

CHAPTER FOUR

LOCATION, RAW MATERIALS, TRANSPORT AND LABOUR

The Location of Ironworks

The location of the furnaces and forges in the mid-eighteenth century Weald was, in every instance, the result of a sometimes lengthy historical development. Even the works which came into operation during the period did so on sites which had previously been occupied for the same purpose; Warren Furnace had been in blast in the late sixteenth century, and Howbourn Forge had been at work until the 1650s at least (Cleere & Crossley 1985: 364, 338). When there had been a spate of furnace construction at the close of the previous century, two of the three known new works had been constructed on existing ironworking sites.¹ The rationale behind this is obvious for, although the occupation of such sites would have necessitated the probable reconstruction of the furnace, or the complete reassembly of the forge machinery, the cost of either would have been insignificant compared with the expense involved in laying out a water management system consisting of bays, ponds and sluices not only for the storage of water but also for the passage of water over the waterwheels and, in the case of gunfounding furnaces, for boring mills as well; costs that would have undoubtedly included considerable legal fees in settling with other landowners or occupiers whose rights to the water would be affected. Some doubt has been expressed as to whether Gravetye Furnace, at West Hoathly, was a completely new works in 1761, or whether it was a case of an earlier site reoccupied (Cleere & Crossley 1985: 333). In the light of the probable financial commitment outlined above, together with the apparent inexperience of the ironmaster, William Clutton, and the location, which cannot be said to have had the easiest access to Woolwich, it seems highly improbable that it was a virgin site.

The 1750s and 60s were a period when, in other parts of the country, furnaces and forges were being established in new locations. However, many of the Wealden gills were already occupied by ironworking sites of earlier periods, over 180 furnaces and forges having been established in the region since the end of the fifteenth century. The fact that both Edward Raby and probably William Clutton had to restore long-abandoned sites suggests that there were no working furnaces readily available, or that if there were, their leaseholders were not prepared to let them go. So it should not necessarily be seen as an indication that the Wealden iron industry lacked industrial vitality when, with those exceptions mentioned above, all the sites of the period had been established and working for most of the preceding century, and many, such as the works at Robertsbridge, Burwash and Ashburnham, with a long history of continuous production.

The determining factors in the survival of Wealden ironworks into the 1750s seem often to have been coincidental; owing as much to family inheritance as to the advantages of location, and the maintenance of waterways and buildings that continued use

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bestowed on a number of sites. The Gott family, for instance, personally involved in the iron trade in the late-seventeenth century, continued to own the freehold of several ironworks a century later; and the Ashburnhams, while generally landlords rather than directly concerned, retained interest in their estate's works through periodic intervention, such as when they were unable to find a lessee for them. Given that the establishment of a furnace depended largely on a suitable flow of water, with reliable sources of ore and charcoal within a radius of little more than five miles, and that by the 1750s, only twenty-five ironworks, at most, were at work in the Weald, the location of several of the works concerned left much to be desired in relation to the transport options available to them, and to the markets for which their products were destined. Even Heathfield furnace, probably the first on its site, and built as late as 1693, was poorly situated, requiring expensive overland transport, either to the Medway or to Newhaven. Because of the state of the roads, carriage of guns was virtually abandoned in the winter months because of both the practical difficulties and the consequent expense.

With the principal market for Wealden iron dictated by the ordnance trade, access to the Medway, or to one of the Channel ports, either directly or via the Ouse, Brede or Eastern Rother, caused the principal concentration of furnaces to be in the north-eastern quarter of Sussex. Northpark, far to the west, may either have sent its products via the Wey at Godalming or along the Western Rother/Arun to Littlehampton. Robertsbridge and Beckley were the most advantageously situated of the furnaces, with access to navigable water throughout the year, although in wartime there were hazards in advantage, as shall be seen below. Perhaps the most surprising locations for works re-established during the war period were of the Warren and Gravetye furnaces; both remote from navigable waterways and from the sea, their location on the northern edge of the High Weald put them within reach of Woolwich by an overland route which apparently remained passable during the winter.

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The location of forges was less dependent on their markets than on the location of the furnaces which provided them with cast iron. A forge was often let with its associated furnace, as in the case of Woodcock and Warren, Pophole and Northpark, or the Robertsbridge works. In the case of Westfield Forge, its ownership by the Gott family, together with the furnaces at Horsmonden, Lamberhurst and Beckley, had ensured its continued association with those works when let to Harrison and Legas in the 1740s. Other forges, such as Maresfield and Abinger, served local markets which were sufficient to sustain them in work even though they had long ceased to be associated with particular furnaces. Bivelham and Glazier's Forges had a long association with Waldron Furnace when they were worked by the Pelham family, and therefore had an established local market as well as being maintained in working order (Cleere & Crossley 1985: 193). Hawksden Forge operated independently in the same district, with iron being purchased from Waldron in the early years of the eighteenth century (Cleere & Crossley 1985: 335). All four were brought under the control of the Harrison/Legas partnership.

