'The vulgar only 'scaped who stood without.' This image of liberation, one of the most powerful graphic renditions of human freedom, remains a document of 1780 and London. Its allusions to slavery, Africa, confinement, escape, death, destruction, revolution and freedom were at once documentary and prophetic.

CHAPTER ELEVEN

SHIPS AND CHIPS: TECHNOLOGICAL REPRESSION AND THE ORIGIN OF THE WAGE

I will gather chips here
to make a fire for you in fere
And for to dight your dinner
Against you come in.

Japheth's Wife in *Noah's Flood*
(The Chester Pageant, fourteenth century)

I

'Morals reformed – health preserved – industry invigorated – instruction diffused – public burthens lightened – economy seated, as it were, upon a rock – the Gordian knot of the Poor Laws not cut, but untied – all by the simple idea in Architecture!' These are the opening lines to Jeremy Bentham's *Panopticon; Or, the Inspection House.*[1] He thought he had found 'a new mode of obtaining power of mind over mind, in a quantity hither-to without example'. Whether the purpose be 'that of punishing the incorrigible, guarding the insane, reforming the vicious, confining the suspected, employing the idle, curing the sick [or] instructing the willing', he felt so certain that this 'simple idea in Architecture' could accomplish it that he spent most of his adult life trying to improve it.

The idea is perhaps now well known. Simply stated, the notion was that of a central inspection house from which radiated spokes (as it were) that contained the 'cells' in which any of a variety of activities might be carried out. The plan was meant to embody several different principles. First, is the centrality of control. Second, is the apparent omnipresence of the inspection. Third, is the invisibility of the inspector, situated in such a position that he can see all and none can see him. Finally, is the principle of isolation that makes it impossible for those confined to communicate with one another. Bentham's life-long obsession has been interpreted in psychological

[1] First drafted as a series of letters in 1787, it was published in 1791. See John Bowring (ed.), *The Works of Jeremy Bentham* (New York, 1962), vol. iv., pp. 39 ff.

terms (Gertrude Himmelfarb's 'haunted house') or as a social metaphor of total control (Foucault's 'carceral archipelago').[2] Neither interpretation accounts for the origin of the idea.

The panopticon was not in fact Jeremy Bentham's idea, but that of his brother, Samuel. He was born in 1757. In 1770, when Samuel began his apprenticeship to a Woolwich shipwright, Woolwich being one of the six Royal Navy dockyards (Sheerness, Chatham, Deptford, Plymouth and Portsmouth were the others), Jeremy took it upon himself to direct the education of his brother in the principles of algebra and Euclid and to encourage in every way his talent for mechanical improvement and invention.[3] Samuel spent less time with axe or adze than with books. Unwilling to work 'alongside', he was excluded from both craft solidarities and networks of preferment.[4] He thought the shipwrights were 'old-fashion'd'. Jeremy consoled him. 'As to the old Shipwrights,' Jeremy stated, 'if the air blowing upon them ... would give them cold, he [may] make each of them the present of an umbrella'.[5]

In 1779, unable to get an appointment in any of the royal dockyards, Samuel Bentham toured continental yards and arrived in Russia at a time of imperialist ambition that enabled him to plan and organize a shipyard in Krichev, on an estate recently sequestered by Prince Potemkin.[6] He relied upon serf labour – which, although

[2]Bentham did not neglect the problems of fortification against external threats. The lesson of the Gordon Riots was one that he also saw architecturally. The panopticon was carefully designed to repel both hostile enterprises from within and 'clandestine enteprises from without'. See ibid., vol. iv, pp. 105 ff. For the many uses that the panopticon might have, at least in Bentham's imagination, his manuscripts need to be consulted at University College, London: Bentham MSS, vol. vii, fols. 53–106. Gertrude Himmelfarb, 'The Haunted House of Jeremy Bentham', *Victorian Minds* (New York, 1968), and Michel Foucault, *Discipline and Punish: The Birth of the Prison*, trans. Alan Sheridan (1977).

[3]Timothy L. S. Sprigge (ed.), *The Correspondence of Jeremy Bentham* (1968), vol. i, p. 136.

[4]ibid., vol. ii, pp. 108 ff; M. S. Bentham, *The Life of Brigadier-General Sir Samuel Bentham* (1862), p. 189; Sprigge, *Correspondence*, vol. i, p. 157; vol. ii, pp. 156, 176.

[5]ibid., vol. i, pp. 164–7.

[6]Matthew S. Anderson, 'Samuel Bentham in Russia, 1779–1791', *The American Slavic and East European Review*, vol. xv (1956), pp. 157–72; Ian R. Christie, 'Samuel Bentham and the Western Colony at Krichev, 1784–1791', *The Slavonic and East European Review*, vol. xlviii (April 1970), pp. 232–47. The most vivid account of Samuel's Russian period is to be found in vol. iii of Jeremy's *Correspondence*.

numerous, was ill-disciplined – and about a score of workers from the armament factories of Carron. This combination of the recalcitrant serfs and the 'Newcastle mob – hirelings from that rabble town' did not work out: drunkenness, arson, theft, idleness, intrigue and sabotage prevailed. In 1786, when Jeremy visited, he found 'that the Russian Utopia was little better than a madhouse'. That summer the smith's shop was burnt to the ground, and one of the glass houses shared a similar fate.

The brothers concentrated. Jeremy wrote to William Pitt proposing that English convicts be sent to Russia. Samuel, meanwhile, had been tinkering. 'My brother,' Jeremy wrote,

> has hit upon a very singular new and I think important (though simple) idea in Architecture ... The architectural idea [in the plan of what we] call an Inspection-house is that of a circular building so contrived that any number of persons may therein be kept in such a situation as either to be, or what comes nearly to the same thing, to seem to themselves to be, constantly under the eye of a person or persons occupying a station in the centre of what we call the Inspector's Lodge.[7]

They could not put this panopticon into practice: Potemkin sold his estates, war with Turkey broke out, and the Bentham brothers left Russia without knowing whether the singular architectural idea would transform a 'madhouse' into a 'utopia', but determined with their experience to put the idea into practice in England.

In London, in the outbuildings of his brother's house, Samuel occupied himself constructing models of the panopticon, while Jeremy in the main building drafted revisions of the plan and wrote letters advancing the idea to influential people. By the 1790s Samuel's considerable experience of mechanical design and shipbuilding, together with his equally important experience of the problems of controlling a large, insubordinate workforce, came to be recognized. In 1795 he was appointed Inspector-General of the Naval Works.

[7]*Correspondence*, vol. iii, p. 501. Even in the first drafts of the panopticon literature Jeremy was careful to specify that all parts of the building be fire-proofed.

II

Any study of working-class power must begin by considering the form and value of payment. For most workers in the eighteenth century the payments were not made in money, or, when they were, such payments were only one of several forms. This was true of Russian serf labour, American slave labour, Irish agricultural labour and the metropolitan labour in London trades. Other factors such as the length and intensity of the working day, the characteristic technologies of production, the methods of circulating the materials of labour in and out of production, the ways in which the final product was appropriated – these too were either determined by the methods of payment to the producers or related to them in a common structure of social and material relations. In eighteenth-century London, just as the necessary value of labour often appeared as 'crime', so the surplus value of the ruling class appeared as 'corruption', and nowhere perhaps was this more in evidence than in the dockyards.

The pay books of any of the six main naval dockyards are readily available and can provide what appear to be the day rates of all the categories of labour employed. These were numerous. A list of them will suggest the magnitude of the problems in the heterogeneous division of labour in what was, perhaps, the largest of eighteenth-century British enterprises. Deptford Yard employed shipwrights, quarterboys, caulkers, oakum boys, joiners, house-carpenters, wheelwrights, plumbers, pitch heaters, blockmakers, bricklayers' labourers, sailmakers, scavelmen, riggers, riggers' labourmen, armourers, smiths, compass-makers. The yard as a whole might employ 900 men and boys during peace and 1,100 to 1,200 during wartime.

