers. The archeology-found devices thought to have been chaplets were not identified by knowing correspondents.[41] As with chills, chaplets will not be displayed.

Country castings and plowshares

By demand of the neighborhood every furnace cast pots, pans and kettles, "country castings." The sale of these castings and plow parts are regular entries in Hopewell Records until the early 1830s.[42]

However, no clue exists nor has a pattern survived identifying any existing "country casting" as made at Hopewell.

Old-looking triangular flasks (at the site) probably look like historic plow-point flasks.

An outside pile of defective pot, pan and skillet castings show this furnace production.

Flasks

A flask is a two-part wooden frame (and a followboard) within which a moulder reproduced an iron copy of a wooden pattern. By his skill the moulder created a hollow space in sand within the flask, filled it with liquid red-hot iron and thereby reproduced an exact copy of the wooden pattern. To cast up to 5,000 stoves annually required Hopewell's moulders to use (and reuse) about 75,000 flasks, one stove plate produced by one moulding. This was the reason for the 80'x 60', L-shaped Cast House, as well as the large – but not large enough – piles of representative flasks presently within and around the structure.

Flasks are illustrated in Diderot's *L'Encyclopedia, ou Dictionnaire Raisonnes des Sciences, des Artes et des Metiers* (Paris, 1793).[43] That Hopewell used flasks as early as 1784 is suggested by the payment to the furnace founder for the production of "62 tons of ladled iron."[44] Records regularly reflect the manufacture of flasks.[45]

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[40] Country casting production at Hopewell ended in 1833. Hopewell Record, SM 21, 92, Feb. 13, 1834, lists the shipment of their patterns, flasks and followboards.

[41] Letter, Sept. 1, 196,7 Grede Foundries.

[42] The sale of country casting patterns, flasks, the ending of their production entered Hopewell Record SM 21, 92b under the date of Feb. 13, 1834. A note below the entry states, "Note, the above flasks and patterns were delivered to the canal, Bannon's Landing, the 24th of July 1833."

[43] Diderot, Plate IX, "Forges, ed. Section, Forneau en Merchandise, Coulage a la Poche" and Plate V, "Forneau en Merchandise, Moulage en Sable," and plates VII and VIII. This encyclopedia is hereafter referred to as Diderot.

[44] Hopewell Record, SM 41 M, Apr. 8, 1784. That ladles would be used to produce open flat-bed castings is opposite the practice illustrated by Diderot , Plate V.

[45] Examples include: Hopewell Document X8000320, listing flasks at Hopewell when Brooke and Buckley took over Hopewell in 1800; Hopewell Record SM 15, Mar. 17, 1831, listing 18¾ days by a carpenter

The large stock of burned and weather-stained flasks on hand, displayed in and around the structure, are probably counterparts of pre-1840 stacks. A number have been altered to a more historic appearance of the single historic flask half surviving at Hopewell.[46]

Flask clamps

A pair of cast-iron flask clamps held the top half of every flask securely to the bottom half, thereby preventing weight of the liquid iron within the flask from lifting the top half and spoiling the casting. At least a pair were necessary for every flask. These modified U-shaped castings (as many other items listed herein) were never charged at Hopewell as a production cost. Seventy recorded in 1816 and the sale of over 1200 pounds of clamps in 1849 are the sole production clues to this necessary article found to date.[47] Yet every archeological dig has produced whole and broken clamps in quantity.[48]

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making flasks in 18309 [*sic*]; and in the last stages of stove production, Hopewell bought flasks from neighboring Isabella Furnace: Hopewell Record, SM 32, Oct. 12, 1846, "got May 23, 1843."

[46] Hopewell Catalog #615 displayed in Exhibit 11 of V.8.

[47] Hopewell Records, SM 8, Nov. 8, 1816; and SM 32, Mar. 31, 1849.

[48] Their profusion is illustrated by a single-page field specimen group from the Cast House: FS 738, 740, 745 and 751. From Field Catalog: Artifacts Recovered during Archeological Excavations and Stabilization in 1962-64, by Leland Abel.

Ladles and ladle carriers
Ladles and the dipping into the forehearth of the furnace for liquid red-hot iron are shown in Diderot.[49] At Hopewell it is believed (account of the historic floor level) and proposed that a pit beneath the damstone tap hole be made to allow moulders to catch running iron in clay-lined iron ladles for carrying to the moulder's rows. All moulding occurred at the end of a moulder's shift, three times a day.[50]

Ladles, by documentation from 1800 to 1840,[51] consisted entirely of forge-hammered shell, which, when lined with clay, were probably lighter than cast ladles. But Hopewell most certainly cast its own ladles, but as with food, for boarding furnace employees and for partner Clement Brooke and for flask-clamp-making, no record entries have been located for such ladle casting. Modern ladles fit the ladle carrier found archeologically.[52]

Ladle carriers
A ladle carrier is an iron rod with a loop at its bottom to accommodate a ladle. At the other end of its four-foot length is a T-handle allowing the moulder to easily tilt and pour red-hot iron from the ladle.

While no documentation for any ladle carriers has been located to date, probably all were Hopewell blacksmith made. One of these tools was among the artifacts found in Hopewell's water-wheel pit.[53] Additional similar carriers and a two-man carrier are at the site.

Every moulder needed a ladle carrier.

Lamps at moulder's rows and cast arch
Late tradition placed oil lamps in the bridge house,[54] but since moulding was a twenty-four hour activity, light use was necessary at the moulder's rows and at the cast arch. Earlier and cheaper fat lamps were probably used in the Cast House.

Moulders' benches
This tool was a wooden table capable of holding smaller flasks and moulders' tools. This allowed the moulder to work comfortably at the flask he was creating without stooping over. As time passed, benches developed a tool-holding back and wheels. While never

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[49] Diderot, Plate IX, "Forges, 3rd Section, Forneau en Merchandise, Coulage a la Poche."
[50] Hopewell Record, SM 46, Sept. 5, 1825. This timebook reports three moulders hunting instead of "ladling." As a result red-hot furnace iron ran onto the cast arch floor. Had the 10 moulders of that year all been working, the other seven moulders could easily have prevented this overflow. Hence, there was a shift moulder operation in 1825. The International Moulders and Foundry Workers' Journal, July 1958, in Joseph A. Bardford's "Reminiscences of the Early Days of Stove-Plate Moulding and the Union," 8, tells of work at nearby and contemporary Isabella Furnace, "casting iron whenever the furnace was ready."
[51] Hopewell Records, SM 2, May 7, 1800; Mar. 14, 1801; Mar. 26, 1802; SM 9, Aug. 22, 1818; SM 14, Mar. 28, 1828, SM 21, Feb. 5, 1833, Document, 8380623, 8400316.
[52] Hopewell Catalog, No. 140, Accession #3.
[53] Ibid.
[54] H2215 Interview, Harker Long, 12. "Coal oil torches with handles attached, and containing a wick and about a pint of oil, were also used to lighten up the dark corners of the bridge house."

mentioned in Hopewell records, documents, or tradition, Diderot portrayed bench moulding a hundred years before Hopewell existed.[55] Weight of the sand-full flask and the strength of the individual moulder and his buddy alongside were determining factors on the size of a flask worked on a bench. Smaller flasks were certainly so moulded. Only when necessary did the moulder stoop to work on the floor. Stove-bottom plates were of a size requiring floor work, hence Hopewell's moulder's rows must display both floor and bench moulding and in large and small flasks. No Hopewell moulding benches survived.

As with the flasks, the benches on hand, looking old and used, came from a foundry dating to 1874 and are considered similar to those used historically at the site.

Moulders' mitts

As with the clock reference, these hand-protection items are mentioned only in a 1935 Kemper List, "Equipment, Trappings, etc., belonging to or Made at Hopewell at One Time." This compilation states: "leather hand mitts used by moulders in possession of Nathan Care, Jr."[56]

While gloves and mitts are purchased with regularity in Hopewell Records, none described as [being] moulders' have been found to date.[57] What these mitts were like is completely unknown; no illustration has been found.