A particular advantage in taking over ironworks in working order was the likelihood of specialist staff being available in the district, who were familiar with the furnace and the sources of raw materials. Where the Weald was able to retain its paramountcy

over other regions in the ordnance trade was in the skill of its workforce. Within the close tolerances of gunfounding, considerable losses in rejected guns could be avoided by employing a competent moulder or founder. An ironmaster, such as John Churchill, who purchased the lease of a working furnace and forge, could expect to be able to employ the skilled personnel already working at the site, although the enquiries he made prior to taking the lease of Robertsbridge did not mention the labour force. For the few who resurrected a defunct furnace or forge, there was the problem of finding suitable skilled men, and the risk of financial disaster if they did not. The skilled workers had to be enticed from other works or from among the small number of founders, moulders and hammermen who had become unemployed by the closure of works elsewhere. The problems John Fuller had in 1751 with poorly cast guns being repaired with lead, serve to emphasize the need for a skilled workforce (Crossley & Saville 1991: 266).

The nearness to London and the prospect of being able to buy the lease of an ironworks in operation or, failing that, one which required restoration, rather than having to bear the expense of establishing works on a virgin site, must have acted as a considerable inducement for an ironmaster wishing to enter the ordnance trade, as must have been the reservoir of skill which the region had to offer. It is significant that, of the twenty-one gunfounding furnaces operating in Great Britain in the period, more than half of them were in the Weald and as many as six of those had been run by concerns from outside the Weald.

Transport

Transport was a major element in the cost of Wealden iron and, as has been seen above, it was an important factor in the location of ironworks. Both land and water transport were liable to cause problems where a heavy commodity such as iron was concerned.

Overland transport was expensive but, when conditions were right, relatively quick. It was expensive because the weight of the iron prevented more than a limited amount being carried on any one wagon and therefore the number of wagons and the number of journeys involved were necessarily great. Robert Knight was carrying guns to Woolwich from Warren furnace every three days in 1762, and in the Ashburnham campaign of 1760-1. at least seventy-one turnpike charges were incurred by the carriers taking guns to Maidstone (Hodgkinson 1978: 14-5).² Wartime placed pressure on gunfounders to send guns to Woolwich overland because of the danger to coastal shipping from French privateers. Presumably to balance the cost against the danger, Crowleys were sending half their output overland, and half by sea from Hastings. Ironworks probably had at least one wagon team to carry out the various transport tasks necessary through the year, but other teams were hired from neighbouring farms, such as Stephen Goodsall's team at Udiam Farm which carried guns from Robertsbridge furnace to Maidstone, or along the short distance to Udiam Bridge where they were offloaded on to barges bound for Rye.³ The state of the roads was a further disincentive to overland transport though clearly this varied from area to area. John Fuller's oft-quoted comment, about his nine pounders tearing up the roads

to universal annoyance, has been used to illustrate the poor condition of Wealden roads.⁴ However the volume of traffic from the Sussex furnaces which converged on the navigable River Medway by road, let alone from other destinations, suggests that road transport, while remaining expensive, was not always as difficult as it has been portrayed.

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The growth of the turnpike system in south-east England contributed to the improvement in the state of roads although the ironworks were seen as a major cause of their decay and, until 1767, ironmasters had an obligation to contribute cinder for road repair. In that year, the use of the road for the carriage of goods to and from the forges at Thursley and Pophole was put forward as an argument for the alteration of the position of the tollgate on the Guildford-Godalming Turnpike, in Surrey.⁵ Forge goods from both works avoided payment of tolls by transferring to barges on the Wey instead of passing through the tollgates. Harrisons' encountered a different problem when attempting to move guns from Lamberhurst in 1756. Their use of a sixwheeled 'machine' to carry one gun conflicted with the terms of the turnpike Act, insofar as it had narrow wheels but required more than the permitted four horses. Compromises involving broad-wheeled wagons, which presumably incurred a higher charge, or the Board of Ordnance interceding on the Harrisons' behalf, did not apparently resolve the matter although the Board Minutes do not record the outcomes

Where the state of the Wealden roads exercised its greatest effect was in the winter months. Carriage of both iron and raw materials cost more at the very time when furnaces and forges were at their busiest. In a letter to the Board in 1762, Rose Fuller stated the impossibility of delivering guns to Woolwich before June of the next year because of the condition of the highways.⁷ Winter carriage was surcharged by 100% at Ashburnham whereas Fuller seemed to pay only 50% over the summer rate. Wartime did not appear to have an effect on carriage costs for, at Ashburnham at least, there was no alteration in the rate between 1757 and 1770. Where the state of the roads had an effect on ironmasters, such as the Fullers, who were loath to spend the extra to move their products in winter, was in the delay in delivery which resulted. As has already been seen, the payment system of the Board of Ordnance was such that gunfounders were only granted a debenture on completion of warrants, which depended on the delivery of guns before the expiry date set by the Board. When peace was declared in 1763, the price of ordnance dropped and many gunfounders found that late arrivals were paid for at deflated, post-war prices.

