How to Run an Ironworks

In the autumn of 1786 Richard Blackledge, a North Carolina businessman, wrote a letter to Henry Drinker of Philadelphia seeking guidance concerning a prospective investment in an ironworks.¹ It was a major decision involving thousands of pounds, and Blackledge had come to the right man for advice. A leading member of Philadelphia’s Quaker elite, Drinker had been a partner in the mercantile firm of James and Drinker from 1756 until 1776. Retiring from trade at the onset of the Revolution, he devoted most of his effort during the 1780s to developing wilderness lands located in northeastern Pennsylvania. These operations were financed largely with income from Atsion Ironworks, which was located on the Atsion River in the pine barrens of southern New Jersey, about thirty miles from Philadelphia. James and Drinker had purchased a controlling interest in Atsion in 1773, and it had proven to be a profitable investment.² Blackledge was probably aware of Drinker’s stake in the works because of longstanding family and business ties. Blackledge’s father had traded with James and Drinker during the 1760s, and immediately after the Revolution several associates of Blackledge dealt with Drinker’s former partner, Abel James.³ Clearly Drinker was a logical source of advice for Blackledge as

¹ Henry Drinker to Richard Blackledge, Oct. 4, 1786, Henry Drinker Letterbook, 1786-1790, 80-84, Henry Drinker Papers, Historical Society of Pennsylvania. All manuscripts concerning Drinker hereinafter cited are from this collection. Recognizing the value of this document, Arthur Cecil Bining cited it several times in Pennsylvania Iron Manufacture in the Eighteenth Century (Harrisburg, 1938), 71, 73, 75, 121, 170.

² Arthur D. Pierce, Iron in the Pines: The Story of New Jersey’s Ghost Towns and Bog Iron (New Brunswick, N.J., 1957), 33. See also James and Drinker to Lancelot Cowper, May 15, 1773, James and Drinker Foreign Letterbook, 1772-1785, 106. By 1788 Drinker valued his five sixteenth share of the works at £5,250, placing its total value at £16,800. See Henry Drinker Journal, 1776-1791, 219. On sales of Atsion lumber, bar iron, and castings between 1784 and 1792, see Henry Drinker Ledger, 1776-1792, 30, 46, 59. For a map showing the location of Atsion and other American ironworks, see Lester J. Cappon, ed., Atlas of Early American History: The Revolutionary Era, 1760-1790 (Princeton, 1976), 29, 105-106, which also contains a good short bibliography on the iron industry. This map incorrectly places Atsion on the northern branch of the Mullica River, the Batsto River, rather than the southern branch, the Atsion River. See the endpapers of Charles S. Boyer, Early Forges and Furnaces in New Jersey (Philadelphia, 1931).

³ James and Drinker to Richard Blackledge [Sr.], Oct. 6, 1763; April 25, 1764; Aug. 18, 1764 James and Drinker Letterbook, 1762-1764, 162, 265, 334; Alice Barnwell Keith, ed., The John Gray Blount Papers, I, 1764-1789 (Raleigh, N.C., 1952) xv, 109, 424. For Richard Blackledge’s will, showing the disposition of his extensive holdings of land, mills, and slaves, see J. Bryan Grimes, ed., North Carolina Wills and Inventories, 1912 (Reprint, Baltimore, 1967), 41-49.
he contemplated a major investment in an unfamiliar industry.

Drinker's response to the query illuminates not only the nature of the charcoal iron industry in the Delaware Valley but also the distinctive mentality of Quaker businessmen of the revolutionary period. Far more than such flamboyant Anglican speculators as Robert Morris or William Bingham, Drinker resembles the rational, systematic businessman depicted by Max Weber in his famous treatise, *The Protestant Ethic and the Spirit of Capitalism*. Drinker composed his response to Blackledge with consummate care and precision. Despite his long involvement in the iron industry, Drinker confessed that he "may fall short of Judgment in such Matters," and he regretted that there were no ironmasters in town who could share their knowledge with Blackledge. As if to make up for his ignorance, he wrote a letter that was judicious, balanced, and comprehensive—full of specific details of great interest to historians.