Moulders' shovels

Straight-bottomed shovels to lift sand into the moulders' riddle and into his flasks were a tool provided by the furnace. Straight-bottomed shovels are shown as early as 1566 and by Diderot.[58] Hopewell Records regularly present the purchase of shovels by a smith and by forges are so billed.[59] No usable shovels survived at the site.[60]

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[55] Diderot, Plates V and VI, "Forges, 3rd Section, Forneau en Marchandise, Moulage en Sable."

[56] "French Creek Project, Mr. Kemper," in file: H2215 Interview, Harker Long.

[57] "The Appendix," Historic Structures Report, Office-Store, covering the 1832 purchases of twenty-five Hopewell Workmen from Hopewell Records, (SM 20) lists buckskin MITTS as purchases by moulder John Care—one of two moulders tabulated for every purchase. The other moulder, John Sheeler, bought NO mitts. But miner Alexander Church, keeper Barney Hart, colliers David Shaffer and David Hart, laborer Wilkinson Hill, filler John Painter and woodcutter Joseph Whitaker also bought mitts. Hopewell Record, SM 25, 170b, displayed within Museum Exhibit #4, also shows Wilkinson Hill purchasing buckskin mitts at 75 cents, November 5, 1836.

[58] George Agricola, De Re Metallica (translated by Herbert Hoover and wife, N.Y., 1950) is illustrated on pages 313, 331, and 337. Hereafter cited as Agricola. Diderot in Figs. 4 & 5 in Plate IX, Forges, 3rd Section Forneau en Marchandise, Coulage a la Poche.

[59] Moulders' shovels are do designated in Hopewell Record, SM 12, Jan. 25, 1825, SM 2, Mar. 1, Apr. 8, May 17, and Aug. 23, 1803, pays for the smithmaking of a dozen. A dozen and a half are billed on Hopewell Document 8230613, from Ringwood Forge. Examples of later purchases are in SM 21, Mar. 29, 1832, June 6, and Oct. 25, 1833.

[60] Archeological-worker Mike McCarthy, on Jan. 15, 1965, told the writer that Leland Abel's work at the furnace had found "five or six shovels."

Moulders' tools

The hand tools of this craft were the choice of the individual moulder. As today, the moulder's personal collection of tools depended on his "individual taste."[61] No historic tools survived at the site. To date, the only one instance of tool purchase, the manufacture and sale of a rammer, has been located in records.[62]

Rammers, with which the moulder packed the damp sand within a flask against a wooden pattern, exist at the site in representative long and short types.

Lifters are long, narrow (1/4" ½", and ¾" widths), L-shaped tools used to lift (especially from a deep mould) surplus sand from a defective or just-repaired mould. A cannon stove required a deep flask and a long lifter. None survive.

Slicks and buttons are small hand tools with rounded bottoms which repaired defective molds by smoothing damp sand into the "spoiled" area. Right angled inner and outer slicks repaired a damaged right-angle section of a mold. These tools are illustrated and described by Overmann in 1851.[63] Representative tools are at the site.

Strikes are more-used tools. Bearing on the level wood surface of a flask, a strike pushed all surplus rammed sand from the flask. Diderot portrayed the operation of a strike.[64]

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[61] Overmann, 29.
[62] Hopewell Records, SM 8, August 12, 1816.
[63] Overmann, 28-29.
[64] Diderot, Plate VI, "Forges, 3rd Section, Forneau en Marchandise, Moulage en Sable." (See Illustration with Moulders' Benches.).

Moulders' tools, casting cleaning, etc.
While pumping rods and balls, hot pliers, tool boxes, and rapping hammers are not mentioned in Hopewell Records (as slicks, lifters, strikes and benches are not), these tools speeded up the casting of iron, improved product quality and made removal from sand more efficient. Likewise, tool boxes kept a moulder's tools readily accessible.

Pumping rods and balls skimmed the slag from the ladle of iron, and when used with an up and down motion in the flask gate, "pumped" liquid iron into the extreme ends of a pattern within the sand, ensuring a better casting.[65] The hot pliers enabled a workman to remove a very hot casting from the sand after it and the casting had been shaken out from the flask. Holding the hot casting in his left hand with these pliers, he rapped the casting with a rapping hammer in his right hand and thereby jarred loose much of the sand adhering to the casting.

Representative pumping rods and balls, hot pliers, rapping hammers and tool boxes, all used in casting production (dating back to 1876), are at the site.

Parting powder
This moulding item prevented moulding sand from adhering to the wooden pattern and to the sand in the other flask half in the creation of a mould. At Hopewell, moulders paid Barney Hart, furnace keeper, for "pounding blacking."[66] This is interpreted as meaning that ordinary charcoal dust – which worked at a Hopewell demonstration – was not used, but that better charcoal was actually pulverized to produce a higher-quality parting powder. A visiting foundry manager remarked upon seeing Hopewell stoves in the Museum, "They [the moulders] must have religiously charcoal-dusted their patterns to have secured such sharp detail."[67]

Riddles
Since fine sand in contact with the wooden pattern insured a beautiful smooth and sharp casting reproduction of the pattern design, a riddle (sieve) was a necessary moulders' tool. Illustrated as round as early as 1556,[68] a riddle had a screen bottom and its wooden parts were about 18 inches in diameter and about 5 inches high. (Size is approximate because dollar values are sole record entries).

Present in the 1800 inventory,[69] this tool seemingly was another purchased by the furnace and provided without cost to the moulders. Records continue these purchases with

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[65] Statement, Raymond Buck, Mar. 21, 1968. Mr. Buck has a 50-year moulding background.
[66] Hopewell Record, SM 21, Mar. 13, 1834; Jan. 19, 1835; Mar. 10, 1836; and Jan. 19, 1837 list payments to Hart. Two are over $20.
[67] Statement, Mr. Fry, Manager, Union Foundry, Boyertown, Pa., Aug. 28, 1967.
[68] Agricola illustrations of 1556, 288, 289 twice, 291, 292 three times, 311, three finenesses, 342, 374, twice, 470 and 485. None show moulding.
[69] Hopewell Document, X8000320.

regularity into the 1830s.[70] While no Hopewell riddles survived, representative riddles discarded by modern foundries are at the site.

Stove patterns

Wooden patterns enabled moulders to reproduce iron copies of the pattern in damp sand, all within the wooden two-part flask. The purchase of costly stove patterns are regular Hopewell Record entries from 1784 to 1839.[71] And the final sale of Hopewell's patterns is on record.[72] Efforts to trace these last mentioned patterns to successor companies were unsuccessful. However, representative copies of contemporary Warwick Furnace stove patterns exist at the site.

Sand, moulding

Apparently almost all of the moulding sand for the stove-making period came from a single source, John Dorlan. Three hundred and nineteen wagon loads for the period 1816-28 are billed on Hopewell Document 8290403. This source continued to bill the furnace for sand into 1842.[73] In the opinion of the Manager Graper of Eastern Foundry, Boyertown, Pa., and of International Foundry Supply Company of Reading, Pa., present-day Albany sand, having heavy clay content, is nearest the "creek sand historically used at Hopewell." Ten tons of yellow Albany have been purchased for demonstrations and most of it survives in the Cast House now.

The late-period sand pile, located by Abel archeology,[74] should be moved from just inside the Cast House entrance into the north side of the cleaning annex. The historic movements of stove plates into the cleaning annex are reasons for the displacement.

Sand, moulding, burned

Sand in contact with red-hot iron lost its "greenness," its ability to adhere to other sand particles, even when properly dampened. Most of this burned sand adhered to the castings and pigs. Historically, the most noticeable accumulation occurred where the castings were cleaned. This sand was discarded. The restored sand floor of the cast arch and unfloored section of the Cast House is modern burned moulding sand, with all modern items screened out. The sand excavated archeologically was not saved.

Burned, green, sand also historically covered the wooden-floored sections of the moulding rooms. This covering was protection against fire caused by spilled iron, from a few drops, the overrun from a flask gate to a spilled full ladle.

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[70] The largest purchase found to date is in Hopewell Document, 8370330B, buying 41 riddles in the period April 28 - Dec. 31, 1836.

[71] Hopewell Records, SM 41M, Dec. 31, 1784; SM 21, May 1, 1832 (for $832.32) and SM 38, Mar. 7, 1839 are examples.

[72] Hopewell Record, SM 32, May 1, 1848.

