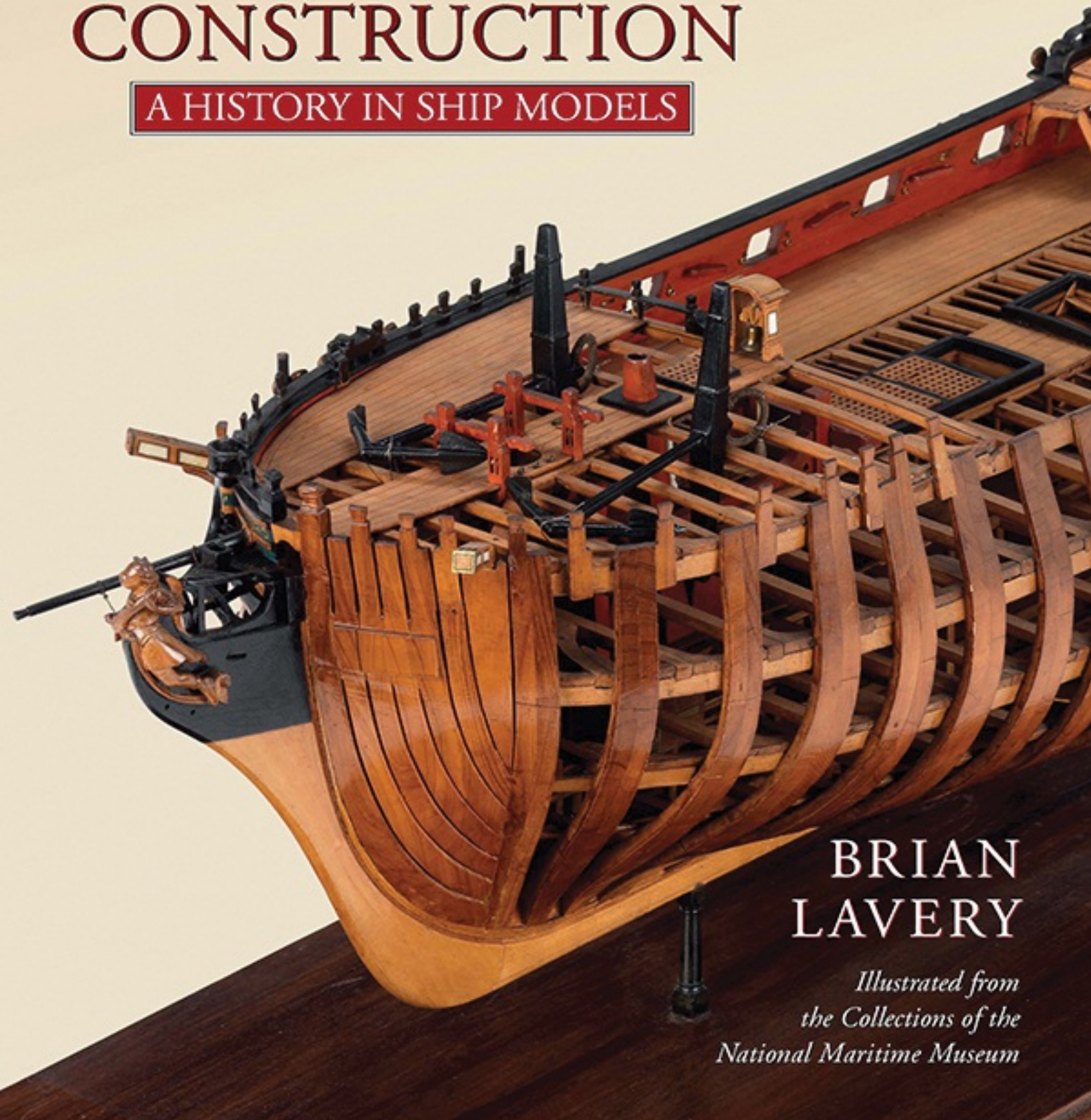
WOODEN WARSHIP CONSTRUCTION

A HISTORY IN SHIP MODELS



BRIAN LAVERY

Illustrated from the Collections of the National Maritime Museum

WOODEN WARSHIP CONSTRUCTION

WOODEN WARSHIP CONSTRUCTION

A HISTORY IN SHIP MODELS

BRIAN LAVERY

Seaforth
PUBLISHING

Acknowledgements

We would like to thank the staff of the National Maritime Museum's Picture Library, and especially Emma Lefley, who faultlessly organised the complicated issues surrounding the large photo orders.

Other models came from the collection of the Science Museum, London, where Jasmine Rodgers was particularly helpful; thanks also to the Charles Miller Gallery.

References

Models in the National Maritime Museum collection are catalogued by SLR number, and in this book these are quoted at the beginning of each caption to one of these models. Further details of these models can be found on the Museum's Collections website at: **http://collections.rmg.co.uk**

Searching by SLR number will turn up a full description of the model and any available photographs.

SLR2216 *Half title:* Frames of the 120-gun *Caledonia*.

SLR2148 *Frontispiece:* Detail of the model of the Royal Dockyard at Sheerness, Kent, depicting ships at different stages of construction.

First published in Great Britain in 2017 by
Seaforth Publishing
An imprint of Pen & Sword Books Ltd
47 Church Street, Barnsley
S Yorkshire S70 2AS

www.seaforthpublishing.com
Email info@seaforthpublishing.com

British Library Cataloguing in Publication Data
A CIP data record for this book is available from the British Library

ISBN 978 1 4738 9480 8 (HARDBACK)
ISBN 978 1 4738 9481 5 (KINDLE)
ISBN 978 1 4738 9482 2 (EPUB)

Contents

1: Labour and Materials

The Sailing Warship

Nearly 1500 warships were built for the Royal Navy between 1715 and the end of the long wars with France a century later. In 1756–1815 alone, 261 of these were ships of the line, the largest warships of the day. They were practically all sailing warships – some of the smaller ones could be rowed as well, but only very inefficiently and slowly. even in the Mediterranean, the home of the galley, the type declined through the century – despite its manoeuvrability, it was no match for the robust hull and heavy gun power of the sailing warship. Only less regular navies, like the Barbary corsairs of North Africa, used chebecs, which could be rowed as well as sailed. Rowing was also used in coastal waters, for example by the Swedes in the Baltic, but the sturdy wooden sailing warships dominated the open seas.

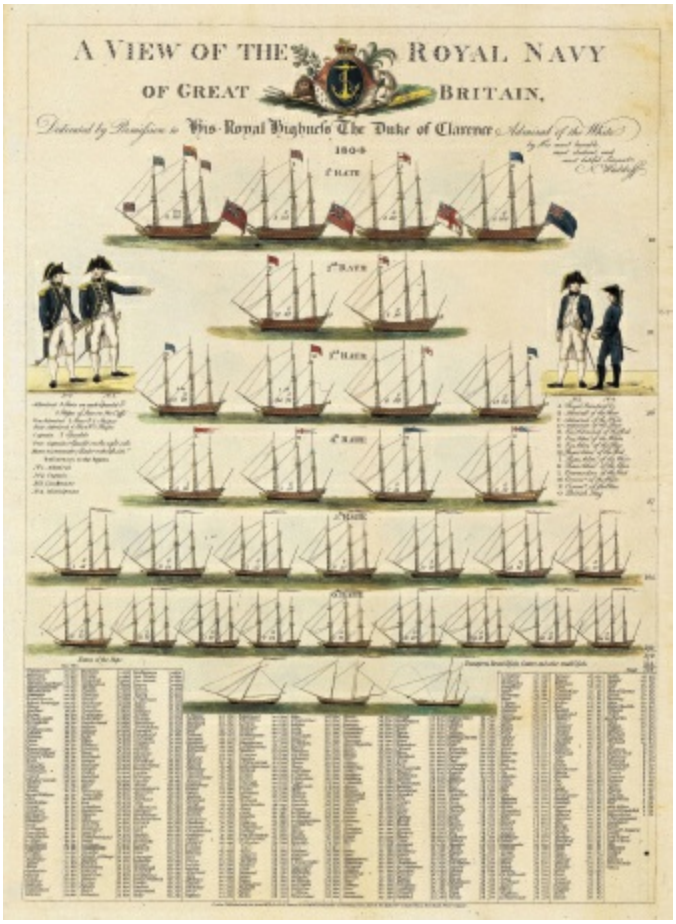
The sailing warship was built almost entirely of wood, with iron for a few key fastenings and later copper on the underwater hull. Its main metallic parts were its guns which were essential to its purpose – the power of a warship was measured in its ‘weight of metal’ as much as anything else. But in most ships the great majority of guns could only be fired over the side, so a ship could produce little fire as it advanced towards an enemy, and not much more as it retreated. But the broadside power of a large or medium-sized warship was equal to that of a whole army or one of the largest fortresses on shore.

PAJ1758 A print showing most of the ship types used by the Royal Navy in 1804. It does not show the fore-andaft rigged and non-rated vessels fully, only a cutter, a schooner and a type of ketch which was obsolescent by that time. It also shows officers' uniform and a selection of naval flags, including those normally used for launching on the First Rate at the top left, and Third Rates of the blue, red and white squadrons.

Other Navies

The warships of the other major naval powers – France, Spain, the Netherlands, Denmark, Portugal, Sweden, Russia and later the United States of America – were generally similar in concept to the British ones, with comparable methods of design and construction. Captured or occasionally purchased ships were transferred quite easily from one navy to another, with only superficial changes to the fitting and rigging. But at the same time each nation's ships had their own individual characteristics. French ships were regarded as faster with finer lines, which fitted their need to make a quick getaway past the British blockades of their ports. British naval officers loved them, but dockyard officials deplored their lighter structure and need for more maintenance. When the great three-deck *Commerce de Marseilles* was captured at Toulon in 1794, her acting captain reported that she was 'Very weatherly; few ships we were in company with were equal to her' and that

she ‘steers remarkably easy, never known to miss stays’. The officers of Plymouth Dockyard, on the other hand, proposed strengthening her by ‘shutting in the openings of the wales with fir 5 inches thick, the bottom with 4 inches and the topside with 3 inches, and to fur out the timbers to make good the different thicknesses, to bolt a few of the bends of riders in the hold, and to bolt the thickstuff through the side and beams in order to stiffen her, as she has no lodging knees’. In fact the ship was never used on active service.



SLR0556 The *Eole* was a French 74-gun ship of 1789. She was built to a standard design by Jacques-Noël Sané, as most French ships were by that time. She has a flatter sheer than British ships of the period, that is, her planks and wales had less upward curve.

Spain employed both British and French émigré shipwrights and evolved two schools, which were sometimes combined to produce some very fine ships. The Dutch had been the leading naval power in the seventeenth century but as ships got larger they were constrained by the need to give their ships shallow draught to enter their own ports. The Americans, arriving towards the

end of the eighteenth century, mainly built medium-sized warships, frigates. They deployed the classic strategy of a small naval power, to make each ship as good as possible and raid enemy possessions and convoys. They were well-built with excellent timber and surprised the British in several frigate actions. The Russians, on the other hand, relied heavily on copying Western ships, including eight built to the lines of the famous HMS *Victory*, after her plans were stolen and copied. The Danes and Swedes also learned from Britain and France, sending out apprentice shipwrights to these countries and often collecting plans on the way. But Sweden produced one of the most innovative naval architects of the age in Fredrik Henrik af Chapman, who designed various types of gunboats for use in the Baltic.

SLR0591 A model of the Dutch 74-gun ship *Washington* of 1797, showing something of the flat bottoms which the Dutch were compelled to use to get into their own waters. The model is to an unusual scale and came with masts, spars etc which were never assembled.

SLR0405 The model of a 50-gun ship of around 1715 which is the starting point for this work. This photograph shows the starboard side which has the modern features – cant frames in the bow, overlapping futtocks and solid lower wales – all of which are explained later. However, it does not show the final form of the changes: the framing above the lower wales would be much more solid in later ships.

British Ships

If most navies produced relatively specialised designs for their own strategic

and tactical needs, the British aimed at world power and deployed more generalised ships. They had to be robust to travel the planet in all weathers, and to stay at sea while blockading the enemy in port. Therefore a strong structure (rather than speed) was a vital factor in British naval success, and in building and maintaining an empire and in protecting British trade which fuelled the Industrial Revolution.

The starting point of this work is 1715, when the Navy Board issued new orders about the building of ships. By that time the English Royal Navy ('British' since the union with Scotland in 1707) had fought three wars with the Dutch and two with the French in the last sixty-three years. It had developed the line of battle at the beginning of that period, with all the major warships fighting in a single line of up to 100 vessels, and which would define tactics and shipbuilding for most of the eighteenth century. After 1715 it had a period of relative peace and consolidation, and often ultra-conservatism about ship design and all other matters.

The main building technique of the time was 'carvel-build'. It was often described as 'frame-first' construction in that the frames or ribs were erected then the 'skin' or planking was put over them. It contrasted with the technique of 'skin-first' or clinkerbuild in which the planks overlapped and formed an important part of the structure, with light frames added later. Carvel-build was the only possibility with such large ships: Henry V's attempt to build a large triple-skin clinker ship, the *Grace Dieu* in 1418, was not repeated. But as with many things of the period, 'frame-first' was never as simple as the term suggests. We cannot assume that the whole frame was complete before any planking was put on, it was not unknown to begin planking of the lower parts before the toptimbers were complete, and much depended on the availability of materials.

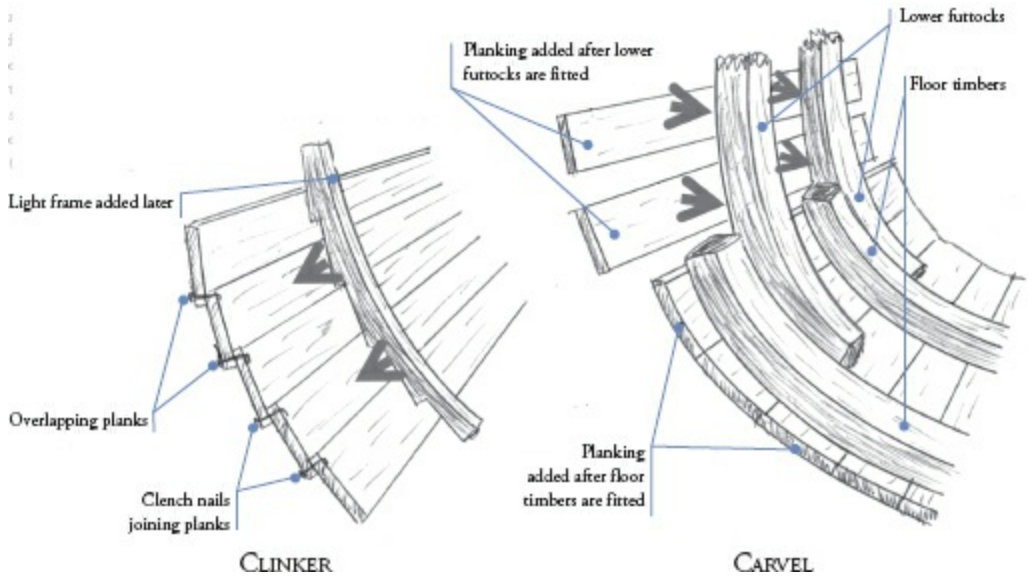
Shipyards

Shipyards were relatively simple in the eighteenth and early nineteenth centuries, needing little capital equipment. The main requirement was a site on a firm bank close to a river which was deep enough for launching the ship on a suitable high tide. The slip was angled down towards the river, and could simply be dug out, or more commonly reinforced by timber or

stonework. Man-powered cranes were needed for unloading timber, plus a considerable amount of space to store it. There might be a few workshops, but despite the weather the great majority of the work was done in the open air. Some kind of office was needed if only to examine and interpret the ship's plans, with a larger and well-lighted loft where full-size moulds for the timbers could be drawn out. Sawpits were dug in the ground for cutting large trees and timbers.

Ships built in private yards were covered by extensive contracts. On 17 November 1755 Thomas West of Deptford signed a contract to build the 74-gun *Warspite*, of the new *Dublin* class, 'agreeable to the draught that accompanies this contract, and to a 22-page specification.' He also agreed,

> I do oblige myself, in case the officers or overseers appointed by the said principal officers and commissioners to inspect the same, shall at any time find any defective or unsound materials, or insufficient workmanship performed to the said ship during her building, the said deficiency both in the one and the other shall, upon notice thereof, be forthwith amended, and the said officers or overseers shall not at any time have any molestation or obstruction.



