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CHAPTER FOUR

The Manufacturing Economy

England was already a substantial manufacturing economy by 1714. True, the methods by which her growing output was achieved were as yet largely untouched by power technology and the factory system, but that would still be true of much of the manufacturing sector in the mid nineteenth century. Deane and Cole estimated that agriculture was contributing 43 per cent of national income in the eighteenth century and manufacturing and commerce together 30 per cent. That now seems an underestimate. It has been suggested that by 1750 agriculture's contribution may have fallen to a quarter, while manufacturing and commerce had become responsible for a half. That may be an over-correction, but an appreciation of the fact that by 1700 manufacturing involvement already exceeded the level usually associated with economic underdevelopment is fundamental to understanding the eighteenth-century English economy. That there was only a very gradual improvement in income per head reflects the fact that early industrialisation was relatively labour intensive and 'low tech' in comparison with the heavy industry based spurts of later industrialising economies. The capital investment threshold was low and while productivity gains were cumulatively significant, only at the very end of the eighteenth century and then only in a few industries were they dramatic.¹

By 1801 combined employment in industry and commerce, at 36 per cent of the occupied population, balanced employment in agriculture (37 per cent). The problem is tracing the path to that parity. From Gregory King's famous survey of 1688, it is commonly suggested that by 1700 around a third of the population depended on manufacturing and mining, and that by the time of Joseph Massie's

1. Deane and Cole, *British Economic Growth*, p. 142; see the revised proportions discussed in Crafts, *British Economic Growth during the Industrial Revolution*, Chs. 2 and 6, and the discussion in Rule, *Experience of Labour*.

survey of 1759 this figure was perhaps a half. Few scholars would now accept Deane and Cole's suggestion of a 60-70 per cent dependence on agriculture as late as 1750. Indeed, an extreme position recently asserted by Lindert and Williamson on the basis of occupational recording in burial registers is that agriculture employed only 55 per cent as far back as 1688.²

The data do not permit precision. Gregory King did not distinguish between agricultural and other 'labourers', and although Professor Mathias has used his figures with great perception, Massie presents similar difficulties. So far as Lindert and Williamson's 'new' data are concerned, burial registers hardly ever give an occupation for women, who may have brought more hands to manufacturing than men, and in the very common cases where men had two occupations they usually record only one. In eighteenth-century reality explicit distinctions would be distorting. The 'putting-out' system was designed to carry manufacturing into the countryside, while many rural craftsmen such as blacksmiths, wheelwrights and others were really part of the agricultural economy, spending more time mending than making.

Historians cannot rigidly separate manufacturing from farming employment for the eighteenth century, because that was not the way in which the economy worked. Dual occupations persisted in many areas throughout the century and in others well into it, even if in some they died out earlier. There is no simple picture of a widespread and equal combining of farming with manufacturing or mining. Regional variation was the keynote. At one extreme a man might be equally dependent on work in both sectors - perhaps even be listed in a parish register as 'tinner-husbandman' or 'weaver-farmer'; at the other a small allotment might be contributing to the well-being of a predominantly manufacturing household. Over time, the first might well have become the second situation. The registers of west Cornwall record the marriages of 'tinner-husbandmen' regularly up to the mid eighteenth century, but less commonly thereafter. By the mid nineteenth century the farming activities of miners were described only as 'collateral aids' to family income. Even within the county the situation varied. Small-holding persisted in the rural mining districts where wasteland was plentiful but declined more rapidly around towns like Camborne and Redruth. Some northern miners were encouraged by the coal owners to take in holdings from the moorland wastes, but Arthur Young com-

2. For example, P.H. Lindert and J.G. Williamson, 'Revising England's social tables 1688-1812', *Explorations in Economic History*, 19, 1982, pp. 385-408.

mented in 1771 that without direct encouragement, few were willing to give up their leisure time to the scraping of poor soils. Small-holding seems to have been rare among West Country woollen weavers, but common enough among cotton weavers in Lancashire to provoke complaints in 1750 that 'farmer-weavers' were undercutting those who sought to make a full-time living. In the clothing districts of the West Riding the 'alliance of land and loom' characterised the small-farming independent master clothiers who were such a feature of the region.³ They usually held between 3 and 7 acres, although a sizeable minority had enough to be considered small farmers as late as 1795. Defoe described the district early in the century.

Every clothier must keep a horse perhaps two to fetch and carry for the use of his manufacture, to fetch home his wool and his provisions from market, to carry his yarn to the spinners, his manufacture to the fulling mill, and when finished to the market to be sold . . . so every manufacturer generally keeps a cow or two, or more for his family, and this employs the two, three or four pieces of enclosed land about his house.⁴

At the end of the eighteenth century the watch and fine-tool makers around Prescott occupied small farms, but according to Arthur Young in 1776, the metal workers of the Black Country hardly ever did so. There, the trend away from the dual economy had begun as early as the 1720s by which time few of those who still held land had more than an acre or two. In part this reflected the growth of the towns like Walsall, Dudley, Stourbridge and Wolverhampton. The last named had 305 houses on 200 acres in 1666, 1,440 houses in 1750 and 2,270 by 1780.⁵

Even if a man was a full-time miner or weaver, he might still head a mixed family economy in which his wife and children filled the labour gap on a family small-holding. Defoe met the wife of a Derbyshire lead miner (living comfortably enough in a cave) and was impressed by the sow and piglets at the door, the lean cow and the barley plot. Seeing to all this and to her five children under ten, she still managed from time to time to earn threepence a day wash-

3. Rule, *Experience of Labour*, pp. 12-14 for a fuller discussion.

4. Daniel Defoe, *A Tour through the Whole Island of Great Britain*, Everyman edn, 1962, II, p. 195.

5. A. Young, *Tours in England and Wales: Selected from the Annals of Agriculture*, London, 1932, pp. 140, 142, 259.

ing ores at the mine and to present herself as a 'tall, well-shaped, clean, and (for the place) a very well looking, comely woman'.⁶

Much occupational mixing was seasonal. Cornish miners took part in the autumn pilchard fishery. Workers of all kinds joined in the harvest. Nor was that simply a matter of a day or two a year. A West Country clothier complained that he lost his weavers to the hay harvest in June and then enjoyed a brief respite before the late-summer corn harvest began, which could last until the autumn apple picking – it was cider country. The earliest of his apologetic letters to impatient customers is dated 15 June and the latest 26 October! Those who put out iron to Black Country nail makers experienced similar problems.⁷

Early nineteenth-century evidence suggests less mixing of employments, although it was still far from uncommon. The shift away from agricultural employment had been increasing over the second half of the eighteenth century. It was not, however, as dramatic as the traditional picture of a mass rural exodus to new industrial towns. It was sufficient to ensure that in the first decade of the nineteenth century the employment shares of manufacturing and agricultural employment were both a third. Over the second decade the trend picked up so that by 1821 manufacturing employed 38.4 per cent – a full 10 per cent more than agriculture.

Table 4.1 Labour force: sectoral growth rates, per cent per annum

	1688-1759	1759-1801
Agriculture	-0.05	0.06
Industry	0.51	1.36

Source: N.F.R. Crafts, *British Economic Growth during the Industrial Revolution*, Oxford UP, 1985, pp.15-16.

To juxtapose an urban manufacturing sector with a rural agricultural one would be a major misrepresentation of the structure of the eighteenth-century economy. Town worker versus country labourer would be a false dichotomy. Better sense is made by a three-way division into rural agricultural, rural non-agricultural and urban. The first was shrinking while the other two were increasing.

6. Defoe, *Tour*, II, pp. 161-3.

7. See Rule, *Experience of Labour*, p. 16.

Table 4.2 Populations: relative indices (1800 total = 100)

	Agricultural	Rural non-agricultural	Urban
1700	89	46	36
1750	84	61	51
1800	100	100	100

Source: E.A. Wrigley in R.I. Rotberg and T.K. Rabb (eds), *Population and Economy*, Cambridge UP, 1986, pp. 140-1.

The agricultural labour force increased by only 18 per cent over the latter half of the eighteenth century, while the rural non-agricultural group did so by 64.4 per cent and the urban group doubled. A continued expansion of rural manufacturing is certainly indicated. This was so true of western Europe as a whole that modern historians have made it the defining characteristic of a phase of 'proto-industrialisation' (see below, pp. 140-5). What was exceptional was the growth of England's urban population.

Table 4.3 Percentage of total populations in towns of 10,000+ inhabitants

	1700	1750	1800
England	13.4	17.5	24
North and west Europe minus England	12.8	12.1	10

Source: E.A. Wrigley in Rotberg and Rabb (eds), *Population and Economy*, p. 148.

However fashionable it has become to stress the role of manufacturing in the countryside, it is difficult to escape the conclusion that England's development advantage may have resided in a unique expansion of urban manufacturing. When nineteenth-century steam power brought the textile mills back to the towns, it emphasised but did not create a manufacturing trend.⁸

Manufacturing had urban and rural forms often within the same industry. In wool and cotton there were town weavers and country

8. On the unusual rate of urban growth in England, see E.A. Wrigley, 'Urban growth and agricultural change: England and the Continent in the early modern period' in Rotberg and Rabb (eds), *Population and Economy*, pp. 123-68.

weavers, just as there were town and country framework knitters. In hardware, too, cutlers could be found in both town and countryside. Defoe's *Tour* made at the beginning of the century reveals an industrial geography of populous, active districts. Sometimes these were sufficiently extensive to be considered regions. Within them were sizeable and small towns, villages and hamlets, all engaged in the local manufacture.

Let them view the County of Devon, and for 20 miles every way round the City of Exeter, where the trade of serges is carried on.

The County of Norfolk, and for as many miles every way about the City of Norwich, where the stuff-weaving is carried on.

The County of Essex, for near 40 miles every way where the bay-making trade is carried on.

The County of Wiltshire through that whole flourishing Vale from Warminster south to Malmesbury north, inclusive of all the great towns of Bradford, Trowbridge, Westbury, Tedbury, Frome and Devizes etc. where the manufacture of the fine Spanish and medley clothing and drugget making is carried on.

The Counties of Gloucester and Worcester from Cirencester and Stroudwater to the City of Worcester where the white-clothing trade for the Turkey merchants is carried on.

The Counties of Warwick and Stafford, every way round the town of Birmingham, where the hardware manufacture and cutlery trade is carried on, as also about Coventry.

The Counties of Yorkshire and Lancashire, round about and every way adjacent to the great manufacturing towns of Manchester, Sheffield, Leeds and Halifax, where the known manufactures of cotton-ware, iron-ware, Yorkshire cloths, kersies etc. are carried on.

