There is no doubt whatever that the people of England work harder, mentally and physically, than the people of any other country on the face of the earth. Whether we take the town or the country population, the same plodding industry is apparent, and the respite enjoyed by either in the shape of holidays are few and far between . . . We have no desire in stating the fact that Englishmen work harder than their neighbours to make them discontented with their lot; far from it. It is due to their untiring industry and to the natural advantages of the country of which we are so justly proud, that England holds the foremost rank among the nations of the earth.


The genius of Great Britain is mechanism; the master-spirit the civil engineer; her tendencies, to relieve labour from its drudgery, and delegate to iron, and steam, and water, the real weight and burden of toil.

*Illustrated Exhibitor*, 7 June 1851.

Nowhere do we find a more shameful squandering of human labour-power for the most despicable purposes than in England, the land of machinery.


The Messrs. Whitehead send their Buenos Aires wool to be picked in the prisons of Manchester, that species of raw material being so coarse and dirty that it is difficult to find free labourers to meddle with it. A great deal of the ordinary picking is, however, done by the women in their cottages in the neighbourhood.

I. Introduction. The Machinery Question

Whatever their disagreements about the origins of the industrial revolution, economic historians are in little doubt about its effects. Steam power and machinery transformed the labour process, and acted on society as an independent or quasi-independent force, demonic or beneficial according to the point of view, but in any event inescapable. Commodities were cheapened and new markets opened up for them; labour was made enormously more productive at the same time as the physical burden of toil was eased; mechanical ingenuity took the place of handicraft skill. David Landes’ summary in The Unbound Prometheus is both influential and representative: 1

In the eighteenth century, a series of inventions transformed the manufacture of cotton in England and gave rise to a new mode of production – the factory system. During these years, other branches of industry effected comparable advances, and all these together, mutually reinforcing one another, made possible further gains on an ever-widening front. The abundance and variety of these innovations almost defy compilation, but they may be subsumed under three principles: the substitution of machines – rapid, regular, precise, tireless – for human skill and effort, the substitution of inanimate for animate sources of power ... thereby opening to man a new and almost unlimited supply of energy, the use of new and far more abundant raw materials, in particular, the substitution of mineral for vegetable or animal substances.

This account has the merit of symmetry, but the notion of substitution is problematic, since in many cases there are no real equivalents to compare. The fireman raising steam in an engine cab, or the boilermaker flanging plates in a furnace, were engaged in wholly new occupations which had no real analogy in previous times. So too, if one thinks of the operations they were called upon to perform, rather than the nature of the finished product, were the mill-hands of Lancashire and the West Riding. And if one looks at technology from the point
of view of labour rather than that of capital, it is a cruel caricature to represent machinery as dispensing with toil. High-pressure engines had their counterpart in high-pressure work, endless chain mechanisms in non-stop jobs. And quite apart from the demands which machinery itself imposed there was a huge army of labour engaged in supplying it with raw materials, from the slave labourers on the cotton plantations of the United States to the tanners and copper miners of Cornwall. The industrial revolution, so far from abridging human labour, created a whole new world of labour-intensive jobs: railway navvyng is a prime example, but one could consider too the puddlers and shinglers in the rolling mills, turning pig-iron into bars, the alkali workers stirring vats of caustic soda, and a whole spectrum of occupations in what the Factory legislation of the 1890s was belatedly to recognise as 'dangerous' trades. Working pace was transformed in old industries as well as new, with slow and cumbersome methods of production giving way, under the pressure of competition, to over-work and sweating.

Nor is it possible to equate the new mode of production with the factory system. Capitalist enterprise took quite different forms in, for instance, cabinet-making and the clothing trades, where rising demand was met by a proliferation of small producers. In agriculture and the fisheries it depended upon an increase in numbers rather than the concentration of production under one roof. In metalwork and engineering — at least until the 1880s — it was the workshop rather than the factory which prevailed, in bootmaking, shoemaking, cottage industry. The distributive trades rested on the broad shoulders of carmen and dockers, the electric telegraph on the juvenile runner's nimble feet. Capitalist growth was rooted in a sub-soil of small-scale enterprise. It depended not on one technology but on many, and made use, too, of a promiscuous variety of profit-making devices, from the adulteration of soot (in which there was an international trade with the West Indies, as well as a local one with farmers for manure) to the artificial colouring of smoked haddocks. Bread was dosed with liberal sprinklings of alum to disguise inferior wheats; low-grade cloths were camouflaged with 'size'. In domestic housebuilding scamped workmanship kept the speculative builder afloat, while in the East End furniture trade orange boxes provided the raw materials for piano stools and Louis Quatorze cabinets. The 'Golden Dustman', immortalized by Charles Dickens in Our Mutual Friend, is as representative a figure of mid-Victorian capitalism as the Bradford millionaires pilloried by John Ruskin for their taste. So too — from the same novel — are the Veneerings, whose provincial counterparts rose to affluence by cotton 'corners' on Liverpool or Manchester Exchange. One thousand needlewomen made the fortunes of Nicoll, the Regent Street sweater, while the railway speculations of the 1840s rested on the muscle power of three hundred thousand navvies.

Economic historians have had remarkably little to say about either labour process or the relationship of technology to work. They are much more concerned with business cycles, and measuring rates of growth. Commercial achievement excites them, and whole histories will be written to celebrate the achievements of individual firms. Railways are discussed as a source of investment, and their comparative contribution to economic growth is a subject of hot debate; nothing at all is said about how the rolling stock was made or the engine cabins staffed or merchandise unloaded. Bricks, too, are treated as an
index of investment, without so much as a word being said of the primitive conditions in which they were made, or the ferocious toil imposed on the men, women and children who made them. Production is seen at second or third remove, in terms of inventory cycles and aggregate profitability: we do not learn how the furnaces were de-clinkerened, or the iron steam ships coaled.

Except in the 'heroic' age of invention, economic historians have very little to say about machinery. They may tell us what it did for production, but not what it meant for the producers, and their preoccupation in recent years with 'take-off' — 'that decisive interval in the history of a society when growth becomes its normal condition' — means that they give far more attention to the progress of mechanisation, and the constellation of circumstances favouring it, than to measuring its human costs. The plight of the hand-loom weavers in the 1830s is admitted, even insisted upon, but since they are regarded as a solitary and to some extent exceptional case, they do not seriously obstruct the linear march of improvement, and once they have been disposed of the historian passes quickly to the problems of a 'mature' economy, and the triumphs of Free Trade.

For labour historians, the machinery question attracts attention chiefly in the 1820s and 1830s, when Cartwright's loom was throwing thousands out of work, and when the rival merits of an agrarian and an industrial society ('past and present') were being vigorously canvassed on all sides. The scenario is arresting, with midnight raiding parties, rickyard incendiaries and factories besieged. But the drama is short-lived, and once the protagonists have performed their parts they are quickly shuffled off-stage. Opposition to machinery is assigned to the pre-history of socialism, when it was 'utopian' rather than 'scientific'; and the machine-breakers, despite Eric Hobsbawn's pioneering attempt to interpret their action in the light of modern collective bargaining (machine-breaking as a form of strike) take their place in the gallery of 'primitive', pre-industrial rebels, along with such other early 19th century martyrs to oppression as Jeremiah Brandreth and Dic Penderyn. Luddism appears as a doomed, if heroic, resistance to the ineluctable forces of change — a fight against the inevitable — the Swing Riots of 1830 as 'the last labourers' revolt'. Yet in industry after industry the machinery question was still being fought out in mid-Victorian times, and there was a whole spectrum of occupations where mechanisation was still being resisted, or its scope drastically curtailed, in the 1890s: the last great machinery strike in the boot and shoe trade did not take place until 1895; while as late as 1898 a steam saw mill was blown up in the Forest of Dean. There were also striking regional variations in the application of invention and progress of the machine, and in some cases at least the strength or otherwise of the workers' opposition seems to have been the deciding factor. In carpet weaving, for instance, the 'extra speeded' Moxon (an improved power loom of the 1870s) was kept out of Kidderminster entirely, where the weavers' organisation was strong, but installed with apparent ease in Rochdale, Halifax and Durham, the northern centres of the trade. In printing, the Hattersley, an early mechanical typesetter, was widely employed by provincial newspapers (the first was installed in the offices of the Bradford Times in 1868) but the London Society of Compositors was successful in keeping it at bay. Similarly in boot and shoe making, the 'stabbing machine' — an application of the sewing machine to waxed threads — was excluded from Northampton, the metropolis of the wholesale trade, after three general strikes against it, fought between 1857 and
1859; but it was widely employed at Leicester, Norwich and Bristol. In metalworking, the treadle-worked ‘Oliver’, a semi-mechanical stamp which had been common in Staffordshire for ‘generations’, was still apparently unknown in Manchester in 1865, and when in that year a local manufacturer attempted to introduce it, the nut and bolt makers (or at any rate the anonymous correspondent who wrote on their behalf) threatened to kill him.

Even when machinery was eventually installed, the struggle to control it remained unresolved, and one of the most common complaints of employers in the late 19th century was that tools were not run at their proper speeds, but were being sabotaged by worker lethargy or resistance. In a cotton mill every spindle was potentially a battleground as mules increased in size: in an ironworks every attempted economy in fuel or alteration to the ‘heat’. Often the machine proved disappointing to its patentees and promoters, either for want of precision, or because of the recalcitrance of the raw material, or because of the irreplaceability of handicraft skill. Patent could follow patent without anything like profitability being achieved, and the employer’s dream of a ‘self-acting’ mechanism – equal to the best hand labour, but driven by itself – remained elusive. Mechanisation, in short, was a process rather than an event. It did not begin with the great inventions of the 18th and early 19th centuries; nor did it end with their application. The process itself was neither linear nor smooth but, on the contrary, discontinuous and subject to a whole complex of competing claims, pulling in opposite directions. For the most part it advanced by small increments rather than by leaps, and forward movements were often followed by retreat, as workers reasserted their claims. In the study of which this article forms a part, I want to argue that the machinery question, so far from being settled by the defeat of the Luddites, is in some sense coterminous with capitalism itself; that resistance to machinery, though often opaque and only intermittently recorded in the documents, was an endemic feature of 19th century industrial life. I also want to look at the repercussions of machinery on skill, and at the ways in which the labour process was reconstructed both from above and below, under the impact of technical change. Finally I want to look at machinery in relationship to the ‘reserve army of labour’ and the demographic changes of the early and middle years of the nineteenth century, and to consider the relationship of factory industry to capitalism in the countryside, domestic outwork and the workshop trades.

Readers of Capital will know that such a discussion inevitably bears on Marx’s ‘stages’ of capitalist development. In chapters XIII to XVI of Capital Vol. I he proposes three great epochs of capitalist development, which are both chronologically and analytically distinct.

1. The handicraft stage, or that of petty commodity production – the chrysalis from which later capitalism grew.
2. Capitalist ‘manufacture’ – the concentration of artisan and handicraft production under the control of a single capitalist, and the systematic extension of the division of labour.
3. ‘Modern’ industry – the epoch inaugurated by the coming of machine tools and the factory system.

In Marx’s discussion each of these epochs appears to supersede its predecessor and in the case of ‘manufacture’ and ‘modern industry’ at least a clear
chronology is suggested, the first being assigned to the period from the middle of the sixteenth to about the middle of the eighteenth century, the second to the age of invention. But as Marx's lengthy chapter on 'modern industry' unfolds — it takes up fully 150 pages of the book — it becomes clear that modern industry incorporates older systems of production rather than superseding them, and that it is in fact a mixed development, in which 'modern' domestic industry and 'modern' manufacture play no less distinctive a part than the machine-based factories. Here, as elsewhere in Capital, there are plainly shifts of emphasis in Marx's discussion, and one way of elucidating them — as well as of determining their theoretical status — would be to consider the historical phenomena to which they were addressed. The discussion of such questions has in recent years been left to the philosophers and the economists, each of them concerned, in their own way, with the theoretical consistency of Marx's texts rather than the industrial reality which he was attempting to dissect. The historian may be ill-equipped to undertake a work of epistemological clarification, or to explore the more problematical reaches of the law of value. But that does not or should not mean that he or she has no contribution to make to theoretical discussion. The territory of Capital Vol. I is, after all, a historian's territory, one whose landmarks are in many cases familiar, and whose signposts the historian will sometimes be better placed than an economist or a philosopher to read.

Another theoretical question which this discussion poses is the relationship of ideology and class struggle. There is no doubt that so far as public agitation is concerned historians have been right to focus upon the 1820s and 1830s as the crucial period for the debate on machinery. All the major questions still seemed open, and the debate was uninhibitedly pursued, with Macaulay and the political economists upholding the 'march of improvement', Cobbett as its most eloquent critic, and Carlyle as the prophet of doom. Even after the defeat of the Luddites the inevitability of mechanisation was by no means accepted. In the 1830s there were widespread working class demands for a tax on machinery, and a vigorous agitation for short-time which was quite openly directed against factory 'slavery'. The economy plunged wildly from hectic bouts of activity to devastating slumps, and in the depths of the 1842 depression even the Prime Minister seemed uncertain as to what the outcome would be. The labour movements of this time openly regarded machinery as an enemy force, one which they held responsible for the huge increases in the reserve army of labour and which, if left to continue unchecked, would make every class of worker redundant. Alternatives to the factory were eagerly canvassed and whenever the opportunity arose they were put into practical effect — spade husbandry and smallholdings on the land, producer co-operatives in the towns. As a public issue the machinery question was settled by the defeat of the Owenite trade unions in the 1830s, and the failure of the producer co-operatives to establish themselves; by the growing confidence of the industrial bourgeoisie; and by the retreat from socialist theory which marked the Chartist years (a subject to be discussed by Gareth Stedman Jones in a future issue). Once the opposition to machinery had been abandoned there was no turning back, and in mid-Victorian times resistance was characteristically fragmented. Trade unions re-wrote their rule books to expunge the anti-machinery clauses; trade union leaders adopted the language of 'improvement' as though it were their own. But at the level of the shop floor the machinery question was not settled at all, either in theory or in
practice, and the battle of ideas continued to be waged around the workshop stove long after it had disappeared from the public stage.

Finally there is the whole question of whether technology should be seen as a cause or an effect, an outside neutral force, or what the sociologists call a 'dependent variable'. It is one of the great unresolved questions about the industrial revolution itself, and it is certainly one which should be posed of the mid-Victorian economy, when Britain was the workshop of the world. Marx's texts are ambiguous on this point. In Chapter XV of Capital Vol. 1 he begins with a purely technical explanation for the rise of modern industry, identifying it with the replacement of hand tools by machine-based technologies. The machine is more than just a giant tool. It is a process, a demonic power, a whole productive system—'Modern Industry'. Machinery takes over from man the role of tool-bearer, manipulating numbers of tools simultaneously, synchronising separate detail processes as one. Instead of labour power, it is the instruments of labour which dominate production. 'It is now no longer the labourer that employs the means of production, but the means of production that employ the labourer'. But as Marx's lengthy discussion of 'modern industry' unfolds, machinery seems less and less essential to its hegemony, which is no less clearly established, and no less exploitative, in manufacture and domestic outwork than it is in factory industry. Mechanisation comes to appear more a result of modern industry than a cause — the capitalist's way of escaping from worker resistance. Earlier, in a letter to Annenkov (28 December 1846) Marx distinguished between two great epochs in the progress of machinery:

One can say that up to the year 1825 — the period of the first general crisis — the general demands of consumption increased more rapidly than production, and the development of machinery was a necessary consequence of the needs of the market. Since 1825, the invention and application of machinery, has been simply the result of the war between workers and employers ... This is only true of England. As for the European nations, they were driven to adopt machinery owing to English competition both in their home markets and on the world market. Finally, in North America the introduction of machinery was due both to competition with other countries and to lack of hands, that is, to the disproportion between the population of North America and its industrial needs.

Marx did not go any further in exploring the first of his two epochs of machinery and they remain unexplored by historians to this day. It is possible that research will show that the rise of machinery in eighteenth century England was much more closely related to class struggle than Marx believed, that, for instance, the migration of the silk trade from Spitalfields to Essex was intimately bound up with the strength of the weavers' combinations, and that similar factors were involved in the migration of the woollen trade from the West Country and Norwich to Yorkshire. Conversely it is by no means clear that mechanisation in mid-Victorian times can be explained by class relationships alone. All these questions remain properly open. The general bias of these chapters is to reduce the part assigned to machinery in the making of modern industry, and to look for wider changes both in technology and in the capitalist organization of work; it is also to reject the idea of mechanisation as a self-generating process, and to look instead at the complexity of competing claims which 19th-century capitalism faced, and with which the workers' movements of the time had to contend.

So far as economic history is concerned one of the main general questions raised by these articles concerns the relationship of mechanisation to overall capitalist growth. It should become clear as the argument proceeds that the two
are in no sense one and the same. Not only is the tempo of change different in different trades, but its character is polyglot. Increased investment was by no means synonymous with the growth of large capitalist firms or the installation of elaborate plant. In some trades – classically in the building industry – it was accompanied by a proliferation of small producers. The response to market competition was also exceedingly various, and impossible to account for simply in terms of economic rationality. The conservatism of the Sheffield employers, which in the 1870s and 1880s exposed them to heavy competition from Germany and America, cannot be separated from the extraordinary power of the workers’ trade societies in mid-Victorian times, and the very special claim of their skills.

Another question in economic history which these articles address – more particularly the third, which will be about ‘sweating’ – is that of the standard of life. This is usually discussed statistically in terms of household budgets, or else of take-home pay. ‘Optimists’ – i.e. 19th century capitalism’s academic partisans – point to the progress of the nation, measured the statistical indices of consumption; ‘pessimists’ point to the vast numbers living at or below subsistence, or to the sanitary condition of the towns. Neither however address themselves centrally to the question of work, or to the momentous transformation which 19th century production imposed on working pace. Yet it is surely impossible to consider the standard of life apart from the conditions under which it was earned. The modest prosperities of mid-Victorian Lancashire were purchased at the cost of putting whole families to work in the mill; those of Victorian railwaymen – as Frank McKenna pointed out in *History Workshop Journal* I – at the price of working hours which turned day into night, and working shifts which could extend to 24 hours at a stretch. High wages in mid-Victorian England were quite often a species of death money, for those who could not hope to live long at their trades; or else a compensation for the fact that they had to work like horses: the Sheffield grinders and the Staffordshire iron puddlers might come into the first class, railway navvies into the second, while the coal miner, with more and more dust in his lungs as deeper shafts were sunk, and more explosives used, could qualify for either. Low wages, as Henry Mayhew pointed out, were in the London trades inseparably associated with over-work and sweating. It is hardly in question that the nineteenth century saw an enormous deterioration in working conditions, yet the matter has inspired little research. Historians are willing to delve into the remotest crevices of the stock market, in searching for the origins of railway investment or the effects of overseas trade, but so far as I know there is not a single modern article attempting to compute the comparative mortality of the trades, or to reconstitute the aetiology of industrial disease, despite the mass of evidence bequeathed to us by the more radically-minded 19th century doctors.

The materials for an inquiry into 19th century work are inexhaustible. Quite apart from the ordinary printed and manuscript sources available to historians, there is a huge technical literature, very little of which is used, and it is hoped that this article may indicate something of its potentiality. There are literally hundreds of treatises devoted to the ‘rudiments’ of individual trades – over 100 titles in Weale’s series alone*.

* The Patent Office Library is a useful resort for British Museum readers who find a title they are searching for has been consigned to that elastic category ‘Destroyed by Bombing in the War’.
manufactures, such as those of Tomlinson and Ure, which are often very well illustrated with prints; the industrial surveys undertaken, from time to time, by provincial newspapers (examples can be seen in the Goldsmith's collection of economic literature in the University of London library, Senate House); and the guides to industrial 'curiosities', a genre of investigative writing, developed around the time of the Great Exhibition, which in subsequent years kept many a Grub Street hack employed, as well as providing Sunday School superintendents with useful prize books: *The Busy Hives Around Us* (1860?) is a representative title. Trade newspapers, ranging from the *Horticultural Times* to the *Iron and Coal Trades Review* have been a rewarding primary source. They are often more informative about industrial conditions, though written from the point of view of capitalists, than labour movement journals. Periodical publications such as the *Journal of the Society of Arts* act as a sensitive register to some of the 'intermediate' technical changes; so too, for heavy industry, do the 'transactions' and 'proceedings' of the various societies of civil and mechanical engineers. As well as reprinting papers these latter journals also contain the discussions which followed them, so that you can sometimes hear the Victorian engineer thinking aloud about his work. Finally there are the Patent journals which, together with the Board of Trade papers at the Public Record Office, make it possible to track the course of speculative invention, and the euphoric hopes invested in self-acting mechanisms of all kinds.