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More often it was coastal transport which gave rise to excuses for late delivery. Carriage by water was considerably cheaper than overland though somewhat slower. Stephen Fuller asked successfully for up to six shillings and six pence per ton more for guns sent overland to Maidstone, rather than out of Newhaven, because the Board were in urgent need of them.⁸ Judging from the time taken to carry guns overland from the Warren to Woolwich, the round trip from Ashburnham or Heathfield to Maidstone cannot have been more than three days, and from Lamberhurst furnace or Horsmonden boring house, half that time. The promotion of the Upper Medway navigation owed much to those in the Weald who had heavy materials, such as timber or iron, to move. In 1760, 30% of cargoes on the upper Medway were guns. Bowen, Tapsell and Fuller, the only three clients who

used the navigation, had 1208 tons of ordnance freighted in that year. By 1770, only 11.8 tons were carried (Hood 1979: 223-4). Carriage to the Medway, whether to Maidstone itself, or to Branbridges on the Medway Navigation, had the advantage during wartime of greater security for there was less chance of a Maidstone hoy, from Millhall or Newhithe, being captured in the Thames estuary than of a vessel travelling round the Forelands from Rye, Hastings or even Newhaven. For this reason, the ordnance storeships either travelled in convoy or awaited escort by a passing naval vessel. The Board requested a convoy for a ship carrying guns for Harrisons' from Newhaven in 1756 but refused a similar request from Churchill the next year, denying their earlier action.⁹ Further requests from Harrisons' the same year, and the next, were acceded to. Movements for the Board of Ordnance were exempt from the Act prohibiting coastal traffic in warlike materials.¹⁰ It is likely that Churchills' were refused because the guns they were exporting were not for the King's service, Churchills' having requested the Board to intercede with the Customs to allow them leave to export. Ironfounders outside the Weald experienced greater problems with enemy threats to the coastal traffic. William Ford, at the Lorn Furnace in Argyllshire, and John Sunderland, at Low Wood in Furness, both shot founders, had considerable distances to send their products, and delays were frequent. The lack of a convoy had prevented shot cast for Edward Raby, by a sub-contractor in the Bristol area, from reaching Woolwich by the end of 1759.¹¹ Sometimes the fault lay with the suppliers. In the same year, a naval vessel sent to escort ships laden with guns from Rye for Harrisons', had to depart without them because they were not ready to leave.¹²

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Bad weather was a further restraint. The convoy carrying Raby's shot was also delayed by contrary winds. Because of delays 'of convoy and wind,' Thomas Pryce's shipment of round shot from Neath took from November to February to reach Woolwich in 1761-2.¹³ The warrants had expired, and the shipment was prevented from landing until the Board's permission had been sought. Pryce had to bear the cost of keeping the crew at sea in the meantime. A similar fate befell guns shipped for Harrisons', Churchills' and Robert Morgan, from Rye in 1763.¹⁴ The delay consequent on contrary winds and then ice in the Thames led to the cancellation of the uncompleted part of their warrants because of the Board's reduced requirements, peace having been declared since the orders were placed.

In wartime in particular, impressment threatened to deprive ships, transporting guns or shot, of their crews. The Board were rarely sympathetic unless their needs suited them to be so. Vessels were also in short supply from time to time during the war period, either because of impressment or because of increased coastal traffic. Eade and Wilton's letter of January 1761, whereby they were unable to deliver guns 'for want of shipping,' typifies the problem.¹⁵ The time limits imposed on warrants by the Board, resulted in financial loss even when out of the founder's control, and the prevailing attitude of the Board, whereby they were generally unsympathetic to most of the founders' excuses, may well have deterred many appeals for mitigation. Robert Morgan, of Carmarthen, was fortunate in the Board's favourable response to his memorial concerning a cargo of guns and shot which, while en route to Woolwich in 1759, had been forced in to Ostend and

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detained. Duly released at the cessation of hostilities, it arrived at its destination four years late¹⁶

RawMaterials

Contrary to the view of Ashton (1963 ed.: 15), the records of Wealden ironworks which survived into the mid-eighteenth century show that sources of wood for charcoal, and of ore, remained within a convenient radius of the works, and there is no evidence to support his assertion that the Weald's specialization in castings was mainly caused by a shortage of charcoal, thus inhibiting the operation of forges. An important determining factor in the location of ironworks was the supply of charcoal which, because of its friability, could not be transported intact from much further than a five mile radius of its destination. This imposed a limit on the area which could be exploited by an ironworks, but it also protected the ironmaster from the competition of major charcoal users further away. The onset of a war in which demands for charcoal, particularly for gunpowder, might be stretched to an unprecedented extent could place pressure on existing consumers in a vulnerable area like the south east. A number of factors inhibited this tendency with regard to the iron industry in the Weald.