Devon was so full of 'great towns' engaged in serge manufacture that it could 'hardly be equalled in Europe'. So great was the appetite of the Essex clothing district for yarn that 'some whole counties and parts of counties' were engaged in spinning it. Wealthy capitalist clothiers in the West Country sent out raw wool to be spun to 'a great number of villages, hamlets and scattered houses'. Even Lancashire, cradle of the factory system, grew, as its historians have remarked, more from a 'thickening of the population over the countryside' than from the growth of individual towns.⁹

Generally urban artisans made higher-quality goods. Better cutlery was made in Sheffield than in the surrounding villages. Wolverhampton and Willenhall concentrated on locks, while Black Country villagers made chains and nails. Coventry's silk ribbon was

9. Defoe, *Tour*, I, pp. 218, 221, 233, 280; II, 88-9, 189-90; A.P. Wadsworth and J. de L. Mann, *Cotton Trade and Industrial Lancashire*, p. 312.

a cut above that woven in Warwickshire villages, and even before they began to specialise in lace, Nottingham's stockings produced a more 'up-market' hose than that knitted in the rural east Midlands. It would, however, be incorrect to think of eighteenth-century England as an economy in which a rude peasantry made rough articles as a by-employment in dark and frozen winter hours. Rural employment may have been more mixed than has sometimes been allowed, but this did not prevent a considerable degree of specialisation on the part of what was by then not so much a peasantry as a 'workforce dwelling in the countryside'.¹⁰ This made possible a sustained, if undramatic, increase in productivity even from cottage manufacture. In some districts it is hardly an exaggeration to write of a 'rural artisanry'. Many rural manufacturing workers became skilled through specialised application and passed this on through succeeding generations to gain sound reputations for their particular products. Whatever their origins, over time country manufacturing workers created and confirmed their own traditions, including a defensive labour consciousness and an ability to organise to protect their interests in a similar way to urban artisans. Even where the country districts did produce inferior goods, like the 'knock-ons' forged around Sheffield, these still had their role in national and even international markets.

Between the manufacturing villages and the larger industrial cities was a host of smaller manufacturing towns. Sometimes, as in the cases of Wigan, Preston, Warrington, Burnley, Cole or Oldham, they were integrated into a regional economy - in this case based on cotton, in the same way that Defoe's woollen towns in Devon, Essex or East Anglia had been integrated into regional woollen manufactories. But there were also isolated small manufacturing towns such as carpet-weaving Wilton, Axminster and Kidderminster. Coventry, Banbury, Newbury and Kendall all had localised woollen manufacturing. Bridport made fishing nets . . . the list is illustrative, not comprehensive.

Important as manufacturing in small towns and the countryside was, a special feature of the century was the very rapid growth of some large manufacturing centres. Defoe remarked on several. 'Black Barnsley' was already so described from the smoke of its iron and steel making, and they were 'all smiths that lived in it'. Sheffield too was 'dark and black', while by mid century in Burslem in

10. M. Berg, 'Political economy and the principles of manufacture, 1700-1800', in Berg, Hudson and Sonenscher (eds), *Manufacture in Town and Country*, p. 39.

the heart of the Potteries people groped their way even through the midday streets. Over the next two decades its manufacturing continued to grow, amazing the itinerant John Wesley with the inflow of people. At Portsmouth the expanding dockyard had brought into being a 'new town' of Portsea, which by 1800 had three times as many houses as the old town. Smoke from glass manufacturing at Bristol so filled the air with 'noxious effluvia' by 1760 that the well-heeled were fleeing to new homes on Kingsdown Hill.¹¹

Five of the ten largest provincial towns in 1775 owed their size primarily to manufacturing: Birmingham (40,000), Norwich (38,500), Manchester (30,000), Sheffield (27,000) and Leeds (24,244). Of the other five only Bath had no really significant manufacturing, for, as well as being ports, Liverpool, Bristol, Newcastle and Plymouth all did. By 1775 other towns, too, had grown rapidly since 1700 from manufacturing: Nottingham by 135.9 per cent from framework knitting; Exeter, even though her best days were already over, by 17.9 per cent from serge making; Coventry by 107.1 per cent from silk weaving; and Leicester by 75 per cent from framework knitting.¹² The growth of Birmingham and Manchester was exceptional even so. Birmingham's 1801 population of 73,000 was a nine-fold increase over the century. Arthur Young reckoned it in 1791 to be 'the first manufacturing town in the world'. Administratively a 'mere village', Manchester (with Salford) housed 19,839 people in 1757, having had less than half as many inhabitants forty years earlier. By 1795 when it was rapidly developing as the world's foremost factory town, the population had reached 27,256.¹³

On a smaller scale, examples of towns growing, or even emerging, as the result of manufacturing or mining can be plucked from all over England. Plymouth's naval dockyard rivalled that of Portsmouth by 1790 and around it the almost separate town of Dock (later Devonport) had grown up, while across the Tamar in Cornwall the satellite town of Torpoint developed. Further west, Camborne grew through copper mining from a small hamlet to a town

11. Hammonds, *Town Labourer*, p. 31; John Wesley, *Journal*, Everyman edn, 1906, IV, p. 202; D. Wilson, 'Government dockyard workers in Portsmouth 1793-1815', PhD thesis, University of Warwick, 1975, pp. 18, 36; P.T. Marcy, *Eighteenth-Century Views of Bristol and Bristolians*, Bristol Historical Association, 1966, p. 14.

12. Figures from P.J. Corfield, 'The industrial towns before the factory' in *The Rise of the New Urban Society*, Open University, 1977, pp. 114-16. The clearest demonstration of the importance of urban manufacturing in the eighteenth century is Ch. 2 of Dr Corfield's excellent *Impact of English Towns*.

13. William Hutton, *Life of William Hutton*, F.A.S.S., 1817 edn, p. 110; Corfield, 'Industrial towns', *op. cit.*, p. 72; Young, *Tours in England and Wales*, p. 257; Defoe, *Tour*, II, p. 261.

of 5,000 inhabitants by 1801 when it was granted its market. St Helens grew from village to town almost overnight with the arrival of plate-glass manufacture.

London dwarfed them all. A multi-functional capital city and port, it could still claim to be the largest centre of manufacturing in the country. It would not otherwise have grown to anything like its population of 570,000 by 1700, or moved through 675,000 by 1750 to exceed a million by 1811. It was especially remarkable for the range of its artisan manufacturing, which employed an immense army of master craftsmen, journeymen and apprentices. Tailors and shoemakers were numbered in thousands and before the end of the century so too were print workers and watchmakers. Building craftsmen and their labourers abounded and hatters, coopers and the like were not far behind. Shipwrights worked along the Thames and a host of smaller trades like engraving, lock making and spectacle making added to the number. The largest single group of manufacturing workers were the silk weavers of Spitalfields;¹⁴ according to Massie, in 1759 14,000 families drew support from this employment.¹⁵

TEXTILES

In all, Massie thought that textiles nationally employed 114,000 families. In 1759 the great age of cotton was still to come, and wool and worsted manufacture dominated. Cotton closed the gap with astonishing speed after 1770, but wool still outweighed it in 1815, although its rival was steaming at its shoulder. The much-used Hoffman index of manufacturing output (1955) had put cotton ahead with a 12.2 per cent share by 1811 compared with wool's 11.0 per cent, although more recent indices consider that a slight over-estimation of the newer textile.¹⁶

Wool and worsted cloths made up 70 per cent of the value of English domestic exports in 1700 and although this share had de-

14. See Corfield, *Impact of English Towns*, Ch. 5, and Wrigley, 'A simple model of London's importance in changing English society and economy', in *Past and Present*, 37, 1967, pp. 37-44.

15. For Massie, see P. Mathias, 'The social structure in the eighteenth century: a calculation by Joseph Massie' in Mathias, *The Transformation of England*, Methuen, 1979, pp. 171-89.

16. The major revision of manufacturing output figures is Harley, 'British industrialization before 1841'.

Table 4.4 Weighting of textiles in total manufacturing

	1770 %	1815 %
Wool	15.0	11.0
Cotton	1.0	8.0
Linen	8.0	6.0
Silk	4.0	2.0

Source: C.K. Harley, 'British industrialisation before 1841: evidence of slower growth during the Industrial Revolution.' *Jn. Econ. Hist.* XLII, 1982, p. 269.

clined by 1770, it still stood at 50 per cent. Arthur Young supposed it in 1776 to be still 'the sacred staple and foundation of all our wealth'. By 1780 cotton output had increased its 1760 value of £0.6 million ten-fold. By 1813 its value at £28.3 million was fifty-seven times greater! By such a standard the two and a half times increase in woollen output seems modest, but its more significant weighting must be kept in mind, as must the special dynamism of one of its regions of production: the West Riding. This area on its own accounted for almost the whole increase in taking its share of national output over the eighteenth century from a fifth to two-thirds.¹⁷

By 1750 the woollen industry had become increasingly concentrated in three areas: the West Riding, the West Country and East Anglia. Two other areas were still important but already passing their greatest days: the Devonshire serge manufacture based on Exeter and Tiverton and reaching to Taunton, and the stuff manufacture around Colchester. Beyond these localised manufacture continued in towns like Coventry, Banbury, Romsey and Kendall. By 1800 there was little left in Devonshire of a manufacture which in 1700 had employed four-fifths of Exeter's population and most of that of Tiverton and the smaller towns and villages of the district. Its boom years were over by 1720. Its lightweight high-quality serges had up to 1714 earned around 28 per cent of the £3 million value of wool cloth exports. By the end of a long period of decline lasting to 1748 the value of serge exports had halved. New markets in Italy

17. Young cited in P. Mantoux, *The Industrial Revolution in the Eighteenth Century*, Methuen, 1961 edn, p. 48. The general pattern of growth in wool output is given in A.E. Musson, *Growth of British Industry*, pp. 85-6; for cotton output statistics, see S.D. Chapman, *Cotton Industry in the Industrial Revolution*, p. 64.

then underwrote some recovery up to the beginning of the French wars in 1793, but its exports never again made up more than 10 per cent of the national total.¹⁸

Essex had specialised in light worsteds – the 'stuffs' which, according to Defoe in 1720, clothed foreign 'nuns and friars'. Slow decline from that time accelerated after 1760, punctuated by short-lived booms, to extinction by 1800. As Devon and Essex declined, the main centre of lighter-cloth manufacture moved to East Anglia around Norwich. By 1750 the merchants of that city were selling six times as much cloth in value to Spain as were their Exeter counterparts. The years from then until the end of the Seven Years War in 1763 were the best ones. Around thirty clothier-dyers organised the manufacture, employing 12,000 looms and providing work of all kinds for 70,000 woollen workers. Trade, after suffering in the later 1760s, picked up again in the 1770s, but despite several short periods of promise the drift of worsted manufacture to the West Riding had become unmistakable by 1800 and by 1820 was virtually complete.¹⁹

Gloucestershire, Wiltshire and parts of Somerset formed the home of the great woollen broadcloth manufacture of the West Country. Over much of the eighteenth century output of its heavy, full woollen cloths stagnated. Its rival was the West Riding, which hardly competed in quality but instead found the rougher, cheaper 'kersies' a better basis for expansion. According to Professor Mann, the doubling in value of West Country output over the eighteenth century represented only a slight increase in output. Extended slumps like those of 1720-70 and 1783-90 brought widespread and severe distress to a population heavily dependent on manufacture. Shorter periods of prosperity hardly compensated, nor did a renewed period of investment in the 1790s which in any event was not sustained into the nineteenth century.²⁰

The history of wool cloth production reveals that the industrial geography of eighteenth-century England was altered by the decline of old manufacturing districts as well as by the rise of new ones.

