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HOFU – Furnace Furnishings Plan August 1967

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Section A

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 refurnished (insofar as practicable) to illustrate an "operating" foundry of the 1820-40 period. Such refurnishing will reflect, particularly, the heavy emphasis at Hopewell in the 1820-40 period on stove production, but also the production of other products (pig iron, pots, pans, kettles - termed country casting - and plow shares) 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.

Section B

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 (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 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[1] at Hopewell on casting exposed to the weather for several years. This treatment is necessary to make 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

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

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 stores "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[2] (as cast at Weatherly, Pa.) may be necessary. Naturally, this cost is unknown. However, casting demonstrations at the Site, last sponsored by EMP&MA, produced castings of aluminum at the cost of ingots, about .25 a pound.

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 tuyere 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

2. Letter, Crede Foundry, Milwaukee, Wisconsin, October 20, 1965.

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-tuyere 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.

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 charges--the 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 5000 stoves passed through this cleaning process annually is understating the fact. For instance, the most common nine-plate Circular

stove[3] 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 consist of twenty plates[4]; hence, 15 plates times 5000 stoves is 75,000 flasks of moulders' work, or stove plates annually. This production is the reason for the huge 80-by-60-foot Cast House.

A partial list of 1831-1837 castings cleaners includes twenty 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.[5] (Recall that an 1832 dollar at Hopewell bought 22½ pounds of beef before passing judgement 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 cleaning and that deliveries could be made with confidence and savings.

Not only did moulders earn .75 a ton by cleaning castings for their coworkers, but the ABSENCE of Record entries implies that they cleaned

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 Q4 p.6.

5. See pp. B III - 5 and 6.

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.[6] 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 and paid by the GRADE of iron he produced,[7] Care did have two keeper-helpers, one for each twelve hour shift. He paid these men. Moreover, one of his keepers, Barney Hart, also cleaned castings and "pounded" charcoal parting dust for moulders.[8]

6. See FN 3 p.B-24.

7. Hopewell Record SM 14, May 30, 1829, p. 60b is an example.

8. Ibid., SM 21 Mar. 13, 1834, Jan. 19, 1835, Mar. 10, 1836 and Jan. 18, 1837 list payments to Hart. Two are over $20.

Section C

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 1820-40, 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[1] and probably an equal number of casting cleaners. In a typical year during the 1820-40 period, cast iron plates for as many as 5000 stoves were produced in the Cast House,[2] 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. (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"[3] 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 with a follow board), individual flasks in varying states of completion on bench or floor and

1. Hopewell Record, SM 46M, Sept. 25, 1825.

2. Ibid., SM 39. 5112 stoves in 1839.

3. Moulding in rows continues today in non-automated foundries. Being paid by the pound, the moulders' product had to be kept separate to properly pay him.

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".

The moulding process basically involved shaping (by wooden patterns and special tools) a hollow space inside two 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 the 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 most of his eight-hour shift -- the moulder took his turn with ladle under the "tap hole" in the front of the furnace cast arch, hurriedly carried therefrom his fifty 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.[4] 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 molding 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.

4. 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 and two base plates plus three door latches. Hopewell Record, SM 64 p. 6 presents extreme cases 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 the museum displays were:[5]

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

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To report that 5000 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 5000

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

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6. Hopewell Record, SM 14, May 30, 1829, is an example.

7. See FN 2 p. E-24.

Section D

EVIDENCE RE. 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 FURNISHING 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 Tuyere Arch, (VI) the loading area of the Cleaning Annex and (VII) piled around the Cast House exterior.

CAST ARCH DRAWING

(I) 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. Bad stove iron, known by a quick-chill test, became pig. Another and yet more historic type of casting was that of flask clamps,[1] a necessity for moulding, and flat-bed cast. 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 accommodated this production. Irridescent red paint will give a "hot" appearance. A new MET sign at the furnace <u>now</u> calls the 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.[1]

I - 2

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 made ready to receive this inferior iron.

1. <u>Hopewell Record</u>, SM 8, Nov. 8, 1816 and SM 32, Mar. 31, 1849.

1. <u>H2215 Interview, Harker Long</u>, p. 12. This late tradition placed a coal oil torch in the bridge house.

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[2] was uncovered at the right side of the furnace cast arch during archeology[3] and will return to the cast arch as the functioning wet-clay kettle. 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.

I - 3

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[4] and English iron authority 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

2. H2215 Interview, Henry Johnson.

3. Leland Abel, Archeological Excavations at Hopewell Furnace, March 6, 1964, p. 50, hereafter cited as Abel.

4. Diderot, Plate IX, "Forges, 2d section, Fourneau a' Fer, Couler la Guese". No translation of Diderot is at the Site.

charcoal blast furnaces."[5]

By name these tools were: (1) the great or 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 tuyere 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 tuyere was fixed. Again size and weight are absent.

In addition, cinder hooks and shovels were necessary to move the partially-cooled slag.[6]

A Cornwall Furnace drawing of an unstated date, but contemporary with Hopewell, shows that furnace's adaptation[7] 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.

I - 4

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

5. H. R. Schubert, History of the British Iron and Steel Industry from 450 B.C. to 1775 (London, 1957) p. 239, 240, the illustration presented is a duplicate of the above Diderot.

6. Ibid.

7. Hopewell Photo 1959-441.

DRAWING

FORGES, 2. SECTION, FOURNEAU A FER, COULER LA GUEUSE

DRAWING

FORGES, 2. SECTION, FOURNEAU A FER, COULER LA GUEUSE

over the dam stone. At casting, the remaining slag was pulled off. Overmann recommended a pair of pits for the collection of this slag,[8] but tradition and documents at Hopewell are mute about pre-1840 slag handling.[9]

Probably at any pre-1840 day there was a pile of broken cooling 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.

I - 5

WATER SUPPLY AND TROUGH

Hopewell has three traditional accounts of water at the cast arch of the furnace. Two lists the cooling of the furnace tools as the reason for trough and water.[10] The third ascribes the water use (without mentioning the trough) as "to wet the sand".[11] Both tool-cooling and sand-wetting needs existed historically. Diderot does NOT show water at the cast arch.

8. Frederick Overmann, The Manufacture of Iron in All Its Various Branches, etc., 3rd Edition, (Philadelphia, 1854), p. 206.