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Most Wealden ironworks were leased by the owners of substantial estates. Thus it was in the interests of landowners, seeking a market for their timber and underwood, to ensure that the ironworks they leased were an integral, viable part of that marketing process. Many of those estates had been founded, in part at least, on the profits of ironworking in earlier centuries, so the estate infrastructure had been geared to servicing the needs of the iron industry. The continuous operation, over more than a century, of many of the ironworks which survived into the 1750s attests to the effectiveness of woodland management on the estates which supplied them. Sir Whistler Webster's steward referred to some 3000 acres of the Battle Abbey estate woods which had always been used for charcoal for the furnace, implying that they could continue to be so used (Whittick 1992: 57). This figure compares comfortably with Hammersley's estimate of 7000 acres for a furnace casting 530 tons, taking into account the additional consumption of Robertsbridge forge and the fact that production at both sites, which were small in comparison to those in other parts of the country, was restricted to between seven and nine months in the year (Hammersley 1973: 606). At Ashburnham, both wood and ore were available during the period from within a similar radius. Nor were Harrisons' apparently experiencing any difficulty in obtaining raw materials. Cattell has shown that Hawksden forge was supplied by the regular rotation of nearby woods, and the lists of locations supplying Gloucester furnace with both wood and ore in the late 1740s reveal a similar hinterland (Cattell 1973: 143-5).¹⁷ Correspondence relating to the attempts to find a lessee for Hawksden forge, following Tapsell's bankruptcy in 1765, concentrates on the problems faced by estates in finding markets for wood when ironworks close.¹⁸ Roger Challice, the incumbent at Mayfield, reported to the Bishop of Durham's steward that, without a tenant at the forge, he saw no better way of disposing of woodland, that was overdue for felling, than to sell to the other tenants of the manor, suggesting that, far from there being competition for the woods, landowners who wanted

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an income from their property depended on the demand the iron industry created. This state of affairs corresponds well with the experience of the ironworks in the East Midlands during the same period, and lends support to Hammersley's view that the price of wood was largely artificial and local in nature (Riden 1991: 76; Hammersley 1973: 608-10). It also calls into some doubt the claim expressed in 1755, in letters to the Board of Ordnance from Stephen Fuller, Sone and Stephens, and Robert Bagshaw on behalf of the Harrison brothers and Richard Tapsell. They claimed the scarcity of fuel and the increased price of carriage and labour as justification for their appeal for a higher price for ordnance from the Board. Acting in concert may have been an indication of strongly held opinions, but may also have been a combined effort to boost prices during a period of peace.¹⁹ There is no evidence that any attempt was made to import coke into the region, but the use of coal as a fuel has been suggested on two sites. Straker refers to its alleged use by Churchill at Robertsbridge, and quantities of it were taken to Warren and Gravetye furnaces (Straker 1931: 316 & 216). The operation of an air furnace, or the drying of cannon moulds remain as likely explanations.

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Undoubtedly the landlord-tenant relationship was important in determining to what extent ironmasters had to compete for wood with other potential purchasers. It was common practice for some rights to be established in the leases for works. Churchill's lease of Robertsbridge furnace in 1754, which virtually reiterated the terms by which the Jukes brothers had it seven years earlier, obliged the landlord to sell all sixteen year underwood grown within fourteen miles to the lessee for seven shillings a cord uncut. If none was to be available the landlord was to give adequate notice for the lessee to make alternative arrangements (Whittick 1992: 45-7). Such may have been the case in March 1763 when James Bourne, on behalf of John Churchill, paid Thomas Hussey for 195 cords of coppice wood.²⁴ Prices fixed in the lease were protected from inflation. Ironmasters who had to negotiate with landowners for supplies of wood for charcoal were necessarily more conscious of the value of the commodity. From an ironmaster's point of view, the ability to sell off wood which was surplus to his needs was an important bonus. Churchill was able to sell as hop poles wood which was too small for coaling. Likewise, Samuel Baker, subsequently tenant at Hawksden, recognised the financial advantage of paying by the acre, and would have had a purchaser for the spray wood if he had been able to buy in that way, rather than paying for just the cord wood, with the timber of other sizes sold elsewhere.²¹ Thus the interests of local woodreeves, wishing to market woodland to the best advantage for their landlords, inevitably conflicted with those of ironmasters, hoping to bargain for rights over a sufficient acreage of woodland to guarantee supply, and to allow for some additional income.