Yet Drinker's prudence was alloyed with candor characteristic of many Quaker merchants. In the opening paragraph of his letter he let it be known that Blackledge's brother-in-law had not even bothered to answer an earlier missive from Drinker; in closing he pointedly expressed the hope that Blackledge would not do likewise. Although Blackledge was a southerner and slaves were sometimes workers in ironworks, Drinker inveighed against the "unchristian" practice of slavery and warned that an investment in an ironworks would be jeopardized by the aversion of southerners to hard work.

So far as the technical process of ironmaking was concerned, Drinker stressed that everything depended upon location. Iron production consisted of cooking iron ore in a large stone furnace, using charcoal as the fuel and limestone as a flux to draw off impurities. These three ingredients were constantly dumped into the top of the furnace while it was "in blast," and the temperature within was intensified by large bellows powered by a water wheel. The molten iron that flowed out of the bottom of the furnace was unrefined cast iron or "pig iron," so called because it was collected into a series of depressions in the ground that resembled a line of suckling piglets. Part of this pig iron might be poured into molds to produce such pieces of "hollow ware" as pans, kettles, and stove backs. Because pig iron was too brittle to be worked by blacksmiths, most large ironworks possessed at least one forge in which the pigs were reheated, pounded with a giant water-powered hammer, and refined into "bar iron." Thus the normal progression of materials in
the ironmaking process was from iron ore to pig iron to bar iron. It was, however, possible to convert ore directly into bar iron in forges known as "bloomeries," a process Drinker disliked because its yield of bar iron was so low.

In order to be profitable, an ironworks had to be convenient to its raw materials, yet not too distant from its markets. Above all, it had to be near a sizeable deposit of iron ore that was of the highest quality, yet not excessively costly to mine. Inferior ore could doom a works from the start by reducing the output of a furnace and lowering the quality of its product. Also important were nearby woodlands as a source of charcoal and limestone to use as a flux, and one could save nearly £100 per year by having a ready supply of stones for rebuilding the hearth of the furnace after each blast. To power the bellows of furnace and forge, an ironworks needed a stream of water that neither overflowed in the spring nor ran dry in the late summer and autumn. A site that met these stringent specifications was likely to be isolated, and consequently ironworks tended to be small, self-contained industrial villages. The workers and their families could purchase supplies at a company store, and frequently both a gristmill and sawmill served the needs of the community.

Once an appropriate site had been found, the great problem was labor. On this subject, Drinker has much of interest to say. His approach seems advanced for his day, resembling to a surprising degree the methods of nineteenth-century industrialists who attempted to reform workers and raise productivity by inculcating modern values of sobriety and punctuality. Drinker would "have nothing to do with Slaves;" he claimed to pay his workers promptly and to trade fairly at the company store; and he attempted to wean them away from rum, with only partial success. Drinker hoped that such policies would reduce labor turnover and secure the loyalty of the "sober, managing Men who do well for themselves & Families." Though clearly inspired by his Quaker values, Drinker's evenhanded policies were encouraged by an

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4 Paul Faler, "Cultural Aspects of the Industrial Revolution: Lynn, Massachusetts, Shoemakers and Industrial Morality, 1826-1860" Labor History XV (1794), 380, quotes an exhortation to shoe manufacturers to "make all your workman [sic] temperate, industrious, punctual and faithful in their business." Drinker's attitudes may have been related to an innovation in Philadelphia poor relief sponsored by Quaker merchants in the 1760s: the replacement of outrelief with a workhouse or "Bettering House," where the poor would be "reformed rather than relieved." See Gary B. Nash, "Poverty and Poor Relief in Pre-Revolutionary Philadelphia" William and Mary Quarterly 3rd Ser., XXXIII (1976), 18.
elementary economic fact: labor, especially skilled labor, was scarce in the Delaware Valley, and more than one ironworks had "suffered largely" from a shortage of workers—a problem Atsion avoided. By the same token, it is possible that a scarcity of labor prevented Drinker from imposing temperance upon his employees to the extent that he might have wished.