9. H2215 Interview, Harker Long, p. 1, "hauled away by mule teams". This is post-1867.

10. H2215 Interview, Thomas Hoffman, p. 5 and H2215 Interview, Sally Boone and Son David, p. II - 2.

11. H2215 Interview, Henry Johnson.

Archeology uncovered a lead water pipe at the cast arch. Archeologist Abel dated it by reporting, (laid) "sometime after the (clay) floor was laid and probably after the building was abandoned."[12] This leadpipe waterline may date from the 1850 installation of a hydraulic ram or the present 1870 water system.[13]

The other traditional source presents a different and earlier water supply,[14] "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 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.

I - 6

A water-supply trough,[15] old-looking and burned and near the size of the traditional trough is at 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

12. Abel, p. 69.

13. 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, p. 209a, but lead-pipe is purchased in 1872, as well. (See SM 62M, Nov. 16, 1872).

14. See footnote #2.

15. H2215 Interview, Thomas Hoffman, p.5.

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[16] 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.

(II) MOULDING ROOMS

In the north and south moulding rooms, moulding equipment will be shown in Moulders' Rows.

MOULDERS' PRODUCTION ROWS

Moulders' rows were necessary to keep every man's production separate; each moulder was paid for his individual production. Records[1] list this production by the individual moulder.

Ten rows[2] 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. Each row also contained most of the moulders' tools enumerated hereafter. The actual number owned and used depended on the whim of the individual moulder.

16. Abel, p. 51.

1. Hopewell Records, SM 74 M, SM 22, SM 55 and SM 49 cover individual production for 1831, 1832, 1837 and 1839.
2. 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 Tuyere Arch, but most of these areas must be reserved for visitor use.

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

I - 1 A wooden pattern is on a followboard in a 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.

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

I - 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.

I - 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.

I - 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.

I - 6 The pattern is re-exposed by the removal of the original follow-board. 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.

I - 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 atop the flask.

I - 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.

I - 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:

II - 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.

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

II - 3 Rows of empty flasks along side 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.

II - 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.

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

These fourteen moulding and pouring steps will be called to all visitors' attention by 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 fourteen displays enumerated above. Not every row had every tool; moulders supplied themselves then, as now, with the tools each felt necessary to produce the BEST castings possible.

II - 1

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 use was 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.[17] 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.[18]

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

II - 2

BRUSH, MOULDERS'

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 individual.[19] Seemingly, as the bellows, etc., these brushes were furnace-furnished. Size and shape are unknown.

17. Hopewell Document, X800320 and Record, SH 2, Feb. 17, 1803.

18. Frederick Overmann, Moulders' and Founders' Pocket Guide, etc. (Philadelphia, 1872), copyrighted in 1850. p. 30. Hereafter cited as Overman.

Overman calls for a "piece of rope" in 1851, adding that for "tufts", paint brushes could be used.[20]

These brushes probably resembled the brushes used by moulders today.

BRUSH, CLEANING

Records regularly show payments from moulders to casting cleaners,[21] but are without entry as to the type of brush used. Most likely the modern moulders' brush is similar to those used historically.

II - 3

CASTINGS STOVE-PLATE

Historically, stove-plates were the profuse product visible in the mouldings rooms. These were visible in the sand of the row and piled at the row's ends with their gates attached. On barrows, but without gates, they were enroute 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 book-keeping purposes.[22] Hopewell made 140 kinds and types of stoves in 1837.

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.

20. Overman, p. 30.

21. Hopewell Records, SM 4M p. 24b, Apr. 20, 1784 to SM 21, p. 190b, Jan. 19, 1837 reflect these payments.

22. Resume Card 1837, Store Research.

CLOCK

The sole reference to timekeeping in the Cast House is in a list made by 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."[23] 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 NOT be shown. The only identification offered to date suggested that they may have been used in removing the core from cannon.[1] Mark Bird did cast cannon at Hopewell,[2] but broken "rasps" were found in profusion.

Country castings, especially teakettles and kettles may have used core-supporting chaplets, but the only proposed display of such production[3] suggested is that of defective pots, pans, skillets and kettles secured from

23. 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.

1. Letter, Aug. 7, 1967, from Grede Foundries, Inc., Milwaukee, Wisc.

2. Hopewell Record, SM 41 M Aug. 12, 1784 and Jan. 17, 1785 sells three cannon at pig iron prices.

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

modern manufacturers. The archeologically-found devices thought to have been chaplets were NOT so identified by knowing correspondents.[4] As with "chills", chaplets will NOT be displayed.

II - 4

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 1830's.[24]

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

4. Letter, Sept. 1, 1967 Grede Foundries.

24. The sale of country casting patterns, flasks, the ending of their production entered Hopewell Record SM 21, p. 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."

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 by 60 foot L-shaped Cast House, as well as the large - but not large enough - piles of representative flasks presently within and around the structure.

II - 5

Flasks are illustrated in Diderot's L'Encyclopedia, ou Dictionnaire Raisonne des Sciences, des Artes et des Metiers (Paris, 1793).[25] 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."[26] Records regularly reflect the manufacture of flasks.[27]

25. 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.

26. 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.

27. Examples include: Hopewell Document X8C00320, listing flasks at Hopewell when Brooke and Buckley took over Hopewell in 1800; Hopewell Record SM 15, Mar. 17, 1831, listing 18 3/4 days by a carpenter making flasks in 1830; 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".

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.[27A]

FLASK CLAMPS

A pair of cast-iron flask clamps held the top half of every flask securely to the bottom half, thereby preventing the 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.[28] Yet every archeological dig has produced whole and broken clamps in quantity.[29]

II - 6

LADLES AND LADLE CARRIERS

Ladles and the dipping into the forehearth of a furnace for liquid red-hot iron are shown in Diderot.[30] At Hopewell it is believed (account of the

27A. Hopewell Catalog #615 displayed in Exhibit 11 of V.C.

28. Hopewell Records, SM 8, Nov. 8, 1816; and SM 32, Mar. 31, 1849.

29. 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.