The historian can only be grateful for such a wealth of documentation. Yet at the same time he or she should be on guard against its bias. The technical treatises, for instance, rarely deal with the industrial and commercial setting, so that it comes as something of a shock to turn from, say, James Facey's *Elementary Decoration* (1882) with its detailed specifications about the nature of the painter's craft, to the realities of 'scamping' in Robert Tressell's *Ragged Trousered Philanthropists*. And beyond an occasional reference to 'the operator' they may tell one nothing about labour at all. Tilt-hammers rise and fall, with never a gang of men to position the metal; convex parts are jointed as by an invisible hand. The trade journals, too, are unsatisfactory as a guide to work. They persistently exaggerate the importance of invention, so that even in the most resolutely handicraft sectors of production it often seems - on the evidence of single instances - that mechanisation is about to take off. The trade reports from Sheffield in *The Ironmonger*, for instance, are filled with trials of machinery in the 1860s and 1870s yet the Sheffield trades remained overwhelmingly handicraft right down to 1914. The *Boot and Shoe Trade Journal* is even more misleading: to read it in the 1870s is to have the impression of an industry on the very edge of automation rather than one in which domestic outwork was still, in the leading centre of manufacture, a major part of the production process.

The Factory Inspectors' reports, another major source for any inquiry into nineteenth century work, also need to be treated with care. Their evidence is strongest on the textile mills, the first great object of factory legislation and, until the Extension Act of 1867, its only subject. But even here it is limited and partial. The Inspectorate's investigations were largely confined to the objects specified by the Factory Acts, working hours and industrial safety. The historian concerned with job control and machinery, or with the class struggle at the point of production, will have to look elsewhere. Another limiting bias is the
restriction of the inspectors' activities to the sphere of women's and children's employment. As a result they have little to say about industries, such as shipbuilding and engineering, where adult male labour predominated; while artisan trades are in many cases neglected, and the building industry ignored. Backyard industries and domestic outwork are also excluded from notice, because the small scale of the production unit disqualified them from protective legislation. It is not until the sweating inquiries of the 1880s that they were exposed to investigation, and then as a special problem rather than as an integral part of 19th century production. The map suggested by the factory inspectors' reports is thus cumulatively misleading; the lateral spread of 'modern' (factory) industry is exaggerated, while its artisan components are ignored, and comparatively little notice is taken of production in the workshop and the home.

To correct these biases the historian can make use of other more fugitive sources. Strikes throw up a great deal of incidental information about working arrangements, and show how custom and practice was shaped in the crucible of struggle; so do the arbitration proceedings which in the 1860s and 1870s were sometimes reprinted verbatim. County Court cases tell one a great deal which could never be learned elsewhere, prosecutions can often illumine the flash-points of resentment which at other times are hidden. Medical evidence can take one closer to the realities of industrial life than the Factory Inspectors' reports, as in Dr. Greenhow's 1861 survey of industrial lung diseases, or Dr. Edward Smith's report on the sanitary circumstances of tailors, printers and dressmakers. A rare though valuable source of evidence is that of workers writing about their own industries at the time, as in the reports by English artisans on the Paris Exhibitions of 1878 and 1889, or the accounts (mainly from the industrial crafts) collected by F. W. Galton in *Workers on their Industries* (1896). Branch reports in trade union journals can tell one a good deal about bargaining conditions, while the proceedings of annual or quarterly trade union meetings often contain extensive reference to the ways the machinery question was discussed. Above all there is the priceless evidence of autobiography, which makes it possible to translate technical process in terms of the individual's experience of work. Enough of them survive for the 19th century - or can be reconstituted through oral history - to provide the historian with a benchmark against which every other class of evidence can be measured.

These articles are based on an unwritten chapter of a half-finished book. The material had been lying fallow for some years and was brought to life as a result of discussions in the History Workshop collective. We were looking for a piece which would address itself to some area that was central in history teaching. 'The Machinery Question in 19th Century England' - the subject of my unwritten chapter - seemed to fit the bill, and was adopted in place of other alternatives on which I had been working. The piece was started in April 1976, but as a result of critical discussion in the collective, each of the sub-sections began to grow into chapters, and the piece is now far too long to be published in the journal, even in serial form. We have finally taken out three closely-related studies. The first, published in this issue of *History Workshop Journal*, is about the balance of steam power and hand technology in the 1850s and 1860s. It offers an epitome, brief, but in intention comprehensive, of the situation in the main areas of industrial activity, and discusses some of the obstacles to
mechanisation. Its basic argument is that labour power was much more important than capital equipment in making Britain, at mid-century, 'the workshop of the world'. A second article, to be published in a future issue of *History Workshop*, is called 'Industrial design and the rise of alternative technologies'. It is about the consumer goods industries of mid-Victorian Britain and the ways in which mass production methods were pioneered. It also attempts to relate work to Victorian industrial design, and to show how the simplification of labour process was accompanied by an increasing elaboration of the product, as manufacturers competed with one another for the market. A third article, called 'Sweating', is primarily about factory industry, though it also discusses the domestic outworkers to whom the writings on 'sweating' usually refer. This argues that the capitalist achievement of the nineteenth century was accompanied by a radical deterioration in working conditions, which can be measured by the incidence of industrial disease, the rise in workplace temperatures, and the intensification of work loads. It looks at some of the hidden components of industrial activity, such as industrial haulage and cleaning, the stoking and charging of furnaces, the sorting and packing of goods, and argues that mechanisation in one department of production was usually accompanied by an increase of drudgery in others.
II. Labour Power

Capitalism in the nineteenth century grew in various ways. Mechanisation in one department of production was often complemented by an increase of sweating in others; the growth of large firms by a proliferation of small producing units; the concentration of production in factories by the spread of outwork in the home. Sugar was refined in factories, like Messrs. Tate and Lyle's at Silvertown; but sweets were manufactured for the million in back street kitchens and courts, as also were such popular children's purchases as ginger beer, sarsaparilla and ice-cream (among the manufacturers, in 1890s East London, were out-of-work dockers, victimized by the employers as a result of their activities in the Dock Strike). Timber was sawn at the saw mills, where steam-driven machinery was, by the 1850s, very general; but it was shaped at the carpenter's bench, on the cabinet-maker's trestles, and at the cooper's coke-fired cresset. In ironmaking, the giant furnaces of the Black Country existed cheek-by-jowl with thousands of back-yard smithies, complementary in their action, yet radically distinct. The same was true of steelmaking and the cutlery trades in Sheffield, where 30 or 40 rolling mills supplied the working material of some 60 handicraft trades in which production was organized by outworking journeymen-masters. Textiles were mechanised and accounted for far more steam power than any other trade - as can be seen from the figures in Table 1 - but the clothing trades, which increased by leaps and bounds in the 1840s and 1850s, depended on the poor needlewoman's fingers.
### Table I
Steam Power in 1870
(Source: P.P. 1871 LXII (440), Return of Factories and Other Manufacturing Establishments)

<table>
<thead>
<tr>
<th>Trade</th>
<th>Textile Trades</th>
<th>Clothing Trades</th>
<th>Ironmaking</th>
<th>Metal Working Trades</th>
<th>Leather Trades</th>
<th>Mineral Working Trades</th>
<th>Building Trades</th>
<th>Food Manufactures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of Works</td>
<td>Steam H.P.</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Cotton factories</td>
<td>2,371</td>
<td>280,602</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Woollen factories</td>
<td>1,550</td>
<td>45,148</td>
<td></td>
<td></td>
<td></td>
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<td>Worsted factories</td>
<td>599</td>
<td>47,140</td>
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<td>Silk factories</td>
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<td>7,485</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Lace factories</td>
<td>223</td>
<td>998</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flax factories</td>
<td>155</td>
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The most complete triumph of the machine was in the cotton trade of industrial Lancashire. Elsewhere its progress was more halting, and there were major sectors of the economy – as Table 1 suggests – where down to the 1870s steam-power had made very little impression at all. Often its effects were secondary, applying only to the preparatory process of manufacture – or to the finishing – while leaving the main body of the work untouched: the case, for example, with firebricks. In other instances it served to make handicraft labour more productive without impairing its skill – as in the example of glass cutting, where steam power turned the grinding wheels, previously worked by a man or boy assistant, but the delicate work of grinding, smoothing and polishing remained in the hands of the craftsman who had traditionally performed it. In yet other instances steam power and machinery were chemical rather than mechanical in their action, and fuel-saving rather than labour-saving in effect. This was the case, in ironmaking, with Neilson's Hot Blast, which cut down coal consumption by about a half, and in glassmaking Siemens' tank furnace. Even when machinery was extensively applied it by no means necessarily reduced workers to the status of mere hands; often its role was ancillary rather than commanding, and it may be useful to suggest a broad line of distinction between the textile industries on the one hand where, by mid-Victorian times, repetition work largely prevailed, and metalwork and engineering on the other, where the production process was discontinuous, and depended on craftsmanly skill. Mechanisation and steam power, in short, were by no means inseparably linked, and a vast amount of 19th century work was affected by them only at second or third remove.

Even in textiles the progress of mechanisation was uneven. It was faster in spinning than in weaving, in worsteds than in woollens, in cotton than in linen or silk. Silk was mainly a hand-loom trade at the time of the Cobden Treaty of 1860; so were many branches of West Riding woollens, while in the linen industry the power loom had only recently made its first appearance. The Nottingham lace trade was a factory trade almost from the start (though much of the machinery was hand rather than steam-powered). But in hosiery, the other great East Midlands staple, the manufacture, so late as 1861, was 'largely . . . domestic' and though the steam-powered rotary made swift progress in the following two decades, the finishing branches of the trade – seaming and stitching – remained almost entirely in the hands of out-workers. In cotton spinning itself, the original site of the 'industrial revolution', hand-mule spinners held their own in the cotton mills right down to the 1870s, where they were employed on the finer counts, and maintained their own trade union organization. Before the Cotton Famine of the 1860s 'only the more venturesome' manufacturers would trust their fortunes to the self-actor mule entirely, and down to the 1880s the self-actor and the hand-mule, instead of competing with one another, were allotted separate departments of the work.

Many trades in mid-Victorian times remained divided between machinery and handicraft sections. In armaments, for instance, the Enfield Rifle was manufactured by machinery on a system of interchangeable parts. But ammunition continued to be made by hand – at Woolwich Arsenal, when Andrew Wynter visited it in 1860, some 800 children 'aged from 8 to 12' were employed at packing cartridges – while in the 'Gun' quarter of Birmingham the small arms trade was diffused among a multitude of small producers, with
lock, stock and barrel as separate handicraft trades. In newspaper printing, press work was transformed by the steam-powered cylinder machines, installed at *The Times* in 1814, but typesetting down to the 1860s, and in London until the introduction of Linotype in the 1890s, remained a work of the individual hand compositor, piecing together letters from a case. In brewing, the twelve big London firms were among the largest manufacturing establishments in the kingdom. They had been among the very first to order James Watt's steam-engine, when it was still in its patent stage, and they conducted operations on a factory scale. But in the 1850s there were still thousands of handicraft brewers — no fewer than 1,800 in Birmingham alone. Steam-powered flour mills were built on the waterfront to process imported wheat, but in the 1850s and 1860s by far the greater part of flour was ground by stone — in some places still in hill-top windmills.

Dual technologies also existed together — in large establishments — under the same roof, as in the example already given of hand mules and self-actors in different departments of cotton spinning, or that of hand looms and power looms in silk mills and woollens. At the Atlas Works, Sheffield, armour plates were tempered in the furnace, but dragged about the factory floor by teams of men in chains. Another striking example from Sheffield, also illustrated in an accompanying engraving, is that of steelmaking, where the ingots were melted in the furnaces, but the crucibles which held them were hand-made on the same premises, and the ganister or clay from which they were made was prepared for manufacture by puddling it underfoot. Pot-making is a well remembered Sheffield occupation, of which we are fortunate to have an excellent autobiographical account, and the process of treading it underfoot — very much akin to the wine-growers trampling of grapes — remained a skilled occupation down to at least 1914. Here is an account of it incorporated in a technical treatise of the time:

When the materials are to be mixed by treading, they are spread out on a concrete floor and are sprinkled with water. The mass is turned over repeatedly with spades and, when it becomes too pasty to be worked in this way, it is again spread out and is trodden by men with bare feet, who squeeze the clay between their toes, and so mix it thoroughly. Each portion of the clay has to be squeezed between the toes, compressed and then pressed on to the previously worked paste. The treader stands in the middle and, working his toes, goes over the whole surface of the clay in a spiral direction, always working towards the edge. Having reached the edge, he turns round and walks in the opposite direction until he arrives at the starting point. Some treaders prefer to walk in straight lines instead of in a spiral direction. The trodden mass is then made up into balls of 40 to 45lbs. weight, and is afterwards beaten into a dense mass. In some works it is 'pugged' after being trodden.

*Treading the clay*

*The Illustrated Exhibitor, London, 1851.*
In transport, too, dual technologies existed side by side. Iron steam-ships shared the coasts with thousands of collier brigs and sailing drifters and their cargo was taken ashore by dumb barges and dockers walking planks. \(^{41}\) Railway engines revolutionised passenger transport, but road haulage remained the province of the one or two horse cart. Goods carried by rail increased from 60 million tons in 1851 to 410 million tons in 1900, while those carried by carts, waggons and vans increased in the same period from 106 million to 671 million tons. \(^{42}\) Over the same period the number of railwaymen increased from 29,000 to 318,000, while those in road transport from 139,000 to 565,000. \(^{43}\) The greater part of the mineral traffic was carried by canal, long after the coming of the railways. \(^{44}\) At Messrs. Chance Brothers, Smethwick, the largest glass factory in the world, 'not a few' of the barges bringing iron, coals and glass-making materials were drawn by human beings: a visitor in December 1850 noticed, in a very short journey, 'no less than five barges, to each of which a man and an ass were yoked together', (the factory was engaged at the time in making the Crystal Palace). \(^{45}\)

'Improvement' in 19th century industry — as the above paragraphs may suggest — by no means worked in a single direction, and in the following pages I want briefly to indicate, industry by industry, some of its characteristic paths.*

A. Mining and Quarrying

In coal mining, steam power transformed the scale of operations, while leaving the technology of hewing unchanged. Steam-driven fans were applied to ventilation, and allowed working places to proliferate, instead of being tied to the foot of the shaft. Steam-driven pumps were applied to underground drainage, and allowed the mining engineers to explore new and deeper levels, more especially in the second half of the century, as the shallower seams showed signs of exhaustion. But there was a total absence of mechanisation at the point of production, where the coal was still excavated by shovel and pick — 'tools of the most primitive description, requiring the utmost amount of bodily exertion to render effective'. \(^{46}\) Mechanical coal-cutters were frequently patented and in times of strike high hopes were entertained by employers of the 'revolution' they might affect; \(^{47}\) but in 1901, forty years after the first wave of patents, only 1\% of total output could be attributed to them \(^{48}\) — a percentage which had still only risen to 8\% in 1913. \(^{49}\) Output was increased not by mechanisation but by recruiting extra men. More and more hewers were needed as workings were extended both laterally and in depth. The numbers of hauliers (mainly boys) also increased: there was more coal for them to handle, and longer galleries to travel. Longer galleries also meant more roofs to prop, more roads to keep up, more rails to be laid down, while the increased use of blasting meant more hand-bored holes. The nineteenth century saw the creation of whole new classes of underground worker — 'stonemen' or rippers who had the job of extending the levels, timbermen to do the propping, \(^{50}\) shot-firers to bore the holes. The mining labour force, which had stood at little over 200,000 in 1841 rose to 1,202,000 by 1911. \(^{51}\) Animal power, too, was brought to production's aid, with the introduction of pit ponies for underground haulage: there were an estimated 11,000 of them in 1851, 25,000 in 1881, 70,000 by 1911. \(^{52}\)

* Detailed discussion of textiles and the clothing trades is held over for a subsequent article.
Stone quarrying, like mining, was a sweat and muscle job, and little that took place in the nineteenth century impaired its labour-intensive character. Technological change characteristically took the form of ‘improved’ hand tools rather than of steam-powered machinery, as with the introduction of the ‘patent axe’ (‘an instrument composed of thin slips of steel tightly bound together’) which first found its way into Scotland about 1818 and by the end of the century was in use at granite-working centres all over the country; or the spread of the ‘feather and tare’ method of stone-splitting, which replaced the old method of wedge and groove, but still required the quarryman’s whole strength (the ‘tares’ had to be repeatedly hit with a sledge-hammer until the rock eventually broke). Gunpowder was increasingly used in quarrying for the rougher class of stone, but boring holes for them was hardly less taxing than working with crowbar and pick: in Clydach Vale a foot an hour was considered a workmanlike progress (‘You kept on turning and twisting the bar ... like buttermaking in a churn’). The most widespread measures of ‘improvement’ were in haulage. Cranes were introduced into the Aberdeenshire quarries as early as 1835, and by the 1900s there were few large quarries without at least the hand-operated version, while in some the stone was carried away on the overhead rails known (after the acrobat of that name) as ‘Blondins’. But in the smaller quarries — still by far and away the most common — the stone was dragged about by main force with men or horses to provide the traction. Fred Bower, who worked there briefly in the 1880s, describes the laborious procedure used on the Isle of Purbeck: the quarrier, having cut his stone, loaded it on to a ‘bogie’ or trolley, to which he harnessed himself ‘just like a horse’ and dragged it to the foot of the incline, from where it was drawn up to the top by a donkey- or mule-driven windlass.

Clay-getting, though providing two major industrial raw materials, for pottery and bricks, was less affected by nineteenth century ‘improvement’ than any other branch of extractive industry, with the possible exception of salt. In the china clay industry of Cornwall, which shipped vast quantities of working materials to the Potteries of North Staffs., there were no mechanical aids and only the most primitive plant. The clay was puddled (i.e. sifted, washed and homogenized) in open-air pans, ‘forty feet in diameter, and from six to ten feet deep’, it was dried by the wind and sun, with reed thatches to cover it when it rained. Pumping engines (bought second-hand from bankrupt tin and copper mines) were an innovation of the 1860s and 1870s; kilns came even later. The clay diggers worked with a heavy pick (the heaviest pick in Cornwall, according to an authoritative account published in 1875), and a long, square-mouthed shovel. In the settling pans they stirred the mass of slime with a ‘dubber’ and brought it to consistency by trampling. The boy-runners, who had the job of haulage, carried the blocks of clay on boards, with a stiff leather shield ‘to keep the wet clay from reaching one’s chest’. ‘Balmaidens’ (the women workers who cleaned the final impurities from the clay) used a small iron scraper ‘resembling a ... Dutch hoe’. In the 1860s they were expected to clean two or three tons a day for the princely sum of 1s.

In the Devon ball-clay industry, another major source of raw materials for North Staffs., the clay was cut dry in open-cast or underground pits, and the intermediate processes of puddling dispensed with, but the technology was no more sophisticated than that in china clay. When it came to carrying the clay
down the Stover Canal to Teignmouth, men were used instead of horses for
haulage, dragging the barges by rope. Loading the ships at Teignmouth was
also primitive, the clay being hoisted aboard by a simple expedient known as
‘jumping’: ‘A rope was suspended from a pulley-block attached to the ship’s
rigging. One end was attached to the basket while the lumper grasped the other
end and jumped from the ship’s deck into the barge below with the effect
that the laden basket was raised by his own weight’.