[73] Hopewell Document, 8350501 for 1831-35, Hopewell Record, SM 21, 200a, Apr. 1, 1837 for 1835-37 and in 1842 (if .75 per load as earlier) $43.50 for 51 loads is charged in SM 38, 246, Dec. 19, 1842.

[74] Abel, 30.

Wheelbarrows
This tool is shown at the furnace cast arch as of 1763 by Diderot.[75] Hopewell Records repeatedly list their purchase and repair.[76] However, definite use is mentioned by neither tradition nor record. Since castings moved three times daily from the moulding floor to the cleaning annex, use of wheelbarrows was more economical than hand carrying (or the use of the horse-drawn cart for short-distance moving). Sand also moved from an outside pile to the cast arch of moulder's rows by barrow.

Window and wall fittings
There is no evidence of shutters, blinds or any other window covering. (Actually, daylight was an aid to the moulder; most likely everyone of them had a lamp for use on darker days.) Likewise there was no evidence of pegs or nails for hanging clothing as a man worked. Probably every row had its clothing nails at the wall side, and individual moulders might have a coat and a shirt hanging from these nails. Likewise, materials purchased for family use at the Office-Store were probably visible in the same area.

Slates as record keepers and message devices
In 1867 slates kept account of furnace charges for filling Hopewell's Bridge House.[77] This use of slate was probably a carryover for earlier record-keeping practices. Probably, slates at other locations than the bridge house kept operational records until transferred into the official records.[78] The entries of individual moulder stove production and of blacksmithing charges suggest such slate record keeping and transfer. Other probable locations for slates to carry instructions or to record work performed are at the Cast House in moulder's rows, in the cleaning annex, and in the shipping area. Outside the Cast House, slates probably carried instructions to hired girls in the spring house, to the hosteler in the barn stable and from wives to husbands (and vice versa) in the tenant houses.

Cleaning annex
The production of each moulder had to be kept separate until recorded, and to determine sound castings and save shipping weight castings had to be cleaned. Because moulding ended at Hopewell in 1844, tradition is mute about most moulding processes. Records repeatedly list payments for cleaning castings by some moulders,[79] but report nothing on cleaning methods or where cleaning occurred. Archeology located only the Annex foundations and marks of the floor joists. Pending the reconstruction of the cleaning shed (wheelwright shop) with a moulders' sleeping loft,[80] cleaning must be depicted in the reconstructed portion of the Cast House now termed the "cleaning annex." Its historic use is unknown, but casting cleaning probably was one of its functions.

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[75] Diderot, Plate IX, "Forges, 2d Section, Forneau Ö Fer, Couler la Gueuse."
[76] From the 1800 Inventory, (Document X8000320) to 1841 purchases in Hopewell Record, SM 38, 137.
[77] H2215 Interview, Harker Long, 2.
[78] Hopewell Record, SM 60 presents the weekly charges of ore and charcoal from Feb. 4, 1852 to Mar. 11, 1874, probably kept on a slate as mentioned by Harker Long.
[79] Hopewell Record, SM 14 M, 34b, April 20, 1784 for 1782 and 1783 to SM 21, 100b, Jan. 19, 1837, the last existing pre-1840 journal. See ~FN 1 extension.
[80] H2215 Interview, Mr. and Mrs. Charles Sheridan Care, 4.

Cleaning support rails

Wooden rails, sufficiently high to allow burned moulding sand to fall and accumulate below the cleaned casting level, probably supported cleaned and unbrushed castings. Castings piled on these rails could be easily tilted by women cleaners.[81] A V in the row, with gray iron visible on the cleaned plate and charcoal dust on the uncleaned, is probably the point where the cleaner went to dinner. Rows are most likely identified by the moulder's name on a slate.

Cleaners, 1831-36

Name	Regular work	Hopewell Record Source SM21
Care, Henry	Moulder	p. 75a
Care, Thomas S4.	Founder	pp. 10b, 51a, 52a, 70a, 73a, and 121a
Hart, Barney	Keeper	p. 121a
Hart, David	Moulder	pp. 10a, 13b, 32a,b, 51a, b, 70a, 120b, 157b, 158a, 161a, 189b, 190b
Hart, John		pp. 75a
Merwine, Elizabeth		pp. 10b, 12a
North, George	Moulder	p. 51b
Painter, Frederick	Keeper(p. 115b)	p. 121a
Painter, George	Carpenter	pp. 52a, 75a, 120b, 122b, 161a
Painter, Margaret	Widow	SM 15, p. 52b, SM 21, p. 32b
Posey, Jesse		p. 121a, 123a, 160a
Shaffer, David	Collier	p. 185b
Shaffer, David's son		p. 190a
Sheeler, John	Moulder	pp. 32b, 51b, 52a, 160a, 185b
Sheeler, John's son		p. 190a
Williams, Samuel		pp. 10a, b
Williams, Samuel's son		p. 190b
Wynn, David's son		pp. 189a, b

A chart showing moulders, moulders paying cleaners, cleaners, their tonnage cleaned, the total product by all moulders, how many moulders cleaned their own product, and the tonnage cleaned follows:

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[81] Hopewell Record, SM 1, 23a and 24a, show Elizabeth Merwine and Margaret Painter as casting cleaners in 1831.

Cleaning Production, 1831 to 1837
(Compiled from Hopewell Record, SM 21)

Year	Moulders working (spaces needed)	Moulders paying cleaners	Cleaners	Tonnage paid to clean	Total product	Tons moulder cleaned
1831	12	7	5	160	248	88
1832 (early)	11	7	6	84	131	47
1832 (late)	12	8	4	215	321	106
1833 (early)	13	5	4	82	171	89
1833 (late)	14	6	4	134	322	188
1834	14	7	6	254	477	233
1835	14	11	7	208	420	212
1836	15	10	6	357	555	198
1837	14	N/A	N/A	N/A	144	N/A

Cleaning brushes
Again, no record of casting-cleaning brushes have been located to date. Size and shape are unknown. They probably were similar to moulding brushes of today. [They were]used to brush adhering sand from the castings, [and] moulders paid other employees for this service,[82] but some cleaned their own and other moulders' castings.[83] Each of the cleaners needed a cleaning brush.

Burned moulding sand
Burned moulding sand covers the floor and an accumulation is clearly visible in a cleaning row, just emptied of its cleaned castings.

Castings in cleaning annex
Castings in the annex will be very similar to those displayed as just-shaken-out in the moulding rooms, except that their gates are detached. Castings probably were stacked on the rails with their narrow side on the rail. A rail row portrays two moulders' output in the eight hours previous. Representative castings are at the site.

Cleaner seating
Since women worked as casting cleaners[84] and their work was just above floor level, it is probable – since no tradition survived – that boxes, old chairs or broken chairs were located in the aisles of a cleaning row.

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[82] See ~FN 1, III-1.
[83] Hopewell Record, SM 15, 24a and b and SM 21, 52a and 88a.
[84] See ~FN 3.

Cleaning annex heating
Because the archeologically-found foundation of the annex suggested a chimney, since restored, it is probably [true] that a stove was located in the annex. Heat from the furnace had no benefit here and the physical activity of the cleaners was probably limited to the tilting and brushing of the castings.

Small castings in storage boxes and on shelf
Since stove moulding ended in 1844, no tradition on actual small-part practice at Hopewell survived. Records regularly credit moulders with precise numbers of stoves produced, but relate no casting handling procedures. However, every moulder had to produce a complete stove with perfect parts. Included were smaller castings: three stove doors, latches, small oven plates, and dove-tailed stove legs.

For efficient operation it is probable that small wooden boxes, labeled with moulders' names, stored small parts until shipment of such stove parts [occurred]. Cleaned and uncleaned small castings, labeled [their] moulder, probably filled the shelf reconstructed along the north side of the annex.

Loft, pattern storage
That wooden patterns were costly is readily documented[85] and that many sets of stove patterns belonged to distant city stove dealers is another fact.[86] One hundred and forty variations of patterns were used at Hopewell in 1837,[87] yet by the end of stove production Hopewell sold only 13 sets.[88]

Safe and dry storage was a must. Dryness on the south Moulding Room loft came from furnace-iron heat, 2400 degrees released three times daily. Security was constant through ever presence of the furnace keepers.

There is neither documentation nor tradition located to date about this loft, its pre-1840 use, or pattern storage.