30. Diderot, Plate IX, "Forges, 3rd Section, Fourneau en Marchandise, Coulage a la Poche".

DRAWING

FORGES, 3 SECTION, FOURNEAU EN MARCHANDISE, MOULAGE EN SABLE

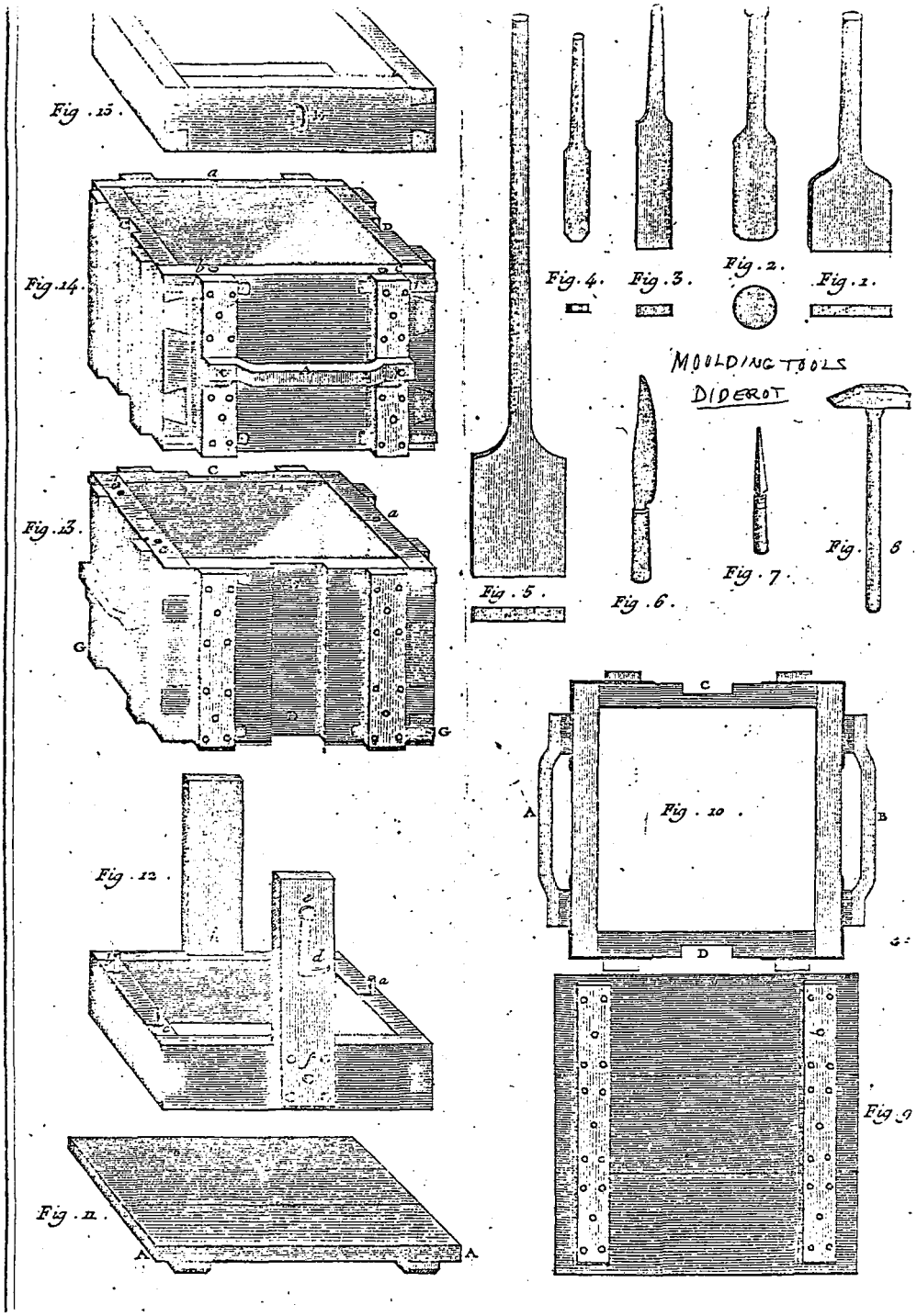


Fig. 15.
Fig. 14.
Fig. 13.
Fig. 12.
Fig. 11.
Fig. 4.
Fig. 3.
Fig. 2.
Fig. 1.
Fig. 5.
Fig. 6.
Fig. 7.
Fig. 8
MOULDING TOOLS
DIDEROT
Fig. 10.
Fig. 9

DRAWING

SOUTH MOULDING ROOM

DRAWING

EAST ELEVATION - CLEANING ANNEX

DRAWING

N. MOULDING ROOM

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 moulders' rows. All moulding occurred at the end of a moulder's shift, three times a day.[31]

Ladles, by documentation from 1800 to 1840,[32] 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.[33]

II - 7

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.

31. 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 ten 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. Hardford's "Reminiscences of the Early Days of Stove-Plate Moulding and the Union", p. 8, tells of work at nearby and contemporary Isabella Furnace, "casting iron whenever the furnace was ready".

32. 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.

33. Hopewell Catalog, No. 140, Accession #3.

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.[34] Additional similar carriers and a two-man carrier are at the Site.

Every moulder needed a ladle carrier.

LAMPS AT MOULDERS' ROWS AND CAST ARCH

Late tradition placed oil lamps in the bridge house,[35] but since moulding was a twenty-four hour activity, light was necessary at the moulders' rows and at the cast arch. Earlier and cheaper fat lamps were probably used in the Cast House.

II - 8

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 mentioned in Hopewell Records, Documents or tradition, Diderot portrayed bench moulding a hundred years before Hopewell existed.[36] 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

34. Ibid.

35. R2215 Interview, Harker Long, p. 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."

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

floor work, hence Hopewell's moulders' 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."[37] This compilation states: "leather hand mitts used by moulders in possession of Nathan Care, Jr."

While gloves and mitts are purchased with regularity in Hopewell Records, none described as MOULDERS' have been found to date.[38] What these MITTS were like is completely unknown; no illustration has been found.

37. "French Creek Project, Mr. Kemper", in file: H2215 Interview, Harker Long.

38. "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, p. 170b, displayed within Museum Exhibit #4, also shows Wilkinson Hill purchasing buckskin mitts at $.75, November 5, 1836.

II - 9

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.[39] Hopewell Records regularly present the purchase of shovels for unstated purposes - colliers also used them. Both the making of shovels by a smith and by forges are so billed.[40] No useable shovels survived at the Site.[41]

II - 10

MOULDERS' TOOLS

The hand tools of this craft were the choice of the individual moulder. As today, the moulders' personal collection of tools depended on his "individual taste".[42] No historic tools survived at the Site. To date, the only one instance of tool purchase, the manufacture and sale of a

39. 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 II, Forges, 3rd Section forneau en Marchandise, Coulage a la Poche.

40. Moulders' shovels are so designated in Hopewell Record, SM 12, Jan. 25, 1825, SM 2, Mar. 1, Apr. 8, May 17, and Aug. 23, 1803 reflect early undesignated shovel purchases. June 1, 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.

41. 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."