18. The Devonshire woollen manufacture lacks a recent history; the only accessible account remains W.G. Hoskins, *Industry, Trade and People in Exeter 1688-1800*, Exeter UP, 1935 and 1968.

19. Defoe, *Tour*, I, p. 63. For the rise and decline of Essex and East Anglia, see Berg, *Age of Manufactures*, pp. 113-15, and C. Wilson, *England's Apprenticeship*, pp. 293-4.

20. The standard account of the west of England woollen manufacture is Mann, *The Cloth Industry in the West of England*. Its progress is summarised in Berg, *Age of Manufactures*, pp. 115-22.

The arrival of new mechanised and powered technologies affected this only towards the very end of our period. The West Riding began its climb to pre-eminence long before coalfields fixed the location of a factory-based woollen industry. It was a matter of compounding advantages rather than of a single or special one. Cheaper cloths were better suited to expanding markets than were the expensive products of the West Country, which were from 30 to 50 per cent dearer. Dr Wilson has cogently argued that it was not simply a matter of a more marketable product but of a more dynamic approach, especially to the possibilities of the American market after 1770. This market increased its share of total wool cloth exports from 25 per cent to 40 per cent over 1770 to 1800. Yorkshire took practically all of this increase.²¹

At the beginning of the century Defoe had applauded the brisk activity of woollen manufacture in almost all of its main centres, but even so, readers of his celebrated *Tour* feel an extra surge of energy when he comes to the district around Halifax.²² The eighteenth-century economy offers no better illustration of what Charles Wilson has termed the 'churning vitality' of industry in the period leading up to the industrial revolution.²³ Yorkshire had resource advantages. Coal was not yet needed to power spinning mules or weaving looms, but it heated the combs used in worsted production and the vats for dyeing. The running waters of the hillside landscape powered the fulling mills, while Yorkshire alone of the major districts had plentiful supplies of local wool. Defoe appreciated these advantages: 'There is scarce a hill but you find, on the highest part of it, a spring of water, and a coalpit.' Lower wages helped, but that differential was being rapidly eroded. The manufacture was distinctive in being based on small working clothiers, whereas elsewhere control had long since passed into the hands of putting-out merchant capitalists, separating capital from labour. As a select committee put it in 1806, in East Anglia and in the West Country 'the work generally speaking is done by persons who have no property in the manufacture'.²⁴ This goes a long way towards explaining the more troubled labour relations in the other districts.

21. R.G. Wilson, 'The supremacy of the Yorkshire cloth industry in the eighteenth century' in N.B. Harte and K. Ponting (eds), *Textile History and Economic History*, pp. 225-46.

22. Defoe, *Tour*, II, pp. 115ff.

23. C. Wilson, *England's Apprenticeship*, p. 288.

24. *Report on the State of the Woollen Manufacture*, BPP, 1806, cited in D. Gregory, *Regional Transformation and Industrial Revolution: A Geography of the Yorkshire Woollen Industry*, Macmillan, 1982, p. 53.

Yet Yorkshire's rise to dominate worsted production in the second half of the century was no less remarkable than its earlier triumph with woollens, and the West Riding's worsted manufacture was organised on a merchant capitalist basis.

Perhaps the reasons lie in the regions which declined. Wool was part of a wider tendency for manufacturing to leave the south and east. E.L. Jones has suggested that this was in part a consequence of the greater potential of these areas for the new agriculture which, by shifting their comparative advantage, drew available capital and energy into farming. Possibly the entrenched traditional attitudes of textile workers in the west and in East Anglia also reduced entrepreneurial inclination to innovate, while their insistence on marketing through London's Blackwell Hall restricted attempts to find new markets. The outcome was that the West Riding, already contributing two-thirds of output by 1800, was to dominate the factory era to an even greater extent. In 1800, however, the factory system so far as woollen manufacture was concerned was still found only in the preparatory processes of carding and scribbling. The stimulus of Lancashire cotton was near by, but wool did not lend itself so readily to machine spinning and weaving. At Benjamin Gott's pioneering mill established at Leeds in 1792, neither of the two main processes was mechanised. Factory mule spinning made little headway in woollen cloth production before the 1830s and power weaving none before the 1840s. Progress was more rapid in the worsted branch. Here, water-powered frame spinning was introduced in 1787 and steam spinning in 1793. By 1800 there were eighteen mills and steam was displacing water power. By 1820 hand spinning of worsted yarn had virtually disappeared from the West Riding, by which time factory weaving had made its entry.²⁵

If anything annoyed early eighteenth-century pamphleteers more than England allowing the Dutch to harvest North Sea herrings, it was that despite a suitable climate for flax-growing, linen came second only to 'groceries' in her imports: 15 per cent of the total up to 1740. A consequent levying of protective duties and restrictions first assisted the ousting of foreign suppliers by Scotland and Ireland and then from 1750 brought about a remarkable expansion of English production which by 1775 was four times its level of 1720. At its peak in 1774 linen was producing 8.3 per cent of the total value of

25. See the discussion in Berg, *Age of Manufactures*, Ch. 5. On the West Riding generally, see D. Gregory, *Regional Transformation and Industrial Revolution*, p. 53; H. Heaton, *The Yorkshire Woollen and Worsted Industry*, Oxford UP, 2nd edn, 1965, and P. Hudson, *Genesis of Industrial Capital*.

exports. Thereafter progress was less spectacular, but its weighting in manufacturing output in 1815 at 0.06 was still half that of wool and three-quarters that of cotton. Pre-factory production had been widespread but tended towards the north-east, north-west and south-west. Factory spinning was introduced in 1787 with the best-known mill, that of John Marshall, opening in Leeds in 1794. Capitalised at more than £250,000 in 1828, it was an outstanding enterprise but one of only a few flax-spinning mills in England. Scotland and Ireland together boasted 700,000 spindles in 1850 compared with the 265,000 in England and Wales.²⁶

Progress in silk manufacture can be measured from its need to import either raw or thrown silk. At the beginning of the eighteenth century these amounted to around £0.5 million a year. By the 1780s the million mark had been passed and by 1815 £1.25 million. Steady and substantial rather than spectacular progress is indicated. In 1770 silk cloth's weighting in total manufacturing was only a quarter of that of wool but four times that of cotton. By 1815 it was a sixth of that of wool and a quarter that of cotton. Nevertheless, to account for 2 per cent of industrial output was a fair performance from a manufacture which was not only specialised and 'up market' but had to compete both with the new product of printed cottons and with established centres of production in France and northern Italy. The 'throwing' stage, producing the yarn from raw silk, precociously entered the factory mode. The waters of the Derwent were powering machinery at Sir Thomas Lombe's famous Derby mill by 1720. William Hutton, who worked there as a child in 1730, was later to curse his luck at having been born in the one place where child labour in a factory could have been his fate. In fact, throwing mills spread quite rapidly to Macclesfield, Stockport and other towns in north Cheshire and south Lancashire. No other stages were mechanised and silk was woven on hand looms. The greatest concentration of broadcloth weavers was in London's Spitalfields district, while Coventry and its neighbourhood dominated ribbon manufacture.²⁷

'King Cotton' shoots like a meteor through the growth statistics of the later eighteenth and early nineteenth centuries. Accounting

26. For linen, see especially Harte, 'The rise of protection and the English linen trade, 1690-1790' in Harte and Ponting (eds), *Textile History and Economic History*, pp. 74-110, and also Musson, *Growth of British Industry*, pp. 90-1.

27. W. Hutton, *The History of Derby*, 2nd edn, Baldwin, Cradock and Joy, London, 1817, p. 158. For levels of output and progress, see Musson, *Growth of British Industry*, p. 92; Berg, *Age of Manufactures*, pp. 28, 31-5, 224-5.

for only 1-per cent of manufacturing output in 1770, its 8 per cent in 1815 was only 3 per cent behind wool. By 1820 the £29.4 million it was adding to national income exceeded the £26 million of wool.

Table 4.5 Annual growth rates of real output, per cent: cotton, wool and the three fastest-growing other manufactures

	Cotton	Wool	Other manufactures
1700-60	1.37	0.97	Copper 2.62 Paper 1.51 Linen 1.25
1760-70	4.59	1.30	Copper 5.61 Silk 3.40 Linen 2.68
1780-90	12.76	0.54	Paper 5.62 Copper 4.14 Iron 3.79
1801-11	4.49	1.64	Iron 7.75 Paper 3.34 Soap 2.63
1821-31	6.82	2.03	Iron 6.47 Silk 6.08 Coal 3.68

Source: N.F.R. Crafts, *British Economic Growth during the Industrial Revolution*, Oxford UP, 1985, p. 23.

Table 4.6 Average annual growth rate of thirteen manufactures*

1700-60	0.89	1801-11	2.33
1760-70	1.92	1821-31	3.35
1780-90	2.82		

* cotton, wool, linen, silk, building, iron, copper, beer, leather, soap, candles, coal and paper

Source: N.F.R. Crafts, *British Economic Growth during the Industrial Revolution*, Oxford UP, 1985, p. 203.

Like silk, cotton uses an imported raw material. Retained imports of raw cotton grew from 8.7 million pounds (lb) in 1781-3 to 99.7 million by 1815-17. The annual gross value of output rose from £0.6 million in 1760, through £4 million in 1781-3 and £10 million in 1794-7 to reach £28.3 million in 1811-13. In percentage terms

this represents 1,760 per cent from 1760 to 1790 and 4,616 per cent from 1760 to 1813! Clearly, cotton was overwhelmingly responsible for the doubling of textile output which was to occur between 1800 and 1820. In 1751, 4,531 hand looms were already at work in Manchester alone, with many times that number in south Lancashire as a whole around centres such as Bolton, Oldham and Preston. By 1788 cotton employed 26,000 male weavers and three times as many women and children in spinning. Adding those employed in other processes like dyeing and printing, the labour force reached 350,000. Factory spinning came with Richard Arkwright's water-powered mill at Cromford in Nottinghamshire in 1771. Following Samuel Crompton's invention of the spinning mule, even fine spinning could be done by machine from 1790. Steam power was first applied to coarse spinning in 1785 and to mule spinning in the 1790s. By 1811 there were more than 4 million steam-mule spindles spread over more than fifty mills in the Manchester district alone. Although Edmund Cartwright patented his power loom in 1785, it became established only in the second quarter of the nineteenth century. In the meantime hand-loom weavers increased from 75,000 to 225,000 between 1795 and 1811, by which year factory employees exceeded 100,000.²⁸

Recent reassessments of manufacturing progress have not failed to point out that cotton grew from a very low base and that its contribution to exports was greater than its contribution to manufacturing output, which had still not reached 10 per cent by 1815. There is little certainty in estimating eighteenth-century growth but it seems clear that while there was a shift towards more rapidly growing manufactures like cotton and iron in the late eighteenth century, it should not be allowed to overshadow the widely based growth across a range of industries which were both less dramatically transformed than cotton and less export oriented. The three manufactures commonly taken to typify the industrial revolution – cotton, iron and engineering – accounted together for less than a quarter of manufacturing output as late as 1840.²⁹

28. In addition to Chapman's excellent pamphlet *Cotton Industry in the Industrial Revolution*, for the progress of the cotton industry generally, see M.M. Edwards, *Growth of the British Cotton Trade*, and for the earlier period Wadsworth and Mann, *Cotton Trade and Industrial Lancashire*; Musson, *Growth of British Industry*, pp. 78–85; Berg, *Age of Manufactures*, pp. 205–7; Deane and Cole, *British Economic Growth*, pp. 50–2.