B. Agriculture and Market Gardening
In agriculture, cheap labour rather than invention was the fulcrum of economic
growth, and the changes inaugurated by the agricultural revolution were
accompanied by a prodigious increase in the work force, as well as by an
intensification of their toil. Heavier crop yields needed more hands to harvest
them, new methods of cultivation demanded a more intensive preparation of the
soil – more draining and ditching, deeper ploughing, heavier and more frequent
dressings of manure. Turnips in particular, the pivot of the new rotation of
crops, demanded an almost gardenly care. The soil had to be in such a state of
pulverisation ‘as to fall from the plough like meal’ with ploughings,
harrowings, rollings, pickings and liberal dressings of manure before it was
ready for the seed, and once the crop had begun to appear the earth had to be
continually prodded and poked; sometimes there would be three different
hoeings. The extension of arable farming into upland, heath and fen – another
feature of the ‘New Husbandry’ – also made heavy demands on labour, with
more claying or marling to bind the sandy soil, more manuring to bring it into a
state of cultivation, more stone-picking and weeding to keep it clean. This was
the origin of the gang system in Norfolk and the Lincolnshire Wolds. In
harvesting, the most labour-intensive sector of farm work, the main innovation
in the early and middle years of the nineteenth century, the replacement of the
sickle by the scythe, took place within a hand technology. Although reaping
machines had been in use since the 1820s, it was not until the last quarter of the
nineteenth century that they began to make serious inroads into the work, and
not until the coming of the reaper-binder, at the very end of the century, that
farmers could dispense with the seasonal need for extra hands.

Market garden crops were even more labour-intensive than wheat. Wage
rates, even by the miserly standards of the British farmer, were exceptionally
low, and much of the labour was performed by the grower and his own family:
even so labour costs per acre were calculated at anything up to £1 1 per acre in
the 1870s, compared with between £1 and £2 per acre on an arable farm. Much
of the ground was dug by spade husbandry – i.e. trenched rather than
ploughed; many of the seeds were dropped by hand rather than sown by horse-
drawn drill; potatoes were individually planted. Heavy and frequent dressings
of manure were administered to offset the intense exploitation of the soil. In
rhubarb farming, wrote Shaw in 1879, describing the practice in the Surrey
market gardens, ‘rank litter’ was used, but because of the softness of the newly-
dug soil it had to be carried by basket, some people being employed to fill them,
others to carry them on their heads, ‘and a few more to empty their contents
over the crowns of the plants’. Earthing-up was by hand-held trowels: it had to
be done two or three times in the case of celery ‘to suit the growth of the
plants’. Other crops, too, needed an individual treatment: cauliflowers had to
be transplanted, onions and cucumbers tied, rhubarb pruned of leaves 'sometimes thrice in the season'.

Weeding — generally a job for women and children — was done with a sharp-bladed knife rather than a hoe, in order to get close to the crops, and baskets rather than wheelbarrows were used to carry the weeds away. Much of the harvesting was done on all fours.

A great deal of market garden work was done by contract. The grower, who bore many resemblances to a peasant proprietor (and some to a kulak), worked by rule of thumb. For much of the year he might employ no regular labour at all except for that of his family. But he would engage poor people in the locality — women and children especially — to take on particular tasks, and for the larger jobs he would engage with labour contractors or itinerant labourers, drawn from further afield. They would be employed not only for picking and pulling but also for other jobs, such as hoeing and weeding. Patrick MacGill was one of those who engaged at it, working with a gang of men and women for a potato farmer in Buteshire, Scotland. The men would dig potatoes from the ground with a short three-pronged 'grapis', a kind of fork. The women followed behind, crawling on their hands and knees, and dragging two baskets a-piece into which they lifted the potatoes thrown out by the men.

The job, bad enough for men, was killing for women. All day long, on their hands and knees, they dragged through the slush and rubble of the field. The baskets which they hauled after them were cased in clay to the depth of several inches, and sometimes when emptied of potatoes a basket weighed over two stone. The strain on the women's arms must have been terrible . . . . Pools of water gathered in the hollows of the dress that covered the calves of their legs. Sometimes they rose and shook the water from their clothes, then went down on their knees again. The Glasgow women sang an obscene song, 'just by way o' passing the time', one of them explained . . . . Two little ruts . . . lay behind the women in the black earth. These were made by their knees.

C. Food Industries

Food processing in mid-Victorian England was perhaps less subject to technological improvement than any other branch of production. Vegetables were dressed for the market by hand. Earth-stained crops, such as celery and radishes, were washed and bunched by women and children, working for market gardeners in their sheds. At Covent Garden, peas were podded in the market itself and sold 'ready for the saucepan' according to their respective size (the work was chiefly in the hands of old women, working at the rate of 1s. or 1½d. a day and recruited by salesmen from the local workhouse). Pickling too, though increasingly a factory trade, was mostly done by hand. The vegetables had to be soaked in brine, diced or sliced to size, liberally sprinkled with vinegar and then 'artistically arranged' in jars. It was cold winter work (the vegetables had to be kept in the cold for fear that they would rot) and chapped hands and cuts are remembered occupational hazards. Onions were particularly labour-intensive as they had to be individually peeled. 'Consequently in a bottle of pickles every onion is always visible from the outside though perhaps a cabbage may fill up the middle — an onion is never allowed to enjoy oblivion.' There was more machinery in jam-making, where by the 1880s steam-jacketed boilers reduced the fruit to pulp, but the preparatory stages were performed by hand. The fruits were sorted out into their respective qualities and the damaged parts cut away, oranges peeled, lemons squeezed, soft fruit separated from brambles. Extra labour was taken on at the jam factories during the height of the fruit-picking
season, and sacked when it was over.80 In the meat trade, cattle continued to be brought live to market and to be sold by dealers 'on the hoof'—i.e. for the purchaser to kill. The great majority were taken by family butchers, who did the slaughtering on their own premises81 (it took four men to kill a bullock, fewer for pigs or sheep).82 Not until the 1880s did anything like a wholesale trade develop on any scale, though in the 'bad meat' trade—whose physiognomy can be studied in the cases which came before the police courts—it seems that there was a class of travelling dealers who supplied the 'slink' butchers with their wares.83 Cheese, one of the very few proteins to form a regular part of the labourer's diet (even workhouse inmates had a ration) was made by a long and protracted process in the farmhouse. Stilton required up to half-a-year for ripening; Cheshire and Cheddar cheeses had to be turned daily for three months. Cheese-making involved a great deal of heavy lifting and carrying, and for the dairymaids who performed the work—or the farmer's wife and daughters—the process was intensely laborious, as well as long drawn-out: 'in many dairies . . . not only the hand, but also the whole arm is immersed in nearly every operation'. Most farms seem not to have made use of either chemical or mechanical aids. The heat of the milk was tested by finger-tips rather than thermometers; curds were broken by hand or knife. A semi-mechanical separator was patented in 1834, but farmers were very slow to take it up, even when it proved successful, and down to the 1880s it seems to have been very little used in Somerset and Cheshire, two of the leading cheese-making counties. 'The women do all the work', wrote Acland in his report on Somerset, the home of Cheddar cheese:84

It is true the men see the cows milked at a very early hour in the summer, and have some trouble with them in the winter, but the real hard labour falls on the women; and very active and industrious they are, but it is a sad sight to see a man standing by doing nothing, while his wife or daughter is turning many times a day a weight above half a cwt . . . Cheese-turners used in the Midlands are not in use in Somerset . . . the farmers who have heard of them say they would occupy too much space.

In the fish trade, too, a purely hand technology prevailed. In the middle years of the nineteenth century more and more boats were engaged at it, especially in the East Coast herring trade, and there was an enormous increase in the volume of the catch. New docks and harbours were laid down to cope with the increased traffic, while the coming of the railways opened up the inland markets. There was a vast increase, too, in fish manufacturing (over half a million barrels of herring a year were being cured in the 1860s), but working practices remained primitive. The Scotch herring girls, who followed the herring down the coast, from North-east Scotland to Lowestoft and Yarmouth, worked ankle-deep in the fish, equipped with nothing more than a short-bladed knife. (The barrels themselves were hand-made by journeymen coopers who migrated to the herring ports for the season.) Smoked haddocks—'the especial dainty of the breakfast table'—were cured over peat and sawdust fires. (Coke was substituted in the back slums of Limehouse and Camberwell, where fish curing remained a cottage industry down to the 1900s.) Bloaters, the favourite fish of the London working class, were prepared in even simpler conditions, since they did not need so much fire. Whelks and winkles were boiled and salted in the backyards of the dealers, and made more attractive by polishing the shells (one of Mayhew's costermonger informants employed children at 1d. an hour to do the works). The potted shrimp trade, which provided the working class of Lancashire and Yorkshire
with a tea-time relish, was hardly more advanced: for the most part it was conducted in the outhouses of Marsh Side, Southport.\textsuperscript{85}

In baking the only mechanical triumph which 19th century capitalism could record was the mass production of biscuits. Milling remained dispersed among thousands of local millers, and depended for motive power on wind and water rather than on steam: not until the spread of roller milling in the 1880s, and the massive importation of foreign wheats, did modern capitalist industry take their place. Bread-making itself was notoriously backward. Marx in \textit{Capital} scathingly described its technology as ‘pre-Christian’, and Seymour Tremenheere, in his report of 1862 on the journeymen bakers of the metropolis, was hardly more complimentary. ‘There is probably no trade supplying a vast and constant demand which has so completely remained in its primitive condition... as the baking trade’. Numerous projects for improvement were canvassed, but except in Birmingham, where steam bakeries seem to have been established in the 1860s, results were disappointing: Dr. Daugleish’s much trumpeted ‘aerated’ bread – which used carbonic acid instead of yeast – proved both expensive to manufacture and tasteless; Mr. Stevens’ ‘Patent Dough-Making Machine’, though it impressed Seymour Tremenheere, seems to have been ignored. Rising demand was met not by mechanisation, but by a proliferation of ‘under-cutting’ bakers, and a marked increase in over-work and sweating.

The London bakehouse of the 1850s and 1860s was as often as not the underground appurtenance of a shop, a single cellar which served simultaneously as storeroom, manufactory and oven, as well as providing the journeymen with planks to take their naps on, and sacks to serve as pillows, while they waited for the dough to rise. The only machinery in use was the rotary action of the workers’ hands and fists. Blending was in many cases performed by manual labour entirely, the different flours being emptied into a bin or trough and ‘thoroughly mixed’ by hand or spade. ‘Making the ferment’ involved mashing boiled potatoes, and then mixing them with yeast, flour and water as a thin, runny mass in a trough. ‘Putting in the sponge’, the next stage of the process, involved ‘very hard work’ in a swill. ‘Making the dough’ which followed was by far the most laborious part of the work.\textsuperscript{86}

The process is usually carried on in some dark corner of a cellar, by a man, stripped naked down to the waist, and painfully engaged in extricating his fingers from a gluey mass into which he furiously plunges alternately his clenched fists.

The bakehouse visited by Andrew Ure was little different, it seems, from those described by Eddie Dare (see below p. 138).

In the sweet trade, as in bread, increasing demand was met by a proliferation of small handicraft producers. In some cases they worked out of their own kitchens – like William Luby, the Ancoats sugar-boiler, whose early experiences are recorded in \textit{Useful Toil}; others used the back of a shop. Apart from access to a fire, very little was needed in the way of plant. Syrups and creams were made with a spatula, boiled sweets with a ladle and pan, lozenges with a rolling pin and cutters. Technology was not necessarily more sophisticated in the little factories which enterprising capitalists began to put up in the 1850s and 1860s. Messrs. Wotherspoon, for instance, the Glasgow confectioners, who produced ‘really fabulous’ quantities of sweets – their trade list included no fewer than fifty-two different classes of lozenges – patented several machines for
superseding hand-cutting, but they were all found impracticable 'in consequence of the difficulty of keeping the cutters clean', and when J. D. Burn visited their works in 1858 they had reverted to cutting by hand. Messrs. Schoolings of Bethnal Green were equipped, according to an admiring observer in 1866, with 'the most perfect' steam appliances in the trade. But 'Surprise Nuts', one of their most popular selling lines, were all individually filled by hand, and the nuts themselves hollowed out by girls with pen-knives and rosecutters. Here is an 1858 account of comfit-making at an Edinburgh sweet factory:

A large copper pan, probably 3 feet in diameter, containing the seeds, is suspended by a double sling from the roof over a low fire or stove. A quantity of sugar is dissolved in water and kept standing in a vessel by the workman's side. He then pours over the seeds a spoonful of this dissolved sugar, and, by a process of shaking and mixing in the hot pan, every seed is made to take on an individual layer. The heat and ... friction soon cause the water to evaporate and the sugar to dry on the hot seed. Another dose of the liquid is then given, another process of shaking and mixing, and thus the manufacture proceeds, until at length the seeds have attained to an enormous bulk, and then the heat is slightly diminished, and the friction increased for the finishing coat. The whole process ... requires great skill in the manipulation, and it also requires the most severe and continuous muscular labour. We know, indeed, of no other kind of labour that requires more. Not a muscle or joint of the whole body remains inactive. It has quite a marvellous affect in taking down superfluous fat. It is well known that a stout man, taken perhaps from lozenge-making, and put to work this hot pan, becomes in six weeks converted into a living skeleton.

D. Building and Construction

The building industry, like mining and agriculture, was labour-intensive and increased output was achieved by putting on extra men: the work force recorded in the census was 376,000 in 1841, by 1901 it had risen to 1,216,000. Building and construction was one of the fastest-growing sectors of the economy in mid-Victorian times, and accounted for between 20 and 30 per cent of gross domestic fixed capital formation, rather more than twice the amount attributed to cotton. But the scale of enterprise was characteristically small, and investment, whether by master-builders or sub-contractors, went on labour and materials, not on plant. The main thrust of technical innovation, such as it was, came in the direction of labour-saving materials rather than of mechanical devices. In the 1850s and 1860s their influence was comparatively slight. The painter still mixed his own colours; bricklayers still cut and shaped their own bricks (so late as 1874 it was considered a more important part of their work than setting); carpenters and joiners worked, very often, to their own designs.

Road-making, one of the earliest 'improvements' associated with the industrial revolution, was transformed by the coming of the turnpikes, and the new surfaces of Telford and Macadam. Large numbers found employment at it, both paid and unpaid: among them, in 1832, were some 32,000 parish paupers. But though road surfaces were revolutionised, the technology of labour was unchanged. Stones were broken up by sledge-hammer, a weary labour at the roadside or in the parish pits; and the new surfaces were trodden down by foot and pitched and packed by hand (the great turnpike roads had to be very closely wedged, 'so as to form a regular convexity' between the centre and the channels). The coming of asphalt seems to have made the work, if anything, more severe. Smoking loads of it were shot from wheelbarrows, raked to and fro to eliminate the harder knobs, and then pressed with red-hot irons, hissing and scorching as the surface set. Many English workmen refused to be employed at the work (despite comparatively favourable wage-rates) on grounds.
of the intolerable heat; and the London companies who pioneered the process used French and Italian workers to take on some of the more fiery work. Steam-rollers, first manufactured and marketed in England by Aveling and Porter in 1867, were slow to be adopted, and it seems that stone-crushers, too, were little used. In Chamberlain’s Birmingham, a go-ahead city when it came to ‘improvement’, they were grudgingly accepted by municipal officials: the Corporation Surveyor, in a report of 1874, complained that with Blake’s Patent Stone-Crusher, one of the most advanced models on the market, some 16% of the stone was lost in dust.

Paving stones — such as those which figure so largely in our cover illustration — were entirely hand-made, and notwithstanding the vast increase in their manufacture, little seems to have been done to alter the character of the work. At Mountsorrel, Leicestershire, one of the great centres of the industry, a variety of hammers were used: the ‘burster’, ‘an immense tool weighing 30 lbs’, which was used for breaking up the large blocks and irregular lumps, the ‘knob hammer’ for knocking off the larger knobs, and the ‘squaring’ hammer, ‘universally employed’ for squaring setts. In Aberdeenshire too, the other great centre of granite paving, sett-making remained a work of the hammer down to the end of the 19th century. ‘The dressing of granite by mechanical means is a problem that has engaged the attention of engineers for many years’, wrote Powis Bale in 1884, ‘and is still, practically speaking, unfulfilled’.

Mid-Victorian town ‘improvement’ owed more to artisans than to civil engineering, and the monumental art forms favoured at this time gave a wide field for the exercise of their skills. Banks competed for grandeur in columns of Bath and Portland stone, Doric, Ionic or Corinthian, according to the architect’s whim. Churches — a major growth industry down to the 1880s, and by far the wealthiest of the architect’s clients — blossomed out in revived Gothic; warehouses and offices went baronial, with turrets, gables and keeps. Stonemasons were very largely responsible for these ornate facades though bricklayers played more part in the revived Queen Anne style of the 1870s. Stonemasons also serviced the mid-Victorian boom in town halls and exchanges, the rage for civic statuary and clock towers, and the proliferation of museums, galleries and halls. All of their work was hand-tooled, and it was not until the very end of the century that stone-working machinery began to make serious inroads on their craft. Most of the decorative work was done by banker masons in the yards, but the stone carvers worked on site, as did the ‘roughers out’ — the walling masons who shaped the stones for fitting.

Railway building was very largely pick-and-shovel work, notwithstanding the achievements of the civil engineers. Contractors were niggardly in their fixed investment, lavish in their use of hands, and at the height of the ‘mania’ of 1845-7 were thought to have had some 300,000 men in their employment. Bricks were manufactured for the viaducts and embankments on site. Millions of tons of earth, sand and gravel were shifted by the spade — twenty tons a day was the normal navvy stint in the 1850s. In tunnelling, the rock was shifted with gunpowder, but bored by handworked drills; heavy clays, such as those encountered by the London and Birmingham railway at Primrose Hill, were broken up by hatchet and cross-cut saw. Hoisting devices were primitive, with nothing more elaborate in the way of handling equipment than cumbersome horse-drawn gins. On deep cuttings, like the Tring works of the London and
Birmingham line, where some 1,400,000 yards of chalk had to be removed before the track could be laid, tipping was conducted on the principle of the seesaw, with a man and horse as weights. There is a vivid description of the work in F. S. Williams *Our Iron Roads* (1852):

Runs, as they are called, are also made by laying planks up the sides of the cutting, on which barrows may be wheeled. The running is performed by stout young men, round the waist of each of whom is a strong belt, fastened to which is a rope running up the side of the cutting, and turning on a wheel at the top, whilst to the other extremity a horse is attached. The barrow being laden... a signal is given to the driver, who leads the horse quickly out a given distance into the field, and thus the man is drawn up the inclivity; the contents of the barrow are emptied, and the horse being led back the rope is slackened, and the man runs down the plank again, drawing the empty barrow after him.

In domestic housebuilding activity expanded with little more in the way of mechanical aids than the wheelbarrow (even this could be controversial – Manchester building workers came out on strike against it in 1864). There were no pile drivers to dig the footings, or, in many cases, hoists to raise the parts: 'it was quite customary to see labourers staggering up a ladder, carrying a window-head or a sill balanced on their shoulders, using both hands to grasp the sides... of the ladders.' All of the work was done by hand tools. House carpenters would have an elaborate set of them, which it could take them an hour or two to grind. Others were simpler: the slater worked with an all-purpose hatchet, pointed at one end, called a 'zax', the gas-fitter with soldering-irons and a blow-pipe, the bell-hanger with a pair of combination pliers which in the 1880s could be bought for as little as 2s. 4d.

Despite the existence of a few large contractors, such as Thomas Cubitt in London, and Johnson of Manchester (the man whose home was blown up by the local brickmakers in 1870), domestic housebuilding fell very largely within the province of the small master economy, with jobbing men acting as subcontractors for portions of the work, or venturing into business on their own. Often the master would be an enterprising carpenter with nothing to lose by failure except a return to the journeyman's ranks, or a man out of work for whom starting up as a 'capitalist' was an alternative to unemployment. 'A £5 note and plenty of cheek' was said in the 1880s to be enough for a man to set up on his own. The plumbing and the slating could be farmed out, the scaffolding hired, the raw materials obtained on tick (the initial load of bricks had to be paid for on the nail, but the cash for that could be borrowed). Rowland Kenney has left a good example of a job like this which he took on, together with a mate, in the 1890s.