The cost of wood was a major element in the economics of iron manufacture. At Ashburnham, wood supply consumed 30% of the expenditure of campaigns between 1756 and 1770. In assessing the consumption of wood for a blast in the Weald in this period, the evidence varies according to location.

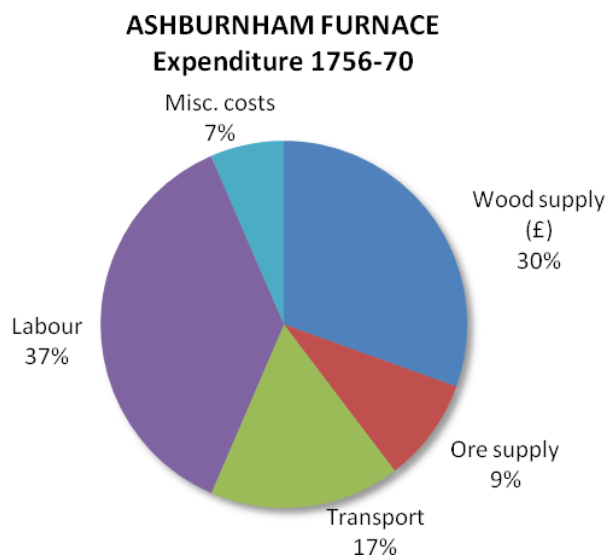


Fig. 12

(ESRO ASH 1815)

At Robertsbridge, the only figures given are those supplied in letters to prospective lessees, in which the estimate was between 1000 and 2000 loads of charcoal to achieve between seven and eleven tons of iron a week at the furnace, with a further seventeen hundredweight of bar iron at the forge. At Ashburnham the expenditure accounts are more detailed and a quantity for each campaign can be calculated. Wood was purchased in a variety of ways and the prices reflecting that diversity require some analysis for comparisons to be made. At Ashburnham there seemed to be little variation between costs during and after the war period. Wood was sold by the cord, cut or uncut, the variation lying in the quality of the wood; topwood, sprays, runts, coppicewood, spillwood. Over this was the cost of cutting, cording, teaming, and the many individual costs incurred by the colliers; cleaving, stacking, coaling, filling sacks. Prices at Robertsbridge and Ashburnham compare closely, those at the former not changing between 1747 and 1768. On top of these costs were those of carriage, 'trespass' over neighbouring land, and the occasional establishment of lodges to house the colliers. Carriage was the determining factor as in it lay the greatest variation; distance.

Expenditure on iron ore was affected by the cost of carriage in the same way as expenditure on wood was, and again the payments made were broken down into a number of separate elements; the rent for the land, the labour of digging or 'drawing' the mine, and the carriage to the furnace. Prices varied with the distance carried and with the quality. The three grades, fine mine or 'veins,' coarse 'greys,' and 'pitty' (or marlpit) were priced at rates which, like the price of wood, did not materially alter throughout the war period and after. Fuller was paying the same price, 1s.6d. a load in the ground, twenty years earlier (Crossley & Saville 1991: 264). Unlike wood, which was a renewable resource, iron ore supplies would inevitably run out, so it is a testament to the richness of the Wealden beds that Ashburnham and Robertsbridge, both working since the mid-sixteenth century, could still draw upon sources which were close at hand. For instance, Foxearth Wood, from which

ore was brought to Ashburnham in 1762-3, lay less than a kilometre away from the furnace.²² The apparent abundance of ore within a short distance may have been the reason for the continued importance of some sites. Certainly, it was not always the case. William Clutton was having ore carried to Gravetye from Boyles Farm, south of East Grinstead, at least five kilometres distant (Hodgkinson 1978: 16). Similarly, in 1767 the anonymous enquiry about ore to Clutton, by then steward of Broadhurst Manor, Horsted Keynes, which probably also relates to Gravetye furnace, would have entailed a journey of six or seven kilometres (Hodgkinson 1987: 35-7). Local land sales throughout the period advertised the presence of beds of ore, and ironmasters who could not benefit from advantageous terms in their lease had to treat with local landowners for the necessary rights, though it is not clear to what extent formal agreements were entered into.

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Technology

Tomlinson (1976: 397) has said that the Wealden ironmasters were unable to adapt to new technology, which was geared to coke and to large scale operation. To some extent this must be open to question as within it lies the assumption that Wealden ironmasters were a different type from their contemporaries elsewhere in the Midlands, Wales or Scotland. It has been established, above, that in many cases the firms which operated ironworks in the Weald originated in the very areas where the innovation was taking place. It was the gunfounding industry, and the specific regional advantages that the Weald offered in that business, which attracted those firms. However, it also can be said that the inflexible specialization of the Weald was a major contributor to its demise as a potent industrial area. What was absent from the Wealden iron industry were the developing manufacturing processes which were bringing prosperity to the other iron producing areas of the country; coke smelting, crucible steel, slitting and rolling mills. Because of specialisation in casting, and ordnance in particular, none of these processes was necessary in the Weald, but when they began to influence the ordnance trade itself, the fate of the Weald as an iron producing region of significance was effectively sealed.