29. For stress on the exceptionality of cotton, see Harley, 'British industrialization before 1841', pp. 267–8, 279; Crafts, *British Economic Growth during the Industrial Revolution*, pp. 33–4, and C.H. Lee, *British Economy since 1700*, pp. 10–11.

Cotton cloth sold well not just because it was cheap and light but also because it could be as brightly coloured and patterned as the much more expensive silks. The branch of the industry usually known as calico printing was crucial for overall success. In the early eighteenth century it was performed largely by skilled male workers who cut and applied the printing blocks. Initially it was based in London, but with the concentration of home manufacture in Lancashire it moved north, taking with it the artisans. Mechanised printing using etched copper cylinders began to de-skill them after 1785, but before then larger employers, such as the elder Robert Peel, had escaped from dependence on the high-paid journeymen by developing simple repetitive hand techniques which employed women and children. 'Picotage' involved patterning the block with thousands of pins or studs and was a more skilled process than 'pencilling' in which the patterns were hand painted. Calico printing reveals how employers faced with high labour costs could attempt to reduce them, not only by employing machinery but also by developing techniques which used cheaper labour.³⁰

Statistics do not reveal the full importance of the cotton manufacture which played a leading and strategic role in the modernisation of the British economy. Silk offered the earliest instances of the modern textile factory, and the importance of its example to the early cotton entrepreneurs has been remarked by Dr Chapman. Cotton, however, made the breakthrough into steam power, and as a consequence gave the world the factory system.³¹

From the beginning the making of cotton piecegoods was concentrated in south Lancashire, but the building of Arkwright's pioneering mill in Nottinghamshire points to the different location of the cotton stocking branch. These were produced mainly in that county, as woollen ones were in Leicestershire and silk in Derbyshire. Together these made up the great east Midland hosiery manufacture. Yarn was turned into stockings on knitting frames, a sixteenth-century innovation which, after a long delay, had substantially replaced the traditional method of hand knitting by 1700. Defoe attributed the decline of knitting in Dorset to competition from the frame. By then it had become concentrated in the East Midlands, moving away from its original London base to escape guild control and cash in on cheap rural labour. By 1740 around 5,000 frames were at work, and when the famous Luddite attacks on

30. The best account of calico printing and its various technologies is Berg, *Age of Manufactures*, pp. 146–8, 216–17, 251.

31. Chapman, *Cotton Industry in the Industrial Revolution*, pp. 14–15.

them began in 1811 there were six times as many creating work for 50,000 persons. Except in the spinning of yarn, the factory appeared only in the mid nineteenth century.³²

Glove making was less concentrated, but there were several important centres. It employed several thousand in Worcestershire and its surrounding district in the 1770s and perhaps 30,000 by the 1820s. At that date perhaps 20,000 glovers worked in and around Yeovil and 3,000 around Hereford. Severe problems then resulted from the removal of import restrictions on French gloves, and by 1832 production from Worcestershire had fallen by two-thirds.³³ Garment manufacture was more dispersed. London was the greatest centre, with most of its tailors by the early eighteenth century working as journeymen in the workshops of large employers. In other towns independent tailors were more in evidence, but in any of size the trend was towards the workshop. The leather industry may have accounted for a fifth of manufacturing output in 1770 and still a sixth in 1815. At the former date it was easily the largest industrial grouping and at the latter only just second to building. In terms of value added its £5.1 million in 1770 was second only to the £7 million contributed by wool, and in 1801 it was only just beaten by cotton (£8.4 million and £9.2 million).³⁴ Yet we know very little of the details of its organisation or development. Shoe-makers, like tailors, were to be found everywhere but again were especially concentrated in London. As with tailors, there was a marked increase in the number of permanent journeymen employed in workshops to cater for a widening market. Provincial shoe-making usually supplied local markets, but the putting out of leather to cheap labour in and around Northamptonshire was growing in importance after 1780. Tanneries were to be found contributing smell and smoke in many larger towns, but the largest concentration was on the south bank of the Thames at Southwark and Rotherhithe.

COAL

In its widespread use of coal, English manufacturing led Europe. Because historians have often restricted their interest to its uses for

32. Defoe, *Tour*, I, p. 213; E.A. Wells, *The British Hosiery and Knitwear Industry: Its History and Organisation*, David and Charles, 1972, pp. 48-9; E.P. Thompson, *Making of the English Working Class*, p. 580.

33. Young, *Northern Tour*, III, p. 306; Berg, *Age of Manufactures*, p. 124.

34. Berg, *Age of Manufactures*, pp. 26, 28, 38-9.

steam power and for iron smelting, they have tended to underestimate its importance before the 1770s. Steam boilers are not the only things that can be fuelled by coal, while iron was the last of the major metals to be smelted with it. Energy in the form of heat had as many applications as did steam. Before the end of the seventeenth century coal was widely used to boil, brew and melt. In the brewing industry, Professor Mathias has identified two stages in coal use. Long before the eighteenth century began it was used to heat brewing vats and from the 1780s it was increasingly substituted for real horsepower to grind malt and raise water. Whitbread's bought a Boulton and Watt steam engine in 1786 and considered that by doing the work of twenty-four relayed horses it was well worth the cost of a bushel of coal an hour and an annual premium of sixty guineas for its use.³⁵ In 1738 parliament received a complaint about the high price of coal from the glass makers, brewers, distillers, sugar bakers, soap boilers, smiths, dyers, brick makers, lime burners, founders and calico printers. A threatened strike by Bristol's local Kingswood colliers in 1792 brought fears of stoppages of 'very numerous and extensive glasshouses, very large copper works, lead works, distilleries and other concerns that consume immense quantities of coal'. None of them did so to fuel steam engines.³⁶

The late and fitful spread of coke smelting in the iron industry must be set against its earlier use with non-ferrous metals, as well as against the fact that it was used to forge iron across the country from the village blacksmith to the cutlers of Sheffield and the nail makers of the Black Country. Such usage was the essence of Professor Nef's argument for an industrial revolution in Tudor and Stuart times, but historians have been surprisingly indifferent to later developments before the eighteenth-century industrial revolution. Professor Harris has cogently put things into perspective. He has shown that Britain served an invaluable apprenticeship in the industrial use of coal during this period as one manufacture after another turned to it and as methods of using it became gradually more efficient and economical from the on-the-job experience of skilled workmen. This was a craft rather than a scientific contribution to Britain's technological leadership.³⁷

Steam engines, too, were widely used in the economy before the

35. P. Mathias, *The Transformation of England*, Methuen, 1979, pp. 225-6.

36. Mantoux, *Industrial Revolution in the Eighteenth Century*, *op. cit.*, p. 283; the letter from Bristol is in A.A. Aspinall, *The Early English Trade Unions*, Batchworth, 1949, p. 6.

37. J.R. Harris, 'Skills, coal and British industry', pp. 168-76.

era of Watt began in the 1780s, important as were the fuel economy of his separate condenser and his translation of reciprocal into rotative motion. Steam-powered beam engines had been employed in draining mines from around 1715, when there were seven or eight Newcomen engines operating from Cornwall to Newcastle. By 1733 there were sixty, and by 1780 around 300. In the 1780s, despite the constraints of Watt's patent, other builders continued to supply engines, and if these are added to the Watt engines there may well have been 1,200 steam engines at work in 1800.³⁸

Early output statistics are difficult to obtain and usually impressionistic. However, Professor Flinn's recent official history provides a reasonably clear outline of the growth of coal output.

Table 4.7 English coal output ('000 tonnes)

1700	2,430
1750	4,295
1775	7,090
1800	11,195
1815	16,665

Source: M.W. Flinn, *History of the British Coal Industry*, II: 1700-1830 *The Industrial Revolution*. Clarendon, 1984, p. 26.

The average annual growth rates between these dates are: 1.5, 2.6, 2.32 and 3.2 per cent. Most coal in 1700 was for household use. Most still was in 1750, but the fact that the annual increase in output between the two dates was more than four times the rate of population increase confirms steadily increasing industrial use, for it cannot be explained by exports. Over the whole period 1700 to 1815 coal output increased almost six-fold.³⁹

To write of 'English' output becomes increasingly misleading. By 1800 a quarter of British coal was coming from Scotland and Wales. Even in the first half of the eighteenth century they had been contributing a fifth. Most of Scotland's output was used at home, but Welsh coal was more closely connected with English manufacturing. From only 2.7 per cent of Britain's output in 1750, South Wales accounted for 11.3 per cent by 1800. On its coalfields the tin-plate industry was established and grew after 1750, while ships taking coal

38. Harris, 'The employment of steam power', pp. 137-44.

39. M.W. Flinn, *History of the British Coal Industry*, Ch. 1.

across the Bristol Channel for Cornwall's mine engines returned laden with copper ore for smelting at Swansea.

Table 4.8 Coalfields: share of output, per cent

	1750-60	1811-20
North-east	35.1	22.2
Yorkshire	11.2	10.2
Lancashire and Cheshire	4.5	9.1
Nottingham and Derby	1.89	6.0
North and South Staffordshire	6.0	14.5
Warwickshire and Leicestershire	2.36	1.08
Shropshire	9.0	5.4

Source: S. Pollard, 'A new estimate of British coal production, 1750-1850.' *Econ. H.R.*, XXXIII, 1980, p. 230.

The contributions of the different coalfields varied over the period, although Northumberland and Durham led throughout. Smaller coalfields had local significance. Kingswood, for example, provided Bristol with 600,000 tonnes in 1815, while the growth of the Cumbrian coalfield over the eighteenth century was based on an export trade to Ireland.⁴⁰

Coal getting was a labour-intensive matter and remained so throughout the nineteenth century. Perhaps as many as 15,000 miners were employed in 1700 and a hundred years later hardly less than 50,000.