Fred learned of a possible job at Standish, a few miles the other side of Wigan. A small local contractor had been offered the job of building a couple of cottages... a considerable cut above the small places in which most of the local miners lived. The 'contractor' was a joiner who had the sense to see that there was going to be some building development in the neighbourhood, and that he would do better contracting than following his trade as a journeyman joiner; but he had no knowledge of bricklaying... It suited him better to sub-let the bricklaying part of the job, and here was where I could perhaps be useful. I was 'quick' at figures and Fred was not; so the suggestion was that he should contract to do the brickwork at so much a square yard. I should be labourer, and also do the measuring up and generally act as clerk of the works. As occasion served I was gradually to take over trowel. We had visions of becoming masters instead of men, and tramping and roughing it seemed likely to be things of the past for me. The scheme did not work out well at all. Whether we had taken the job too cheaply I do not know – the amount Fred had asked per square yard struck me at the time as remarkably small... he had been very reassuring when I questioned about it... but the job never paid even full wages.
E. Building Materials

In the building materials industry, as in building work, increased activity was not matched by technical change. Of the major building materials only wood was seriously affected by machinery, and its influence – for reasons which will be indicated later – was definitely limited. Window-glass was hand-blown at the furnaces, window fittings and door furniture (in ways which will be described in a subsequent article) were hand-hammered at the forge. Builder's lime, the chief ingredient of stuccos and mortar, was reduced to powder at hand-charged furnaces; builder's sand was dug by spade. Cement technology was a bit more advanced, with clays being washed in a mill, but most of the work seems to have involved heavy digging, lifting and carrying, in dismal conditions (at Harwich in 1849 some 500 people were apparently engaged at dredging the harbour to get stones for a local cement works).

Except for marble (extensively used in the manufacture of chimney pieces) almost every class of builder's stone was hand-dressed. Aberdeen granite, a popular architect's embellishment for the more imposing class of shop-front, was both shaped and polished by hand, with emery paper to produce the final gloss when the surface had been smoothed. The hearthstone raised at Godstone, Surrey, was hewn into shape by a peculiar double-headed axe. The window sills and doorsteps manufactured on the Isle of Purbeck, and exported by stone boat to the southern English towns, were shaped by mallet and chisel. Slate, which in the third quarter of the nineteenth century largely displaced tiles as roofing materials, were both hewn and shaped by hand, principally in the slate quarries of Bethesda and Dinorwic. Each slate had to be individually treated, according to the peculiarity of the rock. 'The splitter, the real aristocrat of the quarry craft, had to be able to tell at a glance what size and quality ... he could coax out of a particular block ... to glance at a slab and recognize ... posts, crychs, bends, sparry veins, faults, joints and hardened rock.'

Bricks, like slates, were individually hand-made, though manufactured in prodigious quantities (150 million a year, for instance, on the great Cowley brickfield, which stretched from Southall to Slough). The work, which was sometimes undertaken by family groups or gangs, sometimes sub-contracted, was dirty and laborious, and involved a whole series of exhausting tasks, from the clay digging of the autumn and winter months to the setting of the clamps or kilns (20,000 bricks was an average firing in the 1850s). Stones were picked from the clay by hand, and the puddling or tempering, which reduced the clay to plasticity, depended on bodily weight, the clay being turned over repeatedly by the spade, mixed with water, and then trodden underfoot: the labourers who did this (sometimes horses, sometimes men, sometimes children) were said to develop 'puggers' feet' from the sensitivity with which they could detect the slightest intrusive pebble. Moulders, too, worked in close physical proximity to the clay, pressing their bricks into shape with rapidly working fingers, and taking off surplus pieces with a scraper, or dextrous flicks of the thumb ('wrist-up' or 'lack of joint oil', according to a Chesham brickmaker, was an occupational hazard, 'if you started off too rash'). Numbers of different machines were projected to streamline the work – in 1856 over 230 patents were in existence for machine-moulding alone – but down to the 1880s (and in the southern brickfields a good deal longer) most of them came to grief, either because of the obduracy of the raw materials (London clays were particularly unyielding) or...
because of the inferiority of the finished product. Only the pug-mill, a horse-ginned mixer, was widely adopted, but it was too expensive for the smaller yards, and in the 1870s there were still many districts where it was comparatively rare. ‘Pug mills are not general in Essex and Suffolk’, Factory Inspector Lakeman reported in 1872, ‘the earth is trodden by children who are kept at work tempering a heap of clay from morning to night’. 121

The ingredients of the brick were also got by hand. In London they were drawn from a wide hinterland, though the clay itself was dug on site. Lime, which the moulder used to bind his clay together, came from places like the Merstham limeworks, Surrey. 122 Sand, sprinkled on the inside of the moulds to prevent the clay from sticking, was dredged from the river Thames at Woolwich, spread out thinly to dry, and repeatedly raked over ‘so as to expose every particle in succession to the sun’s rays’. 123 Ashes, ‘thoroughly incorporated’ with the brick earth while the clay was being puddled, both to prevent the warping of the bricks while they were drying, and to assist in their colouring when burnt, 124 came from the great metropolitan dust heaps at places like Paddington Basin. So did the ‘breeze’ or cinders which the brickmakers used as fuel (the larger suburban makers would order as many as 155,000 chaldrons at a time). Sifting the dust for ‘breeze’ was a woman’s occupation in mid-Victorian London, paid for at a rate of 1s. a day plus a perquisite of cinders. The ‘hill women’ who performed the work had the job of sorting out the cinders according to their respective size (the larger ones were reserved for the laundries), making separate piles for the different classes of debris (linen rags went to the papermakers, woollen ones to the shoddy mills of the West Riding), and heaping up the ashes and the ‘breeze’. They were armed with large iron sieves which they held waist-high and riddled, while the men threw up the stuff. 125

Painter’s colours were produced in even more barbarous conditions — those of the Victorian lead works, the most poisonous, perhaps, of all the ‘dangerous’ trades. 126 Paint was a standard product used in great quantities. It should have been a prime candidate for self-acting machinery, especially in view of the known dangers of lead-colic and ‘drop-hand’. But in fact, machinery was only used for crushing and grinding — in most factories all the other processes were done by hand. The women who did the stacking (men, it seems, could not be found to do the work because it had such a bad name) had to carry heavy pots of lead on their heads, from 30 to 50 lbs in weight, and to climb ladders from 10 to 15 feet high. They did the work, as a Newcastle manufacturer gratefully acknowledged, with ‘truly marvellous skill and rapidity’. Lifts were installed in place of ladders at a leading Glasgow works, partly to save the women fatigue, and also because it was ‘upon all accounts . . . a very much more respectable way of doing it than going up ladders for women’. But the Newcastle manufacturers refused to follow suit, partly, it seems, on grounds of productivity, and partly on that of cost (‘ladders would be, perhaps . . . less expensive . . . because they last a long time, and it is not like machinery that wants to be put in order . . . I think we could fill a stack almost as rapidly by ladders as with the hoist’). The puddling and firing of the lead, to reduce it to powder, also involved a more or less continuous risk of poison. Mechanical stoves had been invented to take on portions of this work, but manufacturers in 1893 were still making little use of them, both on grounds of quality (‘there was a prejudice in the trade as to the lumps’) and also on grounds of cost. ‘No perfectly satisfactory mechanical stove
has yet been devised, and their very high price is also a bar to their general introduction'.

F. Glass and Pottery
Manufacturing in other classes of mineral work was as labour-intensive as it was in lead or bricks, though demanding varying degrees of athletic strength and skill. In chemicals the crucial operations were performed by men with long iron rods stirring vats, and furnacemen sifting the powder in kilns. In saltmaking the lumpers, who had the making of the finer class of salt, worked as high-speed rakers over boiling pans of brine. In glassmaking everything was made by hand, whether it was destined for the sideboards of the aristocracy, the shelves of the pharmacist, or the counter of a back-street bar. Even in glass bottlemaking, a manufacture for the millions, every item was individually made, the gatherer taking the 'metal' from the furnace at the end of an iron rod, the blower shaping the body of the bottle with his breath, while the maker who finished the bottle off ('the most difficult task') tooled the neck with a light, spring-handled pair of tongs. Glassmaking was a factory industry in which, however, as late as 1895, 'no machinery' had been applied at all, in spite of the vast proliferation of its products. The glassblower's tools were few and simple, indeed the fewer he used the better so far as the quality of the work was concerned: 'the more these shape the article, the more imperfections are likely to be produced by the scratching and rubbing of the irons'. The chief instrument of production was an iron blow-pipe - 4 or 5ft. long, and with a slightly enlarged nose at the end. In bottlemaking the glass was gently rubbed against a small metal plate known as a 'marver' or blown into a mould; in window glass rolling, the sheets were first blown up into cylinders and then flattened on a rolling table, 'a cast-iron slab of sufficient size to accommodate the largest sheet which has to be rolled'.

Sheet or 'cylinder' glass, the great innovation of early Victorian times (it was first introduced to this country by Messrs. Chance Brothers of Smethwick in 1838), cheapened production by making it possible to use inferior sands in the mix, and brought a whole new trade in window glass. But it owed everything to skilled workmanship, nothing at all to plant. On the part of the blower, swinging and rotating a molten mass of glass, it required both delicacy and strength, delicacy to prevent the glass being mis-shapen or marked, as it swelled on the end of his blow pipe, strength to blow with sufficient force to make a six-foot cylinder. The sixteen acres of glass which covered Mr. Paxton's 'Palace of Industry' were blown into shape in this way, and there is a vivid description of it by George Dodd, written after visiting Messrs. Chances' works at Smethwick:

The workman takes up, on the end of his iron tube, a large mass of glass, and whirls it about in an extraordinary way. He swings it round in a vertical circle, blows into it, swings it again, rolls it, until at length it protrudes beyond the end of the tube, as a cylinder, perhaps four feet long by ten inches in diameter. This cylinder is easily opened at the two ends and detached from the tube. A hot iron wire severs it in a line from end to end; and the cylinder by careful heating and running, opens out into a square sheet, flat, but slightly wrinkled on the surface.

Glass finishing — i.e. ornamentation and polishing — was also a handicraft work, though steam power was applied to the turning wheels. It was a distinct class of labour, carried on for the most part in separate establishments and had more of both drudgery and art than glassblowing. In the best class of ware, such
as wine decanters or cut-glass chandeliers, the worker was his own designer, shaping the vessel on the wheel. Accuracy of eye and steadiness of hand were indispensable. ‘Those arabesques, stars, running lines, vandykes, and often intricate traces which appear on the most costly glass fittings... are produced... without any previous drawing... the workman, holding the glass in his hands, with no more indication of the pattern than two or three pencilmarks dividing the globe or plate, grinds out the pattern on a wheel of Craig Leith stone, guiding the brittle material by eye and hand with a precision and rapidity perfectly marvellous’. In the cheaper classes of ware, such as hall lamps for boarding houses, or frosted glass for pubs, much of the work was done by women, pressing palmfuls of wire and sand against the globes. Polishers, who made the dull surface bright, rubbed it up with pumice stone, and then gave it a finishing sheen with jeweller’s rouge or putty. This was largely women’s and children’s work, and involved a series of processes that were wet, monotonous, and, in the case of the puttying, poisonous, since the putty was made of lead. (Puttying was especially a feature of high class work, and was used to bring out the fine gloss and white colour ‘so much admired in cut glass of the most expensive qualities...').

Despite the absence of mechanisation, glassmaking was subject to a whole series of developments which cheapened production and led to a proliferation of new lines. One important influence was the removal of the Excise Duty in 1845, which led to a great burst of activity – the bottle manufacture is said to have increased fourfold in the following twenty years, while the population of Castleford, a new Yorkshire centre of the industry, increased from 2,000 to 10,000 in the same period. Another was the introduction of the Siemens tank furnace, which allowed for a much more continuous working than the clay pots it displaced, as well as bringing substantial economies in fuel. Then there was the development of new types of commodity, such as the stained glass windows fostered by Ritualism and the Gothic Revival. In the flint glass trade the most striking improvements were in what an 1866 commentator described as its ‘artistic’ development – the adoption of engraving as a method of ornamentation, the introduction of coloured glass and the use of new decorative processes, such as embossing. None of these changes affected the basic technology of work. The blowpipe, ‘invented sometime during the three centuries preceding the Christian Era’, remained the fundamental tool in every class of manufacture except for pressed glass.

The manufacture of china-ware and crockery presents an even more striking instance than glassmaking of mass production on the basis of hand technology. In spite of the early appearance of a factory system (pioneered in the 1760s and 1770s by Josiah Wedgwood), and an intense development of the industry in North Staffordshire, a very simple technology prevailed – ‘the same essential technology'
appliances as were used in Egypt four thousand years ago'. 'There are none of the noisome adjuncts and deafening sounds of the huge cotton or woollen factory, where hundreds of hands are working together, and have to feed the gigantic machinery which dwarfs them all', an American visitor to the Potteries wrote in 1871, '... There are a large number of rooms, and only a few operatives in each. Each potter works independently'. In the 1870s machinery, in the form of steam-powered 'jiggers' and 'jollies', was slowly making its way. But it advanced faster in the out-potteries, such as those of Glasgow and Newcastle-upon-Tyne, than in the hinterland of the industry, at least partly, it seems, because of the strength of the workers' opposition. In 1889 its impact was still sufficiently limited for a Factory Inspector to report that 'by far the larger number of china manufacturers do not employ steam power'.

Pottery work was very physical, and involved, in every department of production, a more or less continuous personal handling of the clay. The thrower shaped his ware on the wheel 'by the exquisitely fine touches of... thumb... finger and palm'. He had to keep his hands constantly wet 'so as to mould the clay with the least possible friction'. So did the handlemakers. 'The operator... gives it the required shape... with no other tools than his wet fingers, a drop of adhesive liquid, and a moist sponge.'* Platemakers worked in a similar way, except that the final shape of their ware depended on flicks of the wrist. Dippers prepared the ware for firing by steeping it in a glaze tub. 'The right hand and arm... are plunged nearly up to the elbow as he passes the piece of ware through the liquid... Then with a rapid circular movement of the hand... a movement that only years of practice can teach... he makes the glaze flow thin and even over the surface, and shakes off what is superfluous'.

Motive power in the Potteries, such as it was, also depended on the human body. The thrower's wheel was turned by a 'bailer' ('generally a female') whom he employed full-time to keep the wheel on the go, and feed him with small lumps of clay.† The turner's wheel was kept moving by a lathe-treader, again a woman, who was paid (in the 1890s) 4d. for every is. that he earned.‡ She rested the weight of her body on the left foot while turning the wheel with her right—Dr. Arlidge described her work in 1878 as a sort of 'perpetual jumping on one foot'.‡ Platemakers also had a wheel turner, though in their case boys were employed rather than women or girls.‡‡ Attempts to introduce steam to these departments of the work were bitterly resisted by the operatives, and also found little favour with the Staffordshire manufacturers, '... With steam it was difficult to regulate the different speeds required', Clara Collet was told in 1893, when enquiring into this particular branch of women's employment.

G. Leather Trades
In the leather trades, every process of production, from the preparatory work to the finishing, depended on manual dexterity and strength. The industry employed some quarter of a million people in the 1830s and McCulloch, in his

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Statistical Account of 1837, estimated it as third or fourth in the kingdom, ‘inferior only . . . to . . . cotton, wool, and iron’. But then and down to a much later date the peculiar nature of its raw material seemed to make it impervious to the machine. ‘I do not think you will ever get machinery into our trade’, a clicker told the Royal Commission on Labour in 1892, ‘until you can grow all the animals of one size with just the same blemishes’. Tanning (the preparation of leather from raw hides) was a dirty business, and for the yardsmen who had the job of lugging heavy animal carcasses in and out of pits, it was also a wet one, which needed a strong constitution (in Bermondsey, Mayhew tells us, the majority were Irish). The hide took a tremendous beating when it was not soaking in the pits. The flesher and the unhairer slashed away at it with their pokes and knives, the shedman pummelled it with a double-headed stave, while at the end of the process the creases were taken out of the leather by a triangular steel pin, with a labourer’s weight behind it. Tanning was a protracted process, though the period varied according to the stoutness of the hide, and the manufacture for which it was destined: in the case of sole leather it could take a year or more to complete. Patent improvements abridged the period of the work (‘almost every tanner has some process peculiar to his establishment’) but they did not alter its essential character. Even in such a large tannery as the Avonside works of Messrs. Evans, ‘the most modern and complete’ in the Bristol region, according to the Boot and Shoe Trade Journal in 1887, it took more than twelve months for a hide to progress through the successive stages of its treatment. The firm used a Tangye pump for pumping water; there was a machine for grinding bark; and there were three boilers, though more than one was rarely used at a time. But beyond these the sound of machinery was ‘scarcely heard’.

Currying — i.e. the softening up of leather for saddlery, coach linings and shoes — was classed as a superior trade, but it required a labourer’s strength to perform it, as well as an artisan skill. ‘Shaving’ for example, ‘the most difficult part of the work, which none but the best workmen can perform’, involved long heavy strokes with the knife — ‘driven with great force’ from the top to the bottom of the beam — while the rest of the worker’s strength was devoted to keeping the hide in place by the weight and pressure of his knees. As in the case of tanning there was a great deal of pummelling and slashing away with knives, though the more delicate nature of the material required a greater care: ‘The unskilful currier is constantly liable to injure the leather by cutting through it, as well as by failing to produce a regular substance’.146

In the manufacturing branches of leatherwork, machinery was hardly more in evidence than it was in tanning and currying. In gloving ‘getting . . . the stretch of the leather’ was the great point, and the finer and more flexible the leather, the more individual care and attention was needed. Yeovil, Torrington, Worcester and Woodstock were the centres of the trade, which largely depended on outwork. The delicate work of cutting out — ‘anything but . . . mechanical’ — was done on the master’s premises, the rest of the work was farmed out. In Worcester, where the famous ‘dogskin’ glove was made, the fingers and thumbs went to women in the villages, while the back and ‘topping’ went to outworking sewers in town. Saddlery and harness were hand-stitched down to the 1870s, and workers in the trade enjoyed a large measure of self-government; many worked at home, and those who worked on the master’s premises elected their own shop constable to govern workshop affairs, and owned their own tools. In
Walsall, which established itself as the centre of the trade in the third quarter of the century, the sewing machine was introduced to the work in the 1870s, but as late as 1898 W. J. Gordon could describe saddle-making there as ‘a genuine trade of the old sort... all handwork’. In London the introduction of the sewing machine was bitterly and successfully resisted. ‘Through the saddlers’ windows’, wrote Japp in *Industrial Curiosities* (1880):

We still see sturdy men slowly stitching away like so many women; and on inquiry we find it asserted that the machine cannot produce sufficiently strong work. Now that waxed-thread machines are common this is a peculiar excuse. All the harness used in the United States is machine-made, even that employed in the artillery, consequently it cannot be said that it will not stand wear and tear. Saddlers and harness-makers are, as a trade, conservative, and obtain very high prices for their present work, and what keeps the machine at arm’s length is the fear of strikes and the lowering of prices.

Boot and shoemaking, though much less aristocratic than saddlery (London saddlers liked to refer to themselves as ‘gentlemen stitchers’) was also, at mid-century, entirely a hand-sewn trade, with vast numbers of men, women and children engaged at it, mostly as domestic outworkers. The industry was revolutionised not by machinery (which did not begin to appear until the 1860s), but by the increasingly elaborate sub-division of labour, and by the rise of wholesale manufacturing. In Northampton, the first great centre of the wholesale trade, the ‘factories’ of the 1840s and 1850s were little more than putting-out stations - warehouses in which the skins were cut, and the finished parts received on the various stages of their progress through production. Not until the 1870s did anything like a modern factory system begin to appear, and not until the great strike of 1895 was its predominance ratified.

**H. Woodworkers**

In wood, as in leather, the variability of the raw material, and the delicacy, in many cases, of the finished product, made mechanisation problematical, and, as in the case of shoemaking, there was a superabundance of labour ready to take up new openings on the basis of handicraft skill. Economic growth took place almost independently of the machine. Steam-power was applied at the saw mills, turning timber into deals, or slicing them up thinly as veneers. And in the 1860s and 1870s steam joineries began to appear, supplying ready-made mouldings and parts. But woodworkers themselves, with the exception of the sawyers, were only indirectly affected by these changes.