Each trade could consist of several grades of worker with corresponding day rates, ranging from 3s. for a master boatbuilder to 1s. for a labourer.[8] In addition to day rates, there were certain forms of overtime pay. These were measured in 'tides' – periods of an hour and a half. The tide rate for shipwrights, joiners, carpenters, caulkers, bricklayers and wheelwrights was sixpence. For labourers and sawyers it amounted to threepence. Overtime was also measured according to 'nights' – that is, the full day rate was paid for five

[8] B. M. Ranft, 'Labour Relations in the Royal Dockyards in 1739', *The Mariner's Mirror*, vol. xvii, no. 4 (November 1961), p. 290.

hours' work at the end of the normal working day.[9]

Let us look first at some *additions* to the base rate. The system of apprenticeship was controlled by the craftsmen, not the dockyard officers, and worked in such a way as to reduce the burden of work and increase the income of the 'skilled' worker to whom the apprentice's wages were paid. Apprentices were also expected to pay £2 2s. 'footing'; the penalty for non-payment was flogging with a hand-saw.[10] The officers of the Royal Naval dockyards often managed yards or supply houses of their own. At Deptford they were in a position to requisition the labour of the yard for their own purposes, so payment on these private accounts must be added to the workers' wage.[11] Against these additions several types of *deductions* from the nominal monetary wage have to be made. The salary of the surgeon resident at Deptford was paid from the men's wages. In some yards the salary of a resident clergyman was supplied by docking the workers' pay.[12] Pay clerks accepted a customary fee from workers before entering the amount of work time in the pay book. Finally, disciplinary deductions were common. Loitering, tippling, playing football or cricket, absence from the mid-morning or mid-afternoon calls, 'baseying' (bounding the walls during the working day) were all common offences punished by deductions from the monetary wage.[13]

The form and frequency of the payment of nominal wages encouraged a system of real payment whose effect was to reduce the money wages even further. In the seventeenth century, wage-payments at Deptford were often several years in arrears. While this appears to have improved *somewhat* in the eighteenth century, it was still an important enough matter to fight about, as the Deptford workers did in 1762, when wages were fifteen months behind.[14] Wages were paid only twice a year (*if* they were paid) and when the dockyard workers complained about this in the 1739 strike the

[9] R. D. Merriman (ed.), *Queen Anne's Navy: Documents Concerning the Administration of the Navy of Queen Anne, 1702–1714*, Navy Record Society (1961), p. 121.
[10] M. D. George, op. cit., p. 282; Daniel A. Baugh, *British Naval Administration in the Age of Walpole* (Princeton, 1965), p. 318.
[11] John Ehrman, *The Navy in the War of William III, 1689–1697* (Cambridge, 1953), p. 94.
[12] Merriman, op. cit., p. 109.
[13] M. Oppenheim, 'The Royal Dockyards', in William Page (ed.), *The Victorian History of the County of Kent*, vol. ii (1926), p. 376.
[14] Baugh, op. cit., pp. 316 ff.

Navy Board chastised them for their 'enormities'. If the officers at Deptford Yard wished to discharge a man they would regard an absence as grounds for marking him 'run' (deserted) and thus deny him his accumulated wages. Long arrears in payment, therefore, were a means of limiting turnover in the yard. Professional wage-buyers and creditors exerted considerable influence in Parliament, and so Deptford Yard rarely actually discharged a man without at least having his creditors repaid.[15] In cases where the wage was paid to the men – instead of being merely a wage of account settled between the Navy Office and the Deptford creditors – Navy tickets, not specie, passed hands. In theory these were redeemable at face value some several miles up the river at the Navy Office in London. In fact, during the first half of the eighteenth century they were redeemed at a usurious discount of between 24 and 50 per cent.[16] Before he entered the business of pirating Bibles, the noted philanthropist Thomas Guy made money by discounting Navy tickets at Deptford. While an initial inspection of pay books suggests the prevalence of money payment, a closer examination challenges such an assumption. The paymaster of the Navy treasury noted 'it has for time immemorial been customary' not to disburse copper money.

The inefficiencies of shipbuilding in both private and Royal Naval dockyards arose from the widespread corruption that flourished at all levels of dockyard organization, from the Commissioners of the Navy Board down to the bottom man in the sawyer's pit. It was observed of dockyard workers that their dwellings were constructed of materials formerly of His Majesty's Naval Stores, and after the naval defeats of the War of American Independence it was remarked that more ships were lost piecemeal in women's aprons than to enemy action at sea. The note of exaggeration in such remarks emphasizes the fact that dockyard inefficiency meant meat and drink for shipyard workers and their families.[17] *The Mariner's Jewel* (1724) advised the purser: 'All that you deliver by weight or measure, you must keep back the 8th part for waste.'

The nominal monetary wage was not at this time a matter of much contention. For the first half of the eighteenth century certainly the wage-rates of the main categories of trades did not change

[15] Ehrman, op. cit., p. 92.
[16] Oppenheim, op. cit., p. 376. In 1762 the discount had dropped to 7.5 per cent.
[17] Robert G. Albion, *Forests and Sea Power: The Timber Problems of the Royal Navy 1652–1862* (Cambridge, Mass., 1926), pp. 87–8.

at Deptford (or at any of the other Royal Naval dockyards).[18] But against this stability in wages must be set the vigour of protracted struggle that defended the men's control over the pace of work, the materials of labour and the structure of the labour force in the yards. In these fields of contention the men enjoyed a power – especially in wartime – that compensated for the low nominal monetary wage. Slow-downs, absenteeism, tippling and baseying were complained of constantly by Deptford Yard supervisors.[19]

At the beginning of the century the Navy Board sought to limit the winter working day to eight hours, not in order to reduce payment of tides or nights, but to eliminate 'the roguery and villainy they commit when it is beginning to grow dark'.[20] One twilight evening in 1694 the commissioner of the Chatham Yard observed 'the horrid consternation' of workers carrying out 'spikes, nails, bolts, lead, rope'.[21] Hemp and cordage were easy to take. Only the removal of large amounts would be discovered: in 1702, for example, a shipwright was stopped for 'accidentally' packing 36 lbs. of cordage in his tool-box. Copper and brass fittings were valuable items. Smuggled treenails provided the initial capital of more than one private shipbuilding enterprise. In 1729 sailmaking, which had been contracted out, took place within the Deptford Yard, and as a result canvas soon provided plentiful business for the small marine dealers outside the dockyard walls. Sailmakers would also cut out canvas and sew up breeches in the yard to sell to shipwrights and seamen for slops.[22]

Even those who were to gain a reputation for transforming the Navy into an efficient enterprise owed their wealth and power to the widespread corruption – this was as true of Phineas Pett and his sons as it was of Samuel Pepys, who made £14,000 at the Navy Board.[23] The chief remuneration of the yard workers was not their

[18] Baugh, op. cit., table 19, p. 309 for wage-rates in 1748, rates that were substantially the same in 1749; see PRO Adm., 42/540, Deptford Yard Pay Books.
[19] Ehrman, op. cit., pp. 90–92, and Baugh, op. cit., pp. 310 ff.
[20] Oppenheim, op. cit., p. 353.
[21] H. E. Richardson, 'Wages of Shipwrights in HM Dockyards, 1496–1788', *The Mariner's Mirror*, vol. xxxiii, no. 4 (October 1947), p. 270.
[22] Oppenheim, op. cit., pp. 363–4, 347.
[23] W. G. Perrin (ed.), *The Autobiography of Phineas Pett*, Royal Navy Record Society, vol. li (1918). Pett failed to reject bad timber; he repaired ships that ought to have been junked; he maintained his own personal storehouse with 'full scope withal to embezzle what he list'. James II 'protested very earnestly the cross

monetary wage, nor such dockyard materials as hemp or cordage. 'Noah's sons' worked in a circuit of wood. The perennial problem of the Admiralty and the basis of life for the men and women of the dockyards was 'chips'.