METALS

The conventional progression of economic historians is from coal to iron. However, in a book which begins in 1714 that great resource combination figures significantly only after 1780. Primacy in the use of coal goes to the non-ferrous metals: lead, tin and copper. Smelting with coal had become normal in England by 1700 and in terms of the value of metal output, if not of final product, lead, tin

40. For regional output estimates and the problems of making them, see S. Pollard, 'A new estimate of Britain's coal production 1750-1850', *Econ. H.R.* XXXIII, 2, 1980, pp. 212-55.

and copper added more than basic iron to the national income for most of the eighteenth century. In the 1750s the annual value of lead output was £496,000, of copper £297,000 and of tin £174,000. Lead alone at least equalled the value of basic iron up to mid century. From then until 1770 it almost doubled, while iron did rather less well. Copper mining and smelting boomed in the 1780s and in 1788 annual output was twice as valuable as that of pig iron. The technological breakthrough into coal smelting had come before the end of the seventeenth century. Fuel economy was achieved through the use of the reverberatory furnace which, by separation of the fuel from the ore, also overcame the problem of pollutants associated with the use of coal. In tin smelting such techniques produced from coal a metal only 10 per cent less pure than that smelted with wood or charcoal.⁴¹

Copper smelting tended to be located on the coalfields, although one smelting works continued alongside the ores in Cornwall at Hayle, where the health of the labourers was damaged by the arsenic fumes given off. For the most part smelting established itself first at Bristol and then at Swansea. When ores from Anglesey came on to the market in the last third of the century, some were smelted at Swansea although a large proportion went to the Lancashire coalfield. Tin continued to be smelted in Cornwall, where it was mined. This centuries-old industry did not, as did copper, enjoy a boom in the eighteenth century. Indeed, by the end of the century attempts to find new export markets in the Far East were being made, for even the growth of tin-plating after 1750 did not sufficiently absorb excess supply in most years. By the eighteenth century the ores of main centres of lead mining in Derbyshire, the northern Pennines and the North and West Ridings were smelted on local coalfields. Smaller amounts of ore raised in Cornwall followed the copper path to South Wales. Output statistics for the period between 1770 and the beginning of the official series in 1845 seem to be unattainable. But increasing demand from manufactures like glass making, paint making and pottery, from builders for piping and roofing and for its growing use in zinc alloy was met with only marginal imports before the 1820s. Copper was an essential ingredient in the brass-

41. Figures for lead production are from R. Burt, 'Lead production in England and Wales, 1700-1770', *Econ. H.R.*, XXII, 1969, pp. 249-68. (See also his more recent *The British Lead Mining Industry*.) For copper and tin output, see J. Rowe, *Cornwall in the Age of the Industrial Revolution*, Liverpool UP, 1953, pp. 58, 76. However, for the last decades of the eighteenth century the output from Anglesey was important and the national data compiled by B.R. Mitchell and P. Deane, *Abstract of British Historical Statistics*, Cambridge UP, 1962 (Ch. VI) can be consulted.

and bronze-using manufactures of Birmingham from coins through buttons and utensils to valves, cocks and pipework for the new machinery. Ore output, around 6,500 tonnes in 1750, exceeded 40,000 tonnes by 1795 and 100,000 by 1825. Tin output in 1750 was still under 3,000 tonnes, a level it did not consistently exceed before 1815. A count of the labour force at Cornish copper mines in 1782 indicated 7,196 workers of whom 2,684 were women and children. This suggests from output figures that by 1800 it was probably around 10,000. If workers in tin and lead are added, the non-ferrous metal mines of England employed around 15,000 people in 1800.⁴²

The traditional view of iron production was that Britain, through de-forestation, suffered from a growing shortage of the charcoal it used for fuel. More recent scholars have cast doubt on this and suggest that the growing dependence on imports of basic iron was more likely due to the generally higher costs of home production, including labour costs and the unsuitability of British iron for some purposes.⁴³ Whatever was at work within the industry, the distribution of charcoal furnaces in 1717 reveals a rather different geography from that which later developed, although Professor Court has doubted whether there ever was a fall at any time in the output of furnaces in Staffordshire and Shropshire even before coke smelting favoured them.⁴⁴

Table 4.9 Distribution of charcoal iron furnaces, 1717

Hampshire	1
Weald	14
South-west	16
South Wales and Midlands	13
Cheshire and North Wales	5
Sheffield and north-east	9
North-west	3
Total	61

Source: E. Pawson, *The Early Industrial Revolution. Britain in the Eighteenth Century*, Barnes & Noble, 1979, p. 115.

42. For relations between mines and smelters, see Rowe, *Cornwall in the Industrial Revolution*, *op. cit.*, pp. 21-2, 63-5.

43. See B. Short, 'The de-industrialisation process: a case study of the Weald, 1600-1850', in Hudson (ed.) *Regions and Industries*, pp. 156-74 and Flinn, 'The growth of the English iron industry 1660-1760', *Econ. H.R.*, XI, 1958-9, pp. 144-53.

44. W.H.B. Court, *The Rise of the Midland Industries, 1600-1838*, Oxford UP, 1953, p. 170; E. Pawson, *Early Industrial Revolution*, pp. 112-16.

In 1806 England's 149,203 tonnes of pig iron constituted 61 per cent of total British output.

Table 4.10 Percentage shares of English pig iron output in 1806

Shropshire	36.8
Staffordshire	33.5
Yorkshire	18.5
Derbyshire	6.1
Northumberland	1.6
Monmouth	1.5
Cumberland	1.3
Lancashire	0.5

Source: E. Pawson, *The Early Industrial Revolution. Britain in the Eighteenth Century*, Barnes & Noble, 1979, p. 113.

The ultimately critical breakthrough into coke smelting made by Abraham Darby at Coalbrookdale in Shropshire in 1709 was not taken on by the industry at large for another fifty years. Recently doubt has been cast on the old myth that this is explained by secrecy and by the fact that the iron produced was inferior. Hyde has shown that for most producers coke smelting offered no cost advantage until the price of charcoal began to rise after 1750, especially since most ironmasters were interested in wrought rather than cast-iron products. Coke smelting thereafter rapidly overtook charcoal smelting. There is some controversy over output levels before mid century, but none over the rapid increase that had set in by 1770. By 1780 output may well have been double that of a generally stagnant level before 1750.⁴⁵

Even had coke smelting diffused more rapidly and readily, Britain would still have needed to supplement her supply of good bar iron. Imports from Sweden and Russia rose from a 1700 level of 15–20,000 tonnes to 50,000 by 1790, then fell away sharply and by 1820 were below the level of 1700. This fall, despite an actual increase in the output of all kinds of finished iron goods, is probably largely attributable to two inventions patented by Henry Cort in

45. The key work of revision is C.K. Hyde, *Technological Change and the British Iron Industry*. See also G. Hammersley, 'The charcoal iron industry and its fuel, 1540–1750', *Econ. H.R.*, XXVI, 4, 1973, pp. 593–613. The technical progress of iron making from the development of coke smelting is concisely described in Mathias, *First Industrial Nation*, pp. 111–14 and in a recent pamphlet by J.R. Harris, *British Iron Industry*.

46. Output figures from P. Riden, 'Iron output before 1870', *Econ. H.R.*, XXX, 1977, pp. 448, 455.

Table 4.11 Pig iron output (tonnes)

1780	62,000
1790	90,000
1800	180,000
1815	340,000

Source: P. Riden, 'The output of the British iron industry before 1870.' *Econ. H.R.*, XXX, 1977, p. 455.

1784: the puddling furnace and the rolling mill. Previously usable bar iron had to be made from pig by re-forging with charcoal and beating with heavy water-powered hammers. Accordingly forges had often to be located away from smelting works. Cort freed the second stage from dependence on charcoal and water power, and made possible greater and more efficient output from integrated sites on the iron and coalfields. Even Hyde, who has pointed out that a widespread adoption of the potting process brought measurable improvement to bar-iron production over the period 1750–88, still regards Cort's invention of puddling as a clear advance and 'one of the bases for Britain's industrial leadership'. With the application of Watt's steam engine to the rolling mill, nothing stood in the way of increasing concentration in Shropshire, Staffordshire, Yorkshire and South Wales. These regions produced between them over 90 per cent of the total output of England and Wales in 1806.⁴⁷ The only huge enterprise outside them was the giant works of Ambrose Crawley set up near Sunderland in 1700, reputedly at the time the largest in Europe. Arthur Young was much impressed in 1776 by 'several hundreds' of workers on an annual wage bill of £12,000. He was even more impressed by Darby's Coalbrookdale works, which he supposed to be 'the greatest in England'.

Past his new slitting mills . . . the immense wheels 20 feet diameter of cast iron were there. . . . Viewed the furnaces, forges etc., with the vast bellows that gave those roaring blasts, which make the whole edifice horribly sublime. . . . The whole process is here gone through from digging the ironstone to making it into cannons, pipes, cylinders etc. etc. All the iron used is raised in the neighbouring hills, and the coal dug likewise which is char'd. . . . Mr Darby in his works employs near 1000 people including colliers . . .⁴⁸

47. Hyde, 'Technological change in the British wrought iron industry, 1750–1815', *Econ. H.R.*, XXVII, 2, 1974, p. 200; Musson, *Growth of British Industry*, p. 101; Court, *Midland Industries*, *op. cit.*, pp. 177–9.

48. Young, *Tours in England and Wales*, p. 151; *Northern Tour*, I, p. 115.

From the last quarter of the eighteenth century the iron industry had taken on a scale of operation and, by and large, a pattern of location which were largely to persist until the second half of the nineteenth century.

HARDWARE MANUFACTURE

By the late eighteenth century the legion of hand nail makers in the Black Country consumed around half of the iron output of the Midlands. Iron rods were put out to workers' homes where they were cut to length on anvils and headed with a single hammer blow. It was a simple occupation but carried out at lightning speed. It was also a humble occupation, performed by women and children as well as men. There was some regional specialisation according to nail type, but in the Midlands, just as in its other centre around Sheffield, it was the bottom rung of a ladder of hardware manufacture which climbed through chain, scythe spur and lock to the huge range of metal products produced by Birmingham's artisans from copper and brass as well as iron. The skilled labour which was the basis of the higher rungs had been developing in the area from the seventeenth century. By 1660 manufacturing parishes were already noticeably more populous than agricultural ones and special skills were becoming locally concentrated: lorimers produced their spurs in Walsall and locksmiths their locks in Wolverhampton and Willenhall, while the higher branches filled out Birmingham, displacing the cruder ones into the Staffordshire countryside.⁴⁹

By 1800 practically all of the iron output of Staffordshire and Shropshire was being made up in the forges and foundries of the district. And not only iron: from around 1700 braziers and copper-smiths began to increase in numbers, so that by 1720 a single brazier capitalist was putting out his metal to be made up in more than fifty cottage workshops. Artisans trained in iron work could easily change into an out-working population of brass and copper workers applying their skills to these metals, which were produced in far greater amounts than could have been consumed by the small number of large establishments. Before the eighteenth-century changes in iron making, the development of iron founding was slow. Only a

49. As well as Court's *Midland Industries*, for the period up to the later eighteenth century, see M. Rowlands, *Masters and Men in the West Midlands Metalware Trades before the Industrial Revolution*, Manchester UP, 1975.

few articles such as chimney backs and garden rollers were cast directly as molten metal into fine sand. But with the development of coke smelting, large concerns like that of the cannon maker John Wilkinson rapidly emerged. He could produce heavy castings up to boilers and cylinders of 7 feet in diameter. The use of copper in large castings fell away, but the lighter 'hollow wares' could not be cast from iron until after 1815, and copper and brass continued to dominate a wide range of household utensil production as well as finding many new uses in Birmingham's coin, button and 'toy' trades. Matthew Boulton minted the first copper coin in 1797 and within two years had produced 45 million of them.