In country districts, remote from the steam-powered saw mills, timber still came to the workshops rough from the woodman’s axe; and down to the end of the century the saw-pit remained an inescapable adjunct of the work at the wheelwright’s shop or the carpenter and joiner’s. At Haddenham, in Buckinghamshire, the village carpenter in the 1880s purchased standing trees, cut them down, and stored them in the yard for twelve months. ‘Then the sides of the logs were trimmed with the axe and afterwards rolled on the saw-pit to be sawn by hand into boards or planks’. At Codnor, Derbyshire, in the carpenter’s shop where Joseph Severn began his apprenticeship in 1877, there was a circular saw ‘ginned by a horse’, but all the rest of the work was done by hand. ‘The first thing... was to learn to plane and saw well... to sharpen planes, saws and chisels, and... to saw straightly long planks nine or eleven by three into spars and scantling.’ The wheelwright’s shop at Farnham, Surrey, where George Sturt began work some seven years later, had even less in the way of plant:
The want of machinery was most evident in the daily task of cutting up plank or board for other work, and of planing and mortising afterwards. We had neither band-saw nor circular saw. Most of the felloes were shaped by adze or axe; the pieces for barrow-wheel felloes were clamped to a woodman’s bench (they were too short and small for an axe), and sawed out there by a boy with a frame-saw. (I hated the job – it was at once lonely and laborious); the heavy boards were cut out (and edged up) with a hand-saw, being held down on the trestles with your knee (it was no joke to cut a set of one-inch elm boards – for a waggon-bottom – your arm knew about it), but all the timbers for framework of waggon or cart, or harrow or plough or wheelbarrow, were cut out by two men on a saw-pit.

The influence of machinery was greater than this in the towns, but the ‘Mechanical Joiner’, exhibited at the Crystal Palace in 1851, proved as phantasmagoric in real life as that later creature of the capitalist imagination, hopefully publicised in the Builders’ Trade Circular for 1862, ‘the self-acting Trowel’. Saw mills did not abolish the need for the hand-saw (the Sheffield manufacture of them was never more flourishing than in mid-Victorian times, when the grinders held the masters in their thrall) nor planing-machines the plane. They could supply the rougher classes of deal, such as flooring boards, railway sleepers, and ships’ timbers. But their action was too crude for many hard woods and too indiscriminate for the different lengths, breadths and thicknesses required in, say, the making of a writing desk, the framing of a roof, or the fitting of a steam-ship cabin. What such machinery did do was to provide a much broader base for handicraft activity by cheapening the raw materials of the trade. The case of machine-cut veneers, one of the earliest and most brilliant successes of 19th century timber technology, is particularly striking. It robbed the sawyers of what had been by far the most skilled and paying branch of their trade. But at the same time it helped to produce a vast proliferation of activity in furniture making, especially at the ‘slop’ or lower-priced end of the trade. It encouraged the wholesalers and dealers – the ‘slaughterhouse’ men who bought the cabinet-makers’ work – to extend the influence of novelty and fashion to new, more plebeian markets, and brought highly-polished furniture within the reach of the comparatively impecunious (by the early 1870s, there were numerous complaints in the capitalist press of miners buying pianos). The process was already apparent in Mayhew’s time, though it was not perhaps until the closing years of the century that its effects were universally felt. ‘I think that machinery has been a benefit to us’, a fancy cabinet-maker told Mayhew, ‘it increases the material for our work. If there wasn’t so much veneering, there wouldn’t be so much fancy cabinet-work’.

In the third quarter of the nineteenth century a number of machine tools were introduced into the woodworking trades, but though they speeded up portions of the work, they did not dispense with the need for either hand tools or handicraft skills. The application of steam power to the turner’s lathe, for instance, enabled a man to produce double the quantity of work in the same time as when the lathe had been turned by hand, but it was still the turner who guided the lathe rather than vice-versa: ‘Steam... is only used... as the motive power, for a man must still be employed to “turn”’. Similarly in the case of the band-saw, a treadle-worked machine which was very widely adopted in the East End cabinet-making trade, the work of cutting out depended on the versatility of man rather than of the machine which served his purposes – indeed the machine was so constructed that it could be handled almost as dextrously as if it had been a chisel or a plane.

The secular shift from wood to iron represented a more serious threat to the
woodworkers' position, but in mid-Victorian times its effects were masked by the growth in the overall volume of work. In factory industry woodworkers found a place as coachmakers and body-builders in the railway works, patternmakers in the foundries, and coopers in the chemical works and breweries. In the shipyards, in spite of the coming of the iron steamship — or because of it — the number of shipwrights recorded in the census increased from 27,805 in 1851 to 70,517 in 1891. In furniture-making the third quarter of the century saw the advent of cheap mass production, though on the basis of hand labour rather than the machine. Windsor chairs, the new staple trade of High Wycombe, were being turned out in the 1860s at the rate of one a minute 'all the year round'; Kentish Town pianos serviced the musical needs of both shabby-genteel and the newly-respectable, while in the East End of London there was a whole new industry of one-room cabinet-makers, using ramshackle materials and highly-polished veneers.

One sign of their handicraft status was that so many woodworkers owned their own means of production. The coopers, in Mayhew's time, found all their tools themselves — 'a kit for a general workman being worth £12' — except for the jointers to weld the staves. A London cooper, who started work in 1912, remembers that those who went on tramp to take part in the cider-making in the Vale of Evesham, or the herring harvest at Great Yarmouth, would leave the heavier tools in the shop, and travel with a hammer and driver, 'a knife or two', and an adze. The value of a good cabinet-maker's chest of tools was reckoned at between £10 and £20 in 1853 Edinburgh. In London at the same time it was stated by Mayhew to be about £10, but less in the more specialist branches of the trade, where the tools were lighter: a buhl-cutter's tools ('very small and niggling') cost £5 to assemble, the wood-carver's about the same. The garret-makers in the slop end of the trade would make their kit up second-hand, and Mayhew has a fine account of the makeshift way it would be assembled:

The tools are generally collected by degrees, and often in the last year of apprenticeship, out of the boy's earnings. They are seldom bought 'first-hand', but at the marine store shops, or at the second-hand furniture broker's, in such places as the New Cut The purchaser grinds and sharpens them at any friendly workman's, where he can meet with the loan of a grindstone, and puts new handles to them himself, out of pieces of waste wood; 1 os., or even 5s., thus invested has started a man with tools; while 20s. has accomplished it in what was considered 'good style'. Old chisels may be bought from id. or 1½d. to 2d.; planing irons from id or 1½d. to 3d.; hammer heads from 1d. to 3d.; saws, from 1s. to 2s 6d., and rules and other tools equally low.

The carpenter and joiner's tools — inscribed with his name — served him as a very title to employment, when he moved from job to job, and also as his means of production when he was forced to set up on his own. They cost a great deal to assemble, and their loss through theft or fire was a personal tragedy. 'Tool benefit' was one of the chief provisions of the Amalgamated Society of Carpenters and Joiners, as it was of other trade unions in the woodworking trade; and the detection of tool-stealing offences seems to have been a recurring preoccupation of the local branches, to judge by the notices they sent up for printing in the Society's Monthly report.*

In factory industry, too, woodworkers characteristically owned their own means of production. A patternmaker's tools cost (in 1884) between £8 and £16 to assemble, and about 6d. a week to keep in repair. They would be insured

* For reasons of space, examples have been eliminated.
with the trade union and jealously guarded against misuse.\textsuperscript{162} The young apprentice was advised to respect them. ‘A patternmaker’s tools are idols’, wrote a Liverpool engineer in 1878: \textsuperscript{163} ‘and one of the first duties the tyro must learn is, to return all tools to their owners properly sharpened and ready for immediate use, and above all things, he should be careful not to leave them kicking about his bench after having made use of them . . .’.

1. Metallurgy

In metallurgy steam power was massively harnessed to the primary processes of production, notably in puddling and rolling; but at the same time new fields were opened up for handicraft skills. In foundry work machine moulding was introduced in the 1850s (during the lock-out of 1852 some engineering employers fondly believed that it would deliver them from their men),\textsuperscript{164} but it remained confined to the most inferior branches of the trade, such as the making of cast-iron drain-pipes.\textsuperscript{165} Moulders – ‘the wildest, the most grimy, the most independent, and, unfortunately, the most drunken and troublesome of any English workmen who have any claim to the title of “skilled”’\textsuperscript{166} – were virtually untouched by it and for the most part worked with the very simplest of tools, whilst their brethren, the dressers, smoothed the rough castings with hand-files.\textsuperscript{167} The Friendly Society of Iron-moulders was composed uniquely of handicraft workers right down to the 1900s and (as employers complained) maintained a high rate of wages, restrictive shop practices, and unsleeping hostility to the machine-based class of worker.\textsuperscript{168}

Engineering, though less severe than foundry work, was a heavier kind of labour than it is to-day, as well as one which demanded much more versatile skills. To begin with it involved working very largely with iron, which was much more difficult to shape than the high speed steel and light alloys of twentieth century engineering. The smith who had the forging of it was engaged in a muscle-hardening work, and one that was no less pivotal to production than it was at a country blacksmith’s. Fitting was almost entirely done by hand. It involved the making of parts rather than the mere assembly of them – a protracted process of chipping and smoothing at the bench with no more sophisticated mechanical aid than a sharp-edged chisel and file.\textsuperscript{169} In the 1860s production engineering was still in its infancy, and the system of manufacture by interchangeable parts, introduced from the United States at the time of the Crimean War, was for the most part confined to the making of sewing machines and small arms. Engineering firms, large and small, went in for a variety of different products rather than limiting themselves to standardised lines, and much of their work was ‘bespoke’ – carried out according to customer specifications and requirements.\textsuperscript{169} In the heavier classes of work, steam power was applied to the coarse, preparatory stages of production – rolling, stamping and cutting out – but most of the precision work was still hand-tooled, whether by smiths, fitters or turners. At the St. Pancras Ironworks where Wal Hannington worked as a boy, making spiral staircases, the iron handrails were bent in a rolling mill, but the shaping of the finished curvature depended on hand-hammered work of an exceedingly laborious kind:\textsuperscript{170}
fitted to an anvil, whilst he held the form block in one hand against the rail and struck it with a weighty club-hammer to get the required bend. It was a crude, old-fashioned trial-and-error method, requiring much hammering before the correct shape was obtained. Holding the curved rail... on the V-block was not as simple as it would appear to be. The correct position was for it to rest evenly on both crowns of the block at the moment the hammer struck it. But if I moved slightly and the rail was a fraction of an inch off one crown the amount of error would be multiplied by the length at which I was holding it and I would get the shock of the hammer blow in my hands and arms. I was always in fear of that happening and when it did I suffered. But my distress never evoked any sympathy from the foreman, on the contrary, he always abused me with the foulest language.

The mid-Victorian engineer was still characteristically a craftsman, an 'artisan' or a 'mechanic' rather than an 'operative' or 'hand'. He was engaged for the most part in speciality work, in which precision was more important than rapidity. He moved freely about the work-place – too freely, according to his critics, who would have preferred to tie him down in one place. He was expected to find his own tools (often he made them), and keep them in good fettle by grinding and sharpening them himself. In a small workshop, the most frequent form of enterprise in the 1850s and 1860s, he would turn his hand to a variety of different tasks, working sometimes at the forge, sometimes at the bench, sometimes on outside jobs. Even in a larger works he would often have to improvise the materials for a job, cutting extra tools and accessories, finding additional jigs, and acting as his own draughtsman and designer. He would also regulate, in some degree, his own work pace (opposition to piecework was a cardinal tenet of the Amalgamated Society of Engineers, defended in some notable strikes). Machine tools were increasingly introduced from the 1840s, but they were very far from automatic, and did not dispense with the need for a keen eye, a steady hand, and an ability to work to fine limits. Fitters, the most numerous class of engineer, were largely unaffected by them. In turners' work, steam power was applied to the lathe, at least in the larger works, and Nasmyth slide-rests attached to them, but it was still the worker who guided the tool rather than the other way round – accuracy and speed depended on personal judgement rather than pre-set chucks or jigs. Not until the technical innovations of the 1890s did the 'machine question' (bitterly fought out in the lock-out of 1896-7) begin to pose a fundamental threat to craftsmanly skills.

Machinery, the chief object of mid-Victorian engineering activity, was built up very largely from hand-made components, all of them requiring individual attention, whether at the foundry where components were cast, at the smithy where they were forged, or at the bench where they were chipped and filed into serviceable parts. It was all precision work, much of it being undertaken to order, and mounted or fitted up on site. A first class reputation was much more important than cheapness, whether for the 'general' engineer or 'jobbing' foundry, servicing local customers, or the manufacturer of specialist machinery exported to the markets of the world. The majority of workers at a machine-builders were artisans, though with a complement of boy labourers and apprentices to take on the more routine drudgeries. Messrs. Platt Brothers, Oldham, the leading manufacturers of textile machinery, were employing some 10,000 workers in the 1890s, and almost every one of them, according to Paul de Rousiers, was skilled.

The work done there is of an extremely delicate and technical kind, and the mounting of the looms in particular requires great care and the most exact finish in all the component parts. Every workman is a specialist. A significant fact in proof of this is that not a single woman is employed by the firm... There is no room for occasional hands or casuals, who take up any
sort of work to-day to drop it for something else tomorrow. Every workman must be a master of his business. Except the porters, who are superseded as far as possible by lifts and locomotives, almost every individual employed by the firm is a skilled workman.

Locomotive engineering, like machine building, was precision work which was simultaneously delicate and exacting. A single locomotive was said in 1852 to contain no fewer than 5,416 separate components, 'and it will readily be conceived that nothing short of the utmost completeness and accuracy, in the finish of these parts, could enable the workmen to combine them in one harmonious and efficient unity... The failure of one screw or bolt, or the bending of one rod, may hereafter involve, not only the costly fabric itself in ruin, but occasion the destruction of property and life to a terrible extent'.179 Hand tools were an indispensable condition of production. The worker would own a chest of them himself; and he would also have access to the 'shop tools' provided by the management.180 At the G.W.R. works, Swindon, in 1852, there were two Nasmyth steam hammers to shape the heavier metals, but no fewer than 176 smith's hearths where the smaller components were forged – axles, piston-rods 'and other pieces too numerous to mention'.181 At Crewe in 1894 – the locomotive engine works of the London and North Western Railway – the smaller parts of the engines were forged at 120 smith's hearths. At the Wolverton works of the London and Birmingham railway there was practically no machinery at all when Hugh Stowell Brown went to work there in the 1840s. All the forging was done by hand ('it was a fine sight to see seven or eight stalwart strikers, at the forging of a crank-axle, plant their huge hammers in rapid succession upon the spot indicated by the smith with a piece of rivet rod iron'). There was no travelling drill ('all keyways had to be first drilled in round holes, and then cut out with a cross-cut chisel, and finished with the file'), and no shaping machine of any account save a machine for cutting nuts.182

Every surface that could not be formed by the planing-machine had to be chipped and filed... Yet there were men who could do wonderfully true work. I have seen a fitter take two rough pieces of wrought iron of more than one pound weight each. I have seen him chip them to a surface almost perfectly smooth, and then with files so perfect the surface that when placed one upon the other the lower piece would hang to the upper by the force of molecular attraction, as if glued to it.

In marine engineering – one of the foundations of Britain's trading supremacy, as well as an important focus for mid-Victorian capital investment – skill was no less at a premium than it was in a railway factory. In a highly competitive market, the reputation of a firm depended not on speed but on quality workmanship and attention to customer needs. Bespoke work was the norm, since every ship had to be individually suited, and it seems to have affected the manufacturers of components in much the same way as the marine engineers themselves. Lockwood and Carlisle of Sheffield, for instance, whose patent piston rings were adopted by some of the leading Clyde shipbuilders, met all their orders in the 1880s with a work force of about a dozen craftsmen: they would work up to 75 hours a week when a new order came in. 'Most of the orders... reflected the views of designers of ships' engines... Each had to be made individually'.183 As in other classes of heavy engineering, the work was both laborious and skilled. Here is an account of it by one who served his apprenticeship on Clydeside in the 1880s, working for a firm which he describes as 'the greatest marine engine works in the world':184
The most powerful engines which have ever been made were then under construction in the works... They were enormous things, and they stood fifty-four feet high when they were finished. Machine tools were not nearly so accurate then as they are now, and nearly everything had to be finished by hand. Bolts weighing over a hundredweight were not uncommon, and these were all fitted in place. It was hard work lifting these monsters all day long and driving them in and then driving them back and scraping them until they fitted perfectly. My wrists used to ache at night and my ribs were sore with swinging the big hammer. These hammers were known as 'mondays' and they weighed forty-two pounds. There was a certain amount of skill required to get in the full force of the blow, and unfortunately for me it was discovered that I had this knack. At first I was flattered when the foreman took me away from my work to knock out a bolt with a monday hammer, but it was a dearly bought pleasure and very exhausting.

Steam boilers - the high-pressure engines which gave life to machinery and put railway trains and steamships on the move - were in the 1850s almost entirely hand-made. Some of the work, such as plating, remained beyond machinery's reach because of the intricacy or peculiarity of the parts; other parts resisted it because hand labour was more adaptable and precise. The plates which gave the boilers their jackets were punched out by machinery, but they had to be forged and welded at the hearth and they were then subjected to a tremendous hammering to make them both ductile and strong, to bend them to the right shape and to bring them to the right density. The joints were made steam-tight by a succession of blows with the sledge-hammer. Hydraulic riveting was introduced in the 1850s, but it made slow progress because it was considered much less trustworthy than hand-hammered work. In the G.W.R. factory at Swindon, the premier locomotive plant in the kingdom, the preference for hand-hammered work continued right down to 1914: 'very little is left to the chance work of the machine, which is often faulty and unreliable. Rivets put in by hand are far more trustworthy'.

There was a great deal of hand riveting in iron shipbuilding too, despite the massive concentration of capital and ownership. In 1884, according to Pollock's *Modern Shipbuilding* published in that year, hydraulic riveting was general in interior work, but shell plating - i.e. the ship's water-tight covering - was still riveted by hand. In 1905, according to a later work by the same writer, the situation had not changed: 'Probably a complete solution of the shell-riveting problem is not now far distant, but meantime the binding of the shell to the ship's framework is mostly accomplished by the old and laborious way by the "hand-and-hammer" of the craftsman'. Hand riveting was also widely employed in constructional engineering, and indeed in every class of wrought-iron work where there were metal plates to be joined. The Britannia Tubular Bridge (1850), one of the mechanical wonders of the age at the time of the Great Exhibition, was riveted entirely by hand, with some 2,000,000 holes to be seamed and jointed.

Ironmaking itself - i.e. the production of pigs and bars from iron ores - was very much a sweat and muscle job, as well as one requiring great vigilance to stave off injuries. Despite the vast mobilization of steam power all of the strategic operations were performed by hand - the preparation of the ores, which were broken up by sledge-hammers; the loading and tapping of the blast furnaces; the puddling of the iron; the shingling and rolling of the bars. In blast furnace work, the first stage of production, steam power was applied to the bellows, magnifying the blast a thousand-fold compared to the old-time

* For reasons of space, a section on boilermaking squads has been cut.
bloomeries. Everything else depended on men, working with heavy weights at almost inhuman temperatures. As Lady Bell wrote of Middlesbrough in *At the Works* (1908): 'From the moment when the ironstone is lifted off the trucks, then dropped into the kilns, afterwards taken to the furnace, and then drawn out of it, it has not been handled by any other means than the arms of powerful men, whose strength and vigilance are constantly strained almost to breaking-point'.

Technology in the rolling mills, the second great department of production, was more sophisticated, with steam-powered hammers to pound the metal and steam-powered rollers to squeeze it into shape. But all the strategic operations were performed by men. Cort’s puddling furnace, which revolutionised the work, was chemical rather than mechanical in its action. It cheapened the production process and made possible an enormous increase in output, but it made labour itself a great deal more severe. The puddler, who had the key role in the new process, was given a task that was simultaneously highly skilled and exhausting, turning a viscous mass of liquid into metal. He worked in conditions of tremendous heat, violently agitating the metal as it boiled, rabbling it from side to side in the furnace, and then gathering it at the end of a rod while the molten liquid thickened and the supercharge of carbon burnt out. The men had to relieve each other every few minutes, so great was the exertion and so intense the heat, but even so it was said that every ounce of excess fat was drained from them and that cataracts ‘induced by the intensely bright light of the furnaces’ were a frequent complaint. Few puddlers, it was said, lived beyond the age of 50.

‘Shingling’, the next stage of the process, was also very physical, a kind of blacksmith’s work in which heavy balls of red-hot metal had to be heaved into place for the steam-hammer (shinglers wore iron masks to protect themselves from the raging heat).