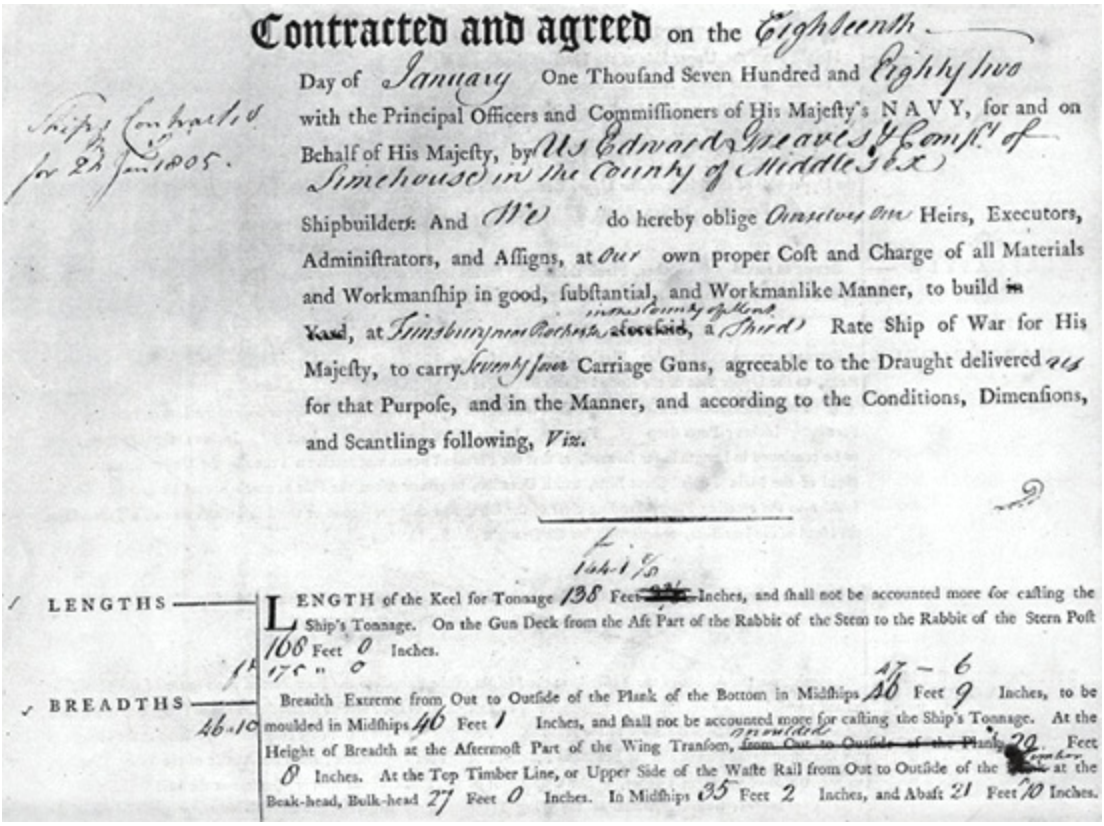
The main differences between clinker building and the more modern form, carvel, are that the planks overlap in the former, and form the essential element in the structure. An early version of carvel building is shown on the right, with the futtocks of the frames not joined together. That is the system which was replaced from 1715 with pairs of futtocks each forming a single unit. (Author's drawing)

Buckler's Hard shipyard on the Beaulieu River in Hampshire, a relatively modern model made by Gerald Wingrove in 1968–9 but based on solid research. It shows the frigate *Euryalus* about to be launched in 1803, with the 74-gun *Swiftsure* in frame. The village is dominated by piles of timber in the streets and gardens. The end of the terrace on the right has the office from which the master shipwright, Henry Adams, kept an eye on the work. (Alamy Stock Photo)

The ship was to be built at the rate of £17 2s per ton for 1546 tons, any excess on that was not to be paid for. The first instalment of £2900 would be paid on signing the contract, the same amount when the keel was laid, stem and stern posts up and the floors crossed; then when the full frames were raised, 'set to rights, levelled and shored'. After that the fitting of the filling frames between the gunports earned another instalment, then when the main wales were wrought and fitted and the bottom planked. The fitting of the gundeck beams earned another £2900, followed by the upper deck, quarterdeck and forecastle beams and planks. The works in the hold and the main channels earned another payment, and finally,

> … a perfect bill for the remainder that shall be due for the said ship, after she shall be entirely completed, launched and delivered safe on float … into the hands of such officer or officers as shall be appointed to receive her; and a certificate of the performance of the whole work, according to the terms of this contract, made and given by such persons as shall be appointed thereto, by the said commissioners …

In January 1782 Graves of Limehouse signed such a contract to build a 74-gun ship, later the famous *Bellerophon*, in a yard at Frindsbury on the Medway. Apart from the details of payment by instalments, its twenty-four pages were nearly all about the dimensions of each part of the ship from the length on the gun deck (168ft) to the iron swivel for the longboat ($1\frac{3}{8}$ in diameter, 4½in round).



Contracted and agreed on the Eighteenth Day of January One Thousand Seven Hundred and Eighty two with the Principal Officers and Commissioners of His Majesty's NAVY, for and on Behalf of His Majesty, by Mr Edward Greaves Ship Comm.r of Limehouse in the County of Middlesex Shipbuilder: And We do hereby oblige Ourselves Our Heirs, Executors, Administrators, and Assigns, at Our own proper Cost and Charge of all Materials and Workmanship in good, substantial, and Workmanlike Manner, to build in Yard, at Frindsbury near Rochester Kent, a Third Rate Ship of War for His Majesty, to carry Seventy four Carriage Guns, agreeable to the Draught delivered us for that Purpose, and in the Manner, and according to the Conditions, Dimensions, and Scantlings following, Viz.

LENGTHS

LENGTH of the Keel for Tonnage 138 Feet [illegible] Inches, and shall not be accounted more for casting the Ship's Tonnage. On the Gun Deck from the Aft Part of the Rabbit of the Stem to the Rabbit of the Stern Post 168 Feet 0 Inches.

BREADTHS

Breadth Extreme from Out to Outside of the Plank of the Bottom in Midships 46 Feet 9 Inches, to be moulded in Midships 46 Feet 1 Inches, and shall not be accounted more for casting the Ship's Tonnage. At the Height of Breadth at the Aftermost Part of the Wing Transom, moulded from Out to Outside of the Plank 29 Feet 8 Inches. At the Top Timber Line, or Upper Side of the Waste Rail from Out to Outside of the [illegible] at the Beak-head, Bulk-head 27 Feet 0 Inches. In Midships 35 Feet 2 Inches, and Abaft 21 Feet 10 Inches.

ADT0009 The front page of the contract for the *Bellerophon.* It is a printed form which could be used for most classes of ship, with the details filled in in ink. This first page gives information on the shipbuilder and the ship's basic dimensions.

A naval overseer, usually a dockyard quarterman, was appointed to ensure that the ship was built 'agreeable to the draught designed for her' and he was to have an attested copy of the contract. He was to 'constantly attend all the working hours, and faithfully and diligently to see that all the works are performed according to your skill and judgement, as to the shape, scantling, and goodness of the timber, (particularly that no green timber is used) …' When payments became due as particular stages were completed, he was to 'give certificates thereof to the contractor'. Work in the upper Thames yards

was mostly under the direct supervision of the Navy Board: '… there are two surveyors, which come over me twice or thrice a week.' One of these was John Binmer, an assistant surveyor who served in the role from 1790 to 1806, though he hinted that the ships building in the merchant yards were less closely supervised than those in the dockyard. 'One officer only is appointed by the government to be immediately on the spot, with the visits of an assistant surveyor once a week, in the River Thames.'

The overseer signed for the ship after her launch, attesting that she had been 'safely launched' and was 'built agreeably to contract'. In March 1812 Nicholas Rundell did so for the *Dublin* at Brent's yard, listing her main dimensions as built and giving an account of the ironwork supplied from Deptford yard.

But still his work was not done.

> … when the ship is launched, she has then to go to a King's yard, and there be docked and surveyed, and examined in the minutest point that can be, before they will grant a certificate … if any defect or fault shall occur in the repair of that ship in the future, my bread is at stake; I am liable to be dismissed if that work is executed in an improper manner …

The role of the overseer and surveyors was highlighted by the case of the 74-gun *Ajax*, launched by Randall, Brent and sons at Rotherhithe in 1798. The Navy Board sued the builders for £40,000 plus 40 shillings costs, claiming that they 'built the said ship in a bad, insufficient and unworkmanlike manner, to wit, the caulking thereof, and for want of sufficient tabling, and in the bending and bringing to the ship planks, knees, and other timbers thereof; and also used, or applied, in and about the building of the said ship diverse large quantities of iron, oakum, and other materials of very inferior qualities, and diverse large quantities of timber which was greatly forced, grain cut and sappy, rent, shaken and unsound …'.

When the navy did not build its own ships in the Royal Dockyards, it preferred sites close to the dockyards where the work could be supervised. Liverpool and Newcastle had large shipbuilding industries but were little used by the navy, and the Clyde was not yet established as a shipbuilding area. Only three ships, all very small, were built in Scotland from 1715 to 1815, at Leith on the Forth. Fourteen more were built in the north of England.

The simplest type of yard is represented by Barnard on the Orwell or

Adams at Buckler's Hard in Hampshire, which largely survives to the present day as a museum. Others were on the much more crowded waters of the Thames. The Barnard family started on the River Orwell at Ipswich and Harwich. In 1764 William Barnard started building on the Thames in partnership with William Dudman, who had worked in Deptford yard but left in 1762 to build an East Indiaman. The partnership used the Grove Street Yard, a nine-acre site just upstream of the victualing yard with a frontage of 450ft and three slips, a wet dock and three dry docks. At first it concentrated on East Indiamen. Dudman died and William Barnard took over the Deptford Green yard between the dockyard and Deptford Creek in 1779, with a dry dock and two slips, with one more added in 1781. The Grove Street yard was given up to Dudman in 1793, and William Barnard died in 1795. His 58-year-old widow Frances took over the business until her sons were old enough. After they added a Rotherhithe yard with four building slips from Wells and Company, employment peaked at 543 men in September 1812, including 360 shipwrights. They built twenty-three warships, mostly 74s, between 1794 and 1813.

The largest yard in the country, however, was the one at Blackwall on the Thames, occupied successively by Sir Henry Johnson until 1708, Phillip Perry until 1776, and his son John after that. From the 1790s it was run by Robert Wigram and John Wells, who had started off in Rotherhithe. It had seven building slips as well as two double and two single docks, which could be used for ship construction was well as repair. It employed 456 shipwrights during a busy period in March 1813, out of a total of 758 workmen. It built forty-one ships for the Royal Navy from 1793 to 1805, including eleven 74s and thirteen frigates, a total of 40,364 tons. It also built twenty-seven East Indiamen of 28,240 tons. In 1804–13 the yard received 17,145 loads of oak timber and 2598 loads of plank from one merchant alone.

BHC1044 This is a composite picture of several ships built by Barnard on the north bank of the River Orwell near the site of the present day Levington Marina. The ship in the centre is thought to be the *Biddeford* of 20 guns being towed downstream by launches, perhaps to be fitted out at Harwich. The bomb vessel *Grenado* is shown mastless just to the left. The ship under construction is believed to be the 50-gun *Hampshire*, launched in 1742. The picture emphasises the rural nature of much of eighteenth-century shipbuilding.

BHC1059 A small shipyard on the River Thames with a frigate about to be launched and another in dock. It shows cranes for unloading timber and buildings which might be used as mould lofts and workshops. As in several paintings, the frigate has the launching flags flying but there is no sign of the cradle which would support her during the process – perhaps the painter felt that would interrupt the view of her fine lines.

BHC1866 The other end of the private shipyard spectrum – the great yard at Blackwall which was successively owned by Johnson, Perry, and Wigram and Wells. The ship on the extreme left is thought to be the *Adventure* of 44 guns, just launched in 1784. The picture also shows several large ships in different stages of construction. The one behind the sails of the cutter is in frame, then there is one almost complete, one with the floors crossed and the stern assembly raised, another almost complete and one in frame.

Royal Dockyards

The Royal Dockyards were even larger and the six of them employed more than 15,000 men at their peak in 1814. They were not devoted to shipbuilding alone, but to the whole process of servicing the navy's ships. They had dry docks for the repair of the underwater hull, with facilities for manufacturing rope, anchors, masts, blocks and other items. However, the dockyards did not deal in food, drink or guns which were handled by victualling and ordnance yards in the vicinity.

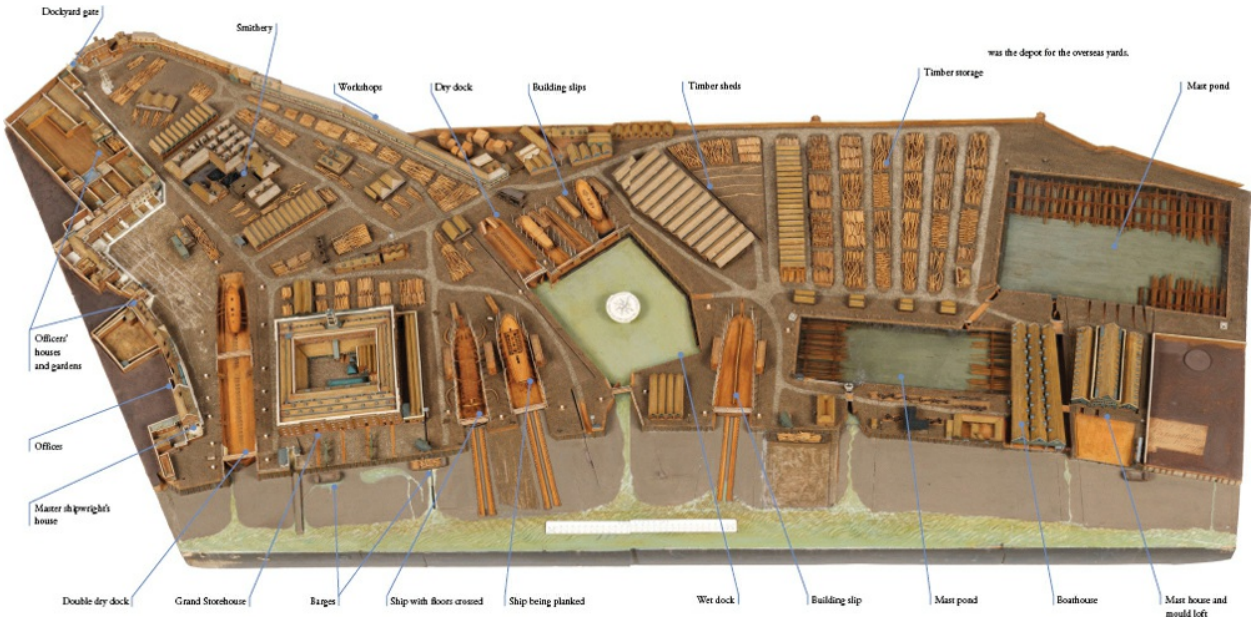
The southern yards – Portsmouth and Plymouth – were at the core of naval bases for active squadrons and fleets. They built many ships in peacetime to keep the workforce together, but in wartime they were largely employed in repair and men were often taken off ships under construction to do more urgent maintenance work. In 1741–2, for example, men were employed 'converting' or shaping timber for a 'new ship in the room of the *Yarmouth*' but were taken off for other work and the ship was never completed.

Sheerness was the smallest of the Royal Dockyards, situated at the mouth of the Medway Estuary. Its main function was to service ships at the Nore anchorage nearby. It built a few frigates and smaller ships, but only one ship of the line, the 64-gun *Polyphemus* of 1782. Chatham Dockyard, further up the Medway, also serviced the ships at the Nore but had substantial building facilities and built many large ships, including the famous *Victory* in 1765

Deptford Dockyard on the Thames was the closest to London, and like Woolwich further downstream it was too far from the sea to serve as an active-service naval base. Instead it was used as a home for the Royal Yachts, for fitting out special vessels such as those used by Captain Cook, for supervising the builders in numerous private yards in the River Thames nearby, and for building ships in its own slips and docks. It also has the most extensive records of any of the dockyards, and perhaps of any industrial

organisation in the world before the nineteenth century. These provide many insights into the shipbuilding practices of the day. It was often used for innovative and experimental work, including the first of the new 74-gun ships and frigates in the late 1750s.

SLR2151 The model of Chatham Dockyard made in 1772–4, with the view as it might have been seen from the masts of a passing ship. The mast ponds are on the left, then the building slips and dry docks, with the houses of the officers' terrace behind. The main storehouses are to the right, with the long building of the ropery behind.



SLR2906 Deptford Dockyard as it was in 1772–4. It saw less modernisation than most of the other yards and its layout still had much in common with the yard started by Henry VIII. The dominant feature is the large square storehouse to the left of the picture, for as well as building and repairing ships Deptford was the depot for the overseas yards.

Types of Ship

The largest warships, the three-deckers of at least 90 guns, were invariably built in the Royal Dockyards, usually in a dry dock from which they could be floated out rather than launched precariously into the river. Smaller three-deckers of 80 guns were retained for many years although there were frequent complaints about their instability. Two-deckers were also classed as ships of the line, able to stand in the line of battle against the strongest

opponent. At the beginning of the period they were of 70 or 60 guns, being superseded from the 1750s by 74s and 64s, though the latter class was found to be too small by the end of the century. Many of them were built in private yards, especially in wartime. The 50-gun ship was an intermediate type, originally planned to serve in the line of battle or as a convoy escort as required. In practice it did neither function well, but the type was revived in the 1770s as a flagship on isolated stations. Smaller warships, initially of 20 or 30 guns, were used for reconnaissance, convoy escort, message carrying and many miscellaneous duties. They were superseded by frigates of 32, 36 and 40 guns, with all their main armament on a single deck and an unarmed lower deck which raised the gunports well above the waterline and gave better sailing qualities. Smaller ships, still with three masts, were outside the normal rating system and were known as sloops. Even smaller were twomasted brigs. Below that, most ships had fore and aft rather than square rig, mostly in the form of cutters and schooners. Ships were almost always defined by size rather than function – the main exceptions were fireships, which might be converted from old vessels and fitted with combustible material, and bomb vessels which were specially strengthened to fire mortars for shore bombardment instead of cannon. Experimental vessels were rare, but they included several fitted with Captain Schanck's 'sliding' or retractable keel on the principle of a modern sailing dinghy.