III

What were chips? What were they worth? Broadly speaking, they consisted of wood scraps and waste created during the work of hewing, chopping and sawing ship timbers. The term refers not to the wood itself but to the right of the worker to appropriate a certain amount of it – a prescriptive right since 1634. The amount of wood taken as chips depended upon the balance of forces between the dockyard workers and the Navy Board. Unlike wages, chips were negotiable and this itself was an ambiguity that benefited the men who under cover of chips might make away with all types of goods. 'There be nothing so frequent in our Minutes,' sighed an official of the Navy Board, 'as Orders respecting Chips.' When the 'chip-women' of Portsmouth were forbidden access to the yards, they rioted in protest.[24]

In 1662 it was ruled that chips could consist only in what could be carried out by one worker one day a week, a ruling that was a dead letter from the start. In 1702 the Deptford men maintained the right to take chips out of the yard three times a day and to enlist the assistance of their families in the appropriation. In 1730 the Admiralty defined chips as those 'lawfully made with Axes and Adzes, but not any sawn ends of Slabs of old Wood of any Kind'. In 1739 the Navy Board said that dockyard workers were entitled only to 'such Chips as shall be split out by their tools'. In 1752 a regulation attempted to limit the amount of chips to those that could be carried out of the yard untied under one arm. In 1764 we learn that at Deptford 'what is called the Poor, were allowed into the Yard twice a week to gather "Offal timber". In 1767 letters were published which explained the 'many Evils' arising from 'upwards of two thousand, mostly Women' who entered the dockyards on Wednesdays and Saturdays 'to take from thence the small

grain was in the men and not in the timber'. Arthur Bryant, *Samuel Pepys*, 3 vols (Cambridge, 1933–39), vol. i, pp. 171–221.

[24] Oppenheim, op. cit., p. 347; *Lloyds Evening Post*, 3–6 September 1771.

Chips and Gleanings of the Yard'.[25] It was ordered that women be allowed to partake only of the small chips and sweepings, and these were twice weekly carted to the yard gates so that the women were prevented from entering the yard itself. The custom was used to shorten the working day. In 1783 the Navy Office reported: 'The Custom hitherto has been for the Men to leave off Work perhaps Half an Hour before Bell ringing, and even during Working Hours, to cut up clandestinely useful Timber to complete their Bundles, which are frequently sold as high as 1s. each.'[26]

In 1795 Samuel Bentham took lodgings by the Portsmouth Yard gatehouse in order to make precise calculations of the amount of chips (each piece less than three feet) that were taken from the yard. He learned that they provided not only one of the main sources of fuel for the poor, but also the characteristic architectural features of the neighbourhood: 'Stairs were just under three feet wide; doors, shutters, cupboards, and so forth were formed of wood in pieces just under three feet long.'[27] To those having a right to this prescriptive custom, chips were an essential part of their ecology – in housing, in energy, in cooking, in furnishings. The intensity of the practice varied with living conditions, prices and nominal wages. It represented both a substantial source of income to yard workers and a serious loss to the Navy. Deptford workers in the seventeenth century said they could not live without the practice. Later historians have agreed.[28] It was a perquisite providing between a third and a half of weekly earnings. Yeoman Lott, a Measurer of the Clerk of the Cheque at Deptford Yard (1752–63), who knew as much about this at Deptford as anyone in the 1740s and 1760s, thought that there was a direct relation between the amount of chips taken and real wages. The price of provisions was 10 per cent higher in Deptford, he said, than in other Royal Naval dockyards, and it was this that in his experience accounted for the more serious extent of Deptford depredations. The amount and value of chips are more easily documented as a loss to the Navy than as fuel, furnishings, etc. to the workers. The most expressive statement of loss – based on computations made once at the beginning of the century and again

[25] Oppenheim, op. cit., pp. 358, 370; Baugh, op. cit., p. 321. Yeoman Lott, *An Account of the Proposals made for the Benefit of His Majesty's Naval Service* (1777), p. 8.

[26] *JHC*, op. cit.

[27] M. S. Bentham, op. cit., p. 143.

[28] Baugh, op. cit., ch. 6; Albion, op. cit., pp. 80 ff; Ehrman, op. cit., p. 95.

[29] William Sutherland, *The Ship-Builder's Assistant* (1711), p. 7. His grandfather

twenty years later – was that only a sixth of the timber entering Deptford Yard left it afloat.[29] There were many others. In the last decade of the century the loss from all Royal Naval dockyards was officially estimated at £500,000 a year. Unofficially the loss was believed to be nearer four times that amount. Yeoman Lott conducted an experiment between 1768 and 1770 designed to determine the monetary loss caused by the taking of chips. He found that in the construction of a third-rate vessel (74 guns), the proportion of lawful chips to the 'neat Content' of timber in the ship ought to be 4:11 and it was *this* proportion that he sought to re-establish. In practice he learned that 60 per cent of all grades of timber ordered for the construction of a third-rate found its way out of the dockyard in the guise of chips.[30]

Time and again the Navy sought to replace the privilege with an increase in the nominal wage. In 1663 the wage was increased by a penny a day for this purpose; but the men took the penny and kept the chips.[31] In 1783 it was proposed that fourpence a day to shipwrights and twopence a day to carpenters 'be entered an extra Sum on the Pay Books, as in lieu of Chips, that the Perquisite may never on any Pretence come into future use'.[32] This too failed. Indeed it is safe to say that any attempt to compound for the chips that did not at the same time abolish the basis of the dockyard workers' power in the job was doomed to fail. Yeoman Lott tried this partial solution, indeed he devoted the best part of ten years at Deptford in the attempt. In 1757 he presented the Admiralty with his plan of allowing 'Artificers of His Majesty's Yards an Equivalent in Lieu of their Perquisite Chips'. In 1767 he published a pamphlet called *Important Hints towards an Amendment of the Royal Dock-Yards*. In 1770 he investigated the dockyards of Amsterdam and Rotterdam. Though proposing an across-the-board wage increase of sixpence a day, his proposal at every step met with the concerted opposition of the artificers. 'He has been,' as he stated in his petition to the Admiralty in 1768, 'a great Sufferer, to the frequent Hazard

[29] William Sutherland, *The Ship-Builder's Assistant* (1711), p. 7. His grandfather was foreman of shipwrights at Deptford for thirty years. He had himself worked for fifteen years in the inspection of work at Portsmouth and Deptford. See also William Sutherland, *Britain's Glory: Or, Shipbuilding Unveil'd*, 2nd edn (1726), introduction.

[30] Lott, op. cit., pp. 33–6.

[31] Oppenheim, op. cit.

[32] *JHC*, op. cit.

of his Person and Employment, and the manifest Injury of his Property.' He was expelled from Deptford. No one would give him a job at Chatham or Woolwich – the two other Royal Naval dockyards on the Thames. When he found work as an agent for the Royal Hospital at Plymouth, his life there became one of continuous trouble. His garden plot was 'intirely destroyed and laid waste'.

The Navy's failures were the yard workers' victories – achieved by 'mutiny', 'commotion' and 'insurrection'. At the beginning of war in 1739 the Deptford workers, together with those of the other naval yards, went out on strike because the Navy had attempted to reduce night and tide work, as well as the number of chips the men could take by requiring them to unbundle their loads as they departed work in the evening. Another issue concerned whether chips were to be carried out under the arm or upon the shoulder. In June 1755 the shipwrights and carpenters of Chatham struck and boycotted the gates to prevent their perquisites from being 'injured'.[33] In October 1758 a similar issue caused the Deptford workers to strike again. In April 1768 shipwrights fought the marines over 'a Bundle of Chips', their 'Custom'.[34] The striking workers at Chatham stated: 'There is not a man amongst us who would not freely die for King and Country, but we will not tamely suffer ourselves to be made slaves to any particular man's whim, *for we are free-born subjects*.'[35] Although magistrates were summoned to read the Riot Act to the men refusing to enter the yards, the strike was finally settled by the Navy Board capitulating to the men's demands.

Thus, chips became associated with some deeply held working-class ideas of freedom and slavery. As a form of value, chips were not as desirable, useful or versatile as money, yet like money they fluctuated with prices, as the shipbuilding communities struggled to live. The Navy regarded chips as a problem of inventory control or of materials handling. In 1726 William Sutherland, author of a leading British work on shipbuilding, calculated that by abolishing the chips of the workers in order to build ships 'with another ship's chips' more than £93,000 might be saved a year, and this was an estimate based only on so-called 'rightful chips'. This was also the reason why virtually all eighteenth-century British treatises

[33] Oppenheim, op. cit., p. 373.

[34] *Berrow's Worcester Journal*, 5 May 1768.

[35] Ranft, op. cit., pp. 285 ff.

on shipbuilding began with the problem of timber supply and handling.[36]

IV

The eighteenth-century shipyard is an example of heterogeneous cooperation – that is, its internal division of labour was characterized by a series of discrete operations separated by time, place and the nature of the tools and materials. Each operation was physically independent of the others. Each required its own shops, its own tools and its own labour force. Daniel Defoe compared the shipyard to 'a well order'd city; and tho' you see the whole place ... in the utmost hurry, yet you see no confusions, every man knows his business'.[37] In the production of the ship we can identify four main stages: the preparation of materials; the fabrication of materials into components; assembly; making watertight. We shall consider each of these stages.