Probably, costly patterns were stored on this loft in bins to keep them readily available. Most likely, charcoal baskets were used to move them from storage to the moulder and back. A stairway probably existed for easy access and for the safe delivery of patterns.

Tuyère arch area
Because of the nearness to liquid red-hot iron, "just around the corner" the tuyère arch was historically filled with moulder's rows for the casting of stove plates. An exception

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[85] Hopewell Document, 8320105A bills Hopewell $1193.88 for patterns in the 1829-31 period.
[86] Hopewell Documents, 8380421, 8430301, 8400115, 8360910 and Record, SM 21, 193b, Feb. 3, 1837.
[87] Stove Research Resume Card, 1837.
[88] Hopewell Record, SM 32, May 1, 1846.

was a narrow path, which allowed the founder or keepers access to the tuyère arch for necessary adjustments of the blast apparatus.

Because of the waterwheel's attraction for tourists, this tuyère arch will not present any portion of its historic moulding operation, but most of its space must accommodate visitors. The remainder will store unused flasks.

Safety at the tuyère arch waterwheel

Safety – close clearance of the moving waterwheel – makes the picket fence at the west side of the tuyère arch area a must. Pickets are historically correct[89] and, unlike an equally historically correct rail fence, discourage climbing by the boys. In operating times, no fence was present; safety demands that this fence continue to bar access to the dangers of the waterwheel.

Loading area, cleaning annex

Both tradition and records are mute about the structure and its uses. Pending reconstruction of the cleaning shed (wheelwright shop), this accessible-to-the-cast-room area probably was used for flask making, flask repairs, shipping crate manufacture, crate filling, sand storage, and stove shipment by wagons.

The sand pile located here is out of the way compared to the late-period sand pile found archeologically just within the Cast House door.

Before 1825, commercial teamsters delivered Hopewell stoves as distant as Philadelphia and York, Pa., after 1825, to the Schuylkill Canal, and after 1838, to the Philadelphia and reading Railroad at Douglassville. All shipments were crated, often a ton to a single crate.[90] Packing and crate loading, probably with the crate on the wagon, probably occurred here also, along with the above-mentioned functions. An appropriate-in-time wagon is at the site.

Exterior Cast House displays

In addition to stacks of flasks presently at four different exterior points, a display pile of stacked pig iron, of defective castings, of flasks awaiting repair and of gate metal would be historically correct. Also within shovel-throwing distance of the southwest door of the cleaning annex, a pile of burned moulding sand, obviously from the cleaning annex, probably existed. Appropriate wagons are already positioned near the annex. The adjacent and post-1840 wheel pit, archeologically discovered as predicted by Harker Long,[91] surviving from the days when the Moulders Cleaning Shed and Sleeping Room was used as a wheelwright shop (1876), should be buried under slag (as the late-period scales pit was.)

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[89] Hopewell Record, SM 1, Apr. 23, 1803.

[90] Hopewell Record, SM 21, 240b is an example: 117 tons were shipped in 105 boxes. SM 51, 9a, shows a two-box shipment containing three tons and 19 pounds in tons of 2,240 pounds.

[91] H2215 Interview, Harker Long, 31, and Abel , 110.

DESCRIPTION OF RECOMMENDED FURNISHINGS WITH COST ESTIMATES CAST ARCH - FURNACE TOOL[S]

The suspension of the heavier furnace tools from chains from a bar now existing is a possibility. No tradition of such suspension survived.

These large tools will have to be manufactured. Efforts to date to locate suitable ("stringy") wrought iron have not succeeded. If none is located, modern wrought iron or steel will have to be purchased. The tools [were] made by a blacksmith, no matter what type of iron was used.

Ladle carriers

No documentation for ladle carriers exists. A ladle carrier was among the artifacts archeologically found in Hopewell's waterwheel pit.[92] It carries a ladle shaped as modern foundry-cast ladles are. Additional carriers and a two-man carrier were purchased with the flasks. These ladle carriers will be displayed either at the end of a moulder's working row and/or at the cast arch.

Lamps at cast arch and moulder's rows

A cast-iron oil lamp, teakettle-shaped and from contemporary Moselem Furnace in Berks County, has been copied in aluminum. From these, sufficient castings for Hopewell's needs will be reproduced. On Establishment Day, one or two – all painted black or rust color – will be placed at every bench or moulder's row. Some should be rope suspended; others, hung and mobile with a J-hook to hold the lamp from timbers above. Several will be at the cast arch. Fat lamps, as made at Hopewell on Establishment Day, might be intermixed with the cast-"iron" lamps.

Additional lamps, beyond those needed for the Cast House, should be cast at Hopewell's Establishment Days for use in furnishing the Bridge House, Charcoal House and Blacksmith Shop.

Clay and clay kettle

Clay was used at the furnace to plug the damstone tap hole and to line the iron ladles which carried liquid red-hot iron to the mould. Hopewell's historic clay kettle was uncovered at the furnace cast arch during archeology[93] and it is proposed that this kettle return to the cast arch as a functioning clay source. Actually, this clay-pot is a broken butcher-size kettle as produced at Hopewell.

Clay can be procured on the site (as was done historically) at no cost.[94]

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[92] Hopewell Catalog, no. 140, Accession 3. Ladles: Since modern cast ladles fit the ladle carrier found archeologically, modern cast ladles are suitable for displays.

[93] H2215 Interview, Henry Johnson and Leland Abel, Archeological Excavations at Hopewell Furnace, March 6, 1964, 50.

[94] Hopewell Record, SM 21, Mar. 18, 1837.

Clock
If funds allow and dampness within the Cast House is not excessive, a clock of suitable age should be wall mounted in the Cast House and, if operable, kept operating.

PLACEMENT OF FURNISHINGS IN THE CAST HOUSE

The tools previously described need to be set up in moulder's rows. At least nine moulding steps[95] must be shown to present the visitor an insight into this vanishing, skilled and historic process.

A gone-to-dinner appearance is the display['s] goal.

The moulding steps may be presented on the moulders' benches or by floor moulding according to pattern size. A mixture of bench and floor work, the casting of a complete stove by a moulder, would be the nearest to the historic scene.

These nine [moulding] steps are:
1. Pattern (on followboard) in flask-half, noticeably partially-dusted with charcoal dust-black cloth charcoal dust bag dropped on pattern.
2. Sand partially sifted over a dusted pattern in flask-half on followboard with a riddle partially filled with Albany sand on the flask-half. (Use of the terms 'cope' and 'drag' are unnecessary; flask difference can be noticed and the flask half "not in process" should be visible alongside.)
3. Flask-half partially rammed with Albany sand, shovel in sand in the peaked pile underneath the bench; hand rammer in flask and a long double rammer [are] leaning on the flask.
4. Flask-half with rammed sand partially "struck off" (evened), with strike in position in the unevened part.
5. A second followboard clamped to the flask-half and the original followboard with two flask clamps. Another unit like this in another row might be at the half turn, setting on its narrow edge.
6. Pattern re-exposed (opposite side) with the other flask-half near or over the original flask half. Pattern is dusted and partially riddled-sanded with Albany sand.
7. Complete flask filled with rammed sand with wooden-gate pattern either in position (suggesting their removal) or removed and atop the flask.
8. Flask opened at the parting line and lean-propped from rear by a long rammer. "Rapped" pattern has been lifted from the sand which shows pattern details. Newly cut molten-metal feeders from gate to pattern space are very visible since charcoal dust makes a vivid contrast between the earlier work and the last; yellow sand against a black background.
9. Completed flask secured with a pair of flask clamps and ready to be lifted from the bench to the floor (or on the floor, if large). This minimum display series presents

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[95] Despite the able "condensation" of the moulding process as presented by R. C. I. Barnes in Hopewell's Establishment Day Literature, the omission of *any* step was a casting failure.

bench or floor moulding *before* metal pouring only. (To show these nine steps in a restricted area with four benches in the North Moulding Room, as proposed by R. M. [Resource Management?] Curator Wilcox is almost an impossibility. A jumble as this could not have existed in an operating foundry.)