Where technological advances could affect production of the Weald's specialism, they were utilised. The reverberatory, or air, furnace, wherein pig and scrap iron, and flawed castings, could be remelted and cast without the decarburization of the forging process, was developed during the seventeenth century, particularly in the use of non-ferrous metals. Its advantages lay in that it did not require a forced blast, thus obviating the need for streams, bays and ponds, nor did it require a nearby ore source, with the attendant problem of the disposal of large quantities of slag. It has not been appreciated how many of these air furnaces there probably were in the Weald. John Churchill's correspondence with Sir Whistler Webster discloses that the Jukes brothers had converted the second finery hearth at Robertsbridge forge into one (Whittick 1992: 37). Straker (1931: 316) ascribed this to Churchill himself. The executors of William Harrison installed one at Hamsell furnace in the late 1740s, which was apparently still in use as late as 1758,²³ and Edward Raby undoubtedly had an air furnace, very probably at Warren furnace, to melt bronze when he widened his production to this metal in about

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1769 (Hodgkinson 1978: 12). Other Wealden founders had air furnaces at works or yards they had in Southwark. William Bowen cast shot from old metal which he received in part payment from the Board of Ordnance, as did Joseph Wright, though whether the latter was in Southwark or at Pophole forge is not known. Linked with their use of surplus iron from Ashburnham, Crowleys would have probably had an air furnace either at Greenwich, or on Tyneside. John Fuller had to decline the Board's offer of part payment in old metal because he had no air furnace, declaring that he 'must lie at the Mercy of those that have, to give what Price they please' (Crossley & Saville 1991: 257). Some shot founders, such as Richard Gilpin and Stephen Remnant, both based in London, worked exclusively with air furnaces. The requirement of the Board of Ordnance that the iron guns they purchased should be cast from ore prevented the expansion of a London-based guncasting trade using air furnaces, which Bowen and Gilpin were already using to cast in bronze, and which Remnant was using at Woolwich to cast for the merchant trade.

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A technological development which had been under way in other regions for more than a century was in the size of furnaces. The capacity and output of Wealden blast furnaces was, in most cases, a legacy of the past, and affected the ability of the region's gunfounders to expand their production to meet the demands of wartime. Estimating output from furnace hearth size relies on archaeological evidence for which there is little in this period. The remains of Northpark furnace were surveyed and, although the hearth had not survived, the overall ground plan of the furnace measured 5.5 metres square, which is comparable to the plan of Batsford or Chingley furnaces, both of which had been abandoned by the third decade of the seventeenth century; Northpark was put up for sale as a working furnace as late as 1777.²⁴ No excavation work has been carried out at any other Wealden furnaces from the Seven Years' War period, so the only estimate as to size can be made from the available output figures. Churchill's initial proposal to the Board was for 200 tons of ordnance in 1757 which, over an assumed average campaign of thirty three weeks, is not unreasonable compared with the output level of seven to eleven tons a week quoted by the estate three years earlier (Whittick 1992: 59).²⁵ Churchill doubled his proposed output for 1759, and it is presumed that he was able to make this offer by running Darwell furnace as well as Robertsbridge.²⁵ In 1757 William Bowen offered to cast 300 tons of ordnance at his furnaces, presumably Cowden and Barden, which is a low figure suggesting small hearth capacity.²⁷ Heathfield was one of three furnaces erected during the 1690s, and it might reasonably be supposed that they were of similar size. Furthermore, it is known that the other two, Lamberhurst and Pippingford, were both larger than the norm for the Weald, as suggested by archaeological evidence; the former being 28 feet (8.5m) high and probably of comparable dimensions around the base, the latter being known to be 8m square at the base. The size of the hearth at Lamberhurst was reported to have been 8¾ sq.ft. (0.8m²) although this figure alone cannot be directly equated with a quantity of iron (Straker 1931: 78). Cleere and Crossley (1985: 212-3) have shown that production at Waldron and Lamberhurst was similar at about 1.4 tons a day in the 1740s, and that Heathfield was achieving slightly more a decade earlier. The warrants issued to Harrison, Bagshaw and Tapsell at the end of 1756 were for almost 1500 tons of ordnance which, at an average output per furnace of 250 tons, would have required the combined production of five furnaces.²⁸ Stephen Fuller was unable to guarantee to supply more than 270 tons for the Board in 1759, although he said he