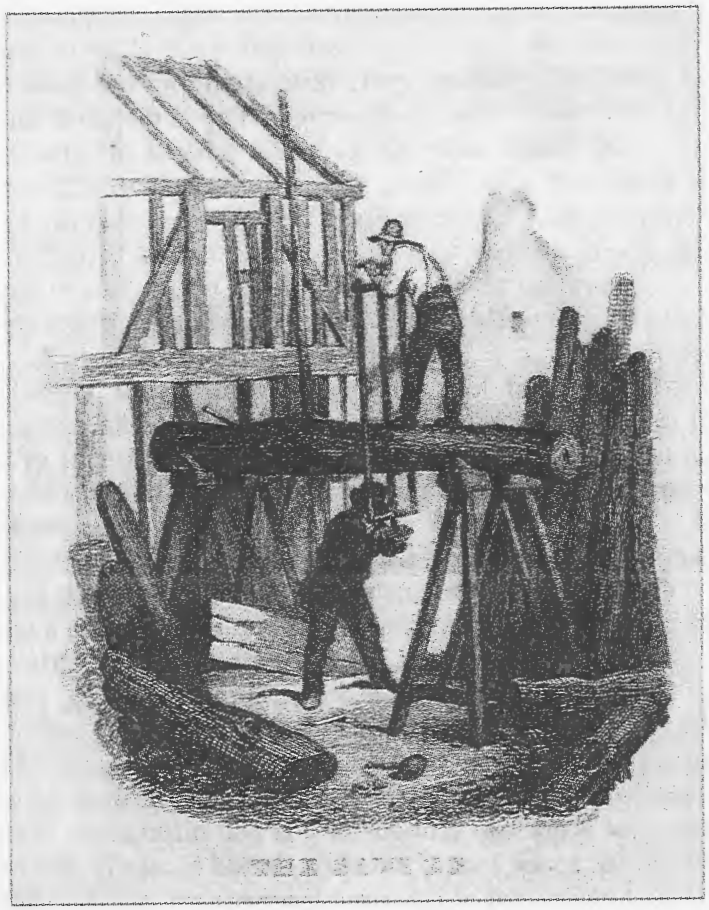
The preparation of materials consisted of two activities that were organized in such a way as to maximize the opportunity of appropriating chips – namely, the *delivery* of timber and its subsequent *conversion* into various shapes and sizes. Virtually all who wrote on the subject wished that the timber might be roughly converted to size in the forests before it was brought to the yards. Snodgrass, a leading builder for the East India Company, considered 'that timber ought always to be cut to its proper shape as near as convenient to the place where it grows'. William Sutherland thought that such a practice would reduce carriage costs alone by five-sixths.[38] But such a plan required close communication between the yards and the areas of forest supply, and accurate specifications for the required timbers. Neither circumstance existed: communication was made difficult by scattered sources of supply that were as far apart as the Baltic and New Hampshire; and accurate specifications required a degree of standardization that did not yet exist. Any large warship would require about 2,000 oak trees in its construction. The *Royal*

[36] Sutherland, *Britain's Glory* (1726), for example, begins with a chapter entitled 'Observations for Regulating the Price of Timber'.
[37] T. S. Ashton, *An Economic History of England: Eighteenth Century* (1955), p. 113.
[38] Sutherland, op. cit., p. 7.

George, a ship of 100 guns launched in 1756, required 2,309 loads (a load = fifty cubic feet) of straight oak and 2,306 loads of compass (curved grain) oak. Before 1771, little attention was paid to the seasoning of timber – large stocks were laid up in the yard, the thick stuff and sawn planks were not properly stacked or separated by battens. Knees and other joining pieces were rarely stored in drying sheds. Some blamed the weakness of British ships upon the practice of using green timbers instead of well-seasoned wood in construction – a practice that was said to have resulted from the men taking the mature timber for chips and leaving the green stuff for production.

The conversion of logs into rough timber took place in the various saw-houses scattered about Deptford Yard. In terms of the volume of wasted timber it was perhaps in the process of rough conversion in the sawyer's pit that most of the largest chips were created. (Samuel Bentham was one of the first to consider the construction of steam-powered saw-mills in order to avoid such waste.) The whip saw used for rough or planking work possessed a broad blade of 7 or 8 ft. in length that was supported in a wooden frame. Two men operated it. The topman sharpened the teeth, marked the timber with a chalked line along its length, and held the tiller. The pitman held the box end of the saw and worked from the bottom of the sawyer's pit – a cavity dug in the ground about 12 ft. long, 6 ft. deep and 2 ft. wide. He also positioned the log on its rollers. The work was arduous. It was also impressive: 'It's really very admirable to see how Two Men should so nicely and exactly strike their Stroke, and at the same time not see one another.'[39] It was precisely the arduous and 'nice' nature of the work that made it vulnerable to increased exploitation. 'A sawyer's no robber – What he takes from one side he gives to the other,' as the saying went. As easily as he might be no robber, he might be one as well. As a result, sawyers were the first category of workers in the shipyards to be placed on piece-rates. Towards the end of the seventeenth century some sawyering knowledge was published. Sutherland devoted six pages to the problems of timber measurement and saw-tooth design. The sawyers determined the rate of work, because they and not the officers determined the dryness or greenness of the timber. Furthermore, 'Men's Notions differ mightily on this Particular of Converting Timber to the best Advantage',

[39] ibid., p. 60.



A sawyer

depending on the grain of the piece and the shape of the piece to be sawn, with the result that none but the sawyers were in a position to decide, and this became another source of their using piece-rates to good advantage as well as producing 'waste'. When in 1768 a steam-powered saw-mill was constructed only a few miles from Deptford, it was no sooner completed than it was destroyed. A generation would pass before another such attempt was made in the London area.

In the fabrication of components the shipwright exercised his art

and craft as one of 'Noah's Sons'. His 'mystery' had been appreciated for centuries: it defied the law that heavy solids should sink and it delivered 'man' from the deluge (in some English traditions, Mrs Noah refused to enter the ark). Edmund Bushnell wrote in *The Compleat Ship-Wright* (1664): 'Yet their knowledge they desire to keep to themselves, or at least among so small a number as they can.' Knowledge of shipbuilding could not be obtained from books, and it is doubtful that books – except those containing mathematical tables – could have been of much assistance at all prior to the 1770s. From the shipwright's point of view the gap between imagination and reality was mediated not by print, but by pricking-out. The mould-loft was the *sanctum sanctorum* where the imagination found practical exercise. There on a vast floor the shipwright worked on his knees, laying out his patterns, tacking them on the floor, setting his fairing lines, and 'proving the frames', so that the proportions of the components – the transoms, keels, futtocks, knees, etc. – would remain true to the whole. From the shape and dimensions of a single piece an experienced shipwright could imagine the shape and dimensions of the finished ship.[40]

Once the shipwright had laid out his patterns, the next step was to fashion the roughly converted timber into components. This was also an art, since the components were not standardized. His tools were the adze and the axe. Adze work was close to the feet and toes. It was a 'universal paring instrument'.[41] As sharp as a razor and as heavy as shot, its use required delicacy and strength. A skilled shipwright, like Kline Falkenham, son and grandson of shipwrights, 'can take a chip off as thin as a piece of paper'. The futtocks provided the rib-like frame of the hull. For a large vessel a futtock might be 11 ins. thick and 18 ft long. Some would have double curves in their length. Each had to be hewn out of rough timbers by axe and adze. They were strongest, of course, when the natural grain of the wood ran with the curve of the final piece. Especially true in the construction of these timbers, but a rule that might apply to all of eighteenth-century shipbuilding, was the fact that the larger the individual component piece the more the skill required in its handling and fabrication – also the greater the loss caused by an error.

[40] As Kline Falkenham was able to show me at the Lunenberg shipyards (Nova Scotia) on 3 June 1981 in the mould-loft where he had laid out the HMS *Bounty* for the second MGM film.

[41] John Fincham, *A History of Naval Architecture* (1851), p. 81.