Other steps in the casting process, ready to pour flasks, just-poured metal and shaken-out product, require display also:
1. Rows of completely "moulded" flasks, in front of benches with benches against the wall (or all larger floor flasks), ready to receive all metal with empty-open gates.
2. Rows of flasks with gates showing red-iridescent paint or light from within through red glass. These are "just poured" flasks, hardening and nearly ready for "shake-out."
3. Rows of empty flasks alongside a pile-row of sand with shaken-out castings protruding from the sand in a "natural" way. The exposed iron is charcoal-dust and sand covered.
4. Row of "peaked" sand and flasks with followboards and flask clamps alongside ready for moulding. A basket of patterns is on the moulder's bench which is as far away from the wall as possible, at the very beginning of "moulding a row."
5. Same as #3, but with a pile of castings, some degated at the sand edge of the floor. The row "shows" the missing castings; the remainder protrude from the sand. Gates are in a pile.

These 14 moulding steps will be called to all visitors' attention by inclusion in the guide literature.

These five steps may be combined with the earlier nine, but as advised by an experienced moulder, not in a manner so jumbled that a moulder, foundryman, or foundry worker would consider the display ridiculous.

Just as an 80'x 60' Cast House was necessary for efficient moulder production, most of this same area will be necessary to provide an efficient and meaningful display of moulding and its many facets As space allows and experience dictates, piles of castings, on the ground and on wheelbarrows, gate metal and pig on the floor and outside the structure, will also be necessary displays.

Cast arch
A tymp stone needs to be added through masonry at this arch to reconstruct the cast arch and furnace to the pre-1840 period. The present tymp is post-1868 and historically inaccurate for the earlier period

Displays within or near the cast arch consist of a water trough (already there) for furnace-tool cooling and sand dampening; clay within the historic clay kettle, found archeologically; and four heavy, long furnace tools of wrought iron with visibly "stringy" sections. A lead pipe or a water line from the head race brings water to the trough.

A pit of cooling slag, "tapped" recently (painted iridescent red) from the furnace and another pit, almost empty, but with a small accumulation of iron at its base, are near the

tap hole. At this last pit moulders caught red-hot flowing iron in their clay-lined cast iron ladles. A bed of flask clamps, also painted iridescent red to represent "just cast" flat-bed work, is also within the area. These clamps are linked with the tapping pit edge by a runner of iron.

These cast-arch displays will be "casualties" on moulding demonstration days – at least until iron (or aluminum) is melted within the furnace.

Castings with and without gates, and gates

Output is a very necessary part of the display in the Cast House. Several moulder's rows will display castings complete with gates, protruding from sand just as shaken out of the flask. The flasks, flask clamps and followboards used to produce the casting will also be a part of this display. A ton of castings in several varieties, copied from aluminum "patterns" from contemporary Warwick Furnace stove patterns, are on hand for such display. More castings will be necessary for the Cast House display and for use in the cleaning annex. These will differ from those displayed in the Cast House in that their gates will not be attached. However, V-shaped gates are a necessary part of any casting display and should emphatically be specified in any casting purchase, since most of the gates found archeologically were V-shaped.

The depth of gate on castings will determine the size of flask displayed in a moulder's row. A deep curved casting with a long gate required a deep flask.

Country castings and plowshares

While Hopewell made pots, pans, kettles, etc. until 1833,[96] the sole presentation of such activity proposed is the display of *defective* modern skillets, pots, and pans of cast iron, so hidden in a pile that modernity is masked and defects shown. Plowshares will be suggested by the presence of triangular flasks (already at the site) and a slate message to a moulder, instructing him to cast some shares.

Flasks

Flasks, wearing out with use and through burning by leaking iron, had to be replaced here with regularity.[97] However, only one-half of one flask survived from the hundreds used until 1844, and is displayed in the Museum. The design of this model has been copied and will be used for displays proposed in the Cast House. Modern but burned, old-looking flasks have been purchased and others have been donated to the site. Large flasks have been dismantled and this used, burned lumber became copies of the sole surviving flask half mentioned above. These flasks are not historic, but are representative of historic flasks. The number of pre-1840 flasks surviving in the U.S. were considered

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[96] The sale of country casting patterns, flasks, [and] the ending of their production is entered in Hopewell Record, SM 21, 92b under the date of Feb. 13, 1834. This end of production for country castings is further dated by note in this entry: "Note, the above flasks and patterns were delivered to the canal, Dannon's Landing, the 24th of July, 1833."

[97] Examples are: Hopewell Document X8000320 listing flasks when Brooke and Buckley took over Hopewell in 1800; Hopewell Record, SM 15, Mar. 17, 1831, listing 18¾ days by a carpenter making flasks in 1830, and in the last stages of stove production when Hopewell bought flasks from neighboring Isabella Furnace, SM 32, Oct. 12, 1848 – "got May 23, 1843."

too inadequate in number and too expensive to locate and transport to the site. Hence, this compromise of old-looking flasks, dovetailed and burned, is the answer to this furnishings challenge.

Not only will the fresh-sawed, dovetailed ends need to be blackened, but more flasks will have to be altered and created to the deeper dovetailed type from the supply bought for this very creation. Contrasting color (repaired) flasks should also be intermixed in all flask stacks, inside and outside. The iron from the purchased supply – as they rot and are altered – should not be saved as artifacts but sold as junk. The various sizes of flasks required are shown in scale drawings attached to this report. (These drawings and suggested slate messages have not been returned to Heydindger). This size-list is compiled from 1837 stove production.

New and repaired flask display through Establishment Day demonstrations
Since new and repaired flasks and followboards should be displayed, intermixed both in and outside the Cast House, the Establishment Day carpenter demonstration should be "repairing" flasks by installing new dovetailed flask parts into old burned ones. Repairing and making new followboards are also pertinent demonstration items.

Moulders
Moulders' names are important for their use on slate "messages" – as historically used in the bridge house – and to "personalize" furnishings in the moulding rooms. Moulders working during the long blast of January 3, 1836 to April 16, 1837, featured in the museum displays were:[98]

Care, David
Care, Nathan
Care, Thomas Sr.
Care, Thomas Jr.
Elliot, Joseph
Hart, David
Hart, Joseph
Hart, Peter
North, George
Painter, Frederick
Painter, John Jr.
Painter, Montgomery, a minor, as his father, John, Sr., collected his wages
Sheeler, John
Walters, Michael

[98] Hopewell Record, SM 21, Dec. 27, 1836, Jan. 9, 17, 18, and Jan. 19, 1837. Records for the end of this blast did not survive.

Moulders' shovels
Since modern shovels practically advertise their newness, suitable shovels for the Cast House will have to be handmade. Handles from Sweden[99] are now at the site for this manufacture.

Moulders' tools
Moulders' slicks and buttons, as shown in Overmann, become Hopewell property again through ENP&MA funds. In addition, a sufficient quantity have been mould-copied to correctly furnish the proposed moulder's rows. This last production again cost the NPS only 25 cents a pound for the aluminum, since ENP&MA paid moulding cost as demonstrations on Establishment Day. Painted black, these tools will represent button and slicks costing currently $1.25 each.

Moulders' lifts – historic long, thin, L-shaped sandworking tools – will have to be purchased. It is impossible to mould this tool, which was historically made of thin steel or bronze. Quarter-, half-, and three-quarter inch widths will be sufficient. A set for every other row will be necessary.

Strikes are a moulder's tool used to "strike away" surplus rammed sand to the level of the flask top. While not shown as a tool by Diderot on his Plate IV, the use of one is shown on his Plate V. Hopewell purchased sufficient strikes with the flasks for furnishing needs. If needed, more may be cast.

Rammers, both long and short, were bought with the flasks and in quantities sufficient for furnishings.

Moulders' tools, "odd," scavenged odd tools, purchased with the flasks for an operating foundry, included distinctively-shaped hammers, pliers (for lifting hot plates from the sand) and "pumping rods and balls." Tool boxes were also part of this purchase; others have been donated.

None of these tools have been located in records or documents, as bellows, lifters, slicks, strikes, buttons, and benches were not found. However, the hammer design might have been whittled by an enterprising moulder or a carpenter; a blacksmith would have manufactured pliers to a moulder's (or the proprietor's) verbal descriptions.

These tools will be secured to the work bench or on large flasks with epoxy glue.

Parting powder dust
Cloth bags sifted charcoal dust will be displayed at every work row as part of the moulder's equipment.