42. Overmann, p. 29.

DRAWING

FORGES, 3 SECTION, FOURNEAU EN MARCHANDISE, MOULAGE EN SABLE

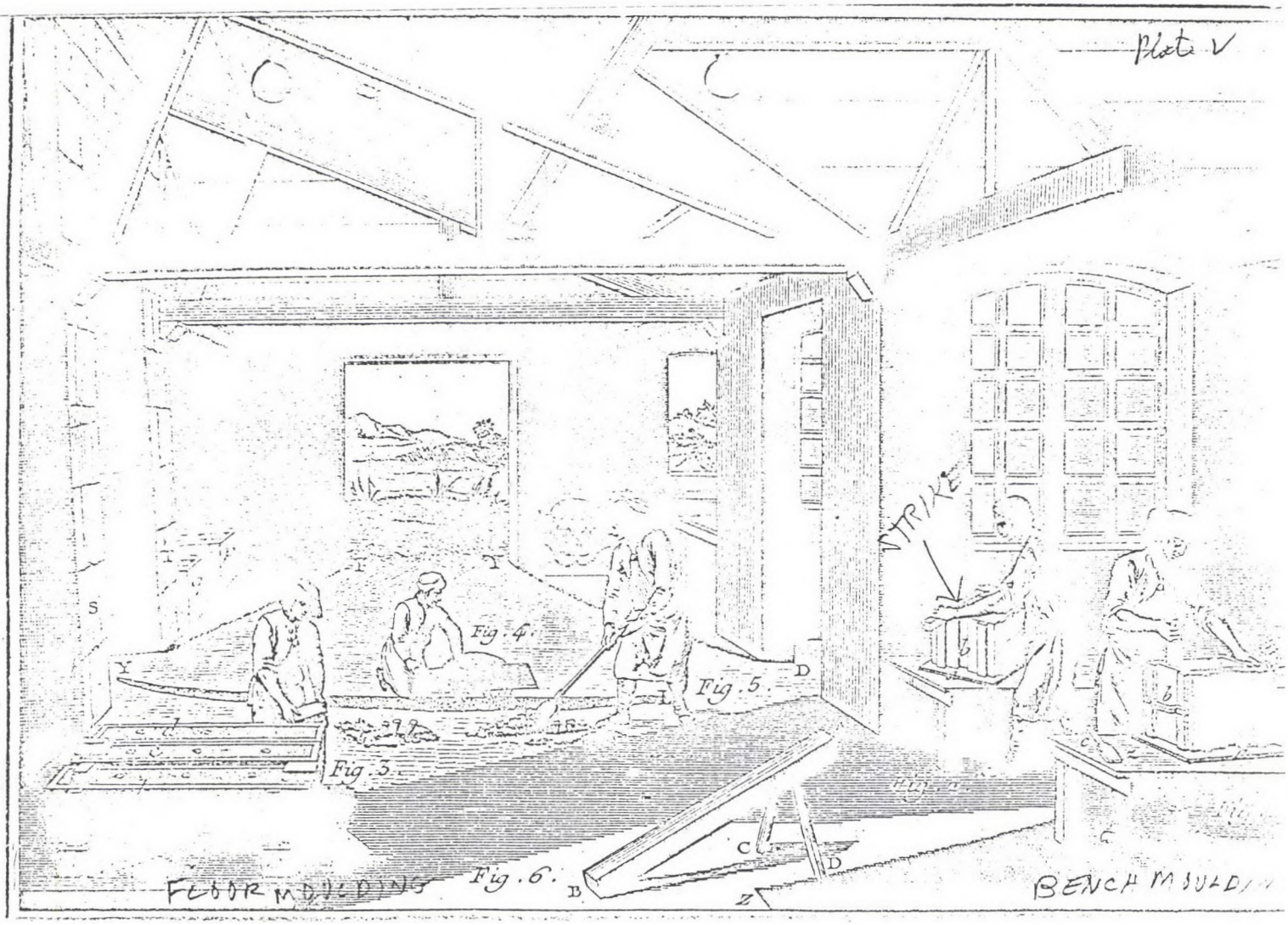
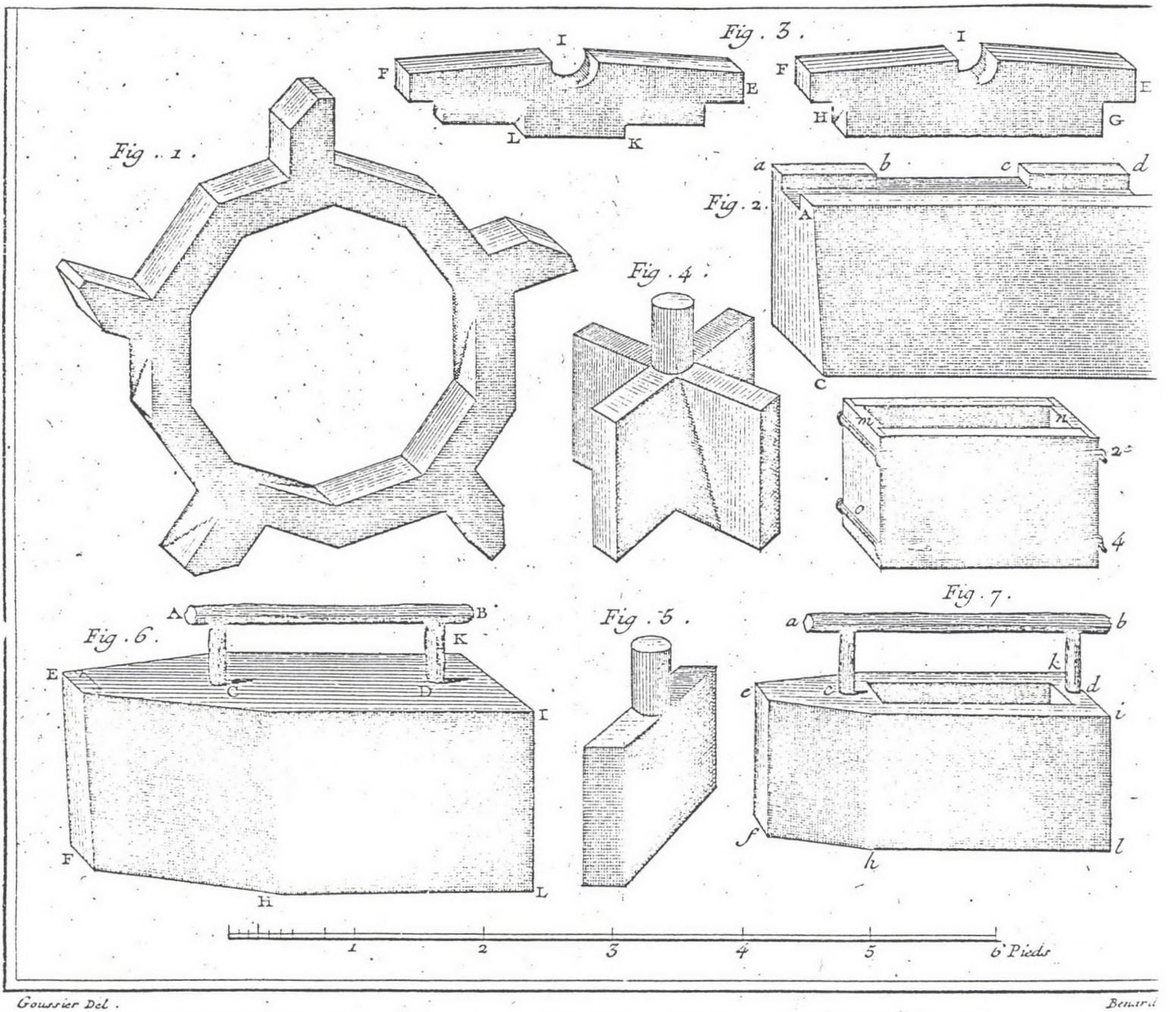