In 1726 it was estimated that in the construction of a futtock or ship's beam the proportion of wood in the piece to the rough timber from which it was fashioned was 7:25 – a proportion that gives us an idea of how chips were inherent in the work.[42] The ship's knees were pieces of timber that attached the cross-beams to the frame of the hull. To fashion the ship's knees was especially challenging because the shipwright had usually to cut across the grain. The first English shipbuilding manuals paid special attention to the methods of forming knees from blocks of wood so as to minimize the wasted pieces.[43]

In the assembly of components we shall look at only two methods of attachment that afforded scope for 'waste': scarphing and treenailing. The first method involved cutting the ends of the futtocks so that they would overlap one another by six or seven feet without increasing the thickness at the join. It can be easily imagined how an error or misjudgement with the adze might 'waste' one of these graceful parts.[44] The second method of attachment depended on the treenail. A treenail was a cylindrical piece of wood that was used to attach the outer and inner planking to the ship's frame or to attach various parts of the frame itself together. Many thousands of them were necessary to the construction of any ship. They were made from oak, generally from pieces towards the top of the tree where wood was most likely to be free of knots. The treenail had to be straight-grained so that it would not fracture upon being driven in. The oak was first sawn into appropriate lengths. Then it was split (finding the grain) into thinner pieces before being worked with the spike shave. Finally it was shaped with the router plane or moot. This was a tool that consisted of two adjustable halves (so that it could be used for different diameters) with a throat plated to resist wear. 'Great part of the Piece [was] wasted for the sake of the But' – that is, for the tapered conical head. Often the middle part of the treenail was thinned somewhat so that it did not have actually to cut the wood (often itself of oak) that it was driven into. During the first half of the century a man might get 6s. for making 1,000 treenails a foot long, and 30s. for 1,000 a yard long. The scope for

[42] Sutherland, op. cit., pp. 36–7.
[43] ibid., pp. 129–30.
[44] Scarphing methods are described in George Dodd, *Days at the Factories; Or, the Manufacturing Industry of Great Britain Described* (1843), p. 463.

waste was huge. William Sutherland found that about £5,000 was lost a year in treenail-making.[45]

The holes in the timbers designed to receive the treenail were bored with a long-pod auger whose bit might be one or two inches across, a 'shell' less likely to 'wander' or follow the grain. The auger's cross-handle was of considerable length so that greater torque could be applied. Extreme care was required in matching auger to treenail: if the match were too tight the planking or framing timbers might be split or weakened, if it was too loose the ship would soon leak. Besides skill in judgement, great strength was required: the wood was often hard, the depth that had to be bored sometimes exceeded four feet, and always the men were placed in awkward positions – now standing on the scaffolding, high above the ground, now horizontal, working close to the keel.[46] In driving treenails William Sutherland 'observed very great Controversies'.[47] The percussion of the hammers had to be exactly true, otherwise planks might split, frame timbers weaken and neighbouring treenails loosen.

The work of making watertight was performed by the caulker. His tools consisted of hammer and pitch-pot; his materials were oakum, leather, pitch and tar. With these he filled the seams between the planks. Seams might vary greatly in depth – from a few inches to many feet – and they were often located in awkward places. Beneath the hull, for instance, the caulker had to prise open seams resting on his back and hammering upwards. These workers resisted Sutherland's attempt to find objective criteria for measuring their work: 'The Caulkers will allow that there can be no Rules given: but Caulking must *of Necessity depend wholly upon the Judgement of the Workman, or true Breed Caulkers, as they term themselves.*' Sutherland, not himself a caulker, had his own opinions. 'I have really seen several experienc'd Caulkers at some times ease their stroke, and at other times force it, and yet in the very same Seam, and in a short Distance, which by any reasonable Man cannot be allowed for good

[45] ibid., p. 486; Sutherland, op. cit., pp. 51–2.
[46] R. A. Salaman, *Dictionary of Tools used in the Woodworking and Allied Trades, c. 1700–1970* (1975). A magnificent volume of social history! See also Nathaniel G. Clark, *A Scale of Prices for Job Work, On Old Ships ... for the Shipwrights of the River Thames* (1825).
[47] Sutherland, op. cit., p. 54.

Work.' He sighed the sigh of productivity specialists: 'You may constantly attend on the Working Man, and he may also seem very forward in his employment, and yet but to very little purpose.'[48] The caulker's hammer drove the pledgets of oakum between the seams of the ship's timbers. 'You got to be at it day and night' to learn to use one properly. The caulker judged how hard to hit by listening to the sound the hammer made on impact.

Like the shipwright, the eighteenth-century caulker shrouded his knowledge in sacred mystery, and this was the first thing that the caulkers made certain that William Sutherland understood. 'The caulkers in Sacred History are termed wise Men of Gebal.' The reference is to Ezekiel 27:9, in which the prophet in exile preaches against Tyre: 'The ancients of Gebal and the wise men thereof were in thee thy caulkers.' In this tradition the wise man and the craftsman were identical, sharing a Faustian combination of technical knowledge and demiurgic power. Many must have been the instances in storms or high seas when mariners thought of these 'wise men'. Yet the age of the Enlightenment sought to distil the practical knowledge of the 'craftsman' from the mysterious airs of the 'wise man' where wisdom was a form of 'idleness', or in this case, resistance to the introduction of piece-rates.

Our examples of the preparation, fabrication, assembly and sealing of a ship suggest a few conclusions. First, the meanings of waste, raw material and finished product were unclear. Second, the meanings were often opposed. What were chips to one were ships to another, and vice versa. Third, such techniques and skills as we have indicated had determinable consequences upon the design, reliability and longevity of the ships, and hence upon the relative strength of the fleet of the Royal Navy against that of other maritime powers.

V

'The English navy was, in fact, in a very bad condition as regarded the building of ships,' wrote a nineteenth-century authority on the

[48] John Fincham, *A History of Naval Architecture* (1851), p. 81; William Sutherland, *Britain's Glory; Or Ship-Building Unveil'd being a General Directory for Building and Compleating the Said Machines* (1726).

history of naval architecture.[49] Another wrote of English ships: 'They were crank, in general heavy sailors, of ill stowage, confined, and inconvenient in the hour of battle.'[50] Ships did not last as long as those of other fleets. Such improvements in design that were made owed more to what was learned from captured enemy vessels than to the ingenuity or talent of English shipwrights.

In 1738 Sir John Norris attempted to have the shipwrights standardize ship design.

> Every particular ship has been built, or re-built, according to different proposed dimensions. Those of the same class or denomination have been built of unequal size and proportions: so that the furniture and stores for one ship have not fitted another of the same rank; which has been the cause of infinite inconveniences to the service, as well as of a great increase in the expense of the navy.[51]

More was affected than furniture and stores. Two ships of the same rate could contain widely differing amounts of timber, even in their frames. The 74-gun *Thunderer* used nearly eighty loads more of timber in her construction than did the *Princess Amelia*, a ship that was actually in a class *above* the *Thunderer*. In 1685 it was stated at Chatham Yard: 'Were it not better done to have a certain size, figure, kind and value of ornament for every sort of boat of every rate, well digested and established as a standing rule not to be departed from?'[52] The relation between wasted timber and unstandardized design was well known. In 1726 Sutherland devoted his major text, *Britain's Glory*, to the thesis that by reducing the lost timber from five-sixths to a half he might at the same time build ships that lasted thirty years instead of twelve.