Sir George Head, visiting the Low Moor ironworks at Wibsey Slack in 1835, likened the working conditions to those of an inferno: Athletic men, bathed in perspiration, naked from the waist upwards, exposed to severe alternations of temperature, some, with long bars, stirring the fused metal through the door of the furnace, whose flaming concavity presented to the view a glowing lake of fire — were working like Cyclopes. By continued and violent applications of strength, visible in writhing changes of attitude and contortions of the body, raking backwards and forwards, and stirring round and about the yielding metal, they contrived to weld together a shapeless mass gradually increasing in size till it became about an hundred pounds weight; this, by a simultaneous effort of two men with massive tongs, was dragged out of the furnace, radiant with white heat... Now subjected to the blows of a ponderous hammer, it was wonderful to mark the vigour and dexterity with which the men contrived to heave the mass round and round at every rise of the hammer... while the fiery ball was now turned one side, again the other side uppermost, with the same facility apparently to the operators as if it had been a horseshoe.

The rolling mills were also fearsome places to work in, with giant plates to be drawn from the furnaces and positioned for ‘Demon Crusher’ hammers. At the Atlas Works of John Brown’s, Sheffield — illustrated in the engraving reprinted on p. 7 — the men who had the job of rolling armour plate would gather some forty strong at the furnace mouth, dragging the plate by main force to subject it to the rollers: 31 tons was an average weight to drag. The men wore thin steel leggings, aprons of steel, and a thin curtain of steel ‘dropping over their faces like a large, long vizor’. All the rest of their bodies were muffled in thick, wet sacking, to keep out the infernal heat. ‘In spite, however, of every precaution that the best workmen can employ, they cannot always escape splashes of melted iron’.
The predominance of hand technology was yet more pronounced in the so-called light metal trades, such as the manufacture of domestic hardware. In the third quarter of the 19th century an increasing number of mechanical aids were being brought into use, such as fly wheels for polishing, and treadle lathes for turning parts; but the vast growth of output was mainly due to new alloys, cheaper iron and skilled workmen. In the Wolverhampton tinware trade stamping machinery was very common in the 1860s, though operated by treadle or crank rather than by steam. But workers in the trade depended on a galaxy of small hand tools for the body of the work, with hammer and mallet as the 'old indispensables' for finishing — 'polished hammers on polished anvils' in the case of quality goods, such as the better class of saucepan, 'hammered... till they acquire a beautifully smooth and silvery surface'.

In the Sheffield cutlery trades steam power was applied to the grinding and polishing wheels, but it provided motive power only, leaving the grinder's work intact, while the actual work of forging remained a purely manual process, with a hearth of fine coke 'forced into intermittent activity by a hand bellows', and frequent beatings with a hammer, to give the blade temper and tact.

In the Birmingham brass trades, which in the third quarter of the 19th century emerged as the town's leading employment, steam power was sometimes rented for polishing, but fittings were turned on a treadle-worked lathe with the guiding power as the worker's. ('In the turner's hand the tool must never be allowed to rest, but must have a proper rotation and a correct inclination to avoid furrowing the work'). Burnishing and decoration — a major feature in a trade wedded to ornamentation — was largely a work of hand-files. 'Any man who can use a hammer and file can be a bedstead maker', wrote Edward Peyton in 1866. Brass founding, a mainly Birmingham trade, carried on in ramshackle premises and open-fronted sheds, was largely in the hands of small masters: the 'plant' consisted for the most part of small moulding tubs where fittings and components were cast.
III. Combined and Uneven Development

The foregoing epitome, though necessarily abbreviated, may be enough to suggest that in speaking of the primacy of labour power one is referring not to single instances, or to curious survivals, but to a dominant pattern of growth. In manufacture, as in agriculture and mineral work, a vast amount of capitalist enterprise was organised on the basis of hand rather than steam-powered technologies. In Marxist terms, the labour process was dependent on the strength, skill, quickness and sureness of touch of the individual worker rather than upon the simultaneous and repetitive operations of the machine. The restraints ‘inseparable from human labour power’ had not yet been cast aside. On the contrary, a great deal of entrepreneurial ingenuity was employed in turning them to advantage. Commercial progress depended quite largely on the physical adaptability of the worker, whether it involved crawling on all fours to gather the woad harvest, climbing up and down perpendicular ladders (in a Cornish tin mine the ascent would take an hour or more each day), or working, like boilermakers on repair jobs, upside down in tanks. The lungs of the glassblower, working as bellows, or those of the gas-fitter, soldering pipes, were not the least of the forces of production which 19th century capitalism summoned to its aid, nor were there any more important in the clothing trades than the needlewoman’s fingers and thumbs. In the Potteries, dinner plates were shaped by dextrous jerks of the flat-presser’s wrists, and surfaces varnished with the dipper’s bare arms in a glaze tub (in 1861 Dr. Greenhow estimated they were immersed for eight of a twelve hour day). Ironmaking depended on violent
muscular exertion, and an ability to withstand white heat, engineering on precision of judgement and touch. In the metal-working trades no action was more highly valued than the ability to deliver well-directed blows with the hammer, while those engaged in press-work were in almost perpetual motion with their arms and wrists: ‘practiced workers’ in the metal button trade were said to make from 14,000 to 20,000 strokes a day, ‘the whole strength of a woman’ being needed on the heavier class of press.\footnote{200}

Human beings were quite often used instead of horses for haulage, not only on the canals, but also on the brickfields, where the children who acted as ‘off-bearers’ or ‘pushers-out’, taking cart-loads of bricks from the moulder’s table to the brick-setter’s kiln, carried an average weight variously computed at between 12 and 25 tons a day.\footnote{201} They were used as lifts in the lead factories, and as shunters in the docks. In the workshop trades, delivery boys were strapped to the heavier loads very much in the manner of Volga boaters; so were some of the bakers’ boys who went on ‘rounds’. Men were also used like this in heavy industry, when there were plates to be drawn from the furnaces, or castings from their beds. At J. G. Thomson’s, Clydeside (Peter Taylor recalls) there were a hundred and fifty men at the ropes when there was a ship’s engine to deliver – they started off at a canter, outside the factory gates.\footnote{202} Sturdy legs were essential for mould-runners in the potteries, carrying plates from the flat-pressers’ wheels to the drying rooms; they were also much in demand at a glassworks, where a whole army of juvenile runners were kept on their feet all day: in a glass bottle factory of the 1860s it was calculated that they travelled the equivalent of between 13 and 17 miles a day. ‘The smaller the articles ... and the rougher the workmanship, the greater is the number of them turned out ... and the greater also is the demand on a boy’s exertion’.\footnote{203}

Human beings were also used as balances and weights, whether to give motion to machinery, like the lathe-treaders, or to act as see-saws when there were heavy loads to hoist. In clay-treading they had to act as mangles, in baking as rotary knives. In the London fur trade grown men were employed in the 1890s to bring seal skins to plasticity by jumping on them. ‘It is a curious sight, on entering a room, to see a row of ... tubs each with its Jack-in-the-box bobbing up and down’, wrote one of Booth’s investigators. ‘Every man is naked except for a vest, and a rough cloth which is tied round his waist and attached to the rim of his barrel. With hands resting on either ledge up and down he treads, and earns 20s to 25s piece-work. Skins cured by this process are said to be softer and silkier’.\footnote{204}

In mid-Victorian England there were few parts of the economy which steam power and machinery had left untouched, but fewer still where it ruled unchallenged. At both top and bottom a mainly hand technology prevailed, at top because of the irreplaceability of human skill, at bottom because of the plentiful supply of drudges. High technology industry – what some Marxists call ‘machinofacture’ – was for the most part confined to the factories, but even here mechanisation was very far from complete. One might refer to the pot-makers at a steel-works, the rag-sorters at a paper-mill or to the bottle hands whom Dodd describes at Day and Martin’s, Holborn, meting out blacking from vats.\footnote{205} In the Lancashire mills the ‘self-acting mule’ depended on the nimble fingers of the piecers, while power-loom weavers kept their machines at work by ‘shuttle-kissing’, threading the weft with their lips.\footnote{206} In ironmaking the whole scale of
enterprise was transformed by technical innovation, but labour remained absolutely primary at the point of production itself. As the Morning Chronicle Commissioner wrote in 1850, after investigating the Monmouthshire iron works: 'Although capital is the motive power, it is upon the rude virtues of the workman that the entire system of manufacture ... rests'. 207

Capitalist development in the 19th century depended on numbers as well as strength. In coal mining, the labour force expanded from some 218,000 in 1841 to 1,202,000 in 1911, at the height of the industry's prosperity. In the building trades, over the same period, it more than trebled. British agriculture was prodigal in its use of hands, and the labour force in the 1850s was greater than at any other time before or since. Factories, too, despite the introduction of labour-saving machinery — and in some cases because of it — required a phenomenal number of hands, both to take charge of the preparatory processes, and to make good the deficiencies of the machine. In the Nottingham lace trade of the 1860s there were many more people employed as outworkers, mending and making up, than there were in the factories themselves. 208 In the workshop trades, employers could rely on the services of a whole army of job-hands and strappers, permanently under-employed, who were only taken on when trade was seasonally brisk.

The slow progress of mechanisation in mid-Victorian times had many different causes, but one of them was undoubtedly the relative abundance of labour, both skilled and unskilled. In striking contrast to the earlier years of the industrial revolution, every branch of employment was over-stocked. In agriculture there was a huge labour surplus, men, women and children who never had full employment except in the harvest months. Railway building and construction sites depended upon a great army of free-lance, tramping navvies, who took up employment only for the duration of a job. The reserve army of labour was no less a feature of the workshop trades. The supply of needlewomen was infinitely elastic — the number recorded in the census tripled between 1841 and 1861 — while that of carpenters and joiners, tailors and shoemakers, printers and bookbinders was always far greater than the number of regular berths. 'Tramping artisans' were very much a feature of the labour market in the new industrial crafts, such as boilermaking. 209 In iron shipbuilding, where most employment was on a job-and-finish basis, they constituted the bulk of the labour force: Samuel Kydd in 1858 described the Clydeside shipbuilders, restlessly scouring the riverside for work, as being more like 'wandering tinkers' than regular mechanics. 210 The trade union records of the mid-Victorian ironmoulders show that there were seldom less than 5% of members out-of-work, and often more than 10%. 211 In the Sheffield trades as many as a fifth of union members in the 1860s were 'on the box' (out of work, and supported from union funds), and indeed it was the strain of maintaining them at a fair level of benefit which seems to have been indirectly responsible for the notorious Sheffield 'outrages' (industrial terrorism against members in arrears with subscriptions). Amongst Yorkshire glass bottlemakers the mean level of unemployment seems to have been even higher, to judge by the figures reproduced in Table 2. 212

This superabundance of labour was a pre-condition of Victorian economic expansion, and it also helped to determine its distinctive physiognomy and style. It encouraged capitalists to engage in capital-saving rather than labour-saving investment, to perpetuate low-intensity technologies, and to rely on workers'
skills even when there was machinery ready, in principle, to replace them.

In the United States, by contrast - a new world, sparsely populated by immigrants - labour-saving improvements were a very condition of capitalist growth, and self-acting machinery, which in many cases the American invented, and in others they adopted as their own, made much more rapid strides than it did in mid-Victorian England.\(^\text{213}\) The reaper-binder was transforming the harvest on the prairies while in England it was still being taken by the sickle or the scythe. In construction work the steam navvy was so extensively employed in America, and from such an early date, that the very word ‘navvy’ was attached not to the men (as it was in England, and as it is to-day) but to the machine;\(^\text{214}\) the steam-navvy was patented in America as early as 1841; it did not appear in England until the 1870s, when the manufacture was taken up by Ruston and Proctor of Lincoln;\(^\text{215}\) and its capabilities only began to be widely recognized in the 1890s, when it was employed on such big construction jobs as the Great Central Railway and the Manchester Ship Canal.\(^\text{216}\) There was an equally pronounced disparity in lock-making, where, in the 1870s, machine-made, cast-iron locks from America were sweeping the markets of the world, while the Willenhall lock was still hand-made: it was widely attributed to the superabundance of cheap handicraft labour, penniless small masters, ‘and... the perpetuation of an ancient and wasteful garret system of working’.\(^\text{217}\) Much the same was true in nailmaking, where machinery had entirely conquered production in America when the Committee on Machinery reported on it in 1854 (the first American machine had been patented as early as 1810); in England, down to the 1880s, the great bulk of production was in the hands of Black Country out-workers, using hammers or treadle-worked ‘Olivers’.\(^\text{218}\) In boot and shoemaking the slow adoption in England of the McKay and Blake machines – patented in America during the Civil War – was also related directly
to the disparities in labour supply. 'In America weekly wages were quite double those ruling in the English shoe trade. Many machines which were profitable to use when they displaced labour at a shilling an hour were hardly worth investing in when hand labour cost but sixpence. And this was about the relative position in the two countries at the time the revolution of manufacturing methods was in its most active phase.' Similarly the slow progress in England of the Danks' puddling furnace – an American innovation of the 1860s in ironmaking – was attributed in 1898 (thirty years after the first patents had been taken out) to the fact that 'good puddlers can be obtained here at a lower price than is paid for even inferior workmen in the United States'.

The contrasting pace of English and American mechanisation was already beginning to arouse notice at the time of the Great Exhibition. By the 1860s it was a commonplace and Marx makes it the subject of a characteristically caustic comment in Capital: 'The Yankees have invented a stone-breaking machine. The English do not make use of it, because the "wretch" who does this work gets paid for such a small portion of his labour, that machinery would increase the cost of production to the capitalist.' Elsewhere in Capital he drew attention to 'the invention now-a-days of machines in England that are employed only in North America' – an observation admirably borne out by the subsequent history of automatic looms and ring spinning.

Another reason for the slow progress of mechanisation was the possibility of increasing productivity within a hand technology, either by the introduction of improved tools, or by a more systematic exploitation of labour, or both. Agriculture provides a prime example, with the change from sickle to the scythe, the extension of soil-improving crops and manures, and the mid-Victorian improvements in field drainage. Coal-mining, too, advanced on the basis of improved hand technology. Between 1850 and 1880 output in the industry doubled, and this was due not only to the increase in the number of underground workers, but also to improved haulage methods, harder work, and improvements in the miner's pick, with the substitution of steel for iron. At the same time better transport, both by sea and land, helped to end local monopolies, and brought down prices to the industrial and domestic consumer. Another striking example, to which Eric Hobsbawm drew attention some years ago, is that of gas-making, an industry which down to almost the end of the century was entirely dependent on the physical strength of the stokers. The amount of coal carbonised in the London gasworks rose by some 75% between 1874 and 1888, while the labour force increased by under a third. The employers' gain may be attributed partly to severer labour discipline, partly to the replacement of the one by the three-man scoop (which gave a much greater charge to the firing though leaving its manual character untouched), and partly to the adoption of new chemical processes. In outwork productivity was increased by 'sweating' – screwing down piece-rates so that earnings could only be made up on the basis of unpaid family labour. This was the very principle of expansion in the clothing trade, and it played a large role in such important domestic or semi-domestic industries as nailmaking, chainmaking and the furniture trade. With rates of 2d. a gross, and children to work all hours as 'little human machines' – the basis on which Bryant and May's got their matchboxes made – the incentives to mechanisation must have been low, particularly when the domestic workers had to pay for their own paste, heat and light.
Cheap, labour-saving materials were another alternative to the machine. In tanning, for instance, the cost structure of the industry was transformed by the use of new tanning extracts imported from abroad. By the 1870s they had cut down the average time taken in treating the individual hide from a year to as little as four months, though the individual stages of production remained unchanged. In bookbinding, the substitution of cloth for leather bindings (an innovation in the 1820s), and the introduction of 'case' work – the sub-division of work on covers – made hand labour much more productive while at the same time reducing raw material costs. Mechanical aids, though bitterly contested by the journeymen bookbinders, were comparatively few, at least until the 1850s, and speeded up production only on the simplest classes of work, such as edge-cutting and flattening. But the amount of hand tooling needed on each individual volume was drastically reduced. In the new cloth binderies books were numbered in thousands rather than hundreds – tens of thousands in the case of the new cheap bibles – and they were produced with an open market rather than individual subscribers in view. Employment increased rapidly and the 'mystery and art' of bookbinding was transformed into something approaching a mass production industry. Cheaper iron was the main basis for expansion in the metalworking trades, together with the invention of new alloys, such as Britannia metal and German Silver. In the Wolverhampton holloware trade, one of the chief sources of mid-Victorian kitchenware, the processes of manufacture remained 'essentially the same' in the fifty years from 1810 to 1860, but costs were reduced by the introduction of enamel linings, and progressive falls in the price, or quality, of iron.

A third alternative to mechanisation – and another avenue to more rapid workmanship – was the division of labour and simplification of the individual task. In mid-Victorian times it was just as likely to take place off the master's premises as on them. A prime example is the introduction of 'riveting' in the boot and shoe trade which brought a new and cheaper class of boot on to the market, and revolutionised the wholesale trade. Under the new system of work the soles were nailed to the uppers, instead of being stitched, and the work of 'making', previously performed by one man, was now divided between two – the riveters and the finishers. Riveting was a spectacular commercial success, and Leicester, where the invention was patented in 1861, rapidly established itself as the largest producer of ready-made footwear. Skill was reduced, labour costs fell, and there was a sharp increase in productivity. 'The old crafts would make about three boots or two pairs a day... the riveter and finisher can produce ten pairs in the same time'. The new labour, however, was unmistakeably handicraft in character:

No machinery was used, the soles and uppers were cut by hand, then the upper was moulded round a last, with the edges pulled inwards. A 'nailer' or 'riveter', as he was variously called, would fill his mouth with 'sprigs', and taking them one by one would hammer on the sole and heel. When this had been done, the edges were trimmed with a sharp knife. Finally, the sole and edges were... polished with a hot iron and a heelball.

Riveters often worked at home; finishers did so 'almost invariably'; and attempts to mechanise their work and put them into factories were for a long time unsuccessful. Indeed so far from hand-riveting being displaced by machine, it seemed at one time as if the reverse was taking place. 'The English workman prefers to drive his rivet by hand, which he can do more quickly than the
machine', wrote the Shoe and Leather Trades Record in 1878, "... thus the rivet machine has been entirely superseded in England."

In the Sheffield trades the division of labour was the primary axis of 19th century growth, and as in the case of boot and shoemaking it was accompanied by a wide extension of outwork. Saw-making was distributed between seven different classes of work, each branching out as a little industry on its own—cutting and paring, hardening and tempering, grinding, glazing, toothing, handlemaking, finishing and polishing. Similarly in the manufacture of table-knives, the work was dispersed into separate, sub-divided processes, with the cutler himself confined to the intermediate and final stages of fitting: 'Forging the blade is now one trade, grinding it another, and forging the scales and springs another... besides... several subsidiary branches, as the cutting up of stag and buffalo horns, and the working of hard wood, pearl or tortoiseshell'.

The work was passed backwards and forwards between these various specialists—in the best class of work a blade might travel three or four times between the grinders and forgers alone, quite apart from its journeyings to and from the cutler.

The division of labour in needle-making—a manufacture for the million largely based on Redditch in Worcestershire—had more in common with Adam Smith's classic example of pin-making in The Wealth of Nations. Here the division of labour was associated with minutely sub-divided repetition work rather than with a proliferation of skills—the needle 'however unconsiderable its size' passing through the hands of 120 different workers. Despite the scale of production, there was little in the way of plant. The needle was cut from the wire with hammer or mallet; the points were ground on a stone; the eyes were pierced with a hand-lever press; the sorting was done by touch. Here is an account of it published in 1861:

The little girl who performs this office places a rag or dolly upon the forefinger of her right hand, and with the left presses the needle against it; the points stick into the soft cotton, and are thus easily withdrawn and laid in the contrary direction. Little children 'rag' with inconceivable rapidity, and with equal speed the process of sorting, according to lengths, is performed, the human hand appreciating even the sixteenth of an inch in length, and separating the different sizes with a kind of instinct with which the reasoning power seems to have nothing to do.