Plate V
STRIKE
Fig. 3.
Fig. 4.
Fig. 5.
Fig. 6.
FLOOR MOULDING
BENCH MOULDING



Goussier Del. Benard

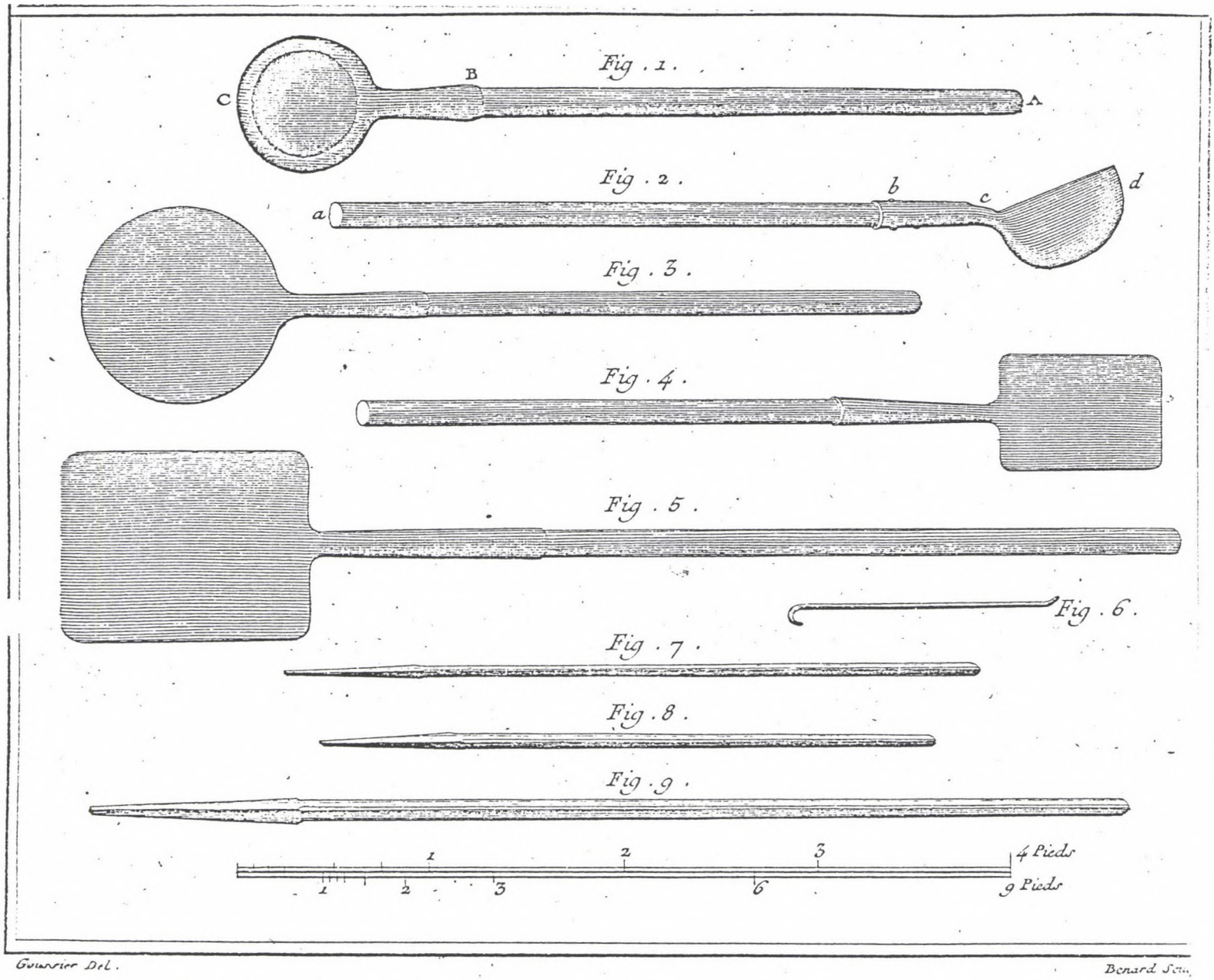
Forges, 3e Section, Fourneau en Marchandise, Moulage en Sable.

DRAWING

FORGES, 3 SECTION, FOURNEAU EN MARCHANDISE, COULAGE A LA POCHE

Plate IX

FLOOR MOULDING



Guarrier Del.

Benard Scu.

Forges, 3e Section, Fourneau en Marchandise, Coulage à la Poche.

"rammer", has been located in Records.[43]

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 (¼, ½ and 3/4" 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.[44] These tools are illustrated and described by Overmann in 1851. 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.[45]

43. Hopewell Records, SM 8, August 12, 1816.

44. Overmann, p. 28-29.

45. Diderot, Plate VI, "Forges, 3rd Section, Fourneau 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 a 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, insuring a better casting.[1] 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

1. Statement, Raymond Buck, Mar. 21, 1968. Mr. Buck has a 50 year moulding background.

blacking."[1] 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."[2]

RIDDLES

Since fine sand in contact with the wooden pattern insured a beautiful smooth and sharp casting reproduction of the pattern design, a riddle (seive) was a necessary moulders' tool. Illustrated as round as early as 1556[1], 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,[2] this tool seemingly was another purchased by the furnace and provided without cost to the moulders. Records continue

1. 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.