SLR0408 The *Royal William*, a First Rate, 100 guns of 1719. The model shows the usual three decks and stern galleries for the officers' accommodation, and a 'double equestrian' figurehead in the bows, a standard type for the very largest ships of the early eighteenth century. The ship is often said to have lasted more than century from 1670, but in fact she was 'rebuilt' in 1719, as shown here, and was in effect a new ship

SLR0391 The 80-gun Third Rate was the smallest and least successful type of three-decker, represented by the *Chichester* of 1706. It was too short for its three decks and therefore ill-proportioned, but conservative officials insisted on keeping the type on the lists until the second half of the century. The decks and rails of the model were restored in the 1970s and it is on a modern base.

SLR0227 The block model of Anson's famous 60-gun ship the *Centurion*, painted very delicately to make it more realistic. The 60 became a more common type in the second quarter of the century, gradually replacing the old 50, but it was too small for the line of battle and disappeared after that.

SLR0311 A 74-gun ship, the *Ajax* of 1767. The model is rather old-fashioned for the period in that it shows the open framing of an earlier age. This type became the standard ship of the line from about 1760 until after 1815 and was dominant in most of the great battles, as well as carrying out gruelling blockade service.

SLR0431 An anonymous 50 of around 1725. Conceived as a ship which could serve in the line or on convoy escort as required, it was not adequate in either role, though with its small crew and imposing height it was useful as a flagship in peacetime. Like the 80 it was too short for its number of decks and had poor sailing qualities, so it largely disappeared in the second half of the eighteenth century.

SLR0400 A 20-gun ship from around 1712, the smallest class of ‘rated’ ship, commanded by a full, or ‘post’ captain. Though it was the best escort of its day, its armament was weak and the guns were too close to the waterline, which inhibited its sailing in strong winds. It was replaced by the frigate from the 1750s. Though the figurehead is missing, this model shows much of the frieze work which was common at the time.

SLR0316 The 32-gun *Winchelsea* of 1764, an example of the early type of frigate which lifted the main guns a deck higher above the water and allowed better sailing qualities as well as a useful armament. Expanded and fitted with more guns, the frigate became the most successful ship outside the line of battle, useful for a great variety of duties. This model was probably made for King George III and the decorations were done by Thomas Burroughs.

SLR0342 A larger frigate, carrying 38 guns but following the same layout as the 32. This is one of the numerous *Diana* class of the 1790s, designed by Sir John Henslow. The model is of the typical 'Georgian' type, with a solid, planked hull under the wales instead of the old open framing.

SLR0340 The ship sloop carried less than 20 guns but was nevertheless full-rigged, with three masts all carrying square sails. This is the 16-gun *Atalanta* of 1775. The model is to an unusually small scale of 1:96, just half the standard 1:48, and is one of the first to carry the name painted on the stern, following an order of 1772. The rigging has been subjected to some restoration.

SLR0673 In contrast the brig sloop had only two masts, by definition. It proved a useful craft, carrying out some of the duties of the frigate but cheaper in men and materials. This is a 16-gun brig sloop of 1810. Ships like these were often built in large numbers to a single design, for example more than 100 of the *Cruiser* class of 1796 onwards.

SLR0510 A cutter of 1763. This was a classic British type, evolved by smugglers in the English Channel and taken up by the navy, initially to chase them. It later became a fast despatch vessel and undertook general duties. This model shows its large single mast, the gaff and boom of its fore-and-aft mainsail and its deep, rounded hull which gave it a turn of speed.

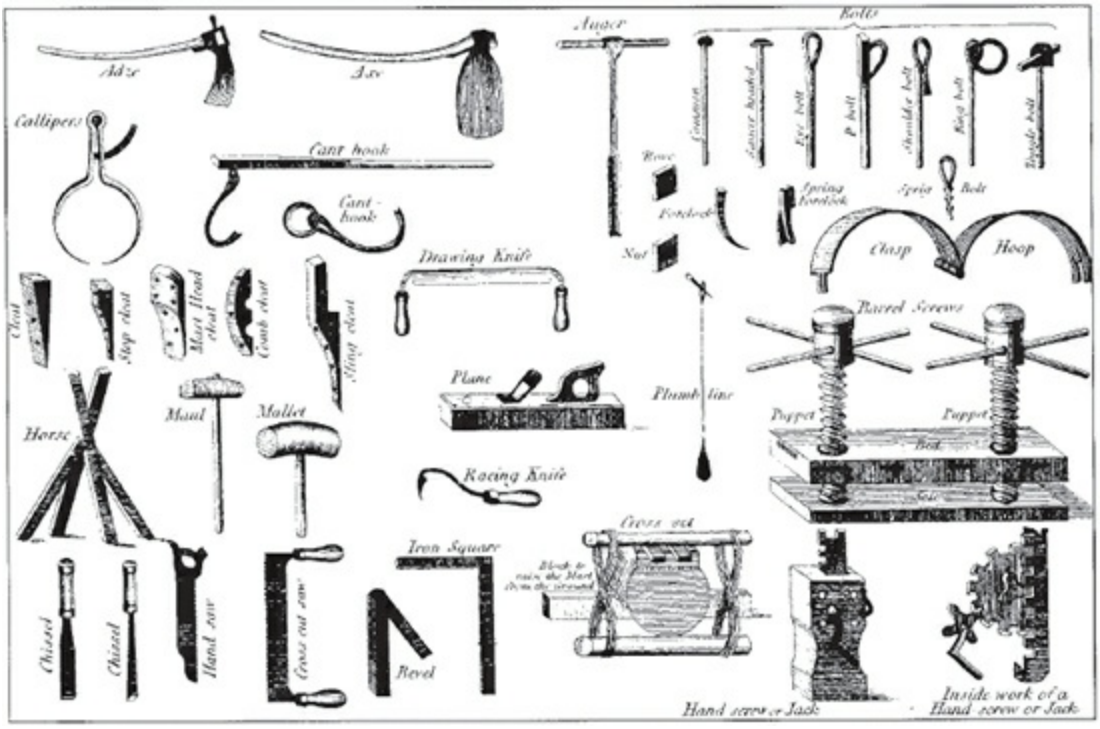
SLR0557 Experimental ships were rare in the eighteenth century, and were often not appreciated by the sailors who had to risk their lives in them. This 16-gun ship, designed by Captain Robert Schanck, was fitted with retractable keels to prevent sideways motion in the wind. Like many inventors of the time Schank used models to demonstrate his ideas, but they never caught on.

SLR0536 The fireship was a rare example of a specialised man of war, though it was usually converted from an older warship or merchant ship. This model shows the *Firebrand* of 1777. The gunports are hinged downwards so that they will not close as the fire burns through their ropes and restrict the supply of air. The model also shows a door near the stern, for the last of the crew to escape after setting her on course towards the enemy.

SLR1798 The other specialised type was the bomb vessel, originally with a two-masted ketch rig to avoid interfering with the forward fire of the mortars, but later with three masts and full rig. This model shows the bed for a heavy mortar in the centre of the ship, with strong pillars underneath to support its recoil. These vessels also had ammunition stowage for the shells.

SHIPWRIGHTS

The building of the ships of the Royal Navy was almost entirely in the hands of skilled shipwrights. In 1814 one of them, James Hughes, claimed that 120 or 130 men, half of them skilled, could build a 74-gun ship in two years. At the peak in 1810, there were 1982 of them employed in private yards on the Thames, mostly on naval work and East Indiamen. But they were only part of the shipyard workforce: the great yard at Blackwall employed 459 shipwrights in September that year, alongside 40 caulkers, 68 sawyers, 30 joiners, 39 blacksmiths and 71 labourers, so shipwrights made up 64 per cent of the workforce, and skilled workers made up 90 per cent. The Royal Dockyards had many other duties besides shipbuilding so the shipwrights were a lower proportion. In 1748 Deptford had 575 shipwrights out of a total of 1532. Overall, there were 4936 shipwrights out of a total workforce of 15,595 in the six Royal Dockyards in 1814, Though they never made up a majority in the dockyards, they regarded themselves as the most important, with some justification, and were fiercely proud of their skills. They were also respected outside the yard as Sophia von la Roche, a German visitor, observed as she watched them leaving Deptford yard for dinner in 1786. 'They were mostly fine-looking fellows; many of them with the eye of a mathematician … I am sure many of them will be reading the papers this evening and talking of the common welfare.' She noticed, 'The respect with which our coachman had to treat these working people, not being allowed to turn in the narrow street until they had passed …' Shipwrights could usually make much more money in the private sector but had greater security and pension rights in royal service. Asked what induced men to enter from merchant yards, the shipwright James Hughes testified, 'Some for thinking they are growing old, and want to be employed there for life; some go in under a certain age, and they work till a certain age, and then they are superannuated.'



A selection of mast-making tools from Steel's *Rigging and Seamanship* of 1794. They are generally similar to shipwright's tools and include the classic axe, adze and auger on the top left. The hand screw or jack which might be used to lift a timber into place is shown on the bottom right, with a selection of chisels and saws on the left, and planes and knives in the centre.

Each shipwright had served a long apprenticeship and as a body they furiously resisted any attempt by outsiders to enter the trade. William Ainell claimed to have served an apprentice with James Clark, carpenter of the *Oxford*, at Deptford but had lost his indenture. He had one made by Henry Bettesworth and in 1740 he took a job in Portsmouth Dockyard, but his work was poorly done and was not enough to fool his colleagues. Commissioner Hughes reported, '… the shipwrights surrounded him, put a piece of quarter between his legs, took him up on their shoulders, carried him just without the gate, then sat him down, gave three shouts … and returned to their duty.' Even when the demand for shipwrights was extremely pressing, dockyard officers were reluctant to dilute their work by having some of it done by labourers. In 1806 the Deptford officers only conceded that 'scavelmen or labourers may be employed with advantage to the service in lieu of shipwrights in making and breaking stages in general; also to convey to the docks, slips etc, and get on board all such materials as may be required for the use of the ships building or repairing.' – but they were not to do any work

on the ships themselves. In 1814 James Hughes was asked if ‘the builders cannot get hold of carpenters, and common and ordinary people and set them on to shipwright’s work?’ He answered, ‘If the builder would, the men would not allow it.’ And furthermore, ‘a builder would not employ a bad man, for fear of having his materials spoiled’.

Mary Lacy disguised herself as a man and began an apprenticeship in Portsmouth Dockyard in 1763. After her indenture was signed, ‘… my master went and bought me a saw, an ax and chizzel, which made me very proud to think I had some new tools to work with’. In 1778 at Chatham, John Allan spent 3 shillings on ‘heeling an ax’ for his apprentice George Carr and 5/6 on a handsaw, then 2 shillings for another handsaw, 1/6 for ‘formers and gouges’ and 4 pence for ‘a plane iron’. The work was often very hard and there were hardly any mechanical aids. Drilling with the pod auger was especially hard, as Mary Lacy found.

> The first work I was called upon was, to bore holes in the bottom of a ship called the *Thunderer*, which, as I was at first unacquainted with the method of doing it, proved hard work for me. This occasioned me to think I should not be able to serve out my time without being discovered.

Formally the shipwrights were all part of the same profession, but a young man was apprenticed to an individual rather than to the dockyard or to the navy as a whole. As a result his career largely depended on the status of his master. If he was bound to a master shipwright or his assistant, the boy would learn all about ship design. If he was apprenticed to an ordinary working shipwright he would become a manual workman himself, knowing how ‘to Hew, or Dub, to Fay a Piece when it is Moulded to his place assigned, or the like’, as was said in a manual of 1664. Blaise Ollivier, a visiting French naval architect, was not impressed with the shipwrights during his visit to Deptford in 1737. ‘I saw about 200 shipwrights in this dockyard, yet among the whole number I saw scarce six who were good craftsmen. All of them seemed to me extremely lazy.’

A rare view of shipwrights at work and using their axes and adzes, from Pyne's Microcosm of 1806. Judging by its hexagonal head nearest the viewer, this is the rudder of an East Indiaman under repair.

In the Royal Dockyards it was normal for about one journeyman in six to be allowed an apprentice at any given time, in rotation. Richard Evans, the son of a late ship's carpenter and former shipwright in the yard with sixteen years' service, was apprenticed to Abraham Gill, a shipwright in the dockyard, in October 1749. His mother had to pay a fee of £30, though she was a widow with five children to support. Both parties kept copies of the document, indented so that they could fit together. Gill promised to teach the young man 'in the same art of a shipwright which he useth, by the best means that he can'. The boy was to serve his master, 'his secrets keep, his lawful commands every where gladly do'. He should not 'haunt taverns or playhouses', 'commit fornication, nor contract matrimony'. In this case he would continue to live with his mother, who would be paid five shillings a week for boarding him, and would provide his clothing. But it did not go well: Gill was dismissed in 1752 for absenting himself from duty and his apprentice went with him. His mother petitioned the Navy Board to allow her to take over his apprenticeship, as she would have to pay at least £10 to find a new master.

Timber

Timber was the essential material for shipbuilding. It was not just any piece of wood that was needed, strong and hard timbers such as British oak were much preferred. Each piece had to be large enough to be useful, and curved pieces such as futtocks or knees had to have the grain running the right way. As a general rule, timbers for larger ships were considerably more expensive than for smaller ones.

Much of Deptford's timber was supplied through merchants. Henry Mills of Cuckold's Point, Rotherhithe, succeeded his father and grandfather to become 'a considerable timber merchant'. In 1771 he brought it in from Worcestershire, Herefordshire and Monmouthshire as well as the upper Thames and Surrey, Kent and Sussex. He was knowledgeable about supplies in many other parts of the country. Other suppliers of Deptford included Richardson and Hutchinson also of Rotherhithe, and Sawkins and Baynes of Hampshire, until their partnership was dissolved in 1779. As to foreign timber, one merchant told an enquiry of 1771, 'the supply of timber and plank from the northern parts of Europe, a little from the Weser, but mostly from the Rhine, the Elbe, the Oder and the Vistula, from which rivers an ample supply of all sorts of species and plank may be had'. As to North America, 'He has imported oak from every province in North America, and also a great deal of American fir, but that in general has not the strength of the Baltic fir; the oak which comes from the provinces south of New York is not fit for the navy.'

Timber was measured in 'loads'. It was reckoned that a tree of 100-years' growth might contain two loads. One and a half loads were needed for every ton of a new ship. On arrival at the yard it was carefully measured as described at Deptford in 1727.

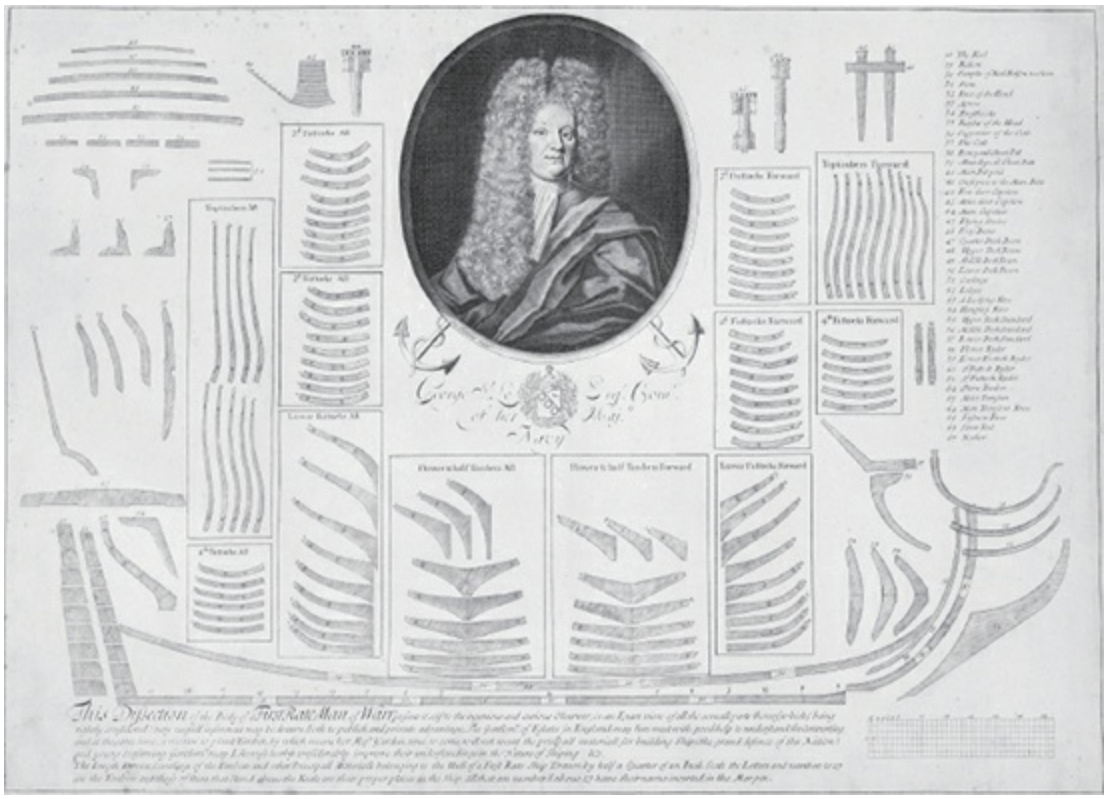
> … where a piece of timber has more than one arm, we take the contents thereof to the forked place and then add thereto the contents of each arm so far as they hold the contract bigness at the top end. Where timber does not taper regularly or has joggles in it we divide it into as many bodies as there is occasion and take the dimensions in the middle of each body; but in case the hewer has left a hill in the proper measuring place of any such body, we then take the dimensions in such place in that body as we observe will make it fairly hewed.