Technical Difficulties

Another obstacle to mechanisation was the gap between expectation and performance. In many cases the machines failed to perform the 'self-acting' miracles promised in the patents, and either needed a great deal of skilled attendance, or failed to execute their appointed tasks. Even if brought 'nearly... to perfection' by its inventor, a machine would often prove difficult to operate. Unexpected snags would be encountered, unintended effects would appear, and it was possible for patent to follow patent without anything like continuous flow production being achieved. Wright's pin machine of 1824, which, according to its promoters, 'during a single revolution... produced a perfect pin', turned out to be so far from perfect that forty years later, despite thousands of pounds spent on costly experiments, the 'nobbing' or heading of the pin had still very often to be done by hand (in Gloucester this was a cottage industry, though the body of the pin was made in factories). Wall's 1880 machine for manufacturing cheap pottery failed more quickly, though causing a brief sensation among the operatives. '... There was one defect in nearly all the
ware independent of the want of polishing; air cracks almost invariably made their appearance in the backs of the ware after firing. The steam-powered ‘Jolly’, which had caused such a panic in the Potteries thirty-five years earlier (the Potters’ Union set up an Emigration Society, and planted a colony in America, as a way of escaping it) failed ‘partly, it is supposed, through the desire of the employers not to come into conflict with the men’, but chiefly ‘owing to some defects in . . . construction’. (Later it resurfaced, and by the 1890s was in general use."

Often the action of machinery was too crude and indiscriminate for the tasks it was appointed to perform. Power-looms, for instance, were too rough in their action for the more delicate processes of weaving, or the finer classes of thread. In hosiery, intricate patterns defeated the steam-powered rotary frame, and ‘fancy’ hosiery (a rapidly-expanding branch of the trade) remained the province of the hand-frame knitters long after the plainer classes of ware had gone to the machine. Steam threshers, though successful with wheat, were much too violent in their action for barley, which continued to be hand-flailed down to the end of the nineteenth century. Mechanical potato-diggers were too clumsy and impetuous in their grasp: J. R. Wallace’s model was a great success when it was put on trial at the Glasgow show of 1875, but trials under more difficult conditions showed that the potatoes were so badly damaged that they could not be stored in pits. Milking machines, despite numerous patents and improvements, were also much too rough: the siphon type injured the cow’s udders and were troublesome to fit; the suction type was abandoned because it was liable to force out blood. In manufacturing industry the difficulty often lay with the raw materials which were too delicate, or too variable, for machinery’s harsh beat. No two skins were ever precisely the same in the leatherworking trades, no two grains in furniture. In the Birmingham trade of pearl-button making, where union members were fined £5 if they worked with steam, the ‘brittle nature’ of the raw material did not allow for a faster rate of working than a foot-lathe would accomplish. In cutlery, the difficulty lay with the steel: ‘. . . Cutlery . . . is not an article that lends itself to alteration’, a Sheffield manufacturer said in 1903, ‘High-class steel is so hard that attempts to manipulate it by machinery break the tools, and heating it to make it work easily would destroy its temper’.

Even when such difficulties were overcome, machinery was rarely self-acting, but required skilled hands to guide and to complete its work. Nor, for the most part, could it be adapted to the finer and more delicate classes of work, where quality counted for more than yield. Machinery was thus used to do some sorts of things and not others, and many manufacturers settled for a mixed development, in which machinery was installed for the coarse, preparatory, stages of production, while the shaping and finishing was done by hand. This was notably the case in the Potteries, where pug-mills were used for mixing the flints and clay, but all of the actual making was done by hand. It was also the compromise reached in the Sheffield trade of saw-making, where the teeth were punched out by machinery, but bent into shape by hand, while the blade itself was tempered on the anvil by repeated hammer blows. ‘The sharpening and setting of a saw requires considerable skill of hand and accuracy of eye; for if any one of the teeth projects either edgewise or sidewise beyond the true line, it renders the sawing harsh’.
Profitability and costs

Economic considerations also limited machinery's scope. In some cases the gains in productivity were comparatively modest, either because the intricacy of the process slowed down working pace (the case in full-fashioned hosiery, and in certain branches of lace-making, where the machine was subject to frequent stoppages), or — in the simpler classes of work — because hand labour could be worked at an almost machine-like pace. In the linen industry of the 1850s the slow tempo of mechanisation in weaving as compared with that in spinning seems to have been due to this cause. A power-loom could produce four times the amount of a hand-loom weaver in any given day, but in spinning the differential was 320:1. 'The enormous saving of expense . . . made the transition from . . . hand-spinning . . . an unavoidable necessity . . . The saving by power-looms not being nearly so great, the transition state will . . . be prolonged'.

Then again, the saving in labour might be counterbalanced by a greater wastage in raw materials (machinery was seldom employed where they were costly) or a need for higher quality inputs. In the galvanised iron trade, for instance, the new machinery of the 1850s and 1860s required a more costly material because the metal could not be 'humoured' as it could when it was shaped by hand; while in cork-cutting it was thought likely to fail because of lack of discrimination: 'a skilful cork-cutter will so manage his material as to lead to a minimum of waste'.

A further disincentive was the possibility of breakdown, which could be expensive to repair, as well as bringing production to a halt.

In agriculture mechanisation brought no overall gain in output. Steam cultivation might be more effective than horse tillage, and reaper-binders than harvesting by hand, but they did not increase the yield of a cornfield. The saving was principally on wages, but since these were screwed down to the barest minimum, farmers had no great incentive to invest in plant. 'In other arts machinery not only renders operations formerly done by hand more effective, but multiplies results to an almost infinite extent, while from the very nature of agriculture such an effect is not to be looked for'.

In metallurgy the gain in yield was offset by the loss in quality. Machine-riveting, for instance, was credited with performing the work at ten times the rate of hand-riveting, but even Fairbairn, a great advocate of hydraulic riveting, had to admit that the machine-made joints were not as strong as those which had been hammered by hand, 'though the faults would not appear in a comparatively small experiment'.

In the making of ship's chains even speed was not on machinery's side. In 1860 the welding of links was still being done at small forge fires with a top tool and hammer to fasten the stay. A recent attempt to abridge the work by introducing mechanical compressors had been abandoned on grounds of both quality and speed. 'However completely this and other machines may do the work, hand labour does the work quicker and better, almost beyond comparison.'

Another set of difficulties presented themselves on the question of fixed and variable costs. A machine had to be kept running all the time to justify the expense of outlay, but even so the rise in output might not be sufficient to offset the running charges, depreciation costs, and investment. For the small producer, engaged in a week-by-week struggle for survival, the cost of installing machinery made it, quite simply, unthinkable — 'economy in time, energy and manpower was . . . less important than economy in cash outlay'. But even for a large and
well-established firm it could be daunting. Mechanisation involved not merely
the substitution of a machine for a tool, but an entire revolution in the
production process. It involved exchanging well-established and familiar
routines for new and untried methods, either with a brand-new work force,
which would have to be trained to perform new tasks, or with an old one
determined to protect their jobs (workers at Waterlow's, the Finsbury
papermakers, held a party when the 'striker', a new-fangled American machine
of 1874, broke down, taking the day off to celebrate and going to Epping for a
swim.) In the workshop trades, with their cramped, overcrowded premises,
want of space made it difficult to accommodate more than a modicum of
plant. Even in a large firm want of space could present an intractable
problem. A potteries, for instance, was a rambling maze of small work-rooms,
and machinery could only be installed if the entire premises were rebuilt. Layout
could be difficult elsewhere. At the Saltley gasworks, Birmingham, in 1895,
two of the three retort-houses, with 960 mouthpieces to feed, depended on
manual labour entirely because: 'These houses being too narrow for . . .
machinery of any kind, the retorts are still drawn and charged by hand, and the
c coal is delivered . . . and the coke removed . . . by barrows.' Extra fuel costs
also militated against the introduction of machinery, especially in districts which
were remote from the coalfields. A steam saw consumed a ton of coal and a quart
of machine oil a day — ginned by a horse it would be as cheap as the local
grass or hay. All the big concentrations of mid-Victorian steam-power were to be
found in close proximity to the coalfields, while in southern England, where coal
prices were about double those in the manufacturing districts of the north, it
was comparatively sparse. Nevertheless fuel costs do not seem to have acted as
an independent force: the production census of 1871 shows that the variations
within the coal districts were almost as steep as those which separated the coal
distRICTS FROM MANUFACTURING INDUSTRIES FURTHER SOUTH. IN Staffordshire, for
instance, 66,425 horse-power were concentrated in the blast furnaces and iron
mills, 2.09 h.p. per worker, while in the whole of the Staffordshire Potteries
there was only 3,101 h.p. (0.09 h.p. per worker). Birmingham, despite the
proximity of the Staffordshire coal-field, had only 11,272 h.p.; Oldham, in the
cotton district of East Lancashire, had 31,025 h.p. Market Uncertainties

Another obstacle to mechanisation was the irregular nature of demand, and its
often limited character. Steam power and machinery were only profitable if they
were geared to large-scale production. But in the workshop trades short
production runs were endemic, and output fluctuated sharply not only with the
trade cycle, but also from season to season and in many cases from week to
week. ‘Little makers’ like the Willenhall locksmiths, the Sheffield cutlers, or the
cabinet-makers of Bethnal Green, could only afford to make up goods in small
quantities at a time, because they had to meet wages and costs out of weekly
earnings. Warehousemen and buyers-up, for their part, were niggardly in their
purchases, and preferred, as a matter of policy, to trade from week to week
rather than to run the risk of carrying unsold stock on their hands. Consumer
demand also tended to favour limited production runs, alternating between
periods of heavy pressure, when there was a helter-skelter rush of work (as in the
‘bull’ weeks immediately preceding Christmas) and others when trade was
dead.\textsuperscript{270} In conditions like these it was easier, when faced with a rush of orders, to take on extra hands, or sub-contract the work, than to install expensive machinery and plant: less risky in the long run, and in the short run at least a great deal more profitable.

The position was not necessarily different in heavy industry, despite the vast scale of many works. Tinplates – the most recent historian of the South Wales industry tells us – ‘were not manufactured ahead of demand but were rolled to order’.\textsuperscript{271} According to Menelaus, the manager of the Dowlais Works, this was also very frequently the case in heavy iron. ‘When rolled iron is wanted either in large masses, or of difficult sections and ... lengths’, he told the South Wales Institute of Engineers in 1860, ‘the quantities generally are so small that even if you have suitable machinery, before you get properly to work ... the order is finished’.\textsuperscript{272} In shipbuilding and engineering, a great deal of work was done to order rather than for stock, while the willingness of British engineering firms to make large numbers of products in small quantities – and to fit them up, if necessary, on site – was the very basis of the world-wide reputation for excellence they enjoyed.\textsuperscript{273} Ransome’s of Ipswich, the East Anglian manufacturers of agricultural machinery, maintained some 700 models in their catalogues, and any of these might be modified on the job at the pattern stage.\textsuperscript{274} Much the same was true of many of the machine-tool makers discussed by Roderick Floud in his recent book.\textsuperscript{275}

Limited production runs were also a feature of the hardware trades, partly because of market uncertainties, but also because demand was highly specific, and new lines were being continually pioneered to meet particular customer requirements. No fewer than 300 different classes of nail were being manufactured in the 1860s, for instance, with at least ten different sizes to each sort, so that in all upwards of 3,000 different kinds of nail were on the market.\textsuperscript{276} ‘Machine-made nails of certain kinds have largely invaded the market, but there seems no likelihood of machine nails superseding the general varieties now made by hand’, runs a trade report from the Black Country in August 1878, ‘for, considering the demand, it would not pay anyone to make these particular classes of nails by machinery’. The Willenhall lockmakers were even more individualistic: at Messrs. Carpenter’s, the oldest works in the town, there were not less than 500 distinct patterns ‘and when it is remembered that each pattern is made in various sizes ranging inch by inch from five to twelve inches an idea may be formed of the bewildering array’.\textsuperscript{277}

‘Specialty’ was also rife in the manufacture of workmen’s tools. In 1850s Birmingham, for instance, 45 different kinds of axe were being made – 14 of them specifically directed at the American market; there were upwards of 70 different types of hoe,\textsuperscript{278} and no fewer than 500 varieties of hammer: ‘not only is each adapted to one particular purpose, but several varieties often serve exclusively for the different operations in one and the same process’.\textsuperscript{279} The larger firms in toolmaking added complications of their own. Wilkinson, the Grimesthorpe saw-makers, with a world-wide market for their hand-made saws, were making them to some 200 different patterns in 1880, and constantly adding improvements to their design;\textsuperscript{280} Messrs. Elwell and Co. at Wednesbury Forge showed some 1200 different patterns in their catalogue ‘including mattocks, plantation hoes, pickaxes, axes, adzes, spades, shovels, and forks’.\textsuperscript{281}

Short production runs were also encouraged by the continuing vitality of local
markets. Baskets, for instance, took on quite different shapes and sizes according to the district in which they were made, and the specific purposes to which they were directed. In Furness they had to serve as corves for the local coal and iron pits, in Nottingham as skips for the dyers and bleachers, in Southport as hampers for the shrimps.\(^2\) Much the same was true of other commodities which were locally manufactured to meet specific local needs, coopers’ ware,\(^3\) for instance, fancy boxes and containers,\(^4\) hay wagons, carts and barrows.

**Consumer Preference**

In many cases hand labour retained favour against machinery because of better performance. In paper-staining, for instance – i.e. the manufacture of wallpapers – block-printers held their own against machine-made competitors because the colours (which they mixed themselves)\(^5\) were less liable to fade. ‘Cheap machine-made papers quickly lose their colour’, an architect advised potential clients in 1872, ‘and as the process of manufacture does not permit of their being properly “set”, the tints rub off and the patterns fade’.\(^6\)

In edge-tool making hand-made planes were preferred on grounds of their greater accuracy, and the superior smoothness of their cut. ‘Machinery has been employed for the manufacture of hand-planes, but with little success’, wrote a commentator in 1866. ‘The irregularity in the thickness of the irons requires the exercise of considerable skill in “bedding” them upon the wood, and hand-labour is indispensable to effect this ... properly. Unless this point is attended to, the tool jumps over the wood it has to plane, and makes it rougher instead of smoother.’\(^7\) Hand-cut files held their own notwithstanding numerous attempts by Sheffield manufacturers to market a cheap, machine-made alternative.\(^8\) ‘The wonderful sympathy of the eye and hand of the file-cutter are as yet totally unapproached by any machinery’, wrote *The Ironmonger* in August 1878, ‘The machine will certainly cut the teeth in the forged shape, but it does not give them that peculiar feather which is the essential feature of the file-cutter’s craft’.\(^9\)

In consumer durables there was a well-established preference for hand-made goods, not only because of their better quality, but also because of their superior finish, and of those additional embellishments which manufacturers were apt to call ‘artistic’. The preference for hand-made goods was particularly marked in mid-Victorian times, when the bourgeoisie, in one or other of its manifestations, not only dominated public taste, but very often constituted the bulk of effective demand. A very common commercial practice of the 1870s and 1880s was for manufacturers and merchants to send machine-made goods to the Colonies and America, while marketing higher-class, hand-made goods at home.\(^10\) In domestic hardware and the cutlery trades, the preference for hand-hammered goods was virtually unchallenged, and continued until the end of the century. When, for instance, about 1900, the Bilston manufacturers began to go over to machine-stamped frying pans, they took good care to do so in disguise. ‘The knowing housewife still looks for the marks of the hammer, so they are added afterwards, just as a little sand is added to sponges.’\(^11\) Hand-made locks held their own in the home market, not only because of their cheapness, but also because they were more cumbersome than their streamlined American competitors and might therefore be more formidable to burglars. They also
possessed that priceless quality of individuality which bourgeois householders have always sought after so eagerly, and held in such esteem. ‘American locks are, it must be granted, marvels of cheapness’, The Ironmonger wrote disparagingly in October 1877,

and the expenditure of manual labour in their production is almost nil... But in thus practically dispensing with manual and patient labour; in thus turning out a gross of locks faster than English makers turn out a dozen... certain features of the article – which used to be thought indispensable – have necessarily to be sacrificed. The ordinary American cast door-lock has... no wards, the only security being in the ‘fancy’ or shape of the keyhole. A few strokes with a file will of course modify this... and then all “security” is destroyed...

Machine-made keys, however ingenious... do not, and cannot in the nature of things sufficiently “differ”.

Industrial design – which will be discussed in a second article – served to reinforce the role of speciality, and the extension of fashion to a new and cheaper range of commodities brought a feverish search for new styles. In boot and shoemaking patterns changed regularly two or three times a year, quite apart from being subject to short-lived crazes such as glazed heels. Wallpaper manufacturers were continually bringing out new lines, with dazzling new tints and a bewildering variety of motifs. Carriage-makers, too, were subject to continual changes of taste, and this seems to have been one of the reasons why, even in the largest works, so little machinery was used. ‘As a class of manufacturers, we labour under many disadvantages in adopting machinery’, a Bath capitalist told the Institute of Carriage Manufacturers in 1890, ‘... Owing to the numerous sizes and great variety of design, even the very largest establishments can only place a limited number of any one carriage in hand at one time.’

In Birmingham, with its multiplicity of small producers, marginal differentiation of the product was a very principle of growth, and responsiveness to changes in public taste a condition of business survival. Patterns were constantly going out of date, and manufacturers continually experimenting with new lines. ‘... in Birmingham the different varieties and sizes and patterns of article are so numerous, that the adjustment of the steam-engine to do the work would be almost impracticable, and unprofitable if practicable’, wrote Charles Knight in 1846, spelling out some of the technological consequences. ‘The adjustments required by the ever-varying tastes and wants of the age can be effected only by men’s fingers: the steam-engine being appealed to for that kind of service which may be common to all the works required’.

Combined and uneven development

Steam power and hand technology may represent different principles of industrial organisation, and to the historian they may well appear as belonging to different epochs, the one innovatory, the other ‘traditional’ and unchanging in its ways. But from the point of view of 19th century capitalist development they were two sides of the same coin, and it is fitting that the Great Exhibition of 1851 – ‘the authentic voice of British capitalism in the hour of its greatest triumph’ should have given symbolic representation to them both. ‘Steam power’, an admiring commentator noted, ‘wholly turned the mahogany which runs round the galleries of the Crystal Palace’. But the 300,000 panes of glass which covered it were blown by hand, and so was the Crystal Fountain which formed the centre-piece of the transept, ‘glittering in all the colours of the rainbow’. The promoters were intoxicated with the idea of ‘self-acting
machinery', and the technological miracles it might perform. But they devoted a great deal of their space to — among other things — needlework; and in demonstrating the competitive capabilities of British industry they were heavily dependent on artisan skills. Most of the manufactures on display were handicraft products, and even in the Machinery Court many of the exhibits were assembled from hand-made components. ‘Few objects’ excited more attention among foreigners than the displays of Sheffield cutlery and edge-tools (the Sheffield Court was one of the most extensive in the building), while domestic visitors, it seems, were no less enraptured by the impenetrable locks, ‘myripermutation’ keys and incombustible safes of Messrs. Chubb, Bramah and Mordan. Superimposed on the idea of mechanical progress there was also a nascent commercial aesthetic which the Exhibition’s promoters rather grandly labelled ‘the marriage of industry and art’. In subsequent years it was to make ‘taste’ a very principle of production and the marginal differentiation of products a primary axis of growth.

The balance of advantage between steam power and hand technology was, in mid-Victorian times, very far from settled, and many manufacturers though experimental in marketing new products and multiplying novelties of design, remained wedded to conservative production routines. Human beings, the main alternative to machinery, were, from a commercial point of view, often a much more attractive proposition. They were a great deal cheaper to install than a power house, and much more adaptable in their action than a self-acting stamp or press. When they broke down, the master did not have to pay for repairs; when they made a mistake, he could fine them; when there was no work for them to do he could give them the sack. Skills too were cheaper than machinery to come by. A steam sawing machine, in 1850, cost £700 to install; a pair of travelling sawyers could be hired to do a job for five shillings, while a circular saw — such as the one used at Joseph Severn’s shop in Codnor — could be ginned by a horse for free. Machinery was thus often adopted as a last resort, when every alternative means of extracting surplus value had failed to yield an adequate return, and it is no accident that manufacturers — like the Sheffield file makers of 1866 — so often turned their eyes to it when they were faced with demands for higher wages.