2. Statement, Mr. Fry, Manager, Union Foundry, Boyertown, Pa. Aug. 28, 1967.

1. Agricola illustrations of 1556, p. 288, 289 twice, 291, 292 three times, 311, three finenesses, 342, 374, twice, 470 and 485. None show moulding.

2. Hopewell Document, X8000320.

these purchases with regularity into the 1830's.[3] While no Hopewell riddles survived, representative riddles discarded by modern foundries are at the Site.

II - 18

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.[1] And the final sale of Hopewell's patterns is on record.[2] 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.

II - 19

SAND, MOULDING

Apparently almost all of the actual moulding sand for the stove-making period came from a single source, John Dorlan. Three hundred and nineteen wagon loads for the period 1816-1828 are billed on Hopewell Document,

3. The largest purchase found to date is in Hopewell Document, 8270330B, buying 41 riddles in the period April 28 - Dec. 31, 1836.

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

2. Hopewell Record, SM 32, May 1, 1848.

829C403. This source continued to bill the furnace for sand into 1842.[1] In the opinion of Manager Draper of Eastern Foundry, Boyertown, Pa., and of International Foundry Supply Company of Reading, Pa., present day Albany sand, having a 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,[2] 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.

II - 20

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.

1. Hopewell Document, 8350501 for 1831-35, Hopewell Record, SM 21, p. 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, p. 246, Dec. 19, 1842.

2. Abel, p. 30.

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 or "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.

WHEELBARROWS

This tool is shown at a furnace cast arch as of 1763 by Diderot,[1] Hopewell Records[2] repeatedly list their purchase and repair. 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 or moulders' rows by barrow.

II - 21

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

1. Diderot, Plate IX, "Forges, 2d Section, Forneau a'Fer, Coular la Cuese".
2. From the 1800 Inventory, (Document X8000320) to 1841 purchases in Hopewell Record, SM 38, p. 137.

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.

II - 22

SLATES AS RECORD KEEPERS AND MESSAGE DEVICES

In 1867 slates kept account of furnace charges - filling - in Hopewell's Bridge House.[1] 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.[2] 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 moulders' 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 hostler in the barn stable and from wives to husbands (and vice-versa) in the tenant houses.

1. H2215 Interview, Harker Long p. 12.

2. 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.

III - 1

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,[1] but report nothing on cleaning methods or where it occurred. Archeology located only the Annex foundations and marks of floor joists. Pending the reconstruction of the Cleaning Shed (wheelwright shop) with a moulders' sleeping loft[2], 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.

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 easily be tilted by women[3] cleaners. 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.

1. Hopewell Record SM 14 M, p. 34b, April 20, 1784 for 1782 and 1783 to SM 21, p. 100b, Jan. 19, 1837 - the last existing pre-1840 Journal. See FM 1 extension.
2. H2215 Interview, Mr. and Mrs. Charles Sheridan Care, p. 4.
3. Hopewell Record, SM 15 p. 23a and 24a show Elizabeth Merwine and Margaret Painter as casting cleaners in 1831.

CLEANERS, 1831-36		HOPEWELL RECORD
NAME	REGULAR WORK	SOURCE SM 21
Care, Henry	moulder	p 75a.
Care, Thomas Sr.	founder	p 10b, 51a, 52a, 70a, 73a and 121a.
Hart, Barney	keeper	p 121a.
Hart, David	moulder	p 10a, 13b, 32a, b, 51a, b, 70a, 120b, 157b, 158a, 161a, 189b, 190b.
Hart, John		p 75a.
Herwine, Elizabeth		p 10b, 12a.
North, George	moulder	p 51b.
Painter, Frederick	keeper (p 115b)	p 121a.
Painter, George	carpenter	p 52a, 75a, 120b, 122b, 161a.
Painter, John Sr.	filler	p 161a, 190a
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	p 32b, 51b, 52a, 160a, 185b.
Sheeler, John's son		p 190a.
Williams, Samuel		p 10a, b.
Williams, Samuel's son		p 190b.
Wynn, David's son		p 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:

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	11	7	6	84	131	47
early						
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	223
1835	14	11	7	208	420	212
1836	15	10	6	357	555	198
1837	14	NA	NA	NA	144	NA

Compiled from Hopewell Record, SM 21.

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. Used to brush adhering sand from the castings, moulders paid other employees for this service,[4] but some cleaned their own and other moulders' castings.[5] 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[6] and their work was just above floor level, it is probable - since no tradition survived - that boxes, old chairs

4. See FN 1, page III - 1.

5. Hopewell Record, SM 15 p. 24a and b and SM 21, p. 52a and 88a.

6. See FN 3.

or broken chairs were located in the aisles of a cleaning row.

CLEANER ANNEX HEATING

Because the archeologically-found foundation of the Annex suggested, a chimney, since restored, it is probably 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 castings.

III - 3

SMALL CASTINGS IN STORAGE BOXES AND ON SHELF.

Since stove moulding ended by 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. Cleaned and uncleaned small castings, labeled by moulder, probably filled the shelf reconstructed along the north side of the Annex.

IV

LOFT, PATTERN STORAGE

That wooden patterns were costly is readily documented[1] and that many sets of stove patterns belonged to distant city stove dealers is another fact.[2]

1. Hopewell Document, 8320105A bills Hopewell $1193.88 for patterns in the 1829-31 period. A dollar then bought 22½ pounds of beef!
2. Hopewell Documents, 8380421, 8430301 8400115, 8360910 and Record, SM 21, p. 193b, Feb. 3, 1837.

One hundred forty variations of patterns were used at Hopewell in 1837,[3] yet by the end of stove production Hopewell sold only thirteen sets.[4]

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 the everpresence 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.

V

TUYERE ARCH AREA

Because of the nearness to liquid red-hot iron, "just around the corner", the Tuyere Arch was historically filled with moulders' rows for the casting of stove plates. An exception was a narrow path, which allowed the founder or keepers access to the tuyere arch for necessary adjustments of the blast apparatus.

Because of the Waterwheel's attraction for tourists, this tuyere 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.