Little progress was made in the science of shipbuilding in eighteenth-century England. 'Success, in all probability, was more attributable to a coincidence of blunders innocently committed ... than to any regular and established system resulting from theoretical knowledge and studious application.' Such was the harsh judgement of John Charnock in 1800. Malachy Postlethwayt and Fincham made similar points contrasting science to experience.[53] At the

[49] Fincham, op. cit., p. 81.
[50] John Charnock, *History of Marine Architecture* (1800), vol. iii, p. 106.
[51] ibid., p. 123.
[52] Bryant, op. cit., vol. iii, p. 197.
[53] Charnock, op. cit., vol. iii, p. 52; Malachy Postlethwayt, *The Universal Dictionary of Trade and Commerce*, 3rd edn (1766), vol. ii, article called 'Shipping'; Fincham, op. cit., p. 177.

beginning of the century Sutherland wrote: 'But the Qualifications requisite to make any Man a Master are really so many, as well in the Theory as in the Practick Part, that it's almost impossible such Qualifications should be concentrat'd.' Earlier he had written: 'Out of the vast number of Shipwrights that are in England, there are scarce two of one Opinion; so that our occupation, altho' very useful, is no other than a Notion.' 'For was it demanded of our celebrated Shipwrights, what the Body of a Ship is, the Answer would be, An irregular confus'd Body.'[54]

If we can summarize these views of ship construction as either empirical ('coincidence of blunders', 'experience') or systematic ('theoretical knowledge,' 'science'), then it is important that we recognize that in the history of eighteenth-century English shipbuilding the former was associated with the working artificers and the latter with those like Sutherland, Snodgrass and Bentham, who, though intellectually systematic, were opponents to the practices of the yards, and the workers' circuit of wood. By the 1770s and the American war it had become clear that the seaworthiness and fighting qualities of the English ships depended upon the social and material nexus of chips. In the American war, the Royal Navy suffered a loss of 200 ships sunk or captured by the Continental Navy, and losses of an additional 600 vessels to privateers. Moreover, it was the sluggishness of the British fleet that prevented it from arriving before the French at Yorktown in order to cover Cornwallis's retreat.

VI

'The efficiency of a yard ... depended not only on its equipment but also on its organization, and particularly on the control which could be exercised over the workmen.' In this way the historian of the Navy of William III summed up the problem.[55] The naval authorities attempted seven solutions.

First, inventory identification. At the Restoration, when James, Duke of York, assumed the office of Lord High Admiral, his first

[54] Sutherland, op. cit., p. xxv; Sutherland, *The Ship-Builder's Assistant* (1711), p. 28.
[55] Ehrman, op. cit., p. 88.

action was to promulgate a rule designed to detect the theft of naval stores: timber and metal goods were to be stamped with a broad arrow; cordage and sailcloth belonging to the Navy were to be marked by a strand of characteristic thread.[56] But as all marine stores regardless of their owners came to be marked in this way the purpose of the regulation was defeated. 'An Act for the better preventing the imbezlement of his Majesty's Stores of War' (9 & 10 Wiliam III, c. 41) passed in 1698 made the practice of marking private stores with the King's sign (the broad arrow on timber, a blue streak in canvas, and a contrary thread in cordage) illegal and punishable by forfeiture of the goods and a £200 fine. In 1722 another Act made this one perpetual and allowed judges considerably more discretion in punishment: in addition to forfeiture and fine, they could now pass sentences of whipping, imprisonment or consignment to the workhouse.[57] By the 1760s the phrase 'red sail-yard docker' became a cant term referring to those who made a living by smuggling the King's naval stores.[58]

Second, fortification. Access to the yards was controlled by enclosing them. Unlike the fortifications surrounding Sheerness or Portsmouth with their bastioned tracing, counter-guards and mortared curtains, the lines formed by the Woolwich and Deptford brick walls were simplicity itself, interrupted only by a walled corridor at the main gate, an architecture designed to contain an enemy within not to repel one without. In 1670 the enclosure of work at Chatham behind brick walls was accomplished against the opposition of the shipwrights. Those at Deptford had been enclosed earlier though not with great effect.[59] At the accession of George I the private passages through the walls backing the houses of the yard officers were bricked up.

Third, security personnel. Access and egress were decisive. A gate is only as strong as its porter. The duties of the Master Porter at Deptford, besides attending the gate, included ringing the work bell at proper times, controlling the walls and private passages through them, preventing baseying, and – in the absence of the Master Shipwright or his assistants – searching 'all shipwrights and

[56] Oppenheim, op. cit., p. 351.
[57] 9 George I, c. 8.
[58] George Parker, *A View of Society*, vol. ii (1781), and Francis Grose, *A Classical Dictionary of the Vulgar Tongue* (1785).
[59] John Hollond, *Two Discourses of the Navy*, Navy Record Society 1896, pp. 97–8.

caulkers going out of the Yard and to take from them all timber, plank or which under the pretence of chips, he may find them carrying with them'.[60] He was assisted in this work by the form of the gate, a sluice, that forced the flow of departing men to trickle, so to speak, rather than flood out. Opposite the porter's office was another department responsible for general security – the Watch. There were 87 on the pay books in 1749 – the third most numerous (behind shipwrights and labourers) of 23 categories of labour employed at Deptford.[61] Rotated in day and night shifts, their job was to patrol the walls and to guard against night-time depredations. Paid but a shilling and a penny a day, they colluded with those they were supposed to watch. As a result the Navy Board in 1764 posted a permanent detachment of marines at Deptford to guard the yard.

Fourth, recruitment. Attempts to improve efficiency by controlling the recruitment to the yards also failed. Shipbuilders in the sixteenth and seventeenth centuries had often been impressed to work in the yards, though by the middle of the seventeenth century voluntary enlistment had become the rule. In the eighteenth century forced labour in the Thames yards appeared to have been important only during the Queen Anne wars.[62] In 1739 and 1755 the apprenticeship system was attacked but the strikes of those years defeated attempts at the 'dilution' of labour. 'Servants,' as Commodore Steward informed Lord Sandwich, provided 'a large supply of active good young workmen by which means you were enabled at all times when mutinous or disorderly behaviour took place to discharge those principally concerned, and in that way supported proper subordination'.[63]

Fifth, divestment. On 4 August 1783 the Navy Board issued the following order to the yards: 'You are not to suffer any person to pass out of the Dock gates with Great Coats, large Trousers, or any

[60] *Parliamentary Papers*, vol. vii (1806), Sixth Report, pp. 323–38. The investigation of the Deptford Yard was conducted in the summer of 1787.

[61] PRO Adm., 42/408 (Deptford Ordinary, 1748–9). Both Baugh, op. cit., and Ranft, op. cit., omit the watch from their summaries of the structure of the Deptford labour force.

[62] E. P. Jupp, *An Historical Account of the Worshipful Company of Carpenters of the City of London* (1848), pp. 183–7, and N. Macleod, 'The Shipwrights of the Royal Dockyards', *The Mariner's Mirror*, vol. xi (July 1925), pp. 282–3; *Journals of the House of Lords*, vol. xxvii, pp. 649 and 661 (February 1752).

[63] Oppenheim, op. cit., p. 379.

other Dress that can conceal stores of any kind ... No trousers are to be used by the labourers employed in the storehouses.' This remained in force throughout the Napoleonic Wars. The 'King's armour' was thus kept by 'unaccommodated man'.[64]

Sixth, criminalization. Over our trouserless, thrice-watched, walled and incarcerated shipbuilder was cast, as a last resort, the shadow of the gallows. An Act of 1589 was brought 'against the imbezelling of armour, habiliments of war and victuals'. An Act of 1670 (22 Charles II, c. 5), by removing benefit of clergy, imposed a mandatory punishment of death.[65] No one in London or Middlesex was hanged under these Acts during the first half of the eighteenth century; the Admiralty preferred to exercise less drastic violence. In the seventeenth century the construction of stocks and a whipping post inside the Chatham and Deptford yards was to no avail: they were no sooner built than torn to pieces. Statutes passed during the reigns of the first and second Georges enlisted the magistracy and the criminal sanction in the fight against 'filching' – 1 George I, c. 25 (1714) and 17 George II, c. 40 (1749).

When Lord Sandwich took his seat on the Admiralty Board in 1749, one of his first acts was to visit all the Royal Naval dockyards and rope-walks. With his brother Lords of the Admiralty he found in June that 'gross negligence, irregularities, waste, and embezzlement were so palpable, that their Lordships ordered an advertisement to be set up in various parts of all the yards, offering encouragement and protection to such as should discover any misdemeanours'.[66] Placards were stuck up. They had little effect. From the evidence of the Kent judicial records (the Deptford and Chatham yards were within the county of Kent), it appears that, if the Acts were used at all, they were not used against those appropriating timber products. During the 1720s there are no examinations, confessions or depositions in the records against the misappropriation of naval stores of any kind at the yards. In the mid and late 1730s the picture changes. In 1736 a master shipwright informs against a bricklayer for taking sheet lead. The next year a foreman turns in a shipwright taking an

[64] Richardson, op. cit., p. 379; Roger Morris, *The Royal Dockyards During the Revolutionary and Napoleonic Wars* (Leicester, 1983), p. 94.