The Atsion labor force was highly differentiated as to function and rank; Drinker lists no less than eighteen different positions, and his workforce numbered over fifty-five men. At the top of the employment hierarchy stood the ironmaster, a salaried manager who might own a stake in the works. The most important manual workers were the specialized ironworkers, such as founders, forgers, and potters, who operated key facilities and were compensated on a piece-work basis, probably to encourage productivity. It is impossible to determine the compensation of these men without having more information about the volume of output and the number of individuals in each position. In the middle of the hierarchy were such artisans as carpenters and blacksmiths who earned £7 Pennsylvania currency per month (£84 per year), and various semi-skilled workers who received 45 to 55 shillings per month (£27-£33 per year) plus room and board. Finally, a miscellany of carters, miners, wood-cutters, and other unskilled workers carried out the laborious menial tasks that kept the furnace and forge constantly supplied with fuel, ore, and pig iron.

For the social historian, a major virtue of the annual wage rates quoted by Drinker is that they eliminate the giant unknown of unemployment. Most eighteenth-century wage rates refer to a day, a week, or a voyage and leave the historian to determine the frequency of employment—a nearly impossible task in a highly seasonal preindustrial economy. But we can be fairly certain that an Atsion carpenter earned £84 during the course of a year, or about £10 more than a busy Philadelphia cordwainer who did not employ a journeyman. A stocktaker at Atsion earned room and board plus £30, as compared to a Philadelphia laborer’s maximum annual earnings in 1762 of £59.3. As for the living standards of these workers, their dietary staples were

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5 Billy G. Smith, "The Material Lives of Laboring Philadelphians, 1750 to 1800," The William and Mary Quarterly 3rd Ser., XXXVIII (1981), 196. (1.67 pounds Pennsylvania currency equals one pound sterling.)

6 Ibid., 183.
corn and salt pork, supplemented by such tropical groceries as molasses, coffee, tea, and rum. Evidently they fared better than their counterparts in England and France, where regular consumption of meat was a luxury beyond the reach of most workers.7

Concerning the lives and outlook of his workers, Drinker's letter merely whets our appetite. What was the rate of labor turnover? How frequently did workers move up and down Atsion's occupational ladder? How many employees were indentured servants? What was the structure of a typical household budget? How long was the work day? Given the isolated nature of ironworks and their multi-faceted influence on the lives of employees, one could answer such questions with considerable precision by analyzing a complete set of records for a works, including letterbooks, journals, ledgers, and other account books. Fortunately, such records are abundant. Within the vaults of the Historical Society of Pennsylvania lies a staggering profusion of records pertaining to charcoal ironworks, amounting in all to nearly eight hundred volumes, which have received little scholarly attention and await the assault of a generation of industrious scholars.8

7 E. P. Thompson, *The Making of the English Working Class* (New York, 1963), 347-351, indicates that grains and potatoes were the staples of English workers during the industrial revolution. Roast beef was "the artisan's pride and the aspiration of the labourer" G. D. H. Cole and Raymond Postgate write "Everywhere in the countrieside, and to a considerable extent in the towns as well, the ordinary labouring population lived mainly on cereals Over most of the South, the labourer got no meat at all, except a little bacon . .In the West, again, there was usually no meat for the labourer, except a little bacon." *The British Common People, 1746-1938* (New York, 1939), 74. According to Dorothy Marshall, town and agricultural laborers lived "chiefly on bread, cheese, small beer, with meat, perhaps, once a week." *English People in the Eighteenth Century* (London, 1956), 169 In France, of course, the situation was far worse. For the poor, "ninety-five percent and upwards of their diet was cereal" and "permanent undernourishment" was their lot. See Olwen Hufton *The Poor of Eighteenth-Century France, 1750-1789* (Oxford, 1974), 44, 48.

Respected Friend
Richard Blackledge Esq'

In the 1st Instant I receiv'd thy favour of 20 Ult° it reachd me in the time of our Yearly Meeting when my House was crouded with a number of my friends out of the Country attending our said annual gathering, & scarcely a minutes leisure allowed me from the various engagements which at such Seasons multiply on my hands—I however contrived to dispatch the Letter to thy Brother in law John Jones the same Evening which he no doubt receiv'd the succeeding Morning—since then I have been in full expectation of seeing him on the Subject of thy Letter, but to my disappointment he has not appear'd & this day I receiv'd from him, by his Neighbour Jehu Roberts, under a blank cover, an exact Copy of thy Letter abovementioned in the same handwriting; which I suppose was inclosed in the Letter I receivd from thee & sent him—why he has not call'd on me or even wrote me anything is is not in my power to Account.—