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[99] Hopewell Accession, 504, Nov. 14, 1966, gift of Mr. Durell of American Fork and Hoe Company, Columbus, Ohio.

Patterns
Contemporary Warwick Furnace patterns exist. Hopewell's staff had discovered as early as 1958 that separate units of contemporary Warwick Furnace stove patterns survived at the Pennsylvania State Museum, and at the Historical Society of Berks County. Later "research" showed this Warwick collection to have been parceled out to the Historical Society of Chester County and to the Bucks County Historical Society, as well. Efforts to secure these historic wooden patterns as gifts were futile.

Historic copies paid by ENP&MA
Through ENP&MA funds, most of the patterns of these collections (with one exception, below) have been borrowed, brought to Hopewell, and copied in aluminum as Establishment Day moulding demonstrations. The exception was the portion at the Bucks County Historical Society.

EAIA demonstration at Doylestown
ENP&MA also provided funds for the moulding of these otherwise inaccessible patterns at the Bucks County Historical Society, thus meeting the legal restriction forbidding removal of any specimen for the custody of the Society. This two-day demonstration by Hopewell was featured at the Bucks County Historical Society as part of the Society's hosting of the Early American Industries (EAIA) Association in 1965. All resultant aluminum pattern copies cost NPS only 25 cents a pound, the price of raw aluminum; ENP&MA paid all other costs. [Since they're] painted black, as historic wooden patterns were, the eye cannot distinguish them from wooden patterns. Visitors will not handle them; dry rot and dampness cannot harm them. Those inquiring will hear the facts. A display, including an iron plate cast from an aluminum "pattern," has been on display in the site's museum for several years.

Additional patterns
In addition to the patterns mentioned above, Hopewell – again with ENP&MA funds – moulded existing Hopewell stoves in aluminum. More stoves need to be so reproduced for "patterns."

Hence, a supply of patterns, sufficient for creating many real-pattern displays in the Cast House already exists, all at minimal cost to the NPS.

Pattern storage
Pattern storage historically required a safe and dry location. The ever presence of the founder and his keepers at the furnace cast arch made the proposed loft safe, and the regular tapping of the furnace provided heat dryness. This plan proposes that bins on the reconstructed loft "display" patterns consisting of approximately treated artifacts, and if necessary, that this supply be augmented by shaped sheet metal painted black. This visible quantity is necessary since the furnace made as many as 140 kinds and types of stoves in 1837.[100] The illusion of full-pattern shelving has to extend far enough westward on the loft so that a tall man cannot see the end of the display.

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[100] Hopewell Record, SM 21, 31b, 69b, 93b, and 126b are examples of founder pay scales.

Since reconstruction provided no stairs to this storage area and patterns were very costly and fragile, a counterweighted (non-usable for children) hinged stair sufficiently strong for a man with a basket of patterns should be constructed at the south side of the loft. A drawing shows the proposed shelving arrangement (and these stairs?).

Pig iron

While space does not allow a large pig bed display at the cast arch, pigs as display items in and out of the Cast House are necessary. Those stacked – real or painted wooden – should be secure to make them safe. An outside pile would be a heap of pigs and might consist of both real and fake pigs. Since the founder's pay for pigs was lowest of the three rates he could earn, pigs were probably made only when the quality of that batch of iron did not meet stove standards.[101]

Personnel

Ideally, a retired moulder would "putter around" in the Cast House. One of his duties would include the "control" of visitors and the keeping of displays at constant top quality. Actual melting and the pouring of red-hot aluminum (and iron, if experiments prove this feasible) into flasks on a cold, damp weekend is another potential benefit. The pouring of a red plastic (Sears sells a set for living room use) is another potential. Student pouring under his supervision might produce a product suitable for classroom display or sale. Naturally, the castings produced of metal would have to be small, in flasks within the capability of this moulder to handle. Stove lids, trivets, doors, and latches are in this category.

Riddles

Since fine sand in contact with the pattern insured a smooth beautiful casting reproduction of the pattern design, a riddle (sieve) was a necessary moulders' tool. Since their shape was round as early as the 1500s,[102] discarded used riddles from an operating foundry will serve as displays on moulder's rows in the Cast House. Several new ones, aged to make them look older may be necessary for demonstration moulding.

Rust prevention, to make castings retain the "just-cast" appearance

The Cast House today is as cold and damp as it was once hot and dry. The prevention of rust on the products displayed in position (in and out of sand) is another unknown to be solved through experience. The very visible presence of charcoal dust on all new castings is both "natural" and a must. Spraying these castings with oil (after removing rust spots, if any) may keep them black and rust proof.

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[101] Hopewell Record, SM 21, 31b, 69b, 93b, and 126b are examples of founder pay scales.

[102] Herbert Hoover's translation of George Agricola's De Re Metallica, 1556, shows round riddles on pages 288, 289 (twice), 291, 311 (three finenesses), 342, 374 (twice), 470 and 485. None of these illustrations show moulding processes, but prove the existence of round riddles in the 16th century. Diderot shows no riddles.

Castings displayed as cleaned and in-the-crate ready for shipment likewise need a spraying with lacquer, wax, or one of the epoxies tested[103] at Hopewell on casting exposed to the weather for several years. This treatment is necessary to keep them constantly appear as just-cleaned gray iron.

Gate and pig displays may be either black from burned moulding sand and charcoal dust, gray as "cleaned," or rusted, depending whether displayed inside or out of the building. Piled outside displays of these two products may be rusty at the bottom of the pile and "black" at the top.

How much snow will blow into the display section of the Cast House is another unknown, but if winter storms "film" castings with snow, plastic covers may be necessary. The storage of displays during the "active" snow season may become a preventive maintenance function. And an annual (or more frequent) cleaning of rust from displays may become necessary.

Should rusting become a major problem, castings of aluminum or Ni-iron[104] (as cast at Weatherly, Pa.,) may be necessary. Naturally, this cost is unknown. However, casting demonstrations at the site, last sponsored by ENP&MA, produced castings of aluminum at the cost of ingots, about 25 cents a pound.

Sand, moulding

While approximately 10 tons of historically appropriate yellow-clay Albany moulding sand[105] are in the Cast House, the purchase of modern "self-ramming" moulding sand is proposed. Once properly placed, either in a pile of a moulding row or in a flask, this self-ramming sand resists being "fingered" or kicked from its proper position. Its first higher cost will save much replacement labor and provide better interpretation by its strength. The yellow Albany sand[106] will be used to color all exposed sand surfaces – the interior of the flasks will be charcoal dusted at their parting line – to disguise their modernity, as well as for casting demonstrations. Glue sprayed on the exposed exterior (only) of the modern sand, Albany sand riddled over the glue, and the surplus removed by brushing when dry, will create the appearance that the entire display is Albany moulding sand, correct historically. To further reduce costs for higher priced modern moulding sand, it is proposed that all inverted V-rows be supported by a strong plywood frame. Such support will greatly reduce the amount of modern sand required. Yet the hardness of the modern sand will resist easy dislocation of display sand.

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[103] Polytok A-C mixture, an epoxy, proved most rust-resistant for clean iron. Report, Iron Preservation 25 July 1967.

[104] Letter, Grede Foundry, Milwaukee, Wisconsin. Oct. 20, 1965.

[105] Apparently most of the moulding sand for the stove-making period came from a single source, John Dorlan (or Darlin). 319 loads for the period 1816-28 are billed on Hopewell Document, 8290403; for 1831-35 on Document, 8350501; Hopewell Record, SM 21, 200a, April 1, 1837, for 1835-37 and in 1842 (if 75 cents per load as earlier) $43.50 for 51 loads.

[106] In the opinion of Manager Graper of Eastern Foundry at Boyertown, Pa., and of International Foundry Supply Co., Reading, Pa., this present-day commercial moulding sand is "the nearest the historic creek sand" used here.

Sand, moulding, burned

A supply of burned moulding sand is another furnishing necessity. The wooden floors of both Cast House sections need this sand as a fire-resisting cover. (The path into the waterwheel-tuyère arch especially needs to have its burned moulding sand glued to the floor as a safety feature. Perhaps all floored surfaces need glue to hold a sand layer. The floor of the cleaning annex also requires burned sand; the empty cleaning row there might have its floor partially swept, with piles ready to be dumped outside.