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would try to deliver 300 tons. More than any other, Fuller's furnace seems to have been devoted to the production of ordnance at this time, so these figures may be a better guide.²⁹ Output figures are available for Ashburnham but they are distorted in that the weight of iron often relates only to ordnance and does not consistently include other castings. Nevertheless figures of 341 tons for 1759/60 and 307 tons for 1760/1, the latter in a campaign apparently lasting only 35 weeks, suggest a capacity substantially similar to the furnaces mentioned above.³⁰

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If Wealden furnace capacity was modest in this period, the ordnance production of furnaces outside the Weald was very similar. Robert Morgan, at Carmarthen, offered the Board of Ordnance 100 tons a year in 1758 and 1759, which appears very low in comparison with Wealden furnaces, but which cannot represent Morgan's maximum output as he was expecting to cast 650 tons in 1760 (Williams 1959: 35). Some Wealden gunfounders, notably the Crowleys and, later, Edward Raby, as well as other non-Wealden gunfounders, such as the Sones, of Sowley in Hampshire, Robert Morgan, and John Wilkinson, of Willey in Shropshire, combined production for the Board of Ordnance with orders for the East India Company, so orders for the Board cannot be taken as an accurate guide to furnace output.

Other technological innovations which began to appear elsewhere in the iron industry included alternative methods of blowing air into the furnaces. The traditional Wealden method, two pairs of leather and oak bellows, allowed little room for improvement. The Ashburnham and Heathfield accounts contain regular payments for hides and oil for their maintenance, without which furnace efficiency would be impaired and water supplies exhausted sooner. There is no reference to the introduction of alternative blowing methods, such as the cylinders that Smeaton made for the Carron Company. Although the Fullers had an engine made to raise water in the 1730s, it does not seem to have been a success, and no other evidence exists of attempts to provide more reliable means of maintaining the water supply to furnaces and forges. The unusually dry years of the mid 1740s had passed, although Edward Raby reported to the Board that dry weather had prevented him from boring his guns to complete his 1759 warrants, and in 1757 Stephen Fuller's clerk, William Gregson, came to an agreement with the miller upstream of Heathfield to allow his water to be used, for a daily charge, to avoid his workers having to tread the water wheel in the absence of water!³¹

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Forges played a role of diminishing significance in the Wealden iron industry during the 1750-70 period. There is no evidence in the Weald of any of the developments which affected forges elsewhere in England, and especially in the West Midlands. Although a wire mill was established at Woodcock Hammer by 1787, the use of rolling or slitting mills is not recorded in the Weald during the Seven Years' War period. The Jukes brothers' conversion of the second finery at Robertsbridge forge into a reverberatory furnace can be related more to the casting of shot, but it is of some interest that John Churchill wished the second finery to be reinstated. In one instance at least, an ironfounder did without a forge altogether. The Crowleys employed their forge site at Ashburnham as a boring mill. Ample boring capacity seems to have been a necessity at the larger furnaces. The Fullers had built a second boring

house in 1742, and there were two at Robertsbridge forge (Crossley & Saville 1991: 161-2; Whittick 1992: 48). A second boring mill was constructed at Ashburnham in 1766, possible with an eye to future demand for ordnance, although the casting of mill cases and garden rollers required boring as well.³² The innovation which perhaps had the most profound effect on the Wealden gunfounding industry, Wilkinson's boring machine, did not appear until the 1770s, after the end of this period.

The relative unimportance of forges may have led to their neglect. In the 1765 correspondence about Hawksden forge, the state of the works, the structure, machinery and waterways, was described as in need of repair, some urgently. It may be that the neglect was, in part, due to the difficulties which had beset Richard Tapsell, the former tenant, prior to his bankruptcy. It also seems likely that tenants of forges had to take pains to ensure that, when they entered into a lease, a full set of tackle was included. Churchill made it clear that he expected Robertsbridge forge to be in a good state of repair when he took it over (Whittick 1992; 60).

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Labour

The permanent labour force of the iron industry in the mid-eighteenth century Weald was small. At Ashburnham, the accounts record payments to a clerk, founder, borer, moulder and labourer, in addition to a wide range of other individuals employed for specific purposes at piece rates. With a minimum of ten furnaces at work at any time between 1750 and 1770, the total permanent personnel at work in them would have been about fifty. In addition were the forges in the region, which again numbered about ten at any one time. Assuming a permanent staff of three at each of these, finer, hammerman and labourer, thirty can be added to the overall total making eighty permanent ironworkers in the Weald at any one time. It is impossible to count accurately the total number of persons engaged in working at, or around, the furnace, for there is no way of knowing how many others were paid for out of the individual expenditure items. For the 1758/9 campaign at Ashburnham furnace, about sixty people can be identified as being paid for one or more jobs, whether it was regular work such as coppicing, coaling, or transporting iron, or for periodic tasks such as repairing a boring bar, making baskets or currying hides, and that number does not include those whose work can be regarded as permanent. Therefore, assuming that half as many again can be added to the sixty already counted, the number of non-permanent personnel may have been as many as ninety at a typical furnace; a total of nearly a thousand permanent and casual workers for a minimum of ten furnaces. Forges required no ore, their output was considerably less than the furnaces (Robertsbridge had an average output of 40 tons a year) and their products were generally distributed in a smaller area. The casual labour force of a forge would therefore have been considerably less than a furnace; perhaps a quarter of the number. For an average of ten forges, we can expect that a little over 300 permanent and casual workers may have been employed, making a grand total of about 1300 for the whole industry in the Weald. In the period 1756-70, labour