It was assessed and marked up as described in 1747:

> … all pieces of timber rounding 5 ins in 12 ft or ⅔ or ¾ of their length on the middle line rounds by the segment of a circle 20 ins in 24 feet to be deemed compass timber and received as such …

to be marked by the purveyors in a triangular form …

… all pieces rounding 17 ins and upwards in 12 feet of length and others that are of an S form and of proper shape for the more circular parts or futtocks and toptimbers of a ship to be marked by the purveyors in the form of a quadrangle …



PAI5058 A selection of the timbers composing a First Rate ship, as shown in a print of around 1710 dedicated to Navy Commissioner George St Lo. According to the inscription part of its aim was that 'The gentlemen of estates in England may here meet with good help to understand the converting and at the same time find a motive to plant timber, by which means Her Majesty's yards will not want the principal material for building ships … '

In 1780 the Deptford officers outlined the current procedure on receiving timber.

When the timber is landed, the defects are searched and bored by the shipwrights appointed for that service and measured for the contents by the master shipwright's measurer and a clerk from each office. As soon as that is done, the master shipwright is acquainted that the timber is ready for survey and when it suits him or he appoints his first assistant to survey, the clerk officer whose week it is to attend is called upon and proceeds with the shipwright officer to survey and take an account of what timber may be ready and to make the proper abatement for defects.

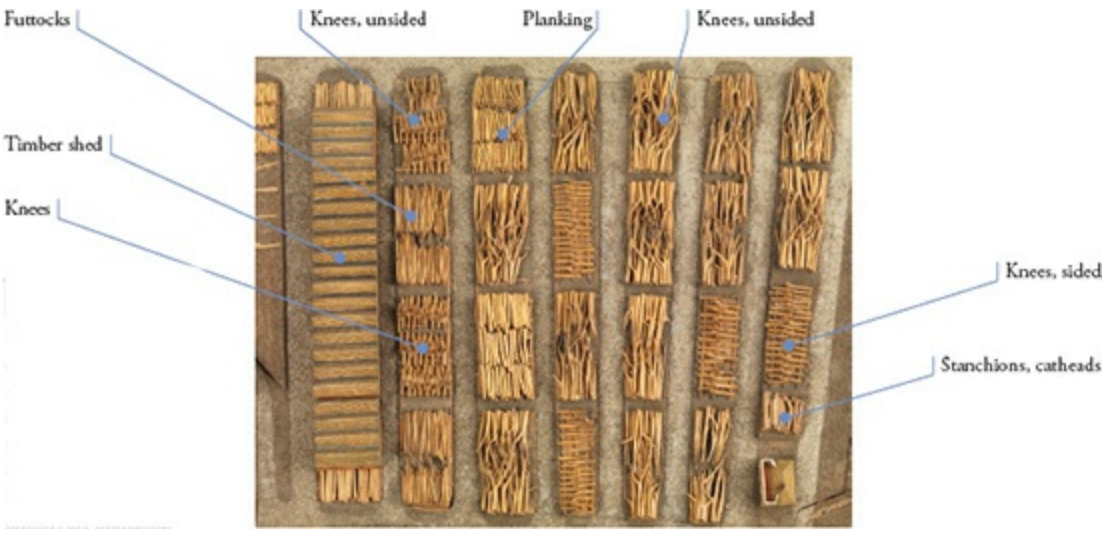
Timber was usually stored in the open and large quantities are to be seen, carefully sorted into type, in the models of the Royal Dockyards made in

1772–4. In 1771, however, the First Lord of the Admiralty Lord Sandwich ordered that sheds be erected for the storage of plank. Examples of these are still to be seen at Chatham.

One way to ease the timber shortage was to use it more carefully, which involved detailed control on the ground. Charles Scammell was a quarterman leading one of the gangs of shipwrights in Deptford in the 1780s and he kept a detailed record of the timber expended. His gang does not seem to have worked much on the framing of ships, except for a major repair of the *Royal Charlotte* yacht in April to June 1783, when among other things they used 673ft of 'English oak timber compass' for 'second futtocks and toptimbers'. During August and September 1788 the gang worked on the 98-gun three-decker *Impregnable* which dominated the Deptford skyline, deploying 'Oak timber straight for the bitts and crosspieces in the fore braces … English oak knees square no 3 for the fore and main channel … Thick stuff yard cut for the steering wheel stanchion … Thick stuff for head ledge forecastle.' They worked on the frigate *Brilliant* in September 1790, using 28ft of 'English oak timber for mast carlings', 14ft of 'English oak timber contract sided for the fore [and] aft carlings to the gangway', 460 more for the bulkheads of the hold and pump well and five more batches of native oak timber. As for foreign supplies, they used 43ft of 'Danzig crown oak plank 3 ins for the quarterdeck breast work and flat of the lower deck' and three more jobs involving the same timber, as well as fir baulks for the platform beams and beech for the bulkheads of the magazine and the upper deck pillars.

SLR2906 The waterfront in front of the Grand Storehouse at Deptford Dockyard in 1772–4, showing two types of barge alongside at low water, with cranes to unload them. At the left-hand edge of the storehouse are the steps used to receive distinguished visitors. To the right, a ship

has her frames crossed and her stern assembly raised.



SLR2906 Types of timber stored in the open at Deptford, shown in great detail in the model of 1772–4. To the left is the roof of one of the timber sheds built during that period to season plank. Possible uses for some of the timbers are indicated.

SLR2151 A timber shed at Chatham Dockyard. Examples of these survive in the yard to this day.

SLR2148 The model of Sheerness Dockyard is the most detailed of the six made to Lord Sandwich's orders in 1772–4. To a scale of 1:480 like the others, it even includes a tiny cart for transporting timber, complete with horses and drivers.

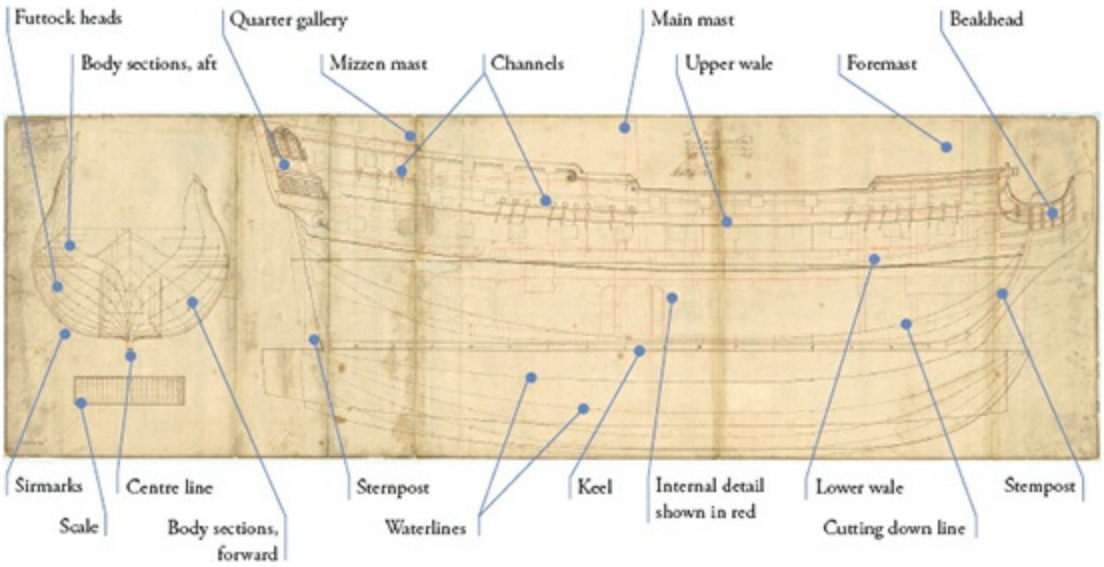
2: Starting the Ship

Design

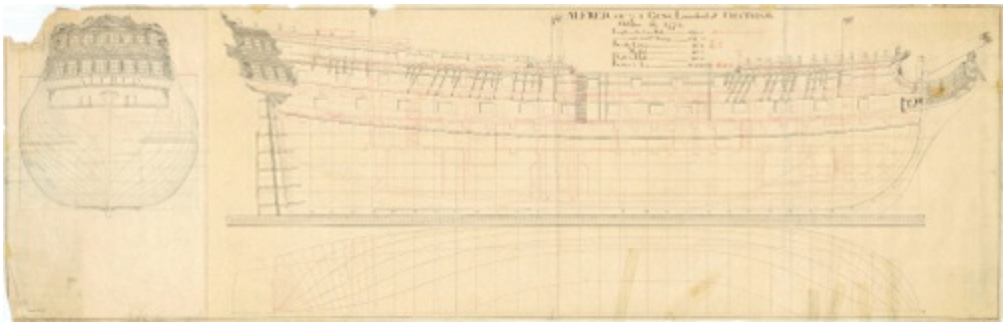
British warships were ordered by the Admiralty in London, which was responsible for naval policy under the King, government and Parliament. Having decided on a particular type of ship, they usually referred it to the Navy Board which included the Surveyor of the Navy, in charge of ship design. In the first half of the eighteenth century the dimensions of ships were controlled by ‘establishments’ which were an attempt at standardisation but also restricted new ideas. From 1719 the establishment also included much detail of the dimensions of individual parts, down to the coamings round the hatchways, but the actual shape of the hull was left to the shipbuilder, whether in a Royal Dockyard or a private shipyard. Under the 1745 Establishment, both dimensions and shape of the hull were fixed by Order-in-Council. That was soon abandoned and from 1755 the ships were usually designed personally by the Surveyors of the Navy. The plan (which might be used for several ships) was copied and sent to the yard in question. Plans were drawn to a scale of 1:48 or 4ft to the inch, and became more elaborate over the period and came to include deck plans, framing plans, and sometimes other features. Though the main aim was to show the shape of the hull, each plan also fixed the positions of the frames which would form it, and of the deck beams. Later, framing plans described the basic structure in some detail.

Until about 1740, ships which were in poor condition were usually ‘rebuilt’ – an ambiguous term which by this time really meant a new ship. Though it probably carried a similar number of guns to its predecessor, it was nearly always slightly larger and incorporated very little, if any, of the old ship’s timber. After 1740 the term disappeared from the naval vocabulary

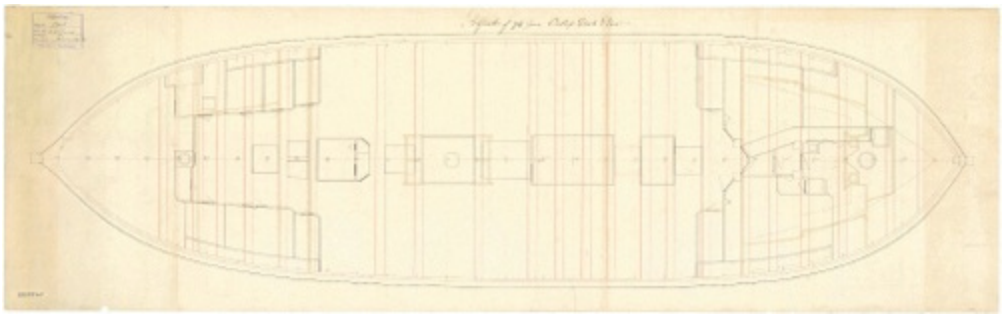
under pressure of war.



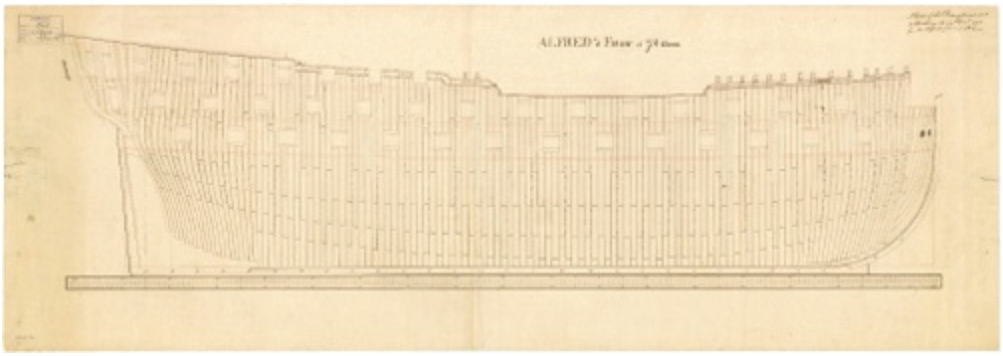
ZAZ1688 The principal draught for the 60-gun *Centurion* of 1737, in which Anson completed his round-the-world voyage in 1740–4. In the early part of the century this was often the only plan drawn, and other features such as deck layout could be constructed from it using standard layouts.



ZAZ0563 The series of plans for the *Alfred*, 74, of 1778, is one of the most complete in existence for the period. This shows the ship ‘as fitted’, complete with decorations of stern and figurehead. As such it post-dated the actual construction, but it was probably based on the original draught of the ship rather on measurements of her after building, which might have revealed any discrepancies in her actual construction.



ZAZ0565 Another plan of the *Alfred*, showing the standard layout of the orlop deck of a ship of the line, with cabins and officers' storerooms towards the stern, the cable tiers in midships and storerooms for the boatswain, carpenter and gunner in the bows, with a passage leading to the magazine below.



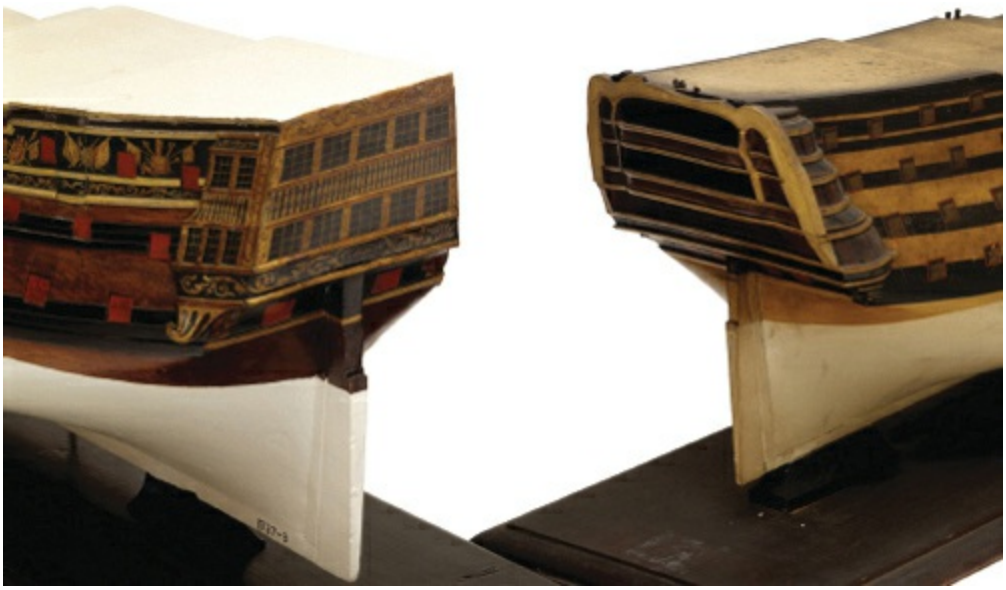
ZAZ0564 The framing plan of the *Alfred*. Drawings like this became quite common, though far from universal, in the last quarter of the century. This one shows the rising deadwood of the stern as an L-shaped blank, with the cant frames of bow and stern. The system of framing is quite conventional.

Use of Models

Models which show the structure of a ship accurately are very rare in the early part of the century, but those showing the shape of the hull are far more common. In 1715 the master shipwrights of the Royal Dockyards were ordered to produce 'a solid or model shaped exactly by the same with the load waterline, the height of decks and wales, the channels, chain plates, ports, galleries, etc., marked thereon …' for each new design. These were 'block' models, made 'bread and butter' style to produce a solid appearance. Occasionally the Admiralty or Navy Board commented on the models sent to them. In July 1717 the master shipwright at Deptford produced two alternatives for rebuilding the *Nottingham* of 60 guns, one with a 'square tuck' or transom stern, the other with a 'round buttock'. The Navy Board concluded that 'the round buttock is the strongest, best in the sea, or in riding at anchor, being little subject to draw dead water in great ships …'. No models are known to survive in the form prescribed in 1715, with 'the load waterline, the height of decks and wales, the channels, chain plates, ports, galleries, etc., marked thereon …'. The surviving block models from the period 1715–50 are all elaborately painted with the ship's decorations. In 1735 Henry Turner was paid ten shillings each for painting 'blocks or

models' at Deptford and asked for a similar sum for painting twenty-two of them at Woolwich. Though this practice did much to establish the shape of a ship's hull, it said very little about the structure.

The best-known models of the early eighteenth century, the open-framed Navy Board models, were not used for ship design and might take as long to build as the ship itself. They were succeeded by the 'Georgian' model with a solid hull usually covered in planking, and these often took just as long to build. In February 1744 the Admiralty complained that a rigged model of a 100-gun ship for display in their boardroom had been ordered in June 1740 but was not yet complete. The officers of Woolwich Dockyard replied that 'her hull is completed, japanned and varnished, and her masts and anchors with part of her rigging and blocks which are in hand with all the help we can find in the yard, and as these matters are of a curious nature and tedious to be performed, tis our opinion 'twill be the latter end of June next before she will be ready for placing in their office'. Such models were mostly for decorative and commemorative purposes, rather than aids to design.