[65] Blackstone, *Commentaries*, bk. 4, ch. 7, sect. 4, treats the felony as an instance of those 'Injurious to the King's Prerogative'.

[66] John Barrow, *The Life of George Lord Anson* (1839), pp. 214–16.

iron eye bolt.[67] These two cases are notable for not involving misappropriations of timber. Thus, despite the new Acts that were passed, it is clear that the men's power in the yard was great enough to enforce their definition of 'lawful Chips' despite the newly expanded criminal sanction.

We find no evidence in the judicial repositories for 1754–6 and 1767–8 that the criminal sanction was used against the yard workers' appropriations. But in the 1770s the situation changes somewhat. A Deptford caulker informs against a 'labourer being in want of Money' caught taking 'some Working Tools'. Many examinations and depositions survive for the 1770s against shipbuilding-related crimes that take place *outside* the yard or within the confines of *private* yards or on board ships moored in the river waiting to be hauled into dry dock for hogging, careening or other major repairs. In December 1774 at Deptford Yard we find the first instance of the use of the criminal sanction against those appropriating timbers, when a worker was caught cutting a hole in the oar-maker's store-house.[68] In 1775, when Lord Sandwich sought to introduce task work into the yards, the judicial records are full of accounts of the yard workers threatening and assaulting their officers, but there is nothing about any punishment for the appropriation of chips. Nevertheless, it appears that in the following years the criminal sanction was increasingly used; foremen, clerks, porters and surveyors were now inspecting even the 'bundles of chips' though not apprehending the men carrying them if they contained nothing but wooden chips.[69] By the 1790s the courts began to restrict those entitled to chips, and punishment became frequent. William Page was sentenced to six months in a house of correction for 'feloniously stealing'. 'I took him by the collar,' said the shipbuilder. 'Says I, what have you got under your arm. He said, chips. I told him, not being a ship-wright, he was not entitled to them.'[70]

Seventh, task work. The abolition of day rates of pay and the introduction of 'task work' amounted to the most systematic attempt to remove the right to chips. In 1752 the Admiralty rebuked

[67] KRO, Q/SB, Sessions Papers, 6 December 1737. Our sample for the 1720s included only the years 1721, 1722, 1723, 1728 and 1729. See also the depositions of 20 November 1738, 18 December 1739, 23 August 1739 and 16 August 1739.
[68] ibid., 5 December 1774, 14 December 1769, 3 January 1770, 18 June 1770, 10 August 1770, 9 August 1770.
[69] ibid., 20 July 1775 and 18 July 1775.
[70] Morris, op. cit., p. 94, and *The Proceedings*, 10 January 1798.

the Navy Board for failing to execute its positive injunction that task work be introduced throughout the yards. The scheme was a favourite with Lord Sandwich, who, faced with the parliamentary investigation into the conduct of the Navy during the American war, had cause to elaborate at length on the issue and account for its failure. He calculated that a shipwright working on time with double tides might make 4s. 2d. a day. With task work, the working week would be five hours shorter and wages 5s. 3d. a day.[71]

In August 1775 the Lords Commissioners of the Admiralty received a comprehensive 'Scheme of Task Work for Shipwrights', which provides us with some evidence about how the system was supposed to work. The document was based upon the limited experience of the previous year at Deptford Yard, where two frigates, *America* and *Culloden*, were built under conditions of task work. Under this pay scheme, the workers were to be reorganized. They were to work in gangs of twenty, supervised by a quarterman or fireman who would set the tasks, determine the time for completing the task, keep track of raw materials, and see that the work was performed 'in a substantial, workmanlike manner ... particularly for the well-driving of the Treenails ... and for the goodness of Materials'. People called 'Single stationed Men' were to keep track of the materials. Despite the view expressed in the 'Scheme' that its execution would benefit 'the Public and the Workman', the men at Deptford 'were not inclined to it'.[72]

In 1775 Sandwich reported that 'factions, enthusiasm, obstinacy, and ignorance ... kept the artificers in dire opposition to work in that mode'. An issue of power was at stake, as the *Annual Register* in its report of the coordinated strikes against task work recognized: the system would put it 'in the power of any petty officers to deprive them of the hard-earned reward of their labour'.[73] Lord Sandwich appreciated this fact too and wistfully remarked: 'In this country of liberty, the idea of forcing people to work in a manner they dislike would not be generally approved, and might occasion great uneasiness, possible general commotions.' The simplification of

[71] G. R. Barnes and J. H. Owen (eds), *The Private Papers of John, Earl of Sandwich, First Lord of the Admiralty, 1771–1782*, Navy Record Society, vol. iv (1938), pp. 363 ff.
[72] *Shelburne Papers*, vol. xliv, 'Dockyard Artificers and Stores', fol. 7 (22 August 1775), William L. Clements Library, University of Michigan.
[73] *Annual Register* (1775), pp. 168–9.

superintendence, the intensification of labour, the control over the materials of labour, and the reduction of income that would have followed in the wake of the operation of task work could not be attained without first being able to determine the meaning of the 'task' itself. The only way that that could be achieved was by revolutionizing the labour process – that is, by a fundamental change in the relations between men, instruments of production and the materials of production. We may now return to Samuel Bentham.

VII

We left Samuel Bentham in the outbuildings of his brother's Westminster property. There he tinkered with his wood-planing mill, the panopticon and other inventions. In 1794 Jeremy and Samuel Bentham testified before a House committee that was considering a 'Bill for preventing frauds and embezzlements in dockyards'. They were concerned to 'introduce Good Morals among the lower Orders of the People'. This could be established only by reducing their income, whose form, they said, produced bad morals. 'Few Servants after they live a Short Time in London and get a Taste for its amusements and Consequently a Desire to possess Money to gratify their new wants but are corrupted by the ready means they find of obtaining it at these Iron Shops.'[74] The number of such shops had increased twelvefold over the past twenty-five years. Regular manufactories were established for the removal of the coloured strand from the King's cordage, others for the purpose of knocking off the broad arrow from copper bolts, new spikes, nails, hoops and copper sheathing. All stores, shops, inns, taverns and lodging-houses were supposed to be inspected, licensed and monitored by a newly formed police. Yet the Benthams agreed that in the circumstances of 1794 'any attack at the present crisis on so large a Body of fraudulent People would be dangerous to the State', because 'they hold Political Opinions favourable to any Set of Men who are at present hostile to the Government'.[75]

Counter-revolutionary war was the 'present crisis', and it demanded ships. Samuel Bentham's attack could not appear political. Yet, while an attack through the labour process seemed indirect, it had

[74] University College, London, Bentham MSS, box 149, pp. 14, 18, 17.
[75] ibid., p. 1.

profound effects. Appointed Inspector-General of the Naval Works in 1795, his genius of mechanical command found realization; he became 'the great innovator ... of dockyard development'. In her memoir of his life, Samuel's widow introduces his first actions in the yards in a significant way: 'He therefore began by classing the several *operations* requisite in the shaping and working up of materials of whatever kind, wholly disregarding the customary artificial arrangement according to trades.' Once this had been done, he was able to contrive machines 'independently of the need for skill or manual dexterity in the workman'.[76] He was able to 'reform abuses' by revolutionizing every aspect of the management and work of the shipyard. He systematically classed operations according to 'the materials to be wrought' 'without regard to the popular divisions of trades' and for the purpose of introducing machines.[77]

His largest creation was the 'floating dam'. By making the dock capable of receiving a fully loaded ship, masts, rigging, fittings, armaments, furniture and stores no longer had to be removed from the ship in its transition from river to dry dock. It had taken five or six days for 700 men to strip a ship for dry dock, and then as much time again to fit her out when the repairs were completed. The floating dam, however, together with his improved method for mooring vessels alongside the quay, saved the time and expense of this exercise, and also removed one of the main occasions for embezzlement.[78]

He introduced a new method of joining wood, which he called, with delicate spelling, 'coqueing'. This produced a mortise-and-tenon join – a 'coque'. 'The most important advantage obtained by this invention is the very great additional strength given to the parts of ships so combined' – and other considerations were that such a method would save 25 per cent in wages, that it admitted the use of smaller timber, and that it removed the necessity of hewing out the scarphs. Furthermore, as the task itself was simplified, it became possible to design engines for making the coques and effective tools for sinking them.[79]

[76] M. S. Bentham, op. cit., p. 98; Morris, op. cit., pp. 46–54, summarizes his technological achievements.
[77] Samuel Bentham, *Services Rendered in the Civil Department of the Navy in Investigating and Bringing to Office Notice Abuses and Imperfections* (1813), p. 140.
[78] ibid., pp. 50 and 54; M. S. Bentham, op. cit., p. 148.
[79] Samuel Bentham, op. cit., pp. 86, 138–9.