It has been my desire & endeavour to have the advice & Information of some judicious Iron Master respecting thy enquiries, but on examination find none such now in this City, tho' several lately left it—therefore shall endeavour to give the best information in my power, tho' many things relative to Iron Works are under the Conduct of Clerks & Managers, & have had so little of my Attention as to leave me incapable of communicating so full explicit an Account as I could wish—

My Concerns in Iron Works have taught me to set a greater or less value on interests of that sort according to their situations or Conveniences in the following respects.—

1st. The Iron Ore, Is it Mountain Ore or Bog Ore? The former is sometimes extracted from the Bowells of the Earth at a heavy Expense & much Labor so as to reduce the benefits of such a Concern greatly—and the latter is often found in Quantities insufficient for employing a Furnace a considerable number of Years—Thy Account of the cost of raising the Ore & the Quantity that may be raised, sets this Article in a very favourable light.—

2d. The Quality of the Ore, is it poor or rich? does it flux kindly with the aid of Limestone? Some Ore tho' rather poor, produces more Iron in the same time & with the same flux & fuel than a richer kind that is often obstinate & hard to manage—is it very hard or is it malleable? does it
incline in any degree to the cold sheer or red sheer? Or is it of a tough good Quality both for Bar Iron & Castings? these with us are essential Matters, but the prices of Iron quoted by thee, seems to place this matter in a beneficial view—

3d. The distance the Ore is to be carted? is from thy Account moderate, many in the Country cart it much further—

4th. The vicinity an quantity of woodland for coaling? this also stands as well as most Works—

5th. The Stream of Water is sufficient to work in the dry Season? this is answer’d by thee to Satisfaction.—

6th. The market for Iron when made, if to be carted a great Distance, it incurs thereby a heavy Expence, but if Sales can be made on the spot or without this charge it is an uncommon Circumstance & makes greatly in favor of the concern—

7th. A saw mill is a necessary and valuable appendage, at least I have found it so, as the quantitites of Boards Scantling & Plank for the various Buildings & Repairs annually required, would amount to a large Sum if purchased & if brought from a distance would swallow up much time & service of Teams—

8th. A Gristmill if merely for the use of the Works, in grinding the Corn for Teams & other purposes, is a necessary & valuable addition—

9th. Here some Furnaces are so situated that the Hearth Stones which are generally renewed every Blast cost a considerable Sum, sometimes the whole expence is little if any less than one hundred pounds—how the Works in Question can be supplied with this Article, or whether in good Quality I am not inform’d.

10th. In the conducting an Iron Works to Advantage much depends on having a capable vigilant manager, and in obtaining Workmen & Labourers in the different branches of the business who will in their respective departments execute the parts entrusted to their Care with fidelity & uprightness—I may own here is one of my greatest doubts, having from Experience found that to the Southward few Men will go thro’ an equal Quantity of Labour with those living more northerly—and I think the Owners of an Iron Works near Snow Hill & of another at Deep Creek, both in the lower parts of Maryland have told me their principal difficulty & final failure of Success was owing to this Cause.—Where it is not the fashion & turn of the People in any Country to be diligent & industrious, it is hard work, if it be effected at
all, to produce a change in any considerable degree for the better

When I entered into the Concern I now hold in a Forge & Furnace in the Jerseys about 30 Miles from this City—I laid down certain Rules & Regulations which have been carefully observed for about 14 years & have been found to answer the good Ends intended.—One was to have nothing to do with Slaves—this perhaps will not be imitated in your Country, tho' it is devoutly to be wish'd that this unchristian practice was universally rejected.—To employ no intemperate drunken Person, or at least when found to be so, turn them off.—Never to oblige those to whom money was due to ask twice for it—Altho' a Store provided with Molasses, Salt, Sugar Coffee, Tea, Cloathing &ca was kept at the Works none were solicited or enjoined to buy nevertheless as they found they were served on reasonable terms and as low as any other would sell their Custom became secure.—as to Rum, much pains has been taken to break them of from the use of it, this has succeeded in part but not wholly and it is the only article I make them pay a high price for, & knowing my motives they submit to it without grumbling—The Fruits of these regulations shew the propriety of them, I have divers Workmen that have continued with me from ten to twelve Years, having found those sober managing Men who do well for themselves & Families will upon the whole do best for the Employer—While other Iron Works, within a few miles have frequently suffered largely for want of hands we have turn'd many away & scarcely ever knew the want of them.—