The orthodox account of the industrial revolution concentrates on the rise of steam power and machinery, and the spread of the factory system. It has much less to say about alternative forms of capitalist enterprise (such as those to be found in mining and quarrying), about the rise of sweating, or the spread of back-yard industries and trades. Nor does it tell us much about the repercussions of technology on work. Landes’ picture has the compelling power of paradigm, with mechanisation on an ‘ever-widening front’ and steam power — ‘rapid, regular, precise’ — effortlessly performing labour’s tasks. But if one looks at the economy as a whole rather than at its most novel and striking features, a less orderly canvas might be drawn — one bearing more resemblance to a Bruegel or even a Hieronymus Bosch than to the geometrical regularities of a modern abstract. The industrial landscape would be seen to be full of diggings and pits as well as of tall factory chimneys. Smithies would sprout in the shadows of the furnaces, sweatshops in those of the looms. Agricultural labourers might take up the foreground, armed with sickle or scythe, while behind them troops of women and children would be bent double over the ripening crops in the field, pulling
charlock, hoeing nettles, or cleaning the furrows of stones. In the middle distance there might be navvies digging sewers and paviours laying flags. On the building sites there would be a bustle of man-powered activity, with house-painters on ladders, and slaters nailing roofs. Carters would be loading and unloading horses, market women carrying baskets of produce on their heads; dockers balancing weights. The factories would be hot and steamy, with men stripped to the singlet, and juvenile runners in bare feet. At the lead works women would be carrying pots of poisonous metal on their heads, in the bleachers’ shed they would be stitching yards of chlorined cloth, at a shoddy mill sorting rags. Instead of calling his picture ‘machinery’ the artist might prefer to name it ‘toil’.

Skill was as important as toil (the two often went hand in hand) and in mid-Victorian times it was plentifully available. The domestic housebuilder could draw on a vast substratum of carpentering skills: so could such booming industries as Kentish Town pianos and High Wycombe chairs. The new iron shipyards were quickly filled with artisans and mechanics drawn from a dozen different trades; by the 1870s they were already a very cockpit of sectarian craft rivalries. Engineering employers recruited their labour from those who had served their apprenticeships in the ‘country’ branches of the trade, with wheelwrights, blacksmiths, and in the small town foundries; and it was a matter of real anxiety in the industry when, towards the end of the century, this source of recruitment began to dry up. ‘There is no evidence that labour supply impeded any of the machine tool firms’, writes Roderick Floud in his recent book, ‘Even as early as the 1830s, Nasmyth was able to break a strike in his works, aimed at forcing him to employ only men who had served an apprenticeship, by importing sixty-four Scottish mechanics and he remarked that “we might easily have obtained three times the number...” No other machine tool maker appears to have had difficulties in securing labour, or, indeed, . . . in dismissing it when times were bad, in the confident expectation that the men could be re-employed if trade improved’.
supported a vast proliferation of handicraft activities, while in metallurgy the cheapening of manufacturing raw materials led to a multiplication of journeymen-masters. The mid-Victorian engineer was a tool-bearer rather than a machine minder; the boilermaker was an artisan rather than a factory hand. In coal mining activity increased by the recruitment of a vast new class of workers who were neither exactly labourers, nor yet artisans, but who very soon laid claim to hereditary craft skills. Much the same was true of workers in the tinplate mills and ironworks. The number of craftsmen in the building trade increased by leaps and bounds, though the rise of new specialities led to a narrowing of all-round skills.

In juxtaposing hand and steam-powered technologies one is speaking of a combined as well as of an uneven development. In mid-Victorian times, as earlier in the 19th century, they represented concurrent phases of capitalist growth, feeding on one another's achievements, endorsing one another's effects. Both were exposed to the same market forces; both depended for their progress upon the mobilisation of wage labour on a hitherto unprecedented scale, and both were equally subject to the new work discipline, though it affected them in different ways. The industrial revolution rested on a broad handicraft basis, which was at once a condition of its development and a restraint on its further growth. In mid-Victorian times — as I shall attempt to show in a second article — the handicraft sector of the economy was quite as dynamic as high technology industry, and just as much subject to technical development and change. It was indeed in the first rather than the second that mass production methods in many cases were pioneered; that new classes of commodity were created; and that modern capitalist methods of exploitation — both of producers and consumers — were most clearly prefigured and explored.
GUIDE TO ABBREVIATIONS AND REFERENCES

MSS - manuscripts; RC - Royal Commission; S.C. - Select Committee; M.B. - Minute Book; M.O. - Medical Officer.

Webb Coll. - London School of Economics, Webb collection of trade union journals and MSS.
Booth MSS. - London School of Economics, Charles Booth's MSS. for London Life and Labour.
Howell Coll. - Bishopsgate Institute, George Howell trade union collection.
Goldsmith Coll. - University of London, Goldsmith's collection of economic literature.
P.R.O. - Public Record Office.
P.P. - Parliamentary Papers.
Newcomen Soc. - Transactions of the Newcomen Society.
Econ. H. R - Economic History Review.
Timmons - ed. Samuel Timmons, The Industrial Resources of Birmingham and the Midland Hardware District, London 1866

For reasons of space, the issue editors have been obliged to omit some footnotes and conflate others.

3 Liverpool Mercury, 10 Oct. 1845, p. 400. I am grateful to Tim Mason for this reference.
5 For the effect of heavy sizing on the health of those who had to work with it in the mills, P.P. 1872 (203) LIV, P.P. 1884 (c.3861) LXXII. For a moving autobiographical account, Alice Foley, A Bolton Childhood, Manchester 1973, p. 51.
6 Goldsmith's Coll., Henry Mayhew, Labour and the Poor, London 1851, p. 40. Nicoll was under-sheriff of the City of London. He and his brother were said to be worth £80,000 a-piece.
7 H. A. Shannon, 'Bricks, a trade index', Economica 1934.
9 P.R.O., For. 3/559,3/263. The explosion, like others in the district, seems to have been the work of Walter Virgo and the Blakeney gang.
12 John Ball, 'Account of the Northamptonshire Boot and Shoe Makers Strike in 1857/8/9', Trade Societies and Strikes, London 1860. There are very full reports of these strikes in the Northampton Mercury and the Northamptonshire Free Press.

13 'Murderous Threats to Workmen in the Screw Bolt Trade', The Ironmonger, 30 Dec. 1865, VII 180-1.

14 Capital XV 464-96; XVI 519.


There is an account of the Tate and Lyle works in W. Glenny Crory, East London Industries, London 1876.

19 Booth MSS. A.24 part A, fols 17-23 for two usefully detailed biographies, ibid B.10, fol. 125, B 16, fols. 43, 91, B.44, fols. 26, 41, B.45, fols. 60, 147 for some other back-street manufacturers.

20 For the rolling mills, P.P. 1876 (c.1443-1) XXX, Rep ... Fact. & Workshops Act, QQ. 12058-61, for a list of the 55 trades 'in union', Frank Hill, 'Combinations in Sheffield', Trade Societies and Strikes, London 1860, pp. 564-5.


23 Sir R. Lloyd Patterson, 'The Linen Industry' in Cox, British Industries, p. 58. For some strike movements among the hand-loom linen weavers of Barnsley, Beehive, 10 Feb.; 10, 24, 31 March, 10, 17, 24 Nov.; 8 Dec. 1866.


27 For a good account of one of them, George Dodd, Days at Factories, London 1843, pp. 17-40.


30 Nineteenth century windmills seems to have been as much subject to 'improvement' as any other species of capital equipment. Among them Messrs. J. Warner's patent annular sails. John Ashton, The History of Bread, London 1904, p. 106. For some other 19th century improvements in windmills, Rex Wales, 'Suffolk windmills', Newcomen Soc., XXII, XXIII, 1941-3.

38 J. W. C. Haldane, Steam Ships and then Machinery, London 1893, p. 000.

39 There is an account of the collier bngs by one who served with them in Walter Runciman, Collier Brgs and their Sailors, London 1926.

40 Mitchell and Deane, p. 60.

41 Samuel, 'Mineral Workers', in Miners, Quarrymen, and Saltworkers, 1977, p 9 for some details of the traffic.

42 F. M. L. Thompson 'Nineteenth-Century Horse Sense', Econ. H R, Feb. 1976, 2nd Ser. XXIX/1, for these and other useful horse statistics and an interesting discussion of them.

43 J. W. C. Haldane, Steam Ships and then Machinery, London 1893, p. 000.


45 William Knight, 'Granite Quarries of Aberdeenshire', Transactions of the Highland Agricultural Society, 1835, 2nd Ser. IV.


Ibid., pp. 850, 864. For potato planting near Gillingham, Trinity Coll., Cambridge, MS Diary of A. J. Munby, XVIII, 9 March 1863. I am grateful to Anna Davin for this and the other Munby market gardening references.


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novelties, A. E. Coombe, ‘A General Chat on the Toffee Trade’, Confectionery, 12 March 1896, p. 50; Confectionery, 13 April, 12 May 1896, J. D. Burn, Commercial Enterprise and Social Progress, London 1858, p. 130; Andrew Wynter, Our Social Bees, 2nd Ser., London 1866, pp. 204-5. Goldsmith’s Coll., ‘The Working Classes of Edinburgh, 1853; Confectioners’. So late as the 1890s G. H. Duckworth, visiting an East London sweet factory, noted that ‘the steam process used in jam-making is not powerful enough for sweets’, Booth MSS. B. 117 36


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* For some examples, The Builder, 11 May 1867, 6 July, 21 Sept. 1878, XXXVI 997. ‘Church Building News’, together with its appendage, ‘Dissenting Church Building News’ is a regular column in The Builder of the 1860s and 1870s, and ‘Town Halls and Exchanges’ became a regular heading in 1865. For the employment this gave Jude Fawley, Thomas Hardy, Jude The Obscure, St. Martin’s paperback ed., Part 5 ch. VII.

Henry Broadhurst, The Story of His Life Told by Himself, London 1901, pp. 28-9, Reminiscences of a Stonemason, pp. 89-90, 105. So late as the 1890s stone working machinery seems to have made little impact on the industry, so far as stonemasons themselves were concerned. cf Booth MSS, A.3 fol. 279 (interview with Hancock, secretary of the Operative Stonemasons); Congress House records, United Builders and Labourers, Trade Circular and Monthly Report, Sept. 1895, pp. 8-9. For an early strike against machinery, interestingly by masons’ labourers, Bee-hive, 25 Aug. 1866, p. 6, col. 3. For patents and experiments, M. Powis Bale, Stoneworking Machinery, London 1884, Building News, 6 Jan. 1865, XII 17, Capital and Labour, 1875, II 723; 14 Nov. 1877, IV 605. For the eventual impact of machinery on workers in the trade, Reminiscences of a Stonemason, p. 255.


Personal recollections of English Engineers, by a Civil Engineer, London 1868, p. 42; Coleman, Railway Navvies, p. 48.

When a moving platform was invented by the engineer to ‘supersede the necessity of thus perilling life and limb’, the navvies, ‘considering it to diminish their labour and wages’, broke it. F. S. Williams, Our Iron Roads, London 1852, p. 72.

P. P. 1867 (3873) XXXII, R. C. Trade Unions, Q. 2546; Free Lance, 27 Feb. 1869, IV 66.


Carpenters claimed ‘grinding money’ when they were sacked from a job – i.e. a monetary equivalent for the time it took them to make their tools ship-shape. For the one hour claim, North Yorks. Bldg. Trades Review, 22 Jan. 1876, p. 7; Brick, Tile and Blدرs. Gas., 8 May 1888, III 336; for the two hours claim, Builders’ Wkly. Reporter, 26 Feb. 1875, p. 209; Capital and Labour, 5 May 1875, 8 March 1876.

Davidson, Houses, p. 59.


Black, Gas Fitting, p. 18.

111 George R. Burnell, Rudimentary Treatise on Limes, Cements ... Plastering, London 1850, for contemporary uses of lime.
112 Morning Chronicle, 29 Dec. 1849.
113 Dobson, Building, p. 109; Davidson, Houses, p. 46.
114 C. Le Neve Foster, Ore and Stone Mining, London 1894, p. 546.
116 Merlyn Jones, 'Y Chwarelwyr: the Slate Quarrymen of North Wales', in Miners Quarrymen and Saltworkers, p. 121.
117 The British Clayworker, Oct. 1898.
122 Thomas Allen, A History of Surrey, London 1831, I 35; K. W. Graven and E. S. Wood, 'Merstham Limeworks', Surrey Arch. Colls., 1967, LXIX; Surrey Record Office, Merstham Limeworks, accounts and papers. I am grateful to Miss Gollancz, the County archivist, for bringing these papers to my notice.
123 Dobson, Bricks, p. 122.
124 Ibid., and Chamberlain, 'Manufacture of Bricks', p. 500.
125 James Greenwood, 'Mr. Dodd's Dust-Yard', in Unsentimental Journeys, London 1867, pp. 64 sq. for a description, and engraving, of one of them. The most famous metropolitan dust heap was the one at the King's Cross end of what is today Gray's Inn Road. It was sold by an enterprising London capitalist to the Tsarist government for the rebuilding of Moscow after the great burning of 1812. G. M. L. Strauss et al., England's Workshops, London 1862, p. 248; cf. also 'Glass and its Manufacture', p. 20 in his Curiosities of Industry, London 1852. For other descriptions of sheet glass making at Messrs. Chance's Smethwick works, Morning Chronicle, 23 Dec. 1850; 'Birmingham and her Manufactures IV', in The Leisure Hour, 20 Jan. 1853.
...
68 HISTORY WORKSHOP


Morning Chronicle, 12 Sept. 1850.


Goldsmith's Coll., Condition of the Working Classes of Edinburgh and Leith, 1853.


When the premises of Mesters. Holland and Hannen, the Bloomsbury builders, were destroyed by fire in 1866, joiners' tools were valued from £4 and £5 to as much as £50 or £60 a man. Annual Register, August 1866, II 124. Darlington joiners in the same year estimated the average value of their tools at £20, with 'not less than is. 6d. a week' for replenishment and repairs, Darlington and Stockton Times, 23 June 1866. Morning Chronicle, 11 July 1850, 'Labour and the Poor, Met. Dists. LIX, Carpenters & Joiners', p. 5 is full of valuable details about tool insurance.


The Cabinet and Upholstery Advertiser, 14 Dec. 1878.

H. J. Fryth and Henry Collins, The Foundry Workers, Manchester 1959, p. 44.

Ure, Dictionary, II 203.

Recall of English Engineers, p. 218.

Ure, loc. cit.

For the trade union, Fryth and Collins, for the restrictive practices, Capital and Labour, 22 April 1874, W. G. Riddell, Adventures of an Obscure Victorian, London 1932, pp. 33-6, Booth MSS. B.89, fol. 55, P.P. 1867-8 (3980-1) XXXIX, R. C. Trade Unions, QQ 13, 176-13, 211. Ure describes the moulders as 'a very numerous class of mechanics demanding and receiving high wages' Ure, loc. cit.


Wal Hannington, Never on Our Knees, London 1967, pp. 28-9. This book should be warmly commended to anyone who cares about London history or who would like to read the autobiography of a fine agitator. There are brief references to the St. Pancras Ironworks in Monthly Reports, May 1886.


For a brief description of a workshop in 1870s Shoreditch see George Barnes, From Workshop to War Cabinet, London 1924, pp. 26-7.


Jefferys, pp. 59, 101, 123; Rowe, pp. 90-2, 101-2; Cressey, Mechanical Engineering, p. 208.


179 Williams, Our Iron Roads, p. 250.
181 Williams, Our Iron Roads, p. 190; for a splendid description of the smith's work at Swandon in later times, Williams, Railway Factory, pp. 82-8.
184 Riddell, The Thankless Years, p. 22.
185 Robert Armstrong, Rudimentary Treatise on Steam Boilers, London 1850, p. 98; George Piggott, 'Boiler Plate Working', in Timmins, p. 97; at Laird's Birkenhead, in the early 1890s, the larger boiler plates were bent by machinery, the smaller ones by hand (James Samuelson, Labour Saving Machinery, London 1893, p. 26).
187 Williams, Railway Factory, p. 113.
189 Lady Bell, At the Works, London 1908, pp. 68-70.
190 Ure, Dictionary, II 579-80; The Engineer, 19, 26 May 1865; Baines, Industrial North, p. 25, Ironworkers Journal, 15 April 1872, pp. 2-3; Williams, Railway Factory, p. 17.
196 Capital, p. 000.
199 Williams, Railway Factory, p. 115.
201 George Smith, The Cry of the Children, from the Brickyards, Leicester, 1871, p. 11; P.P. 1873 (c.745) XIX, Fact. Insp. Repts., pp. 14-15; P.P. 1866 (c.3675) XXIV, 5th Rep. Ch. Emp. Com., K.55,59. At a Tipton yard it was estimated that the girl clay-earners, who brought clay to the moulder's table, made 300 journeys a day, travelling 17 miles and carrying an average weight of eight tons each. They carried the clay in their arms or on the head. P.P. 1865 (3473) XX, Fact. Insp. Repts., p. 22.
202 Autobiography of Peter Taylor, p. 76.
203 P.P. 1865 (3548) XX, 4th Rep. Ch. Emp. Com., Q68; also generally ibid, QQ64-79 and pp. xli-xlv.
205 Dodd, Days at the Factories.
207 Morning Chronicle, 4 March 1850.
209 E. J. Hobsbawm, 'The Tramping Artisan' in his Labouring Men is the fundamental article on this subject.
210 Goldsmith's Coll., Samuel Kydd, 'The Condition of the People', fol. 88. 'As to the boilermakers, the numbers vary with the work. We have never less than forty or fifty, and at present we have 100', Captain Watson, Gen. Supt. Cunard Co., Rep.... Unemployed in Liverpool, Liverpool 1894; for the still greater irregularity of employment in the ship repair yards, Howell Coll., Am. Soc. of Shipwrights, 60th Q. Rep. Jan.-March 1897, p. 17, Jan.-March 1899, p. 1.
214 Coleman, Railway Navvies, p. 50.
215 The Builder, 28 Sept. 1878, XXXVI 1010-11 for an early account of it.
219 John T. Day, 'The Boot and Shoe Trade' in Cox, British Industries, p. 239.
221 Great Exhibition of 1851, Juries Reports, I 428; P.P. 1854-5 (O.11) L, Committee on Machinery, p. 52.
222 Marx, Capital, pp. 390-1.
229 For the workers' opposition cf. Jaffray papers British Museum Add. MSS., 57576, 57623.
233 Boot and Shoe Trade Journal, 23 April 1892, XXVII 535.
For the 'bull' week in the Sheffield trades (and the 'calf and 'cow' weeks preceding it): 4 July 1850. Morning Chronicle, 241


Pottery Gazette, 1 Nov. 1879, p. 128; Pottery and Glass Trades Gazette, April 1881, V 305.


Wheatman and Smith of Sheffield tried to introduce machinery into saw grinding, the men's trade union attempted to blow the works up. Frank Hill, 'Combinations in Sheffield', Trades Societies and Strikes, 1860, p. 527.

The description of earlier stages of the needle-making process is taken from Ure and from W. C. Aiken, 'Needles', pp. 106-7, in Bevan, Manufacturing Industries.


For some examples, The British Clayworker, London 1866, III 190.

When Messrs. Wheatman and Smith of Sheffield tried to introduce machinery into saw grinding, the men's trade union attempted to blow the works up. Frank Hill, 'Combinations in Sheffield', Trades Societies and Strikes, 1860, p. 527.

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The description of earlier stages of the needle-making process is taken from Ure and from W. C. Aiken, 'Needles', pp. 106-7, in Bevan, Manufacturing Industries.


For some examples, The British Clayworker, London 1866, III 190.
As the demand did not yet exist for a standardized product there were no economic advantages to be secured by building larger works, 

'Ibid., p. 35.


Floud, Machine Tools, pp. 51, 55-8

Museum of Eng. Rural Life, Reading, Ransome Collection. I am grateful to Alun Howkins for this reference.

Floud, Machine Tools, pp. 51, 55-6, 67.

Ironmonger, 30 Sept. 1865, VII 136.

Ibid., 1 March 1873, XV 291; 10 Aug. 1878, XX 799.

Samuel Sidney, "Rides on Railways", London 1851, p. 96

Marx, Capital, 337.

Ironmonger, 28 Feb. 1880, XXIII 298-9.


Timmins, p. 66.


Ironmonger, 10 Aug. 1878, XX 792.

For examples in copper brazery, Ironmonger, 15 Nov 1879, XXII 625; 25 Sept. 1880, XXIV 338.


Ironmonger, 1 Oct. 1877, XIX 388.

S. C. L. Fuller, 'Machinery in the Carridge Manufactory', Papers Read before the Institute of British Carridge Manufacturers, 1883-1901, p. 361.


Illustrated Exhibitor, 7 June 1851.

Illustrated Exhibitor, 23 Aug 1851.

Morning Chronicle, 4 July 1850.

Floud, Machine Tools, p. 49.