An outside pile suggest quantity cleaning and production by its size. This pile might be false supported and have its sand glued to that plywood surface to prevent children from "carrying away" shoesful.

Cost of this sand will be transportation only. However, all modern content must be screened out.

Water supply and trough

While not shown in Diderot, Hopewell has three traditional accounts of water at the cast arch of the furnace. Two list the cooling of furnace tools as the reason for trough and water.[107] The third ascribes the water use – without mention of the trough – "to wet the moulding sand."[108] Both cooling and wetting needs existed historically.

Archeology uncovered a lead water pipe at the cast arch. Archeologist Abel dated it by telling [that it was] "[laid] sometime after the [clay] floor was laid and probably after the building was abandoned."[109] This lead-pipe water line may date from the 1850 installation of hydraulic ram or from the 1870-present water system.[110] The pre-water system tradition presents a logical water source:[111] "An iron pipe (about 1 inch) ran from the east headrace trough [flume] along the west and south faces of the furnace and then into the Casting House. Water [was] used to wet moulding sand." This informant was evidently speaking of the period before the lead-pipe installation.

Since archeology found no drain, either water supply was most likely controlled by a valve.

The least costly restoration of the water "supply" is to have lead pipe protrude from the ground and curve over a wooden trough at the south side of the cast arch. A valve would be visible on the upper part of this (dry) lead pipe. Should funds allow, a one-inch line from the west headrace, as described, should be reconstructed. Again, a valve should be a part of this restoration.

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[107] H2215 Interview, Thomas Hoffman, 5 and H2215 Interview Sally Boone and son David, II-2.

[108] H2215 Interview, Henry Johnson.

[109] Leland Abel, Archeological Excavations at Hopewell Furnace, March 6, 1964, 69.

[110] Hopewell Record, SM 31, Mar. 29, 1850. Lead pipe soldering in 1854 in SM 65, Sept. 23, 1854, is the sole clue found to date on early lead pipe. Today's system dates to 1870, SM 34, 209a, but lead pipe is purchased in 1872, as well. See SM 62M, Nov. 16, 1872.

[111] Abel, Archeological Excavations at Hopewell Furnace, March 6, 1964, 69.

A trough, old-looking and burned, is at the cast arch and is near the size of the traditional trough.[112]

Wheelbarrows
Shown at the furnace cast arch as of 1763 by Diderot,[113] Hopewell Records[114] repeatedly list their purchase.

Several wooden-wheeled barrows are appropriate in the cast area. One should be loaded with degated castings, another with gates. A third might be loaded with fresh clean Albany sand. (This placement is especially appropriate for the winter season.)

Cleaning annex, moulders as casting cleaners
Every casting had to be cleaned to reveal defectives and to save shipping charges. The cleaning, packing, and shipping of castings had to keep pace with the furnace moulding output. Product had to move daily into and out of the cleaning annex, perhaps three times daily. (And until more space is available, all cleaning will have to be shown here.)

To report that 5,000 stoves passed through this closing process annually is understating the fact. For instance, the common nine-plate Circular stove[115] consisted of nine outside and three oven plates, plus three doors (each with separately cast latches) and two stand plates (or dovetailed feet). Some stoves consisted of 20 plates.[116] Hence, 15 plates times 5,000 stoves is 75,000 flasks of moulders' work or stove plates annually. This production is the reason for the huge 80'x 60' Cast House.

A partial list of 1831-37 castings cleaners includes 20 persons: a carpenter, a collier, a keeper, moulders, women, [and] at least four boys. Even the highest-paid furnace employee, founder Thomas Care, earned extra pay in this cleaning process. [The number of] paid cleaners varied annually, from four to seven, and moulder-cleaners from three to eight. Individual cleaner earnings found to date varied from $2.20 to $40.88. (Recall that an 1832 dollar at Hopewell bought 22 1/2 pounds of beef before passing judgment on work value.)

Need for cleaning space
No matter how many cleaners or moulders, there had to be a cleaning row for every moulder so that his output could be credited to him after a cleaning and that deliveries could be made with confidence and savings.

Not only did moulders earn 75 cents a ton by cleaning castings for their coworkers, but the absence of record entries implies that they cleaned their own production as well. That moulders here worked an eight-hour shift is based on record entries and tradition in the

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[112] H2215 Interview, Thomas Hoffman, 5.
[113] Diderot, Plate IX, "Forges 2d Section, Forneau Ö Fer, Couler la Gueuse."
[114] From the 1800 Inventory, Document, X8000320 to 1841 purchases in Hopewell record, SM 38, 137.
[115] Also made in nine sizes with two different tops and at least three bottoms for each size.
[116] Hopewell Record, SM 64, 6.

nearby moulders' union.[117] Hence, Hopewell moulders worked extra time to clean their own and other moulders' production after working their own eight-hour moulding-pouring day. That the furnace owners knew of this "moonlighting" is proven by the record entries, generally under each moulder's semi-annual production credit.

Furnace-founder Thomas Care, Sr., is a prime example of such double-shift work. Sixty-one years old in 1836, he cleaned casting for other moulders, moulded, and by the absence of charges against himself or credit to others for this service, cleaned his own castings. Know-how of furnace activities was his skill. Responsible for furnace operation and paid for actual production by the grade of iron he produced, Care did have two keeper-helpers, one each for 12-hour shift. He paid these men. Moreover, one of his keepers, Barney Hart, also cleaned casting and "pounded" charcoal parting dust for moulders.[118] This account of founder, keeper, moulders, and other cleaning products accents the constant great need for castings cleaning space now, space for both hired and moulder cleaners. Tradition listed additional cleaning areas, near Wall G and in a building "across the road," most likely the cleaning shed-wheelwright shop, Building 325. Two photographs exist of this structure in whose attic "moulders slept."[119]

The need for the reconstruction of the pre-1840 cleaning shed-wheelwright shop assumes its real importance as a part of this great need for cleaning space, a row for every moulder.

Cost Estimates

Furnace cast arch

1	Ringer, and other four furnace tools of wrought iron 12-20' long, material and blacksmithing (ENP&MA pays blacksmith)	$100.00 Each
2	Sand, Albany Sand, Self Setting	have $200.00 E
3	Burned sand for (all) floors	free transportation
4	Slag pits, melting disc for one pit	$25.00 E
5	Cart loaded with broken slag	Have

[117] Hopewell Record, SM 46 M, Sept. 25, 1825, and International Moulders and Foundry Workers' Journal, July, 1958, Joseph A. Barford, "Reminiscences of the Early Days of Stove Plate Moulding and the Union," 8.

[118] Hopewell Record, SM 21, Mar. 13, 1834; Jan. 19, 1835; Mar. 10, 1836; and Jan. 18, 1837 list payments to Hart. Two are over $20.

[119] Hopewell Photos, 125-01 and 101-03 and H2215 Interview Mr. & Mrs. Charles Sheridan Care, 4.

6	Cast bed of flask clamps	$25.00 E
7	Kettle for daubing clay	Have
8	Clay	free transportation
9	Ladles, daubed and undaubed with clay $2.50 ea. 10	$25.00
10	Ladle carriers	Have
11	Wooden cooling trough	Have
12	Old pipe to bring water from W Head Race & Valve	$25.00 E
13	Iridescent red paint for "hotness" effect	$10.00 E

CAST HOUSE AREA, material movement

1	Pile of Albany Sand	Have
2	Cart, partly loaded with gate metal	Have
3	Gate metal, in cart and pile several ton @ $50	$100.00 E
4	Wheelbarrow (loaded with stove plates)	$100.00 E
5	Burned sand on floor	Free Transportation
6	Stack of pig iron (w[ith] wooden foolers)	$50.00 E