3. Stove Research Resume Card, 1837.

4. Hopewell Record, SM 32, May 1, 1846.

SAFETY AT TUYERE ARCH-WATERWHEEL

Safety-close clearance of the moving waterwheel- makes the picket fence at the west side of the Tuyere arch area a must. Pickets are historically correct[1] and, unlike an equally historically correct rail fence, discourage climbing by boys. In operating times, NO fence was present; safety demands that this fence continue to bar access to the dangers of the waterwheel.

1. Hopewell Record, SH 1, Apr. 23, 1803.

VI

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.[1] 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.

VII

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

1. Hopewell Record, SM 21, p 240b is an example: 117 tons were shipped in 105 boxes. SM 51, p. 9a shows a two box shipment containing three tons and 19 pounds in tons of 2240 pounds.

flasks awaiting repair and another 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 clearing 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,[1] 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.)

1. H2215 Interview, Harker Long, p. 31, and Abel, p. 110.

Section F

SPECIAL INSTALLATIONS

Again 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 redhot 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 of 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 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[1] 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 of Ni-iron[2] (as cast at Weatherly, Pa.,) may be necessary. Naturally, this cost is unknown. However, casting demonstrations at the Site, last sponsored by

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

2. Letter, Grede Foundry, Milwaukee, Wisconsin, Oct. 20, 1965.

EUREKA, produced castings of aluminum at the cost of ingots, about .25 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 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 into the Tuyere Arch area, will require regular replacement of this sand cover.

"CREATION" OF RED-HOT CASTINGS

To make the cast arch and the moulding rooms 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 tops of gates of "just-poured" flasks with irridescent red paint is a possibility.

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-tuyere arch especially needs 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 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" shoes' full.)

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

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 tuyere 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 furnishings items will suggest non-entrance at various points. Specific planned paths include an entrance to the waterwheel-tuyere 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 Tuyere-Arch area and the Waterwheel is strictly non-historic, but must remain for 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.[1] A post-and-rail fence would invite climbing and entry into this most dangerous area.

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

Section E

DESCRIPTION OF RECOMMENDED FURNISHINGS WITH COST ESTIMATES

CAST ARCH - FURNACE TOOL

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 made by a blacksmith, no matter what type iron was used.

LADLE CARRIERS

No documentation for ladle carriers exists. A ladle carrier was among the artifacts archeologically found in Hopewell waterwheel pit.[1] 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 MOULDERS' 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

1. Hopewell Catalog, No. 1140, Accession 3. Ladles: Since modern cast ladles fit the ladle carrier found archeologically, modern cast ladles are suitable for displays.

every bench or moulders' 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 unmovered at the furnace cast arch during archeology[1] and it is proposed that this kettle return to the cast arch as the 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 historically at no cost.[2]

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.

1. H2215 Interview, Henry Johnson and Leland Abel, Archeological Excavations at Hopewell Furnace, March 6, 1964, p. 50.

2. Hopewell Record, SN 21, Mar. 18, 1837.

PART II

PLACEMENT OF FURNISHINGS IN CAST HOUSE

The tools previously described need be set up in moulders' rows. At least nine MOULDING STEPS* must be shown to present the visitor an insight into this vanishing, skilled and historic process.

A "Gone to Dinner" appearance is the display 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 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 leaning on the flask;

4 Flask-half with rammed sand partially "struck off" (evened), with strike in position in the unevened part;

*Despite the able "condensation" of the moulding process as presented by RCI Barnes in Hopewell's Est. Day Literature. The omission of ANY step was a casting FAILURE.

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 and 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 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. 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-irridescent 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 FOURTEEN 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 eighty-by-sixty 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 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 irridescent 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 irridescent 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 moulders' 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 last 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[1], 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 the defects shown. Plow shares 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.

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

FLASKS

Flasks, wearing out with use and through burning by leaking iron, had to be replaced here with regularity.[1] 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 the displays proposed in the Cast House. Modern, but burned and 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 too inadequate in number and too expensive to locate and to 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

1. Examples are: Hopewell Document X8000320 listing flasks when Brooke and Buckley took over Hopewell in 1800; Hopewell Record, SM 15, Mar. 17, 1831, listing 18 3/4 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."

report. (These and suggested slate messages were not returned to Hdger). 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, Jan. 3, 1836, to April 16, 1837, featured in the museum displays were:[1]

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

1. 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[1] are now at the Site for this manufacture.

MOULDERS' TOOLS

Moulders' slicks and buttons, as shown in Overmann, became Hopewell property again through EMP&MA funds. In addition, a sufficient quantity have been mould copied to correctly furnish the proposed moulders' rows. This las production again cost the NPS only .25 a pound for the aluminum, since EMP&MA paid moulding costs as demonstrations on Establishment Day. Painted black, these tools will represent buttons 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 VI, the use of one is shown on his Plate V. Hopewell purchased sufficient strikes with the flasks for furnishings needs. If needed, more may be cast.

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

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

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 EMP&MA

Through EMP&MA funds, most 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 collection portion at the Bucks County Historical Society.

EAIA DEMONSTRATION AT DOYLESTOWN

Again EMP &MA provided funds for the moulding of these otherwise inaccessible patterns at the above Society, thus meeting the legal restrictions forbidding removal of any specimen for the custody of the Society. This two-day demonstration by Hopewell was featured by the Bucks County Historical Society as part of their being host to the Early American Industries Association in 1965. ALL resultant aluminum pattern copies cost NPS only .25 a pound, the price of raw aluminum; EMP&MA paid all other costs. Painted black, as historic wooden patterns were, the eye cannot distinguish them from wooden patterns. Visitors will not handle them; dryrot 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 EMPAMA funds - moulded existing Hopewell stoves in aluminum. Move stoves need be so reproduced for "patterns".

Hence, a supply of patterns, sufficient for creating many real-pattern displays in the Cast House already exist, all at minimal cost to 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 the heat-dryness. This plan proposes that bins on the reconstructed loft "display" patterns consisting of appropriately 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.[1] 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.

Since reconstruction provided no stairs to this storage area and patterns were VERY costly and fragile, a counterweighted (non-useable for children) hinged stair sufficiently strong for a man with a basket of patterns should

1. Hopewell Record, SM 21, p. 31b, 69b, 93b, and 126b are examples of founder pay scales.

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. These stacked, real or painted wooden, should be secured 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 the 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.[1]

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.

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RIDDLES

Since fine sand in contact with the pattern insured a smooth beautiful casting reproduction of the pattern design, a riddle (seive) was a necessary moulders' tool. Since their shape was round as early as the 1500's,[1] discarded used riddles from an operating foundry will serve as displays on moulders' rows in the Cast House. Several new ones, aged to make them look older, may be necessary for demonstration moulding.