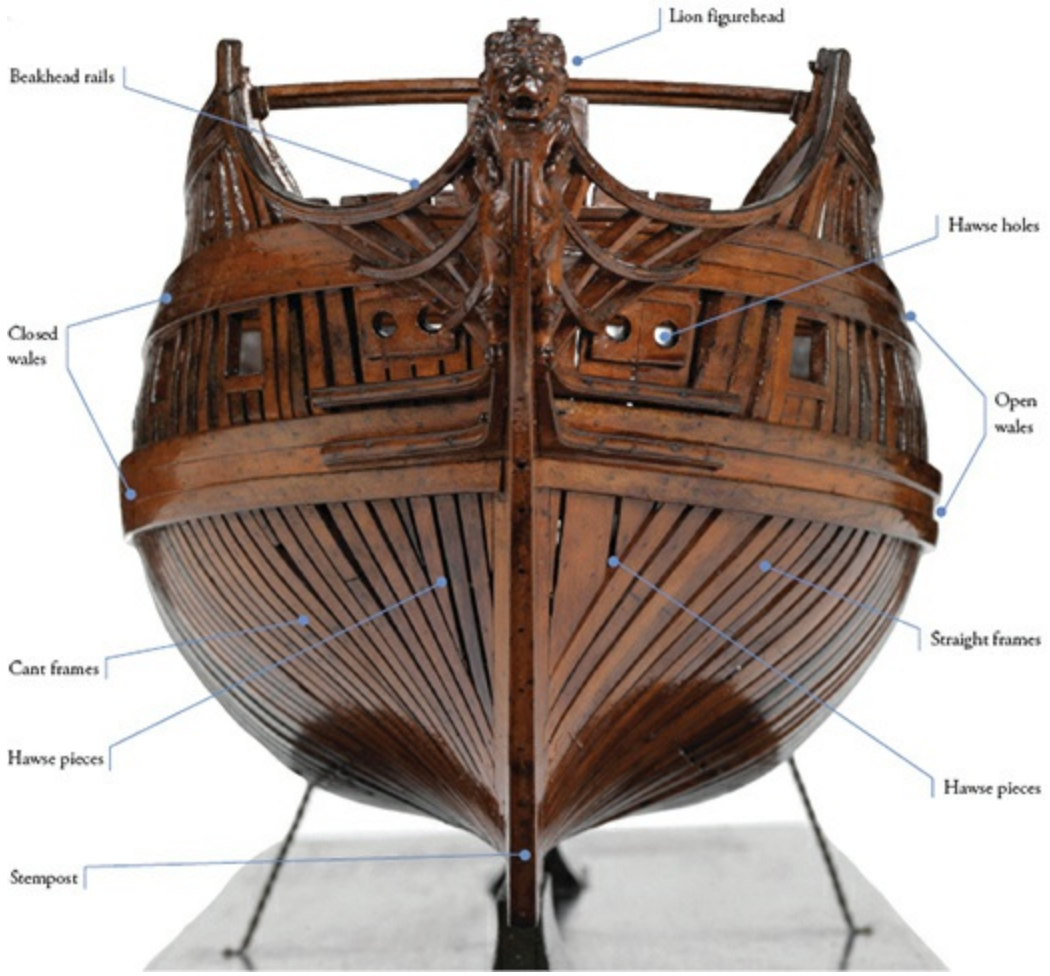
SLR0451 The block models of the 70-gun *Elizabeth* of 1737 and the 100-gun *Royal Sovereign* of 1786. Like practically all known models of this type and period, that of the *Elizabeth* was painted at Deptford after being shown to the Admiralty for the approval of the design. It was clearly not intended to show the quarter galleries when originally made and they were painted on later.

SLR0449 The model of the *Victory* of 1737, the greatest ship of her day, is to a very different style with complete detail of guns and rigging. A similar model, made for the Admiralty Boardroom, took four years to build and the ship was lost by the time it was finished so it clearly did not play part in the design process. The *Victory* was unique in having four galleries at the stern.

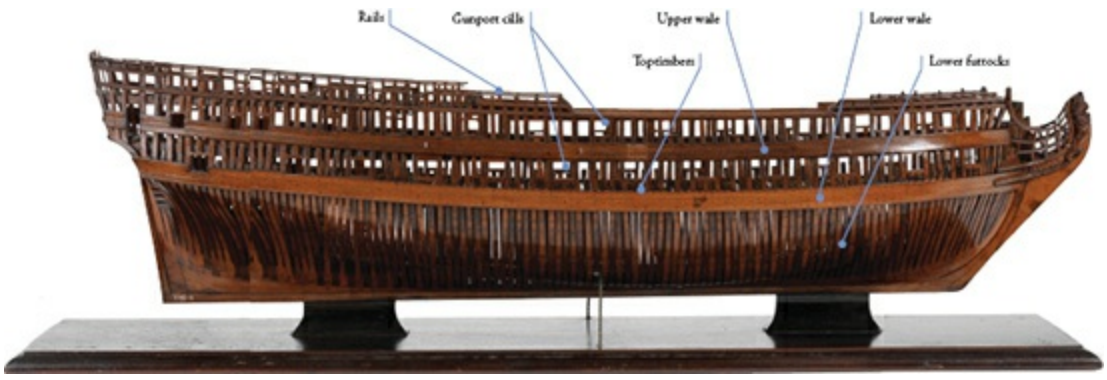
The first true structural model was produced to illustrate the reforms of 1715 and it is the starting point of this book. It is probably related to a Navy Board order of October 1715, reacting to 'the extra and sudden decay of many ships lately built or repaired'. It demanded the use of younger timber, among other things, but the order's most important effect, which was not taken up by most other navies, was to use 'canted' or angled timbers in the bow and stern.

The timber of a ship in frame afore and abaft, where there is any considerable bevelling, calls for large timber, and those parts of the ship found by experience to be most subject to a sudden decay, that they be canted from the rising timbers afore and abaft to the extreme parts of the ship, so as to be

wrought as near a square as possible; and this will likewise rake them so as to make them less circular and more supporting to the body than timbers set perpendicular and square athwartships, especially when upon the stem, and much easier to be got … A change that was more visible on the completed ship was that the double wales, thick planks just below the level of the gundeck which were characteristic of seventeenth-century ships, were to be combined into single wales. The order demanded, ‘the main wales and strakes between them wrought in narrower strakes, all of a thickness, by lessening the thickness of the wales and increasing that of the stuff between to maintain an equal or superior strength to the former practice …’. This, it was felt, would ‘make a fair side’ which would ‘consequently be an advantage in many cases and prevent filling in between the wales as is constantly done, and as often the plank under it’. Above that, the corresponding pieces for the upper deck, the channel wales, ‘might be wrought in the same manner’.



SLR0405 The bows of the 1715 model showing the old system to the right and the new method, with cant frames and closed wales, on the left.



SLR0408 The side view of the 1715 model, showing the wales and the arrangement of the futtocks.

The Mould Loft

The workers in the mould loft had the task of turning the paper plan of the ship into reality. To do this they drew out a full-sized plan of the hull on the mould loft floor, sometimes situated above the mast house where there was enough space and light. Abraham Rees wrote in his *Cyclopaedia* of 1819: 'The sheer-draught, being completely drawn upon paper … forty-eight times the real size of the ship, it remains to expand it to that size on the mould-loft floor; but the latter is seldom long enough to admit the laying off of any large vessel in one length … Indeed, to lay-off in one length would cause unnecessary waste of time; for many of the joints of the timbers, or the particulars of the fore-body, answer alike for the after body.' That applied to the sheer plan or side, view, the body sections had to be drawn out in full, often in more detail than on the draught, with every frame shown rather than just one in two or three.

SLR2151 The mast house at Chatham Dockyard, with the mould loft above, a pattern which can be seen in other dockyards as it provided space and light for lofting. The building survives today, though the pond in front of it has been filled in. Another timber shed can be seen to the right of the picture.

In 1714 up to fourteen men and boys were employed in the Deptford mould loft, including a foreman, two quartermen, six apprentices, two joiners and a house carpenter, but only intermittently, with four people there for most of the time. The shipwrights and their apprentices drew out the shape using straight lines and circles, scribing it with a knife and perhaps marking it out in chalk. The joiners were employed to make the moulds, the actual shape of each timber in light wood, perhaps ¾in fir. In 1806 the Commissioners of

Naval Enquiry claimed, ‘In order to make the moulds, it is necessary “to lay off the ship,” as it is technically termed; that is to mark off from the drawings sent from the Navy Board, the plan of the ship on the floor of the mould loft in the dockyard, the full size of the ship; and this, together with the making of the moulds, is stated generally to occupy six apprentices and two joiners six or seven weeks.’

Visiting officials tended to be suspicious about numbers employed in the mould loft, regarding it as an easy job which prevented men learning their trade properly. In 1749 Lord Sandwich complained ‘… observing in the accounts of shipwrights and other artificers employed in the officers offices and mould loft, there are no less than seventeen exclusive of the cabin keepers …’ – but shipwrights argued that precision was essential in such work if ships were to be built accurately to draughts. It also became more complicated with the introduction of cant timbers, whose shape could not simply be taken off the cross sections which formed part of the draught. Instructions on how to ‘lay off’ the cant timbers often took up several pages in the shipbuilding manuals.

Choosing the Timber

The converter was a shipwright chosen to select timber for particular parts of a ship and supervise its cutting by the sawyers. Amid a litany of misuses of material, Richard Williamson provides a detailed picture of the work of a timber convertor in the early 1700s. He might be expected to find particular pieces in the stacks. ‘According to the builder’s order, I looked out for an upper piece of stem for a fourth rate ship then going to be built, and showing it to the builder, he found fault, and swore I was an extravagant fellow, he would look out for a piece himself, but his pieces being 15 foot bigger, I modestly acquainted him of the difference; but he harshly replied, “You are not to dictate to me my business, since this will make a noble piece”.’ He might try to get the most out of a piece but it was not always appreciated: ‘… according to my office I lined it for three pieces of thick stuff, but the builder ordered it off again, and his son Ben told me “His father designed it for a knee of a head”. I replied, “Then half the piece will be wasted”; he answered, that mattered not, it must be so.’

Sawyers

Some timber arrived in the yards already ‘sided’ or with the parallel sides pre-cut; others had to be cut in the yard. It was impossible to find a single piece of timber which would follow the curves of a ship’s rib, for as Yeoman Lott of Deptford put it in his *An Account of the Proposals Made for the Benefit of His Majesty’s Naval Service* of 1777, ‘nature has not produced the form and size of the tree exactly answerable to the curve laid down by the artist’. Once a piece of timber was selected for a futtock, for example, it was then ‘converted’ to give it its curved shape. The French shipwright Blaise Olliver described the sawpits at Woolwich during his visit of 1737.

> They have in their dockyard sawpits which are 22 to 25 feet long …. The walls of these sawpits are lined with brick, with two or three small lodging places cut in the walls where the sawyers keep their tools. When they wish to saw up a timber they place it on rollers over one of the pits; the rollers are blocked with wedges; one of the sawyers descends into the pit, the other stands on top of the timber, and after they have sawn the full length afforded by the pit they slide the timber easily on its rollers, with no need of any other device than a crow. When the timber has been sawn the planks lie so that they can easily be carried away.

SLR2149 A row of sawpits at Plymouth under a roof. At Chatham they were under the clock tower building which was mainly used as a storehouse.

The shipwright and author William Sutherland admired the sawyers’ techniques, writing in his *Britain’s Glory, or Ship-building Unvail’d*, ‘… the power is communicated by the strength of two men, one standing up on the timber, and the other under it; it is 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’.

Joining Timber

When pieces of timber were joined end to end, this was done by means of overlapping joints known as scarphs. According to the *Shipwright's Vade Mecum*, 'They are called coak scarphs when they have coaks in them; hook and butt scarphs when they are formed with a hook or projection, for one part to form into the other … and key scarphs, when their lips are made to form tail, and are set close by wedge-like keys at the hook … ' Chocks were wedges which performed a similar function, such as the large cross wedges which were set above the keel to join the lower futtocks, and smaller ones to join the upper futtocks and toptimbers.

Most of the fasting of the hull was done by means of trenails ('Tree-nails') or wooden pegs. According to the *Vade Mecum* they were 'Cylindrical oak pins driven through the planks and timbers of a vessel to fasten or connect them together. These certainly make the best fastenings when driven quite through, and caulked or wedged inside. They should be made of the very best oak split out near the butt, and perfectly dry or well seasoned.'

SLR2315 The assembly of one type of keel scarf, with coaks inserted at the ends of the joins in the lower picture to lock it in place.

One advantage of the trenail over the iron nail or bolt was that it allowed the shipwright to trim the timbers round it by 'dubbing' with his adze, without any danger of blunting his favourite tool.

Metal bolts were used instead of trenails in key places, often where the join was too long for a wooden fastening, or where the outside surface did not need to be trimmed. In many cases they were also used at the ends of the planking of the hull. Long bolts through the deadwood might be up to 17ft,

and those through the knee of the head could be 20ft in a large ship. They were made of iron up to the 1780s when interaction with the copper plating caused rapid deterioration in those below the waterline. They were replaced by bolts made with copper alloy. They had different heads – 'common', 'saucer', collar', 'lee' and conical. At the inner end they were usually fixed by a forelock. This was key-shaped and fitted through a hole near the end of the bolt before being bent over. This of course meant that the bolt had to be made to the right length, including the hole for the forelock, before assembly. A washer was placed under the forelock and against the timber. Spike nails were used where strength was less crucial, to fix the deck plank to the beams – a flat head that could be driven level with the deck was essential for this purpose. Nails were also used for fastening the pintles of the rudder.

A key as used at the end of an iron or copper alloy bolt. In this case it has been found in a building in Chatham Historic Dockyard, but it is believed that a similar system was used afloat. (Author's photo)

Preparing the Slip

Much of the position of the ship on the building slip was based on the need to launch it into the river, including its angling downwards towards the water – even though that made it much more difficult to check if the frames were perpendicular to the keel during construction. According to Rees's *Cyclopaedia*,

> A slip being provided, the blocks on which the keel is laid are usually about five feet asunder. Each block is laid upon a ground-way in the middle of the slip … The blocks, being the foundation of the whole, must be very carefully fixed, and their upper surface to a declivity of five-eighths of an inch to every foot in the length, observing that there may be water enough to launch the ship into, and keeping them high enough at the fore-part to clear the fore-foot of the

> ground-ways in launching … The caps or upper blocks should be more in depth than the false keel; and they should be clear-grained oak, that they may be split out the easier when the dales keel is out under.

A slip often had a ‘bridge’ or ramp alongside, as Ollivier observed at Deptford. ‘They rise obliquely to the plankshеer; their width up to the height of the breadth is about 12 feet, and from there to the top about 8 to 9 feet … I find these bridges very useful for bringing on board all the timbers more conveniently and at less cost than we do. They are not taken down when the ship is launched into the water …’ Larger ships, especially three-decker First Rates, were usually built in dry docks and floated out.

Task Work

‘Task’ or piece work was often advocated by the London offices in the mid-eighteenth century but consistently rejected by the more conservative dockyard officials. However, Lord Sandwich, on his restoration to the Board of Admiralty in 1771, was determined to apply it. He asked the current surveyor of the navy, Sir John Williams, to come up with a scheme and he devised ‘a method formed with great pains’ which ‘divided the whole works of a ship of each class, from laying their keels to their launching, into 25 sections …’ (see Appendix). It was supported the master shipwrights at Deptford, Portsmouth and Plymouth. According to instructions issued in March 1775, the ‘most able’ shipwrights were to be ‘shoaled’ or divided into new gangs. The old, incompetent or lazy would be ‘employed only in easy works such as in the masthouses, boat houses, capstan houses and other indoor works’. A task gang was to be paid a sum for completion of each of twenty-five stages in building a ship (though two-deckers only needed twenty-four stages because there was no middle deck, and smaller ships needed twenty-three). Payments for each stage were graded according to the size of the ship, for example the first stage, laying the keel and erecting the stem and stern posts, would earn them £330.14.0 for a First Rate and £39.7.0 for a 300-ton sloop. In total a 74 would earn £4131 and a frigate £1491, though no single gang would be paid that as they moved from ship to ship during construction. Task gangs were to be employed ‘by turns to preserve an equality in their earnings each year as nearly as may be’.

SLR2149 Building slips at Plymouth Dockyard in 1772–4. Both slope downwards towards the water's edge. The one on the left has the blocks which will support the keel, the other one also has part of the rails which will support the ship during a launch. Both are surrounded by scaffolding poles and have ramps to bring pieces of timber up to the hull.