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charges at Ashburnham, excluding any part of the cost of transport, consumed 37% of the total expenditure. A comparison between the labour costs at the beginning and the end of the period is less easy to assess as rates are not always given. Where they are, however, no change can be discerned over fourteen years.³³ There is some evidence that ironmasters made some provision for the accommodation of their workforce, particularly in areas where there may have been insufficient housing in the surrounding agricultural community. A map of the lands of Sir Kenrick Clayton in 1761 shows a number of small closes with cottages, adjacent to the Warren furnace, let to Mr Masters, one of the partnership operating the works.³⁴ At Northpark furnace, memories of a 'shanty town' survive locally (Barnes 1991: 28).

In an industry where the number of skilled personnel was so small, it is inevitable that individuals became widely known, and that there was a distinct market for such artisans. The Diamond family, who in successive generations were moulders at Ashburnham, and of whom John Fuller thought highly, were called upon for advice at other furnaces than their own. William Bowen, whose career in the Weald began with his purchase of Cowden furnace in 1741, appears to have had a practical training in ironfounding, for in 1744 John Fuller described him as "the best Molder among us" (Crossley & Saville 1991: 194). Bowen may have worked for Samuel Remnant early in his career. John Butler, however, experienced some difficulty attracting specialist workers to his furnace near Fernhurst, outside the main area of Wealden gunfoundries. His response was to employ workmen from the north, though it is not known from where, until local men had acquired the necessary skills (Butler & Butler 1845: 11).

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With the gunfounding industry spreading outside the region, the specialized skills of the Wealden workers were in demand elsewhere. Following the death of George Tyler, his founder, Robert Morgan had considerable difficulty attracting a replacement in 1759. A suitable candidate from the Weald could not be engaged. Desperation nearly drove him to employ "Drunken Bets," whose poor workmanship had caused such a disastrous proof for Abel Walter at Sowley, that the latter had given up trying to cast guns for the Board (Williams 1959: 34-5). Coincidentally perhaps, the moulder at Ashburnham in the 1760s was a John Betts. The Carron Company employed moulders from Sussex, but in inadequate numbers for the output they were contemplating, and the use of unskilled labour led to a lower standard that the company were aiming for (Campbell 1961: 82).

Notes and References

1. Heathfield furnace was built in 1693, Lamberhurst adjacent to the site of Hoadly forge, in 1695, and Pippingford, on or adjacent to the site of Steel Forge, in 1696; Cleere & Crossley 1985: 194-5, 350.
2. ESRO ASH 1815.
3. ESRO ALF 9/9.

4. John Fuller to Samuel Remnant 26th February 1742/3.
- 5 GMR LM1064.
- 6 PRO WO47 48 ff.545, 566, 582 & 593.
- 7 PRO WO47 60 f.366.
8. PRO WO47 47 f.618.
9. PRO WO47 47 f.652; 49 f.11.
10. PRO PC2 105.
11. PRO WO47 54 f.507.
12. PRO WO47 54 f.22.
13. PRO WO47 57 f.87.
14. PRO WO47 61 f.50.
15. PRO WO47 57 f.31.
16. PRO WO47 61 f.433.
17. GL Ms.3736/4.
18. ESRO GLY 2770.
19. PRO WO47 45 f.396.
20. KAO U1776.E19A.
21. ESRO GLY 2771.
22. ESRO ASH 1815.
23. PRO WO47 51 f.405.
24. Magilton 1990: 32; Bedwin 1980: 98; Crossley 1975: 31.
25. The average length of campaign at Ashburnham from 1757-70 was 232 days; ESRO ASH 1815.
26. PRO WO47 49 f.314.
27. PRO WO47 49 f.577.
28. PRO WO47 48 f.602.
29. PRO WO47 50 f.409.
30. ESRO ASH 1815.
31. PRO WO47 54 f.507. ESRO SAS RF 16/V/9.
32. ESRO ASH 1815.
33. ESRO ASH 1815.
34. SyRO 61/3/2.