II - 4

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.

Castings displayed as "cleaned" and in-the-crate ready for shipment likewise need a spraying with lacquer, wax or one of the epoxies tested[1] 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."

1. Herbert Hoover's translation of George Agricola's De Re Metellica, 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.

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

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 of Ni-iron[2] (as cast at Westherly, Pa.,) may be necessary. Naturally, this cost is unknown. However, casting demonstrations at the Site, last sponsored by EHPCMA, produced castings of aluminum at the cost of ingots, about .25 a pound.

SAND, MOULDING

While approximately ten tons of historically appropriate yellow-clay Albany moulding sand[1] are in the Cast House, the purchase of modern "self-ramming" moulding sand is proposed. Once properly placed, either in a pile of a

2. Letter, Grede Foundry, Milwaukee, Wisconsin. Oct. 20, 1965.

1. 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 1816-1828 are billed on Hopewell Document, 8290403; for 1831-1835 on Document, 8350501; Hopewell Record, S.F. 21, p. 200a, April 1, 1837 for 1835-1837 and in 1842 (if .75 per load as earlier) $43.50 for 51 loads.

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[2] will be used to color all exposed sand surfaces - the interior of 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.

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 - tuyere arch especially needs have its burned moulding sand glued to the floor as a safety feature. Perhaps all floored surface needs 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.

2. In the opinion of Manager Draper 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.

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" shoes full.)

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.[1] The third ascribes the water use - without mention of the trough - "to wet the moulding sand".[2] Both cooling and wetting needs existed historically.

Archeology uncovered a lead water pipe at the cast arch. Archeologist Abel dated it by telling: /laid/ sometime after the /clay/ floor was laid and probably after the building was abandoned."[3] This lead-pipe water line may date from the 1850 installation of a hydraulic ram or from the 1870-present water system.[4] The pre-water system tradition presents a logical water source:[5] "An iron pipe (about 1 inch) ran from the east headrace trough

1. H2215 Interview, Thomas Hoffman, p. 5 and H2215 Interview Sally Boone and Son David, p. II-2.

2. H2215 Interview, Henry Johnson.

3. Leland Abel, Archeological Excavations at Hopewell Furnace, March 6, 1964, p. 69.

4. 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, p. 209a, but lead pipe is purchased in 1872, as well. See SM 62M, Nov. 16, 1872.

5. See footnote 3.

[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 evidentially 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 a 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 1 inch line from the east-west headrace, as described, should be reconstructed. Again, a valve should be a part of this restoration.

A trough, old-looking and burned is at the cast arch and is near the size of the traditional trough.[6]

WHEELBARROWS

Shown at a furnace cast arch as of 1763 by Diderot,[1] Hopewell Records repeatedly list their purchase.[2]

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.)

6. H2215 Interview, Thomas Hoffman, p. 5.

1. Diderot, Plate IX, "Forges 2d Section, Fourneau d'Fer, Coular la Guese."

2. From the 1800 Inventory, Document XB000320 to 1841 purchases in Hopewell Record, SM 38, p. 137.

CLEANING ANNEX, MOULDERS AS CASTING CLEANERS, NEED FOR SPACE

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 5000 stoves passed through this cleaning process annually is understating the fact. For instance, the common nine-plate Circular stove[1] 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.[2] Hence, 15 plates times 5000 stoves is 75,000 flasks of moulders' work or stove plates annually. This production is the reason for the huge 80-by-60 foot Cast House.

A partial list of 1831-1837 castings cleaners includes twenty persons: a carpenter, a collier, a keeper, moulders, women, 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

1. Also made in nine sizes with two different tops and at least three bottoms for each size.

2. Hopewell Record, SM Q4, p. 6.

dollar at Hopewell bought 22½ pounds of beef before passing judgement 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 cleaning and that deliveries could be made with confidence and savings.

Not only did moulders earn .75 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.[1] 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 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 and paid for actual produc-

1. 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", p. 8.

tion by the GRADE of iron he produced, Care did have two keeper-helpers, one each for twelve-hour shift. He paid these men. Moreover, one of his keepers, Barney Hart, also cleaned casting and "pounded" charcoal parting dust for moulders.[2] This account of founder, keeper, moulders and others 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 #25. Two photographs exist of this structure in whose "attic moulders slept."[3]

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.

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

3. Hopewell Photos 125-01 and 101-03 and #2215 Interview Mr. & Mrs. Charles Sheridan Care, p. 4.

COST ESTIMATES

FURNACE CAST ARCH

1	Ringer, and other four furnace tools of wrought iron 12-20 ft. long, material and blacksmithing (EMP&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
6	Cast bed of flask clamps	$25.00 E
7	Kettle for daubing clay	have
8	Clay	free transportation only
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	Irridescent 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 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 lb.)

3	Moulders' benches	have
4	Patterns (made by EMF&MA) on benches and visible in loft above . Aluminum for more patterns. EMF&MA to pay moulding.	have some $200.00 E
5	Slate with chalk and protective spray	$5.00
6	Moulders' Tools plus riddles, pumpballs, "pliers", strikes, hammers, bellows	have
7	Black paint and protective spray for patterns	$10.00 E
8	Lifters, ¼", ½" and 3/4", ten sets @ $12	$120.00 E
9	Flasks and Flow Flasks	have
10	Shovels, straight bottom & D handles 12	$120.00 or $50.00 materia and blacksmithing
11	Clamps for flasks	have
12	Chills and chaplets	if decided upon, thru EMF&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 E
5	Small castings, doors, latches, lids - on shelf (Aluminum cost) EXPANA 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

ENTRY OF ANNEX, SUGGESTED SHIPMENT OF PRODUCT TO DISTANT MARKET

1	Wagon with a partially-loaded crate of stove plates		have
		crate	$25.00
2	Crate with cover		$25.00
		labor	$25.00
3	Burned Sand		free transportation

STORAGE AREA OF ANNEX

1	Crate, partially assembled		$15.00
		labor	$12.50
2	Crate lumber, stacked		$100.00 E
3	Flask lumber, stacked white pine (knots elim)		$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)		$500.00 E
	Labor to make flasks		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
			have
2	Slate		

STACKS OF FLASKS AROUND CAST HOUSE

Four Stacks	have
Pile burned sand	
Pile imperfect pots, pans, kettles, etc. Buy $100	free

TUYERE ARCH AREA

Stack flasks	have
Bench	have
More benches	$50 E