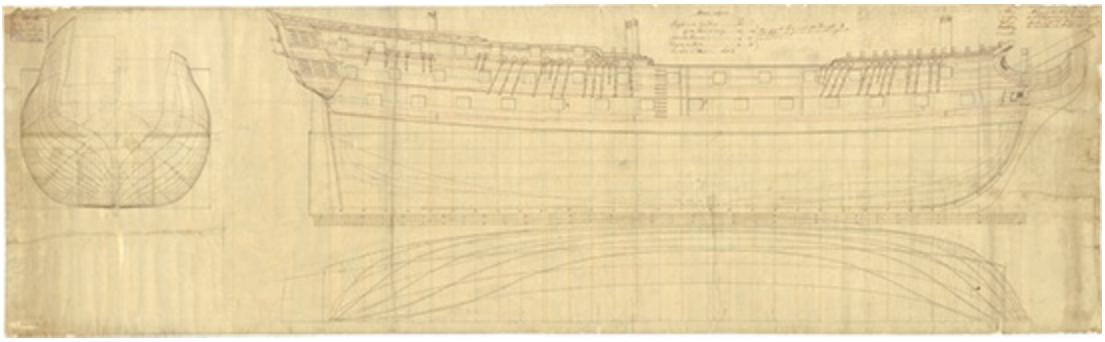
Sandwich was typically shrewd in applying the scheme, consulting with the yard officers and shipwrights and making sure it did not lead to any dismissals in the short term. This did not stop strong and sometimes violent opposition in some of the yards, with near-riots in Portsmouth after it was announced in March 1775. The Navy Board accepted many of the points raised by the workers and agreed to meet a deputation from Deptford – 'the Board attended to everything the people had to say and answered very coolly all their objections, except that of the money for putting the false keel on being subtracted from the 25th Article'. The Board asked who was willing to work under these terms and six out of fourteen gangs at Deptford agreed. In August the Deptford shipwrights began to implement the scheme and the other yards eventually followed.

SLR2151 Empty dry docks at Chatham, showing the wooden construction common at the time. The 1772–4 model also shows the steps on the sides and the form of the gates, braced against the pressure of the water. Though designed for ship repair, they were used to build the largest ships, the First Rates, such as HMS *Victory* in 1765.

Beginning the Building

The system of task work gives us a brief glimpse of how particular ships were put together. The 74-gun *Alcide*, named triumphantly after a French prize, was the third of the *Albion* class, designed by Sir Thomas Slade in 1759 as part of his policy of experimenting with the lines of his 74-gun ships – though she was not ordered until three years after his death, and due to other work her construction did not begin for another twenty months. Compared with other 74-gun ships of the time, the original *Albion* (built at Deptford in 1759–63) had an unusually square midship section. She sailed well in fair weather but was unstable and a poor sailer in high winds – but presumably these were considered acceptable faults. With a plan already existing, Slade's original draught merely had to be taken out of a drawer in the Navy Office and copied by pricking the key points onto a sheet below, and joining them up. It was sent down to Deptford for the shipwrights to begin work.

Navy Board orders of November 1773 had demanded that ‘When you receive a draught and orders to set up a new ship, you are to begin immediately to convert the frame …’ without necessarily waiting for the building slip to be ready. These orders had ‘not been so exactly attended to as they might and ought to have been’ in some of the yards, especially Portsmouth, according to another order of July 1774. The new ship at Deptford had to wait until the *Culloden* had been launched on 18 May 1775, then the slip which had just been vacated needed some repair. But, Sandwich was pleased to observe, ‘this will not retard the works of the *Alcide;* as the first Article of her is begun by task, and the timbers all ready to be taken in hand as they are called for.’



ZAZ0776 The plan used for the *Alcide* of 1779. This was the original plan of the *Albion*. According to the notes on the top right, copies were made for building the *Grafton* of 1771, the *Fortitude* of 1780 and the *Irresistible* of 1782 as well as the *Alcide.* The draft follows the usual pattern with stern and bow body sections, sheer plan and waterlines below.

The shipwrights began work on Article 1 of task work for the *Alcide* on 23 March 1775, nearly two months before the *Culloden* was launched. Two gangs worked intermittently for ten weeks making parts of the keel, the curved stempost and the straight stempost, the rising deadwood towards the bow and stern, and the floor timbers which would cross the keel and form the lowest part of the frame. It was 6 June when the first parts of the keel were recorded as being laid down on the building slip.

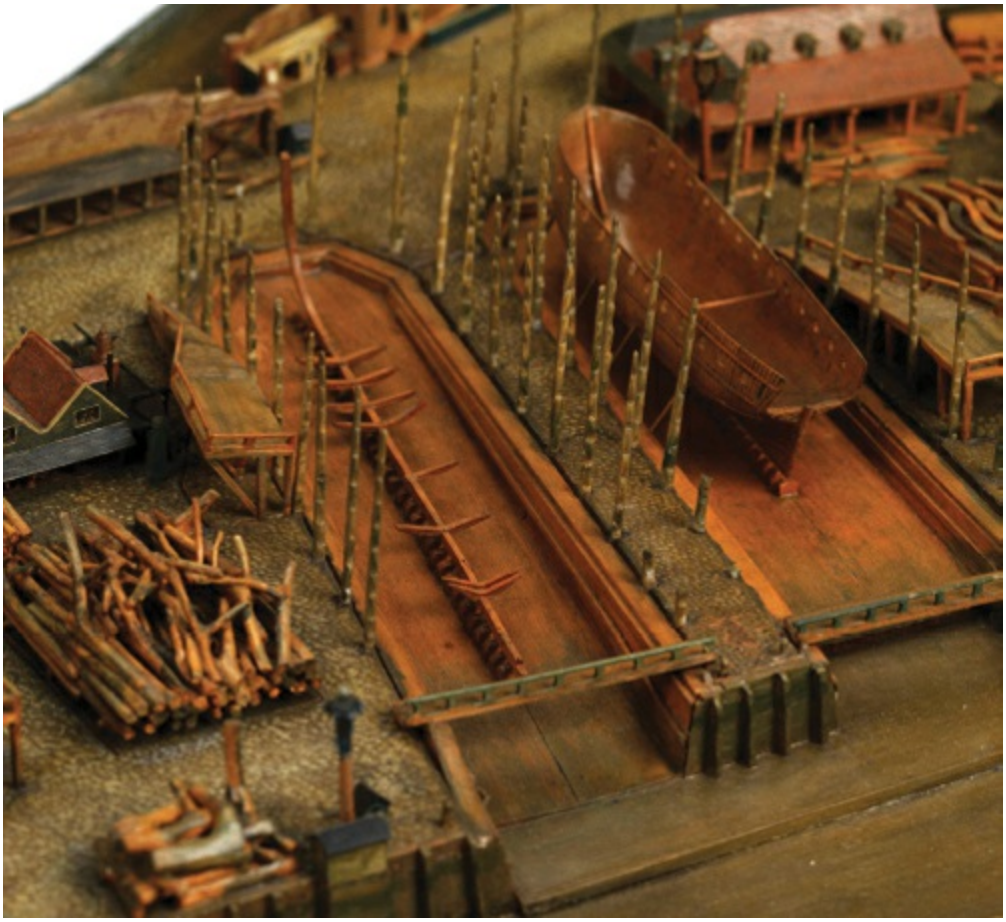
Keel and Stempost

The keel was the first part of a ship to be constructed, and laid on blocks on a building slip. It was usually of elm, which was straighter than oak. That of

the *Bellerophon*, like many of the 74-gun ships built during the period, was to be 1ft 6in square in midships, keeping its height throughout its length but tapering to 1ft 2in forward and 12½in aft, as seen from above. It had a triangular 'rabbet' or recess along its top outer edge for much of its length, to receive the edge of the planking of the hull. It was to be made in not more than six pieces with scarph joints 4ft 6in long, 'tabled into one another, laid with white flannel or kersey, and bolted with 8 bolts of 1¼ inches diameter, the lips of the said scarphs not to be left more in thickness than 5¼ inches'. In 1737 Blaise Ollivier observed that the British used vertical rather than horizontal scarphs on the keel. 'Our method is the better, for in our ships there can never be a leak sprung through the bolts of the keel scarphs, whereas the bolts of the English keel scarphs being of necessity clenched with roves on one side or the other of the keel and these roves being exposed to rusting are liable to fall away so as to cause a leak.' The same issue exercised John Fincham in 1821, writing in his *An Introductory Outline of the Practice of Shipbuilding* that 'The French and most other nations have flat or horizontal scarphs; but as these scarphs tend to weaken the keel, in the direction in which it must subject to strain, more than the side scarphs, the English mode is preferable, for the keel bends vertically, which brings a tension on the upper or lower fibres, which fibres are cut off, in a greater number of these scarphs, to let in the lips; and when sagging takes place there is a tendency to open the lower lip; this opening will cause the scarphs to leak …'

SLR2310 Constructing a keel using a horizontal scarf, the method usually favoured by French and other shipwrights. This annotated model was made in 1977 but shows the principle used in the eighteenth century. It also shows where the trenails which held it together were placed.

SLR2311 A vertical scarf, as usually favoured by the British, though it was claimed that it allowed water to enter.

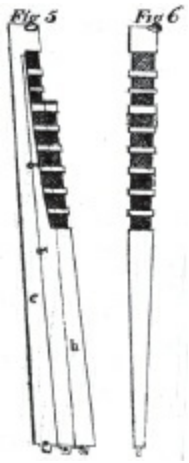


SLR2908 Building slips at Woolwich. On the left, the keel has been laid, the stem post erected and a few of the floor timbers put in position – they were not necessarily erected in order, but as the pieces became available. To the right, a frigate is in frame. Scaffolding poles are erected round both slips.

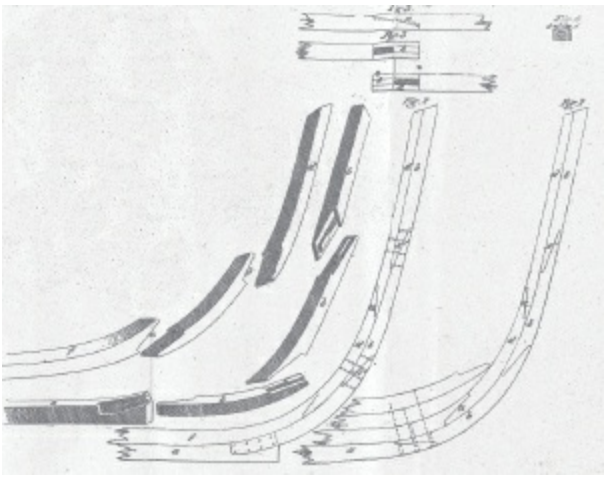
The sternpost, which formed the essential part of the lower stern, was relatively simple and made in a single piece. In the *Bellerophon* it was to be ‘of good sound oak timber of the best kind, free from defects, square at the

head 1 feet 11 inches, fore and aft on the keel (the back or false post if any included) 2 feet 8 ½ inches'. Apart from a tenon which joined it to the keel, it was normally attached by metal 'dovetail plates' on the outside of the join, though *Bellerophon* contract specified 'a square plate of iron of the knee kind in the flat way'. The fitting of the stem post was normally kept until later, and the transoms and fashion pieces were fitted to it before it was raised into place.

The stempost, the core feature of the bow, was curved and more complex in construction. According to William Sutherland in 1711, 'the stem is crooked, and cannot be well performed otherwise; but must have principal compass timber; and also in a certain number of pieces, according to the size of the ship'. That of the *Bellerophon* was to be 2ft 2in thick at its head, diminishing to 1ft 6in forward, and to 1ft 2in lower down where it met the keel. It was to be made of 'not more than three pieces of good oak' joined by 4ft scarphs each with six bolts of 1⅛ in diameter. A much more elaborate structure would be fitted forward of that, but not until later in the construction process.



A stern post, from Fincham's *Outline of Shipbuilding* of 1821, showing the recesses cut out for the transoms. It also shows the inner post (h) which helps to support it and the tenons for fixing them to the keel. Though the new Seppings system was coming into use by this time, Fincham mostly dealt with slightly older practices.



Parts of the stempost and associated features from Fincham. There are several kinds of scarf, including the specialised boxing scarf to link the end of the lower stem piece to the fore foot.

a – keel

b – stem

d – apron

f – deadwood

s – bolts

u – scarfs

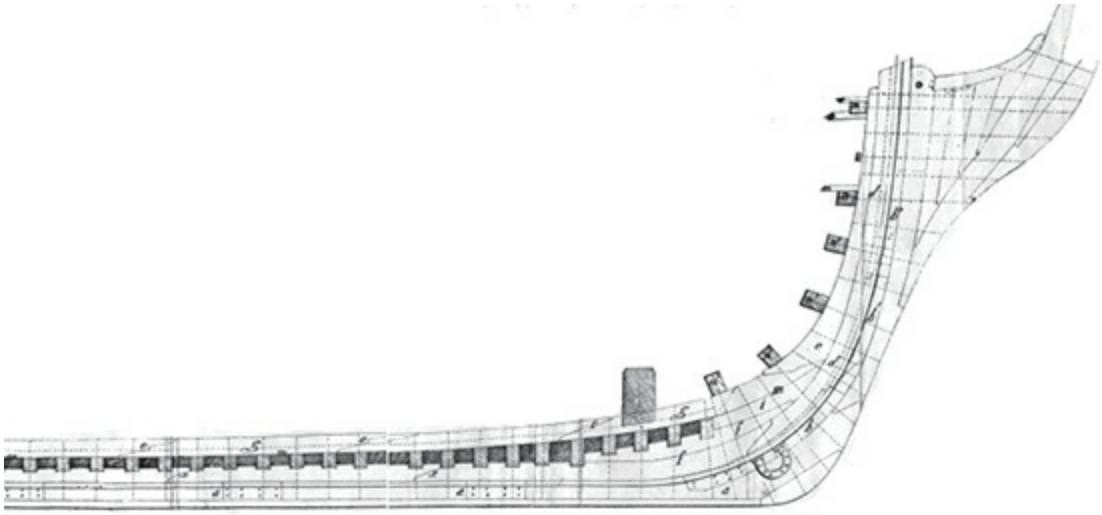
The Deadwood

In midships, the deadwood was placed over the keel and was about two-thirds of its width in the early period, though later it was broader than the keel. The *Shipwrights' Vade Mecum* said: 'The pieces along the midships, are of the thickness given in the Table of Dimensions, and, in breadth, to overhang the keel about two inches on each side. The scarphs give shift to the scarphs of the keel, and fasten thereto with trenails.' That of the *Bellerophon* was 8in deep and 1ft 10in broad, and indeed projected from the keel by 2in on each side. It was cut with recesses to hold the first parts of the frame, the floor timbers.

This continued for about two-thirds of the length of the keel until close to the bow and stern where the fitting of the cant or angled timbers required a different method. The rising deadwood rose much higher above the keel, with its top edge defined by a gentle curve and filling in the spaces between the keel and the stem and stern posts. 'The deadwood afore and abaft, for the

security of the half timbers, is to be closely fayed together, and to be of such height as to answer with the underside of the keelson and give shift to the scarphs of the main keel and to each other.' The edges of the cant frames on either side were to butt against it and be bolted in place. The shape of the rising deadwood was shown clearly on the plan, by a curve known as the cutting-down line. In 1737 Ollivier observed three different methods of scarphing the parts of the deadwood together at Deptford. 'In one of the ships which is on the stocks at Deptford the deadwood of the stern is made up of a straight timber laid over the rising wood of the keel, assembled with hooked scarphs and scarphed to the deadwood knee; in another ship there are two like timbers placed one over the other on the rising wood; in the third ship here are three timbers over the rising wood.'

SLR0676 The bow and stern of a model of around 1813, made to open into two halves. This one shows the old system before the Seppings reforms and has much detail of the internal structure.

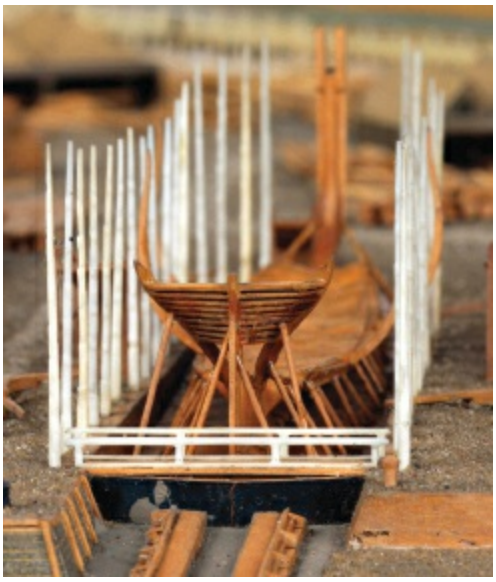


The shape of the bow structure from Fincham, showing the keel (a), the deadwood (f), the keelson (g), cross sections of the floor timbers (shaded) and the breast and deck hooks (n), the large shaded block aft of the breast hooks is the step of the foremast to the right, the diagram also shows the structure of the knee of the head, made up in several pieces.