Although it owed so much to the application of power – first water then steam – to the rolling and slitting mills, providing a material (wire, rod or plate) which was itself semi-manufactured, hardware manufacture was dominated by what Professor Court has called a 'vast multiplication of small producers'.⁵⁰ Even by 1851 the average metal-working business employed less than six men and many none at all.

'A fine large town of manufacture of all sorts of toys, and implements in the iron way, and some in brass, and they japan also and enamel to great perfection, and cheap.'⁵¹ This traveller's description of 1751, if not the manufacturing understatement of the century, is at least a most concise description of Birmingham, already the greatest centre of hardware manufacture in the world. It was noted for its multiplicity of small metal workshops at which quasi-independent craftsmen made an amazing range of items from iron, tin, bronze, brass and copper: buckles, cutlery, spurs, candlesticks, toys, guns, buttons, whip handles, coffee pots, inkstands, carriage fittings, snuff boxes, lead pipes, jewellery, lamps, tools, kitchen items, coins and medals. Most of the small items were known together as the 'toy trades' and varied from a few pence to many guineas in individual value. Characteristically the patterns of such items changed with great frequency. The eighteenth century was their time. They were not much known before, but there is evidence of a significant export trade by 1712. In the mid eighteenth century they employed around 20,000 hands and had a value in excess of £500,000.⁵²

50. Court, *Midland Industries*, *op. cit.*, p. 180; Musson, *Growth of British Industry*, pp. 104-6; Berg, *Age of Manufactures*, Ch. 11.

51. J.J. Cartwright (ed.), *Travels through England of Dr Richard Pococke*, II, Camden Society, 1889.

52. Berg, *Age of Manufactures*, pp. 288-9.

Frequent changes in fashion and form did not suit mechanised mass production. Arthur Young in 1791 expressed surprise at the

small or no use that is made of water; in the town there are no mills, and the number in the vicinity, for the direct operations of a fabric, are inconsiderable; the number of little and distinct forges for works performed by a single hand, surprised me; I had conceived that machinery was carried much further . . . so many operations yet remain performed by the re-iterated strokes of the hand. . . . I saw no machines comparable to a cotton mill or a stocking engine.⁵³

His reaction was fundamentally correct, but requires qualification. Powered machinery was needed to provide the semi-processed raw material, especially the sheet metal, tin and copper plate. The rolling mill had done this for some time but more cheaply and in greater amount after the rotary steam engine was employed to drive the heavy rollers in the 1780s. Sheet metal was provided, from the thin plate needed by the toy makers to half-inch-thick iron for boiler making. The enormous increase in Birmingham's population in the 1780s and 1790s owed as much to developments in iron making, rolling, slitting and wire drawing as it did to changes in the processes of manufacturing finished goods. The latter, however, did not stand still.⁵⁴ In the second half of the seventeenth century the turning lathe, stamp and press gradually took over in manufacturing from sheet metal those items which had previously been cast from solid metal and finished with hammer, anvil, file and grindstone. The new tools were generic types which were rapidly adapted by craftsmen to suit their particular specialisms. It was this which led to Birmingham being noted for inventiveness rather than for the application of power technology. Young conceded 'some tools of beautiful invention', while Lord Shelbourne noted in 1766 'an infinity of smaller improvements which each workman has and sedulously keeps secret from the rest'.⁵⁵

He especially noted the advent of the stamp which, by forcing the die on the metal, made possible the continuous production of impressed goods like coins, buttons and medals. The stamp worked on blanks now produced by the press, which could itself, where less than momentary force was needed, impress the less sharp designs for cruder work as well as producing percussion caps and heading pins. These two complementary machines were not confined to a

53. Young, *Tours in England and Wales*, pp. 254-5.

54. Court, *Midland Industries, op. cit.*, pp. 241-2.

55. Cited in Berg, *Age of Manufactures*, pp. 300-1.

small number of trades. They were, as Professor Court has put it, adapted to make the output of a whole range of metal items, 'cheap, swift and large'. The stamp and the press underpinned Birmingham's spectacular eighteenth-century growth. Even where a more precious metal was involved, London's silversmiths rightly feared competition from Matthew Boulton's candlesticks which by 1773 could be made from one sixth of the weight of metal compared with those cast in a traditional manner.⁵⁶ By this time he was producing a range of goods including coffee pots and jugs. Less of a 'craft' product than those made in the old way, they were in effect a new product creating as much as responding to demand.

The adaptability of Birmingham's artisans is well illustrated by the expansion of metal button making after changing fashion in shoes reduced the demand for buckles. There was a short period in the 1790s when wearers of the new-fangled buttoned shoes risked insult and injury in the streets, but then button making quickly absorbed the slack in skill and in raw materials. In general the division of labour was as significant as the development of new techniques and products. In gun making, for example, the 'gunmaker' whose name was eventually stamped on the finished firearm in fact bought in semi-finished parts and gave them out again to specialised craftsmen: barrel makers, lock makers, sight stampers, trigger makers, ramrod forgers, gun furniture makers and bayonet forgers. From such manufactures, produced from product specialisation and shop-floor technical adaptation, Birmingham contributed very strongly to the rise of metal goods from 7 per cent of manufactured exports in 1722-4 to 14 per cent by 1772-4.⁵⁷

It is difficult to date the origins of so many varied and changing branches of hardware manufacture. Japanware is one, however, which can be dated. This highly popular form of decorative enamelling was introduced in the 1720s and was at first confined to small and much soldered tin-plate articles. With the advent of larger stamped tin-plate articles, the product range extended remarkably. Around 1750 papier mâché offered a new cheap material capable of taking the japanning process. By this time the production of cheap decorative knick-knacks like tea trays and snuff boxes had spread to Wolverhampton and Bilston.⁵⁸ Although Birmingham manufacturing was in general dominated by small workshops, there were exceptions. John Taylor, who specialised in japanned paper boxes, was

56. Court, *Midland Industries, op. cit.*, pp. 244-5.

57. Berg, *Age of Manufactures*, pp. 288-9.

58. *Ibid.*, p. 289.

the town's largest concentrated producer before the arrival of Matthew Boulton; his method of stamping on pictures and rapidly drying in ovens was described in 1766. He combined japanning with button making, as did Clay who in 1772 introduced a new method of pasting layers of paper as a base instead of the pulped papier mâché. At his peak he employed 300 people.⁵⁹ Boulton's great Soho Works commenced operations in 1765 using a source of water power to the north of the town. The uncertainty of the water flow was a potent reason for going into partnership with James Watt in 1775. For the next twenty years, until the opening of the Soho Foundry in 1791, Soho was not only one of the most celebrated of steam-powered factories, it was the largest supplier of steam engines to the Midlands, surpassing even Coalbrookdale. Its triumph did not signal a radical transformation of Midlands hardware manufacturing, however. At Watt's death in 1819 the use of steam power was still very limited, and its most important contribution remained the transformation of the supply of wrought iron, sheet metal and wire on which the metal-workers practised their skills, rather than the making of the finished product.⁶⁰

Tool making was widespread in the west Midlands, but was not confined to that region. South-west Lancashire and adjacent Cheshire had long been noted in this respect. Peasant tool makers in and around St Helens produced chisels, pliers, vices, gauges, small lathes and files to be used by whitesmiths, clock and watch makers and, later, machine makers. The area was also known for making watch parts, as well as locks and hinges. By 1750 most British watch makers whose names appeared on the finished product and whose final stages of manufacture were concentrated in London or Coventry bought their rough movements from Lancashire. The area around Warrington was noted for its files and although there were some eighteenth-century makers who made them from start to finish, more usually one forged, another cut and a third hardened.⁶¹

Files were an important manufacture in Sheffield, but that city was best known as the great centre of edged steel tool making. A directory of 1797 shows 40 firms engaged in file manufacture, while 134 made pocket knives, 81 table knives, 60 shears, sickles and scythes, 33 razors, 34 saws and other edged carpenter's tools and 34 surgical instruments. The city specialised in high-quality goods, cheaper items being made in the surrounding villages. Forks

59. Court, *Midland Industries*, *op. cit.*, pp. 234–5.

60. *Ibid.*, pp. 251–3.

61. Berg, *Age of Manufactures*, pp. 271–3.

needed less skill than knives and 20 firms made them outside the city compared with 15 within its boundaries. Around 6,000 workers were employed in the various branches in 1800 and several hundred more in the manufacture of Birmingham-type utensils from the recently developed Sheffield plate.⁶²

In the cutlery trades a separation into forging and grinding sections had come about by 1750. Forging was performed by one or two workers, while grinding was done in separate departments of the larger establishments, or else on separate premises known as 'wheels'. The grinding wheels were turned either by water or by boys turning huge fly-wheels. Steam was first introduced to grinding in 1786, but until well into the second half of the nineteenth century the Sheffield trades remained small-scale and dependent on hand skills. After grinding, blades were refined with hammer, emery, whetstone and buffing wheel, with the final processes of building up handles – 'halfing' – being the most skilled of all. The benefits of substituting mechanical methods were limited in a manufacturing system in which goods such as pocket knives were made in a wide variety of types even by single firms. Accordingly the characteristic unit of production remained small, typically in forges attached to the metal-workers' houses. Little capital was required: 'a man with a very small sum of money can employ two, three or four men'. This blurred the line between dependent artisans working at piece rates on put-out materials and small masters producing on a subcontractual basis, perhaps even for the same merchant capitalist.⁶³

With metal-working activity so widespread in eighteenth-century England, it is not surprising that *finished* iron and steel goods, in accounting for almost 7 per cent of the value of British industrial output in 1812, were worth two and a half times the value of iron and steel as raw materials. Such a ratio indicates a substantial manufacturing achievement.

GLASS AND PAPER MAKING

Ranking behind coal, textiles and iron in importance, these two in-

62. *Ibid.*, pp. 275–7. The standard work on the cutlery trade remains G.I.H. Lloyd, *The Cutlery Trades: An Historical Essay in the Economics of Small Scale Production*, 1913, new edn, Cass, 1968. For the district around Sheffield, see D. Hey, *The Rural Metalworkers of the Sheffield Region*, Leicester UP, 1972.