He designed new treenails that were less likely to wound the wood, and more likely to resist moisture or decay. They could be made by machine and, owing to their greater joining effectiveness, fewer of them were needed for any ship. Therefore, fewer workers were needed, and those who remained could not find opportunity for making chips. He made better mooting machines and pointing tools. His invention of a separate punch for the hammering of treenails prevented them from splitting. He designed, made and introduced auger shanks possessing a universal joint, thus eliminating opportunities for chips that treenail-borers had theretofore enjoyed.[80]

In the reformation of abuses there really seemed to be no part of the ship's construction that Bentham did not touch upon. He said that he did 'away with the uses of Knees, and introduced in their stead for connecting the deck to the sides, a thick String-piece along the sides of the Vessels, under the beams'. (He was not the first to have 'done away with Knees'. Gabriel Snodgrass had caused a great change in them in the 1770s for the ships of the East India Company.[81]) Bentham made other 'improvements' that accorded with what he called the 'principle of inter-convertibility'; he attempted to apply this principle to every part of the ship in its construction, fitting and furnishing. A strict proportionality among the rates would not only have standardized ships of a particular class but would have made some parts of all rates interchangeable.[82]

Bentham realized that the biggest revolution in shipbuilding would come with the replacement of wood by metal. He was far too sensible to expect that this could be done at a stroke, so he contented himself with the provision of a millwright's shop at each yard and the mechanization of tools. He introduced several wood-working machines capable of planing, rebating, mortising and sawing in curved, winding and transverse directions. But of more importance than these were the carefully planned steps taken to introduce a steam-powered saw-mill for the conversion of rough timber – a process more responsible than any other for eliminating chips. He was well aware that such an innovation had its dangers, for it had been the 'machinations of sawyers' that had destroyed Dingley's steam-powered saw-mill in 1768. The first such engine was for the purpose of pumping up clear water for the men to

[80] ibid., pp. 86–7, 139–40.
[81] Westcott Abell, *The Shipwright's Tale* (1948), p. 95.
[82] Samuel Bentham, op. cit., pp. 111–13.

drink. When it was demonstrated – and for the novelty Lord Hugh Seymour came down from London – the machine's piston-rod broke. A copper nail had been placed in the cylinder.[83] Perhaps it was reasons such as this that led Sir Thomas Trowbridge to say, 'All the master shipwrights ought to be *hanged*, every one of them, without exception.'[84]

Such changes permitted Bentham to alter the job structure of the yards, and with it the wage structure. First, he attempted to reduce the denominations of artificers as much as possible. Second, within each denomination he established two or three classes according 'to their degrees of ability, diligence and good behaviour'. Thus social tractability was tied directly to the wage rate.[85] He established the principle of 'INCESSANT WORK', as he wrote it – namely twenty-four-hour shift work.[86] He devised and introduced as many closely covered docks as possible. These changes permitted the introduction of piece-work in 1801–3, which even though it was met by a great strike had nevertheless come to stay. Bentham alone was not responsible for the change, nor did it occur at a single stroke. Shipbuilders suffered an array of repression. A blacklist circulated from 1795; embezzlement was again criminalized in 1800; in addition to 1,100 made redundant by the peace with France, 450 shipwrights were discharged for disciplinary reasons in 1801; the artillery was deployed against rioting shipwrights the same year. So the technological repressions of Bentham were clearly assisted by other forms of repression, and when 'chip money' of 3d. a day for labourers and 6d. a day for shipwrights was introduced in July 1801 the ancient custom of chips had been decisively defeated.[87]

Bentham was deeply committed to crushing the power of ship-yard workers, not just in his day but for the future. Therefore he paid close attention to the abolition of the ship workers' apprenticeship system. He wished to establish 'Naval Seminaries' that would divide knowledge according to class: 'the common workman' and the 'superior officers' would attend different branches. Courses in mathematics, physics and other sciences necessary to the building and sailing of ships would become mandatory. When it was objected

[83] ibid., p. 144.
[84] ibid., p. 216.
[85] ibid., p. 192.
[86] ibid., pp. 15, 54–5.
[87] Morris, op. cit., pp. 121–3.

that an increase in the number of men competent to do shipbuilding work would mean more trouble, Bentham answered: 'It is well known that an increase of the number of workpeople in any business is the most effectual bar to combinations.' As all would have to study the shaping and designing and working of metal, the way to the full removal of wood was clear, and an era of metal ships made possible. John Fincham wrote: 'In addition to the ... intelligence necessary to official competency, their sentiments and associations ... would fit them to command with proper effect.'[88] In other words, class despotism in the yards would now be fully planned and grounded less on force than on 'rationality'. Science and command were now allied, and the productive power of the yard would thenceforth appear to be less the result of the cooperation of workers than a force of capital.

> We propose to take all the important decisions and planning which vitally affect the output of the shop out of the hands of the workmen, and centralise them in a few men, each of whom is especially trained in the art of making those decisions and in seeing that they are carried out, each man having his own particular function in which he is supreme, and not interfering with the functions of other men.[89]

The words are not those of Samuel Bentham, but of Frederick Winslow Taylor writing a century later. The comparison with Taylor may have struck the reader before this point. Both Bentham and Taylor were early in life confronted with the forms of workers' power in a labour process characterized by the combination and cooperation of many detailed labourers and in which the technical organization of production was not separable from the forms of workers' self-organization. Both devoted much of their life to developing a system of management that would destroy that relation, and would instead complete the despotism of capital in the process of production. Both understood that essential to that task was the development of tools of adequate measurement, so that an objective standard of the amount of work completed, independent from the judgement of the worker, could be introduced – one of Bentham's earliest contributions was the 'curvature', a device for accurately measuring amounts of sawn curved timber. Both recognized that only when the 'task' itself had come under the control of

[88] Fincham, op. cit., pp. 174–7.
[89] F. W. Taylor, *The Art of Cutting Metals* (New York, 1906), sect. 124.

capitalist definitions could a system of piece-rates be established that would at once greatly increase profitability and raise wages. Both knew too that an increase of wages was fully consistent with an increase in the rate of exploitation. Finally, each was aware that before mechanization could be satisfactorily introduced a prior revolution in the labour process was required.

Between Sutherland's 'Notions' of 1724 and Bentham's 'system' eighty years later there were many developments. These were the result of a serious, protracted struggle, whose consequences in ship design, in nautical engineering, in mechanical operations, in productivity – perhaps even in the victories of the Navy during the Napoleonic Wars – are well known. Out of historical context they may appear to be improvements, but in context only the most interested or apologetic could view Bentham's mechanical reorganizations unequivocally as such. John Charnock published an encyclopaedic three-volume *History of Marine Architecture* in 1800. In it he described many of the 'discoveries' that had lately been introduced in ship-building. He reflected that 'avarice, luxury, and ambition' were the moral qualities that promoted the technical changes. The application of changes, he observed, had two important effects. First, they 'augmented the general inquietude of man'. Second, they promoted 'those horrid scenes of slaughter or desecration which, during so many ages, have disgraced the universe'.

While Charnock presented a historical context for understanding technological change in ship construction, the context he chose was one of moral philosophy. Such philosophic moralism has its own limitations. Its moral categories can be as general and distant as the categories of political economy; the language of 'depravity', 'luxury' or 'avarice' can be as alien to the antagonistic actualities of production as the language of 'improvement' and 'efficiency'. The 'language of chips' arose from within the struggle; its morality and its economies were far different from Bentham's or Charnock's. If they belonged to a 'republic of letters' the chip men and women belonged to a 'republic of wood'. Their profession was no less intelligible than philosophy or engineering – at least to those admitted to it. It had its ways of doing things – its arts and mysteries, its circuits of exchange and barter, its solutions to the ecological and energy crises of working people, its social structures between men and women, adults and children, the healthy and the infirm, and as we have seen, its characteristic ships.