NORTH AND SOUTH MOULDING ROOMS

1	Albany moulding sand Sand, self setting	Have
2	Stove plates with and without gates, several tons	$800.00 (20 cents a pound)
3	Moulders' benches	Have
4	Patterns (made by ENP&MA) on benches and visible in loft above. Aluminum for more patterns. ENP&MA to pay moulding.	Have some $200.00 E
5	Slate with chalk and protective spray	$5.00
6	Moulders' tools, plus	Have

	riddles, pump balls, "pliers," strikes, hammers, bellows	
7	Black paint and protective spray for patterns	$10.00 E
8	Lifters, ¼", ½", and ¾", 10 sets @12	$120.00 E
9	Flasks and Plow Flasks	Have
10	Shovels, straight bottom & D handles 12	$120.00 or $50.00 materials and blacksmithing
11	Clamps for flasks	Have
12	Chills and chaplets	If decided upon, thru ENP&MA
13	Burned sand on floors	Free Transportation
14	Glue-epoxy to keep paths sandy and secure tools	$10.00 E
15	Labor to make cement flasks (perhaps free from Birdsboro Corp.)	$500.00
16	Cement or self-ramming sand	$75.00
17	Castings – just shaken out	Have a ton
18	Hammers, pliers, "pumping balls"	Have

LOFT

1	Boards for shelving	$200.00 E
2	Stairs	$50.00 E
3	Labor	$100.00 E

CLEANING ROOM OF ANNEX, TO SUGGEST CLEANING OF STOVEPLATES BY THOUSANDS

1	Wood rails on which to stack plates	$10.00
2	Burned sand on floor	Free transportation
3	Slates, chalk and spray protection	(Above)
4	Large stove plates in variety 5 ton $400 sides, tops, bottoms, ends	$2,000.00 E

5	Small castings, doors, latches, lids-on shelf (Aluminum cost) ENP&MA pays moulders	$50.00 E
6	Charcoal dust here on castings and elsewhere	Have
7	Brushes	$20.00 E
8	Bench, stool, or old chairs	$50.00 E

ENTRY OF ANNEX, SUGGESTING SHIPMENT OF PRODUCT TO DISTANT MARKET

1	Wagon with a partially-loaded crate of stove plates	Have
2	Crate with cover crate labor	$25.00 $25.00
3	Burned sand	Free transportation

STORAGE AREA OF ANNEX

1	Crate, partially assembled labor	$15 $12.50
2	Crate lumber, stacked	$100.00 E
3	Flask lumber, stacked white pine (knots elim[inated?])	$100.00 E
4	Shipping tags, painted on crates	$5.00
5	Slate for instructions	Have
6	Stack of completely new flasks, w/o iron (12) Labor to make flasks	$500.00 E $100.00 E
7	Stack of flasks waiting repair	Have
8	Repaired flasks showing new wood	$100.00 w/labor

BELL TOWER

1	Rope	$5.00
2	Slate	Have

STACKS OF FLASKS AROUND CAST HOUSE

1	Four Stacks	Have
2	Pile burned sand	Free

3	Pile imperfect pots, pans, kettles, etc.	$100.00

TUYÈRE ARCH AREA

1	Stack flasks	Have
2	Bench	Have
3	More benches	$50.00 E

Special installations
Again, a need for special installations may develop as operation of the furnished Cast House proceeds. Among those recognized prior to operation include plastic moulding demonstrations, rust prevention on castings permanently displayed in the moulding row and in the cleaners' row, burned sand coverings for wooden floors, the "creation" of red-hot hearth castings, slag, visitor observation space, and paths for their movement. These are examined below.

Possible moulding demonstrations
Ideally, a retired moulder would "putter around" in the Cast House. One of his duties would include the "control" of visitors and the keeping of displays in constant top quality. Actual smelting and pouring of red-hot aluminum (and iron if experiments prove this feasible) into flasks on a cold, damp weekend is another potential benefit. The pouring of a quick-setting red plastic (Sears sells a set for living room use) is yet another potential. Student pouring of this plastic under his supervision might produce a product suitable for classroom display or for sale by the site. Naturally, the castings produced of metal would have to be small, in flasks within the capability of this moulder to lift. Stove lids, trivets, stove doors, and latches are in this category.

Rust prevention, to make castings retain the just-cast appearance
The Cast House today is as cold and damp as it was once hot and dry. The prevention of rust on the products displayed in position (in and out of sand) is another unknown to be solved through experience. The very visible presence of charcoal dust is on all new castings is both "natural" and a must. Spraying these castings with oil (after removing rust spots – if any) may [help] keep them black and rust proof.

Castings displayed as cleaned and in-the-crate ready for shipment likewise need a spraying with lacquer, wax, or one of the epoxies tested[120] at Hopewell on casting exposed to the weather for several years. This treatment is necessary to keep them constantly appear as just-cleaned gray iron. Gate and pig displays may be either black from burned moulding sand and charcoal dust, gray as "cleaned," or rusted, depending [upon] whether displayed inside or out of the building. Piled outside displays of those two products may be rusty at the bottom of the pile and black at the top.

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[120] Polytok A-C mixture, an epoxy, proved most rust resistant for clean iron. Report, Iron Preservation, 27 July 1967.

How much snow will blow into the display section of the Cast House is another unknown, but if winter storms "film" castings with snow, plastic covers may be necessary. The storage of displays during the "active" snow season may become a preventive maintenance function. And an annual (or more frequent) cleaning of rust from displays may become necessary.

Should rusting become a major problem, castings of aluminum or Ni-iron[121] (as cast at Weatherly, Pa.,) may become necessary. Naturally, this cost is unknown. However, casting demonstrations at the site, last sponsored by ENP&MA, produced castings of aluminum at the cost of ingots, about 25 cents a pound.

Sand covering for floors

Because archeology uncovered floor supporting joists in both the north and south moulding rooms, wooden floors were reconstructed in a building where red-hot iron was spilled with some regularity. The floors were most likely installed because of excessive moisture in the natural ground floor, despite a large drain hole into the north moulding room.

While red-hotness within the Cast House may never be an actuality, these wooden floors must have a layer of burned moulding sand covering them. To insure its permanence, because walking on it will scatter it, this sand covering should be secured to the floor by glue. Visitor traffic, especially in the tuyère arch area, will require regular replacement of this sand cover.

Creation of red-hot castings

To make the cast arch and the moulding room "real," the creation of red-hotness is desirable. Inquiry has shown that infrared light is impossible in daylight. Hence, painting the hearth interior, the surface of slag pits, and the top of gates of "just poured" flasks with iridescent red paint is a possibility.

Sand, moulding, burned

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The floor of the cleaning annex also requires burned sand; the empty cleaning row there might have its floor partially swept, with piles ready to be dumped outside. An outside pile suggests quantity cleaning and production by its size. (This pile might be false supported and have its sand glued to that plywood surface to prevent children from "carrying away" shoesful.)

Cost of this sand will be transportation only. However, all modern content must be screened out.

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[121] Letter, Grede Foundry, Milwaukee, Wisconsin, Oct. 20, 1965.

Visitor space
To include this topic in a furnishing plan is necessary. If space is not provided, the visitor will "make and take" space. Without doubt, most of the tuyère arch area – in front of the popular waterwheel – was once used for stove production. However, except for a stack of flasks to suggest this use, that area will be without furnishings.

Likewise, visitor space and passage must be provided within the Cast House, not only for ordinary visitation but especially for demonstrations and the observance of Establishment Day. As long as air pumped by the historic waterwheel is used to fire the metal-melting "cupola," space on those days at the cast arch will require hiding of displays otherwise visible. This means that the clay kettle, ladle pit, and the flask-clamp casting display will be hidden during demonstrations. Experience gained from setting up and operating the furnished Cast House will eventually determine the space needed for visitors. Safety is another factor. Stacked flasks, piles of gate metal, furnace tools and other furnishings items will suggest non-entrance at various points. Specific planned paths include an entrance to the waterwheel-tuyère arch area and a passage out of the rear (west) door of the Cast House. Naturally, there will be an entrance for the visitor into the sand floor section of the building.

Traffic will be easily kept out of the operating-display section of the cleaning annex by crate and other barriers.

Picket fence (pales) at tuyere arch-waterwheel
A fence between the tuyère arch area and the waterwheel is strictly non-historic, but must remain for the safety of visitors. Clearances at the wheel are dangerously close. While a post-and-rail fence may seem more appropriate, the use of pales is as old and is documented to 1803.[122] A post-and-rail fence would invite climbing and entry into this most dangerous area.

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[122] Hopewell Record, SM 1, 27, Apr. 23, 1803; SM 59, 20b, Apr. 2, 1827.