63. See Document 6 in Aspinall, *Early Trade Unions*, p. 4.

dustries are representative of those manufactures which had a sustained if unspectacular growth over the period catering for an expanding home market. Both experienced a degree of technological advance. Glass production resembled that of metal in that its new techniques and location depended on coal. The combined output of bottle and white glass almost doubled from 1747 to 1800 from 10,600 to 19,400 tonnes; it was white glass which was largely responsible. The high spot was the opening in 1773 of the Ravenshead works at St Helens to manufacture plate glass using imported French expertise. Otherwise, although London and Birmingham maintained important works, notably for quality decorative glassware, and Bristol used its local coal to good effect in eleven works making white and bottle glass by 1800, the north-east around Newcastle and Stourbridge and Dudley in the Midlands were the main centres. Newcastle produced more window glass than the other centres together in 1800. This illustrates yet again the pull of coal which was needed to fire the reverberatory furnaces; the other essential ingredient, sand, had to be brought all the way from Norfolk. A coastal location helped, for the two essential chemical ingredients of potash and soda were mostly imported. Although Dudley had two large firms and a smaller one in 1796, and a tradition going back to 1713, Stourbridge was the main Midlands centre. It specialised mainly in flint glass and crystal cutting. The growth of glass output therefore reflects several different market developments. The window glass makers reflected the growth of the building industry, while the flint glass makers catered, with their glasses, decanters and cruets, for the expanding market in small household wares. The plate glass from St Helens was used for mirrors and coach windows.⁶⁴

Glass making reveals the importance of coal, but paper making illustrates T.S. Ashton's reminder of the great and continuing importance of water to eighteenth-century manufacturing. By 1700 the number of water-powered paper mills scattered through rural England exceeded a hundred. There was a tendency to concentrate in the south-east. The older process of fermenting rags in water – pulping – was replaced over the eighteenth century by mills which used wooden rollers fitted with knives to destruct the rags, but these 'hollanders' remained water powered. Only one Boulton and Watt steam engine was in use at a paper mill in 1800. Turning the

64. Useful accounts of the glass industry are provided in Pawson, *Early Industrial Revolution*, pp. 126–7; Court, *Midland Industries*, *op. cit.*, pp. 219–23; Musson, *Growth of British Industry*, pp. 126–7.

pulp into paper remained a skilled hand process in which separate sheets were produced with vats and wire-mesh moulds. The paper-making machine invented in 1799 and developed in England by the Fourdrinier Brothers enabled the making of a continuous web of paper on a wire-mesh belt, but it made little progress before 1830. More significant by 1800 were chemical developments in chlorine bleaching, which not only made whiter paper with less labour but enabled coloured rags to be used. Output, as Professor Coleman has shown, increased fairly slowly over the first half of the eighteenth century, then increased three-fold between 1740 and 1800. Over the century 1714 to 1815 tonnage increased from 2,764 to 18,715: almost seven times. By the latter date paper and printing together accounted for around 2 per cent of total manufacturing output, almost equal to silk and a quarter of the share of cotton and of metal.⁶⁵

The great expansion in paper manufacture paralleled one in printing. Technological change was confined largely to the press, with little change in setting where the skills of the compositor remained paramount. Change in the press was slow – *The Times* was the first newspaper to print by steam cylinder press at the end of 1814 – and the progress of the industry is accordingly best revealed in the number of print workers. In 1831 4,000 out of a United Kingdom total of 9,000 worked in London and since the share of the provinces had been increasing since the eighteenth century, it can be presumed that more than half of all eighteenth-century print workers were located in London. There were 2,500 in the capital in 1815 after a rapid expansion over the first decade of the century, so perhaps the national total in 1800 was between 4,000 and 5,000. The book and periodical trades, newspapers and parliamentary printing brought about expanding demand in London as well as creating jobs on a smaller scale for associated trades like book binding and type founding. In the provinces it was above all the appearance of the weekly local newspapers which created the demand for hands to bring out such local institutions as the *Stamford Mercury*, *Northamptonshire Advertiser*, *Exeter Flying Post* and *Sherborne Mercury*.⁶⁶

65. The fullest account of paper making is D.C. Coleman, *The British Paper Industry*.

66. Musson, *Growth of British Industry*, pp. 137–8.

OTHER MANUFACTURES

In an age when large industrial establishments were rare, the greatest concentrations of labour were to be found in the royal dockyards. Even the newest of them at Plymouth had passed the thousand mark by mid century – the establishment of 2,033 was only a little below the 2,228 at Portsmouth. Chatham then employed 1,553, Deptford 939 and Woolwich 868. Even the smallest, Sheerness with 439, was by eighteenth-century standards a large establishment. At the height of the French wars in 1813 the workforce at Portsmouth reached 3,582 but fell rapidly with the return of peace to a low of 1,610 in 1822. The Navy's need for ships fluctuated widely. In 1714 it had 247; at the end of the Seven Years War in 1763 it had 432; on the eve of the American war in 1776 only 340, but at its end 617. When the wars with revolutionary France began in 1793 there were 411, but at the height of the naval war in 1810 the fleet exceeded 1,048. By the middle of the peaceful 1820s there were less than 200. Accordingly the establishments at the yards were never stable.⁶⁷

The workforce included many unskilled labourers, but its distinguishing feature was the variety of artisans. Of Portsmouth's establishment of 2,704 in 1803, 900 were shipwrights, 140 sawyers, 200 rope makers, 100 carpenters and 140 caulkers. Skilled workers therefore considerably outnumbered the 350 general labourers. By the end of the eighteenth century these included skilled metal-workers like chain makers, anchor smiths and, with the introduction of copper sheathing, coppersmiths. The shipwright, the true builder of the wooden ship, was the core craftsman and in the flurry of activity at the time of Trafalgar (1805) there were 3,193 of them at work in naval yards. Their skill remained unchallenged until the advent of the iron ship. It was not so with the block makers. Their position was lost under the reorganisation of the yards by Samuel Bentham, brother of the philosopher, who became Inspector General of Naval Works in 1796. Between 1803 and 1809 he introduced a series of machine tools for fashioning blocks. Designed by Marc Kingdom Brunel, father of the more famous engineer, and manufactured by Henry Maudsley, one of the nascent engineering industry's most

67. Dockyard employment figures for 1772 from M. Oppenheim, 'The Royal Dockyards' in *Victoria County History of Kent*, II, Institute of Historical Research, 1926, p. 378; D. Wilson, *England's Apprenticeship*, p. 148; G. and F.L. Harris, *The Making of a Cornish Town: Torpoint and its Neighbourhood*, University of Exeter, extra-mural publication, 1976, p.22; naval shipping statistics from C. Lloyd, *The British Seaman*, Paladin, 1970, p. 261.

successful and innovative entrepreneurs, the machinery enabled ten unskilled men to do the work of more than a hundred skilled ones. In 1849 only nineteen men and nine boys were employed in the making of 37,786 blocks at Portsmouth. Bentham also introduced copper sheathing and in 1797 installed the first steam engine which worked the yard pumps by night and the saw mills by day.⁶⁸

Fond popular memory will always associate the royal dockyards with the building of great ships. In fact, most of their activity was in repair and refitting. With its need for ships so variable, the Navy often preferred to give orders to private yards rather than keep a full establishment at the yards. Most orders went to the Thames yards, but in the American war orders were placed in the north-east for the first time and even on the Solent itself naval ships were often built at Bursledon or Bucklers Hard rather than at Portsmouth. The private yards were much smaller and only those on the Thames were capable of building the larger ships before late in the eighteenth century, although Okill and Co. at Liverpool were building up to 700 tonnes by 1740. Aggregate output vastly exceeded that of the naval yards; even at the height of the naval war in 1810, Britain's merchant fleet of 12,198 was sixteen times the size of the Navy.⁶⁹

By the second half of the century the leadership of the Thames was being challenged. It was still the largest single centre in 1790, but the combined output of the yards in the north-east was greater, and that of the north-west not far behind.

The north-east centres, Whitby, Newcastle, Scarborough, Sunderland and Stockton, had long met the demand for the small ships carrying coal to London along much the busiest of the coastal routes. London continued to build the large East and West India-men and the ships for the Levant trade, but its lead in larger vessel construction was dwindling as the century progressed. For much of the time its rival had been not the north-east but the American colonies – as early as 1714 Thames yards were complaining of competition from New England. Up to the Revolution, output from across the Atlantic was increasing: one in four of English merchant ships in 1760, one in three by 1776. MacPherson in his *Annals of Commerce* appreciated which industry benefited most from the war

68. D. Wilson, *England's Apprenticeship*, p. 148; Samuel Bentham hardly deserves to be so much less known than his brother Jeremy. He is a key figure in the history of management. See P. Linebaugh, 'Labour history without the labour process', *Social History*, VII, 3, 1982, pp. 320-2.

69. T.S. Ashton, *The Eighteenth Century*, p. 140.

Table 4.12 Shipbuilding in the years 1790-1, by district

	Tonnage	No.	No. 200 tonnes +
London	16,372	119	25
East Anglia	7,787	136	2
South coast	15,740	341	7
Bristol Channel and Wales	8,240	145	10
North-west coast	14,945	166	18
North-east coast	40,926	249	88
Total	104,010	1,156	150

Source: R. Davis, *The Rise of the English Shipping Industry in the Seventeenth and Eighteenth Centuries*, David and Charles, 1962, p. 69.

with America: 'A very important advantage was the recovery of the valuable trade of shipbuilding, which had in very great measure been, very impolitically, sacrificed to the zeal for promoting the prosperity of the colonies.'