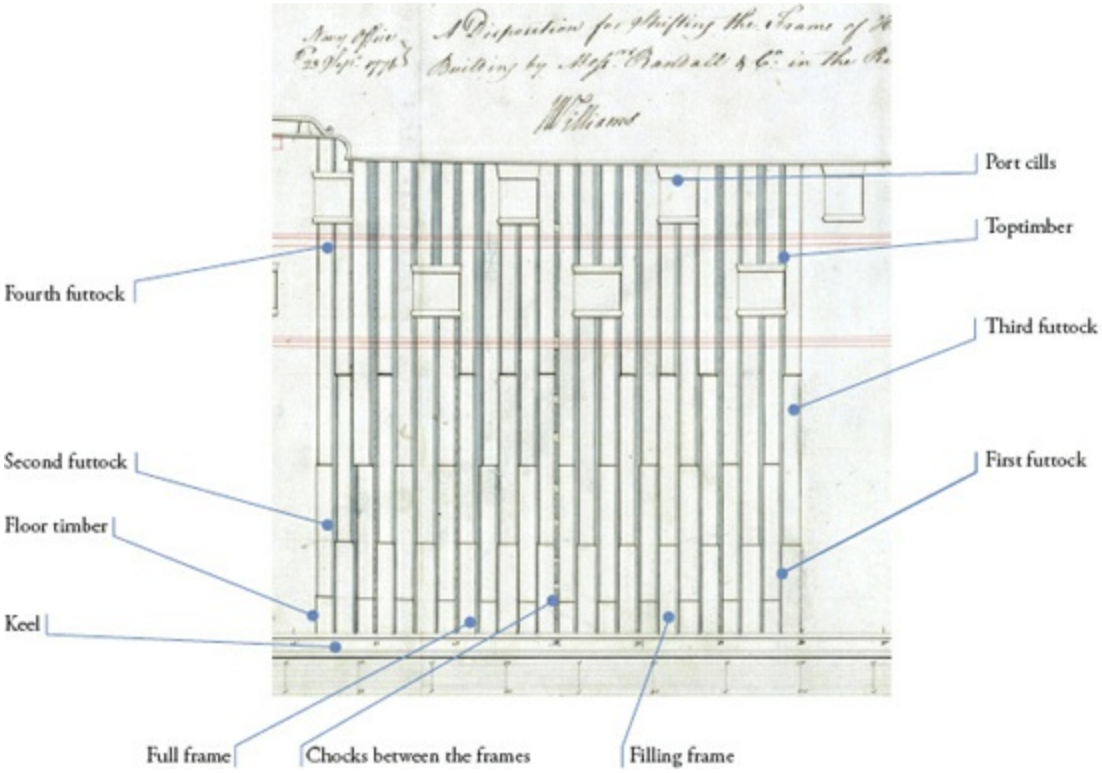
3: Frames

So far the work on the ship had been entirely twodimensional, except that most of the transoms had been fitted horizontally and at right angles to the stern post. According to Ollivier, ‘Here they assemble the sternpost with the fashion pieces and all the transoms save the helm-port transom before raising them up, and all these timbers are raised together just as we do in France, with the difference that the English shipwrights do not as we do fasten either the helmport transom or the top-timbers of the fashion piece; they only add to these timbers when the ship has been framed to the height of breadth, and it costs them more labour than we expend.’

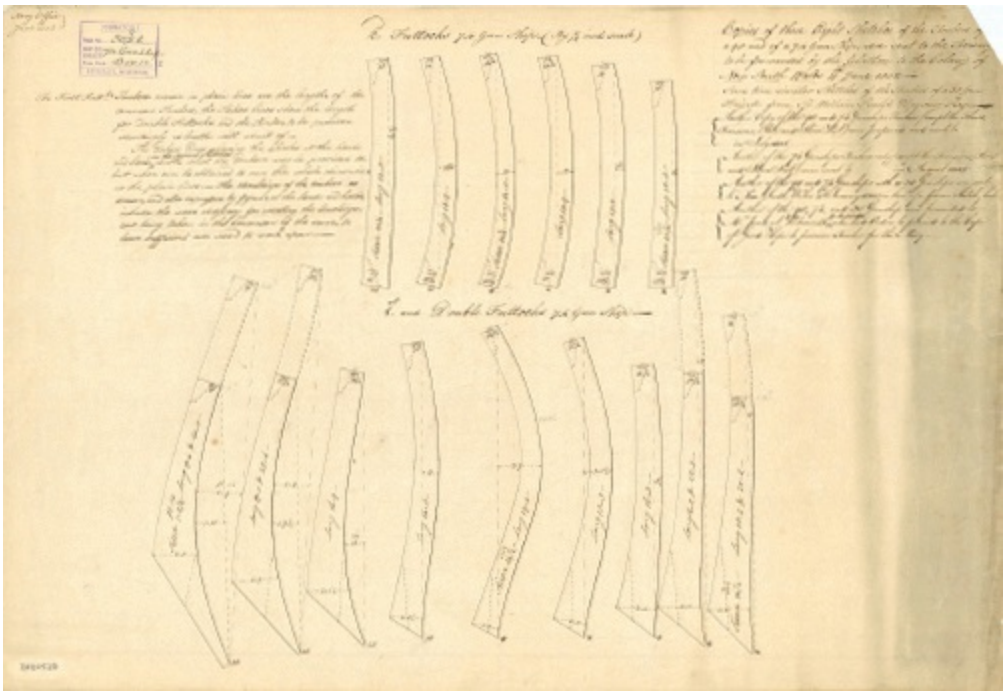
Now it was time to consider the frames or ribs which would give the ship its elegant and streamlined shape, and much of its strength. It had to be carefully planned, on paper in the latter part of the eighteenth century. The gunports which allowed the ship to use its main armament were staggered deck by deck to avoid creating points of weakness, and usually there was just enough room for a pair of frames to pass between those on alternate decks, forming, for example, the forward side of a lower-deck port then the after side of the one above, and so on where there were more than two decks. In the first half of the eighteenth century this was left to the discretion of the builder, whether private or merchant, but after that it was increasingly common for the Navy Office to produce a detailed plan showing the layout of the timbers. This was outlined in the contract of the *Bellerophon*. ‘It being of the utmost consequence to the strength of the ship that all the timbers of the frame should as much as possible be preserved from being cut by ports on each deck, a disposition for that purpose is made on the said draught.’



SLR2906 A ship on the stocks at Deptford, showing the arrangement of the sternpost, fashion piece and transoms.



ZAZ1832 A standard arrangement of frames in midships, from a plan of the *Jupiter*, 50 guns, of 1778. In this case the futtocks are not contiguous, but linked by small chocks between them.



ZAZ0537 Drawings of individual timbers for a 74-gun ship, sent out to the newly-colonised New South Wales to aid in the search for timber there in 1802. Second futtocks to the top, half timbers and first futtocks below.

Making the Frame

According to the *Shipwright's Vade Mecum*, 'The frame timbers should be converted of sound well-grown wood, without sap or vein appearing in the wake of the ports …' The main work of the shipwright was described by the Deptford officers, incidentally giving an insight into the relationship between design and construction.

> … the master shipwright who may be ordered to build any ship, be he ever so skilful, and use his utmost care in designing and moulding the ship's body and timbers, his endeavours will be defeated by attempting to carry his design into execution by the careless workmanship of the persons who are employed there upon, who instead of having the timbers as they are exactly moulded, and dubbing them to their precise bevellings (which is absolutely necessary to be performed with great care and attention) will unavoidable slight such work as it's impossible to be done in a hurry, and as when the frame bends are brought together and raised in their proper places, and the ribbands bought about, in order to the ship's frame being confined to its proper dimensions and figure, the utmost care and precaution is to be used in fixing the several shores. men in a hurry and intent upon getting as much money as they can in a day will not take sufficient care to perform this most essential part in shipbuilding, by which means the ship so built and the ship originally designed will be two different things.

Earlier in the century, as reported by richard Williamson, the sawyers had sided the frame of the fourth rate *Gloucester* and Williamson wanted them to ‘convert’ the timbers to their curved shapes by sawing. Instead the shipwrights were ordered to hew them, wasting much more timber. Questioning this with the foreman, he was told, ‘It matters not, for the shipwrights have little to do.’ This was banned by a navy Board order of 1729, which perhaps only reinforced established practices. shipwrights were ‘not to convert timber or plank with an axe or an adze that can be sawn with any advantage to his majesty, and take care such as is converted with the saw be converted as near to its proper shape and scantlings as possible.’ This change is described by the cantankerous timber measurer Yeoman Lott in 1778. ‘… forty or fifty years ago the major part of oak materials’ was ‘hewn by the axe’ creating much more waste, and incidentally more chips for the shipwright to take home. In other words the sawyers were expected to cut the timbers as accurately as possible to the moulds, leaving less to be hewed off by the shipwrights.

Part of the timbers found under a floor at Chatham Dockyard, showing a futtock cut at its end to receive a chock. (Author’s photo)

SLR2888 A model showing filling frames from around 1813 using shorter futtocks to conserve timber, and flattened out to show the system more clearly.

Disposition of the Frames

The frames or ribs of a ship formed its essential shape, and were quite closely spaced in warships. no timber had the right length and curve to form a single rib, so each was made up of at least four pieces on each side, or more likely up to six. After 1715 frames were fitted in pairs, with the joints between the individual sections staggered to avoid points of weakness in the structure. According to Blaise ollivier in 1737, '… the frames are set up so that they all touch one another as far as the ends of the lower futtocks, or else if there be any space left in the arrangement of the frames it is filled with filling timbers'. The advantages, he believed, were that they took the place of ballast, and were fitted lower than ordinary ballast and that the system stopped water accumulating in any gaps, preventing 'the vapours from this water which remains in the bottom of the ship' which might spoil the bread. he did not mention that this might also make the frame more rigid. At that time, as ollivier observed, … the futtocks do not form pairs or frames as in our ships; these timbers are not fastened in any way one to another; there are neither trenails, nor iron bolts; they are maintained in their place only by the planking of the hull and of the ceiling and by the bolts of the riders'. he recognised that the absence of about 2000 iron bolts saved labour and helped to reduce topweight and thus increase stability, and there was no evidence that it made the British ships any weaker.

Nevertheless, the system had changed by the 1780s and the contract for the *Bellerophon* demanded that the timbers 'be framed in bends, 1st, 2nd, 3rd and 4th futtocks and toptimbers together …' Sometimes the two parts of the pair were directly adjoining, at other times with the timbers separated by a small piece of wood at each bolt or trenail. The task work orders of 1777 directed that the frame bends have 'dry plank or board (as may be directed) between them'.

Every second frame bend started with a floor timber, which was fitted across the keel and formed the lower shape on both sides of the ship. Above and outside of that, joined end-on to the floor timber, was the second futtock

(originally foot hook) which began the curve of the hull. The join between the two was usually formed by having a portion of each cut away with a wedge filling the gap – in the second half of the century it was no longer triangular but had its outer corners cut off to give a more rigid join. For the full timbers, which passed all the way up the side of the hull uninterrupted by gunports, the next stage was the fourth futtock which joined the second futtock in the same way. The adjacent frame had a first futtock on each side, joined by a large wedge over the keel. These were joined to the third futtocks in the usual way, and then came the toptimbers which reached to the top of the side, or the planksheer.

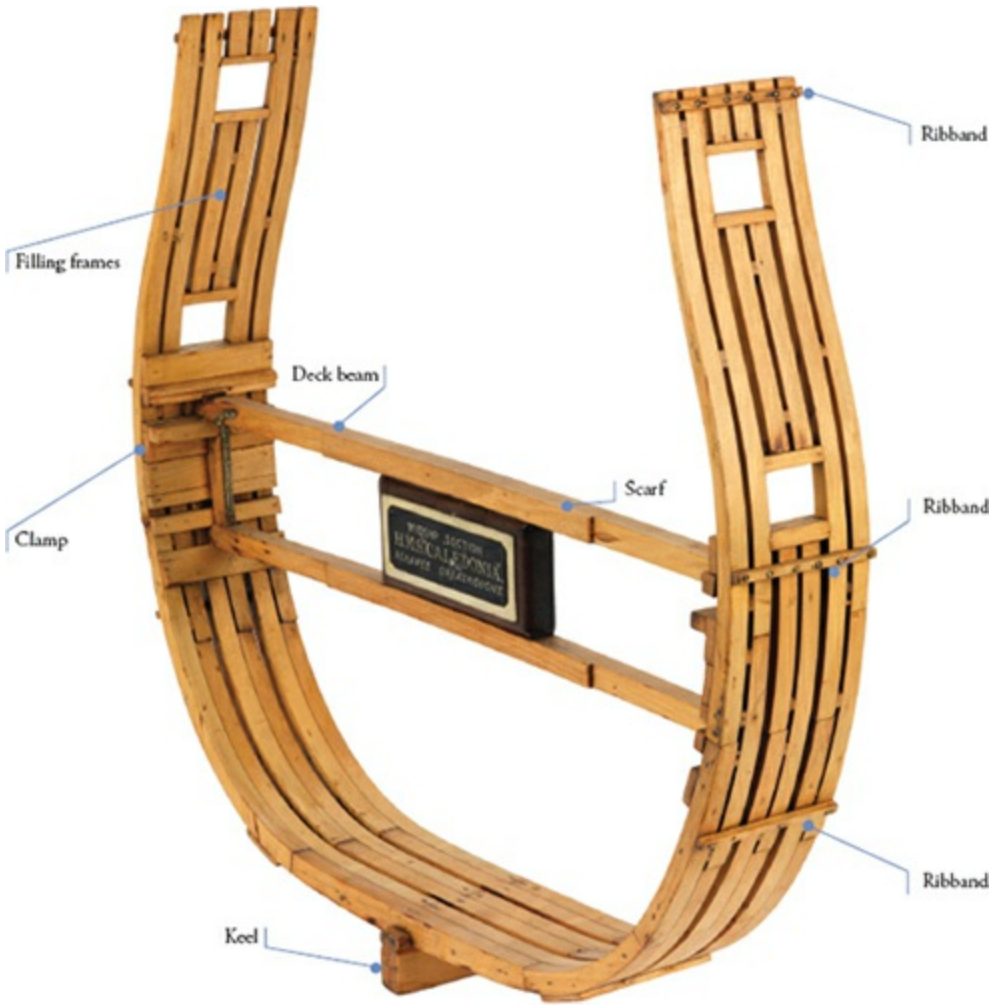
SL2297 This model of around 1814 shows the pre-Seppings system of framing over a range of seven pairs of frames and three gunports. The chocks are omitted to highlight the joins between the futtocks and the keelson is in place over the keel. It shows how the futtocks tend to narrow as they rise, touching one another at the level of floors and first futtocks but with gaps at fourth futtock

and toptimber level.

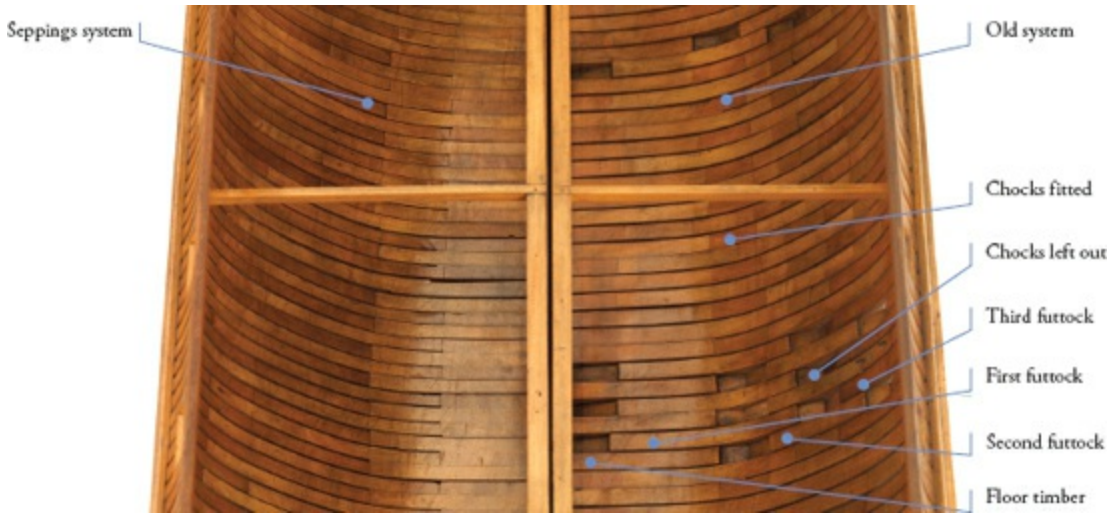
The various timbers were reduced in width from the keel to the gunwale. The floor timbers of the *Bellerophon* were to be 1ft 4in thick in midships, the second futtocks were 1ft 1½in thick and the fourth futtocks 1ft 1in.

Room and space was the measurement of a fixed point on one pair of timbers to the same point on the next, so it indicated the space needed for each individual pair of frames. Less directly it gave an indication of how solid the structure was under the planking. The room and space of the *Bellerophon* was 2ft 8½in while the floor timbers were 1ft 4in ‘sided’ or thick in midships, and the lower futtocks were sided 1ft 2½in, leaving a gap of only 2in between the timbers at this level. That increased further up the hull, and the fourth futtocks were sided 1ft 1in and the adjacent toptimbers 10½in, leaving a gap of 4½in.

The frames in midships were generally square in cross section, in that their faces were at right angles to their sides and they were relatively easy to cut out.



SLR2216 A model showing three frames of the 120-gun *Caledonia* of 1808, the second ship of that number of guns built in Britain, and the largest so far. The framing is conventional but the arrangement of the clamp and other pieces under the deck beams suggest some experimentation. It only shows two gunports because the middle deck ports are staggered and do not appear.



SLR0676 The interior of a model constructed around 1812–14 to contrast the new Seppings system (on the left) with the old method. This time most of the chocks of the old system are shown in place, with a slightly different colour of wood to pick them out. The Seppings system used dowels at the end of each futtock rather than chocks and these are not visible seen in the model.

SLR0503 A detail of a model of the *Bellona* of 1760, showing the unusual fore-and-aft curve of some of the timbers to avoid the gunports.