To return to thy Queries—As to how much Iron a Furnace will make P day—the Quantities differ very widely in this Country some not more than 12 or 14 Tons P Week few exceed twenty Tons tho' some rise as high as 28 Tons P Week.—much depends on the quality of the Ore, some Iron ore will flux much more kindly than others.—The size of the Furnace is a material matter, none in this Country are more than what is call'd three quarter size & some not above a half size—If employed in running Pigs only more Iron by several Tons in a week will be made than if the Blast is frequently stopt while the Hearth is filling for lading out Metal for hollow Ware & other Castings.—

I am at a loss to know by the Letter whether Bar Iron is made out of Pigs or from the Ore the latter we call Blooming, which is seldom or ever practiced when there is a Furnace from whence Pigs can be had —yet it would seem by thy saying that the three Fires at Work make 200lb Iron P day, that it must be a Bloomery, & even that is a small
quantity for one Fire to produce each Day—and to me it appears it
would be eminently advantageous to decline Blooming & to work on
Pigs, when 3 Tons if not 4 Tons P Week of Bar Iron might be
made—On this Circumstance the estimate of the Value very much
depends—Food with you both for Man & Horse is abundantly cheaper
than with us.—Here Corn is 4/ to 5/ P bush1 and salt pork, the
principal Food for Workmen, worth at least 6d Plb—while Bar Iron is
not worth above £25 P Ton, Flask'd Castings about the same price &
Pig Iron £8 to £9 P Ton—

At a Furnace the Hands & Wages are nearly as follows—
The Founders has 5/P Ton for Pigs

20/P Ton for the metal laded out & used by the
potters

40/P Ton for Stove Plates & other open Castings
made by the Founder he paying two Keepers—

Gutterman. . .45/@ 50/
2 Fillers. . .55/
Ore Wheeler. . .50/
Stock-taker. . .50/  P Month & found
Ditto in Coal House. . .50/
Ore pounder. . .45/
Ore burner. . .45/

Black smith. . .140/  P Month & find themselves
Carpenter. . .140/

Stoker for Blacksmith 50/P Month & found
Potters 4/ P Ct weight & allowed 6d a piece on hand ware, or articles
under 20lb each, this price on flask'd ware
Forgemen for Blooming Ore & drawing into Bar Iron £5 P Ton, 750
bus Coals used to each Ton

for Bar Iron from Pigs 80/P Ton, that is
the Finers. . .45/ P Ton
the Chafery. . .35/ P Ton
450 bush1 Coals P Ton
Forge Carpenter. . .140/ P Month finds himself
Stock-taker for Forge. . .50/ P Month & found
3 Teams may be wanted for hauling Ore to Furnace
3 Ditto for Coal. . .D9
2 Ox Teams for hauling floats to cover Coal pits
3 Hands for digging Ore for ditto
2 to 3 Ct Limestone P day may be used at the Furnace
Carting. d9 & Boating
2 1/2 Cords Wood $100 bus\(^1\) Coals

Colliers finding all hands have 15/ P 100 bush\(^1\) they paying for cutting the Wood wheeling, setting, firing, & delivering into the Wagons Furnace may use about 800 bus. Coals in 24 hours, this may employ 12 Colliers Forge may use 450 bus. P ton if from Pigs & employ 4 Colliers Wood Cutters number according to the business done, here we pay 2/6 P Cord I should suppose the Buildings Improvements, Utensils &c could hardly be worth less than from 4 to £5000 first Cost exclusive of the Land & ore—and from the best estimation I have found of the striking Advantages attending both the making & selling the Iron, it would seem to me that the Estate described would be cheap at six thousand pounds & probably not dear at ten Thousand pounds, & yet it is hard at this Distance to move on certain ground in a Matter of such weight and importance & subject to so many contingencies that can be best judg'd of on the spot—Upon the whole I have striven to furnish the best information I am possess'd of...the Candour & good Intention thereof thou mayest rely on however I may fall short of Judgement in such Matters—To hear that this is of any use to thee & that it reaches thy hands in due season will be acceptable to

thys assure'd ready Friend—

THOMAS M. DOERFLINGER