Earlier naval wars had not led to a great increase in orders because of the successful habit of taking prize vessels. Over the period 1756 to 1763, 1,885 ships had been added to the merchant fleet in this way. However, from the end of the American war in 1783 to the end of the French wars in 1815 there was a 75 per cent increase in the number of ships registered and a doubling of the tonnage. From this significant increase in shipbuilding the north-east was the significant beneficiary.⁷⁰

In 1766 a hundred Cornish tin miners burst into Redruth market and smashed all the Staffordshire earthenware on sale. They went on to Falmouth and repeated their action and were not pacified until a number of prominent citizens promised to do all they could to discourage the use of pottery, indicating their sympathy by bespoking a quantity of pewter dishes.⁷¹ There was irony in the incident, for the white china clays which supplied the surging potteries were increasingly coming from Cornish pits. They had been used in Worcester and Staffordshire porcelain ware for some time before William Cookworthy's Plymouth works began to exploit them more

70. This account has been based on R. Davis, *The Rise of the English Shipping Industry*, Ch. 4.

71. A. Rees, 'Cornwall's place in ceramic history', *Rep. Royal Cornwall Polytechnic Society*, 1935, p. 61.

systematically in 1755. By 1816 Cornish output of china clay and china stone had reached 4,000 tonnes, although it grew even faster over the next decade to 13,000 tonnes by 1826. Perhaps the tinners had a point, for it was obtained from a form of quarrying, which created much less employment than deep mining for tin. Even after a century of growth in 1857 the industry employed only 1,700 men.⁷²

Whatever localised fears of unemployment it created in far Cornwall, pottery was one of the success stories of consumer goods production and marketing. As late as 1725 few considered it of much importance or potential, although key techniques had already been learned from the continent including those of making both the lead-glazed 'slipware' and the harder glazed 'ironware'. By 1750, however, London at Bow and Chelsea, Worcester, Derby, Lowestoft and Liverpool as well as Staffordshire had porcelain works. But it was the common Staffordshire ware which was to attain a mass market: 'plate was too expensive, pewter too scarce and porcelain too fragile, to compete with the versatile pot'. Rising population and an increasing ability to purchase 'decencies' as well as 'necessaries' provided an expanding market.⁷³

In 1730 even Staffordshire's potters were mostly making from local clays and selling in their own area, but by 1760 the Weaver Navigation was transporting six times as much pottery as twenty years earlier. By then the greatest of the eighteenth-century potters, Josiah Wedgwood, was sending most of his wares to London and by 1795 was selling through Europe and beyond. The 'Potteries', centred on the Five Towns around Burslem, became one of England's best-known manufacturing regions. Burslem had 150 potteries by 1762 supporting a population of 7,000, and John Wesley, who visited then and again twenty years later, commented on how much it had grown in between. Arthur Young visited it in 1771 and remarked on the Potteries' 'late' success, attributing it to 'the inventive genius of Mr Wedgwood'. This was not entirely true - other potters such as Spode and Minton have their place. But it was the celebrated Josiah who most successfully drew together the various threads and experiences of his predecessors and contemporaries. Seizing firmly on the advantages of the division of labour and training

72. Rowe, *Cornwall in the Industrial Revolution*, *op. cit.*, pp. 48-9, 90, 117.

73. Wilson, *England's Apprenticeship*, p. 309; N. McKenrick, 'The commercialisation of the Potteries' in McKenrick, Brewer and Plumb (eds), *Birth of the Consumer Society*, p. 104. The standard account of the rise of the pottery industry is now Weatherill, *The Pottery Trade and North Staffordshire*.

new hands in highly specialised details of decoration, he closed the gap between quality production and the wider market.⁷⁴

If Wedgwood best represents the new potter, the tea service represents the new product. Nothing contributed as much to the broadening demand for china ware as did the remarkable increase in tea drinking as it percolated downwards through society. Ale tastes fine from a pewter tankard, but tea tastes best from a china cup. Tea consumption increased six-fold over the middle years of the century, then doubled again by its end. Figures are approximate, for tea was a staple of the smuggling trade. If this was pleasing to the makers of Staffordshire teapots, it was not so to the commercial brewers of beer. They had seen off the challenge of the 'Gin Age' – excised spirit consumption peaked at 7,955,000 gallons in 1742 and had fallen back to 2,639,000 by 1780. But tea presented a more permanent challenge as its fall in price changed it from an upper-class luxury stored in locked tea caddies into a daily essential for all social classes. The brewers' response was a new product: porter. Introduced in 1722, it was cheaper to produce and more standard in type than traditional ales. On its sales were based the fortunes of the likes of Whitbread, Barclays and Truman. A dozen large brewers produced a third of London's output by the 1740s and a half by the 1760s. In the provinces firms usually remained small, although things were already coming to a foaming head in the Trent valley, where the establishment of Worthington's at Burton in 1744 saw the beginnings of another of England's best-known industrial locations.⁷⁵

Professor Mathias has shown just how capital intensive large-scale brewing became in the industrial revolution. Outlay was needed for the large copper vats and other utensils, for coal for boiling and, by the 1780s, to raise steam for engines grinding malt. This made the industry exceptional in the food and drink sector (although sugar boiling at Bristol and Liverpool was on a fairly large scale). Harley estimates that the sector as a whole made up 8 per cent of English manufacturing in 1770 and 6 per cent in 1815, although exact statistics are difficult in a sector characterised for the most part by self-employed small producers trading in local markets.⁷⁶

74. Wilson, *England's Apprenticeship*, pp. 309–10; McKendrick, 'Commercialisation of the Potteries', p. 103. The tendency to overstate Wedgwood's importance has been corrected by Weatherill, *Pottery Trade*.

75. Wilson, *England's Apprenticeship*, p. 309.

76. Mathias, *Brewing Industry in England*; Harley, 'British industrialization before 1841', p. 269.

The building industry was by and large similarly structured. Even in 1851, only 70 out of 26,360 employers had a hundred or more men. Around 60 per cent employed only one or two, or worked on their own. Hoffman's index of manufacturing gave the sector 9.2 per cent of total output in 1812, but Harley's more recent estimate is 12 per cent in 1770 and 15 per cent in 1815. Figures for so universal and scattered an industry are guesstimates indeed. Masons, bricklayers, carpenters, plumbers and graziers were found in any town of size, although jobbing 'builders' ready to turn their hands to any task more suited the village economy. When building craftsmen did build on a speculative rather than on a bespoke basis, they often joined together, or else one master craftsman subcontracted others. Mortgage and credit both for supplies and for the wages of labour were characteristic.⁷⁷

No equivalent index to the modern 'number of housing starts' exists for the eighteenth century. The appreciable growth in the number and size of towns means the housing stock must have been very considerably augmented at a rapidly increasing rate over the period. Timber imports increased in value from £121,000 in 1714 to £171,000 in 1750. After 1765 they went up even more sharply from £245,000 to £602,000 in 1815. Excise duties provide a measure of brick output from 1785, when duty was paid on 385.8 million bricks. Over the next twenty years the average output was 646 million, but from 1805 to 1815 it was 866.6 million.

Professor Feinstein's calculations in Table 4.13 reveal the central importance of building to total investment. His figures do not separate agricultural building from total investment in agriculture, but they do for the manufacturing sector. Construction in the transport sector, roads, canals, bridges and docks is not included.

The industrial revolution required a greater investment in bricks and mortar, even without workers' housing, than it did in machinery. Investment in the latter from 1760 to 1820 was on average only around a third of investment in industrial and commercial buildings.⁷⁸

Josiah Tucker, Dean of Gloucester, one of the shrewdest of writers on economic matters in the mid eighteenth century, drew attention in 1757 to the progress of machinery in English manufacturing.

77. Harley, 'British industrialization before 1841', p. 269. The structure of the industry is analysed in C.W. Chalklin, *Provincial Towns of Georgian England*.

78. C. Feinstein, 'Capital formation in Great Britain' in Mathias and Postan (eds), *Cambridge Economic History of Europe*, Pt 1, pp. 40–8.

Table 4.13 Great Britain: gross domestic fixed capital formation

(Constant [1851–60] prices. £ million p.a. decade averages)

	1761–70	1791–1800	1811–20
Dwellings	1.49	3.35	5.82
Public buildings	0.15	0.33	0.58
Industrial and commercial buildings	0.97	2.20	4.16
Total (per cent of GDFC)	39.3	41.0	51.0

Source: Based on Feinstein in M.M. Postan and P. Mathias (eds), *Cambridge Economic History of Europe*, vol. 7, *The Industrial Economies. Part I: Britain, France, Germany and Scandinavia*, Cambridge, 1982, pp. 40–1.

Few countries are equal, perhaps none excel; the English in the number of contrivances of their machines to abridge labour . . . the English are uncommonly dexterous in their contrivance of the mechanic powers . . . [they exhibit] a specimen of practical mechanics scarce to be paralleled in any part of the world.⁷⁹

Here is an early example of a modern usage. Thirty years earlier, to Daniel Defoe, 'the guides or masters in handicrafts' and craftsmen in general from weavers to coppersmiths 'are all understood in this one word mechanics'.⁸⁰ This broad use remained common until 1815, but association of the word with machinery was developing alongside. The engineering industry grew from several well-developed strands. Pride of place has usually been given to the millwrights. Originally the fitters of wind and water mills, after 1750 they worked increasingly in metal rather than wood in applying their special skill of linking the source of power to its object through shafts and gears. The successful early nineteenth-century engineer Alexander Fairbairn described the eighteenth-century millwright as 'an itinerant engineer and mechanic' who could handle axe, hammer and plane, bore and forge, and cut stone with a skill equal to those who specialised in those trades. It was such men who turned to the manufacture of the early textile machinery, developing a regional specialisation in Lancashire. Traditionally the millwright had carried his tools to work on the spot, but in the late

79. Cited in C. Wilson, *England's Apprenticeship*, p. 311.

80. Defoe, *A Plan of the English Commerce*, 1728, reprinted Oxford 1928, p. 3.

eighteenth century the machine shop began to emerge in engine building. Specialisation increased: pattern makers, iron and brass founders, vicemen, turners, planers, etc. emerged in the place of generalised millwrights, carpenters and blacksmiths. Most of the specialist workers rose from the ranks of those generally known as 'smiths'.

The long-established skills in tool making, especially in Lancashire and those in precision part making and assembly in watch making, have already been noted. There was little wanting in terms of the skills necessary for an engineering industry. Indeed, before their new Soho Foundry opened in 1795, even Boulton and Watt supplied only a supervisor to oversee the erection of their engines on site and arrange for the local supply of labour and materials. The Soho Foundry was the first heavy engineering shop concentrating on producing patterns for castings and on the manufacture of parts which called for special accuracy. Here Watt, concerned about the skill level of his workmen, set about training a body of men, who might well be considered the first purpose-trained engineering workers. Soho was to become a nursery from which engineering skills emanated, as were the later pioneering engineering works such as that of Henry Maudsley established in London in 1798. Development was not dramatic. In 1814 Fairbairn discovered that Manchester shops were still commonly dependent upon hand rather than machine tools and spent a large amount of time chipping and filing. Nevertheless, by then a distinctive engineering industry had clearly come into being: the future was a matter of wider and more rapid skill dissemination and specialisation and a growing use of increasingly sophisticated machine tools.⁸¹

Arthur Young's much-quoted remark of 1791 that 'All the activity and industry of this kingdom is fast concentrating where there are coalpits' was only a shade hyperbolic. It does not tell the whole story, however. Professor Mathias has suggested that the concentration of steam-powered cotton mills in Lancashire was due as much to the presence of local engineering firms with specialised fitters as to coal.⁸² It was the possession of the skills to exploit them which was as critical as the possession of natural resources like coal and iron to the English lead in manufacturing. The localisation of these

81. The emergence of the engineering industry is well described in Berg, *Age of Manufactures*, pp. 269–73, and Mathias, *First Industrial Nation*, pp. 125–7.

82. Young, *Tours in England and Wales*, p. 275; Mathias, *First Industrial Nation*, p. 120.

skills and of those resources explains why the familiar map of nineteenth-century manufacturing had already taken on much of its shape by the late eighteenth century. The student of the industrial history of eighteenth-century England will note some unexpected presences and some surprising absences, but will not feel like a traveller in a strange country.