Towards the bow and stern they required bevelling, that is, having one side reduced compared with the other. This process, which occupied a good deal of space in textbooks on naval architecture, was done by means of a bevelling board, often one for each futtock and the same width as it. The angle to be cut down at various stages was marked on the board in the mould loft, and transferred to the timber by mean of set square and compasses. The surplus timber was then hewed away. This had to be done externally and also internally, in order that the inside planking could be fitted.

The framing model of the 74-gun *Bellona* of 1760 shows an unusual disposition of the frames. Instead of being straight in profile, some of them are curved under the edge of the upper deck ports, with a short frame placed under the gap. This must have demanded a special shape of timber and may have been experimental, but a similar system was used on the *Vengeance* of 1774 and possibly on other ships.

Crossing the Floor Timbers

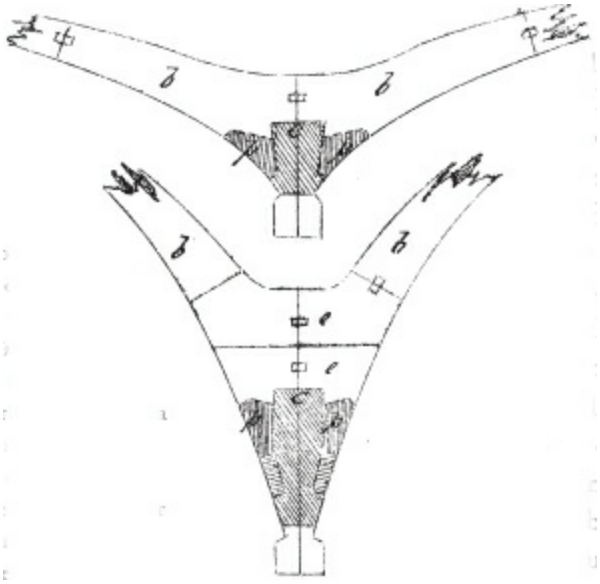
The first stage in framing was to cross the floor timbers, that it to attach them across the keel.

According to Rees,

> The floors, when correctly trimmed, are let down into scores cut in the dead-wood, to the exact height of the cutting-down from the upper edge of the rabbet of the keel, in their respective situations; set precisely level, and at right angles with the middle of the keel. The floors are then ribbanded and shored, securing the shores at the head and heel to prevent any alteration; for the truth and precision of the whole fabric may be said to depend upon the accuracy of the floors, when got into the ribband.

This meant that relatively thin strips of timber, known as rib-bands or ribbands, were fixed to each timber to keep them rigid, and exactly the right distance apart, Their positions were marked on the ship's plan and when transferred to the frames they were known as sir-marks. They were fixed in place by ribband nails, which, according to Fincham, had 'large round heads, that they may be easily drawn, and have round points'. This practice would continue with the upper frames. At this stage the structure looked rather like a ladder which is perhaps why the ends of the floor timbers were sometimes known as the rungheads

SLR2151 A ship under construction at Chatham with the stern assembly, consisting of stern post, transoms and fashion pieces, in place. This was normally assembled bedside the ship then raised. As usual the slip is surrounded by scaffolding poles with a ramp to bring up heavy pieces. A wooden dam is used to keep water out during very high tides.



Methods of constructing floor timbers, from Fincham's *Outline of Shipbuilding*. Top, a rising floor with two stepping pieces marked p. Bottom, a rising floor with two cross pieces. These methods became

necessary as timber was in increasingly short supply after about 1800.

The crossing of the floors and fitting of their ribbands represented the completion of Article 1 of task work and it was May 1776, eleven months after starting, before this stage was complete in the *Alcide*. The shipwrights had worked on the ship for 993 mandays, which with about 40 men in the two gangs means that they had only worked 24 days over 13 months – clearly they had often been diverted to other tasks.

Raising the Frame

After the long-delayed completion of Article 1, work on the *Alcide* speeded up from March 1777, perhaps because war with France now seemed likely and ships like this would be needed urgently. To ease the work of the shipwrights, horses were to be 'allowed for bringing the timbers, beams and thickstuff to the slips where the ships are building …' and labourers were to bring lighter pieces such as planking. Work on Article 2, erecting the main frame, began on 1 March and continued for eight weeks until 24 April.

According to the *Bellerophon* contract the futtocks and toptimbers which formed the major part of the frame were to be fastened together with three bolts of 1¼in diameter. The various frames were assembled beside the building slip as shown both in the Milton/Canot print of Deptford Dockyard and on the 1774 model, with plank or board between each pair them to keep them the right distance apart. Triangles were erected at each end of the keel and a rope slung between. A tackle was fitted on each side and the frames were raised in pairs, to be kept apart by temporary cross-spalls until the deck beams were ready to be fitted. It was one of the most dramatic stages of the building, as the hull began to take shape. The process was described by the Deptford officers in 1749. 'And as when the frame bends are brought together and raised in their proper places, and the ribbands brought about in order to the ship's frame being confined in its proper dimensions and figure, the utmost care and precaution is to be used in fixing the several shores …' According to Rees, 'Great care should be taken that the frame be not strained in hoisting, as tis form would be altered, and of consequence the true shape of the body lost.' This was also the most labourintensive part of the process,

needing 1751 man-days in the case of the *Alcide*, but it was completed on 24 April, after less than two months.

According to Fincham,

> The several futtocks are then united together in frames … upon the ground, by first bolting the second futtock to the first, which agrees in form from the floor to the first head; these timbers are then turned over and the third is bolted to the second, the third agreeing in form from the first to the second head. The same progressive manner is pursued until the whole of the timbers are connected into frames, and each over-launching part bolted with two or three bolts.

The process of raising the frames of a British ship around 1750 was described by Fredrik Henrik af Chapman (quoted in Daniel Harris' *F H Chapman, The First Naval Architect and his Work*).

> Then put all your frames together as near their rooms as your slip will admit of, for all above 20 guns frame only the 1st, 2nd, 3rd, and 4th futtocks, and from 20 guns downward the whole frame, and in every ship drive three trenails very taut through the frames. When the frames are together, cant them on their bag, keeping their setts on until they are hoisted in their places, then check the frames before you get them up, the proceed to get them up, first getting a ribband about a foot from the side of the keel, for the heels of the first futtocks to lodge on, slightly shored. For getting them up in their places, there is three ways [i.e. stages]. First, with a ridge rope from the foremost sheerhead to the after sheerhead, with travellers passing fore and aft on the ridge rope, to make the tackle fast. Second, to hoist up the frames by the opposite standards securely guided. Third, with the sheers you hoist the stem …

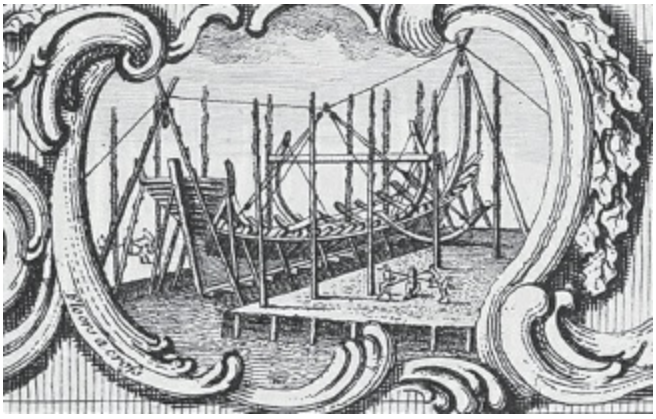
In 1749 the *Shipwright's Vade Mecum* suggested that '… the strength of a ship entirely depends upon the proper shift and faying of the several works and the due bolting and fastening of the thick stuff without board and within, such as the wales, clamps etc, and in a particular manner the floor and futtock riders, breasthooks, knees, standards etc.' To 'fay' was to join two pieces of timber together.

SLR2906 At Deptford, the floors are crossed and futtocks have been assembled into frames beside the ship, and each will be hoisted into place with its opposite number on the other side, to create balance. A ship of the line is under construction, with a frigate behind. The model also shows the triangular projections on the scaffolding poles, to attach planks.

The Bow

At the same time the different structures of the bow and stern were constructed. There most of the frames butted onto the rising deadwood rather than crossing the keel, and as they approached the extremity they were increasingly angled forward, or canted, to match the shape. According to the *Shipwright's Vade Mecum,* 'the canting of the timbers is of great utility, as it contributes very much to the strength of the ship in the fore and after parts; and likewise, greatly assists in the conversion of timber. For, … by canting the timbers gradually from a thwartships line, we thereby bring each timber nearer to a square with the planks of the bottom, which is not only better for the security of the planks, but the timbers are also more able to bear that security.' In the extreme bow the timbers, known as hawse pieces, were fitted parallel to the keel when seen from above. 'These hawse pieces, when in their places, are supposed to stand perpendicular, and their sides to look fore and aft, exactly similar to the square timbers, only their sides looking fore and aft

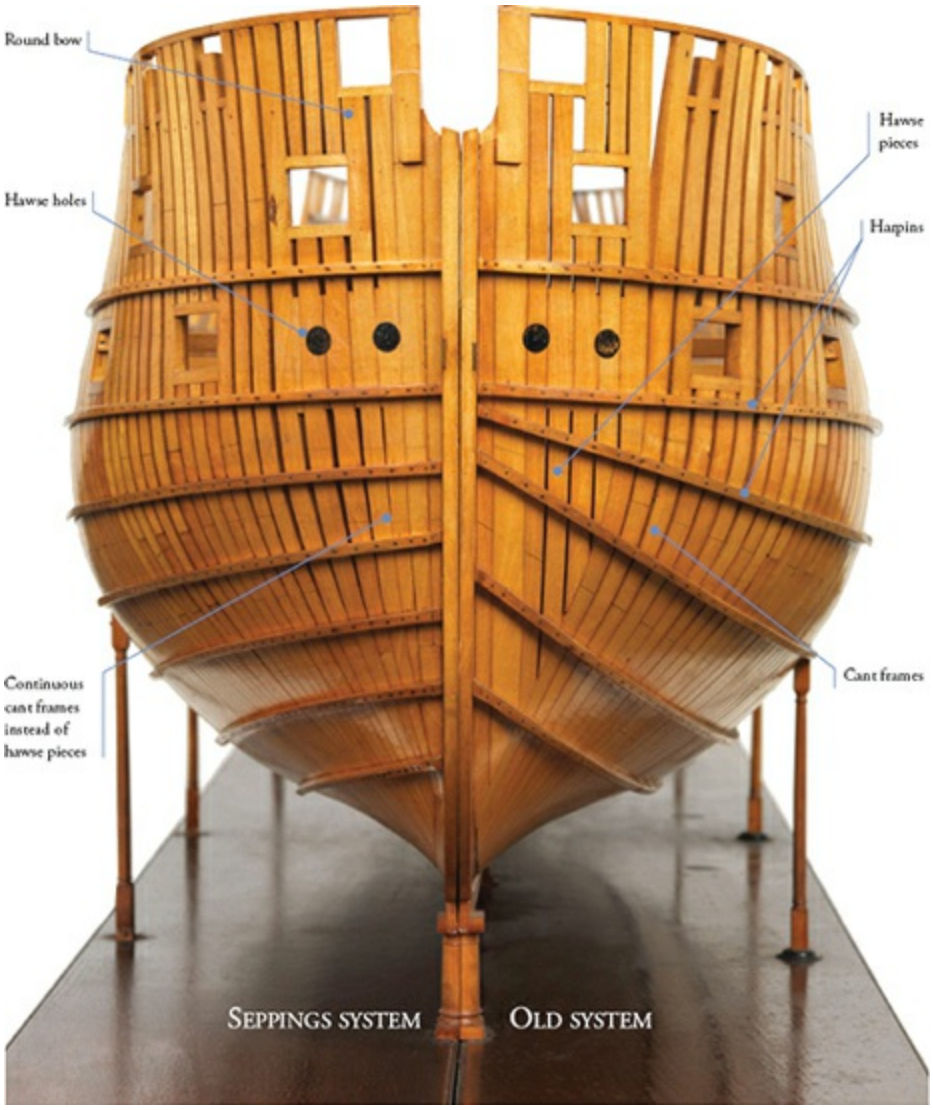
instead of thwartships.’ The foremost hawse piece on each side, fixed to the stempost, was known as the knighthead because originally it had carried attachments for ropes at its head. Two pairs of hawse timbers on each side were drilled with holes for the anchor cables to pass through. According to Ollivier, ‘The futtocks on one side and the other are fastened to each other by trenails which pass through the deadwood, and these timbers thus take the place of floors.’



PAJ3961 A pair of frames assembled from futtocks being raised at Deptford, a detail from a print of 1755. The erection of poles and the rope stretched between them can be seen. Capstans are in use, though it probably needed more than two men

SLR2179 Exterior and interior views of a model of the structure of a bow, made by Robert Seppings during his apprenticeship. There is no sign that he had any innovative ideas at this time, and it shows the conventional structure of cant frames, hawse pieces, stempost and ribbands.

It was particularly important to get the shape of the bow and stern right, and the timbers were held in place by harpins. Unlike the ribbands which performed the same function in the central portion of the ship, the harpins were not just bent round the frame timbers at the appropriate places, but were carefully shaped to the correct curves to define the essential shape. As the *Shipwright's Vade Mecum* says : 'The harpins are sawed to the moulds and bevellings; then trimmed, and scarphed together with a key scarph, because of their curvature. They consist of two or more pieces, and the scarphs are lined over with oak or elm board, to strengthen them.'



SLR2819 A much later Seppings model, contrasting his new method of bow structure (on the left) with the older system. The main difference is that the cant frames continue all the way to the stem post, with no need for hawse pieces. It shows the round bow of a ship of the line, with the main structure carried all the way up to the gunwales. This was introduced after 1805 and is apparently taken for granted, as both halves of the model have it.

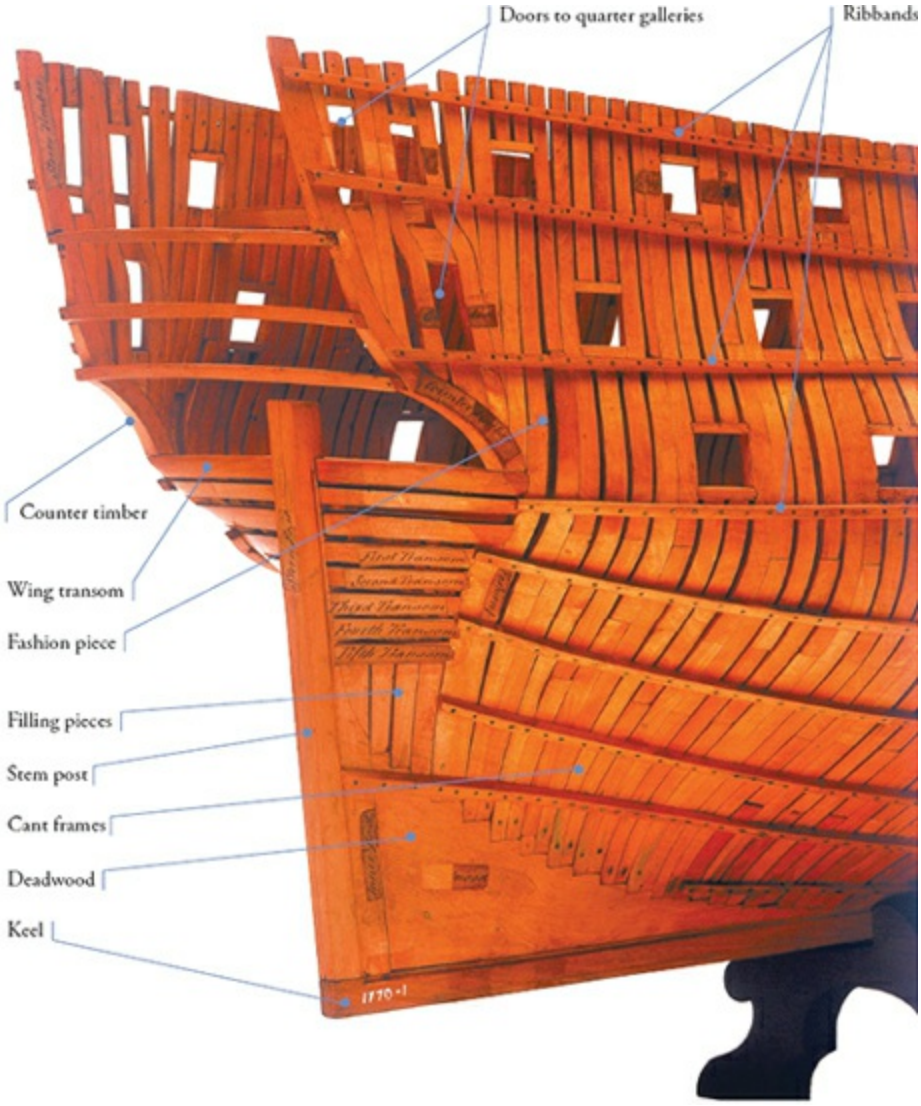
The main structure of the bow only went as high as the upper deck in ships of the line, though it went all the way up in frigates. This necessitated the beakhead bulkhead, a light, flat structure which filled the space at the forward end between the upper deck and forecastle. It became recognised as a source of weakness as ships began to sail directly towards the enemy as Nelson did at Trafalgar, and Sir Robert Seppings' first major reform was to carry the main structure all the way up to the forecastle in new-built ships.

The Stern

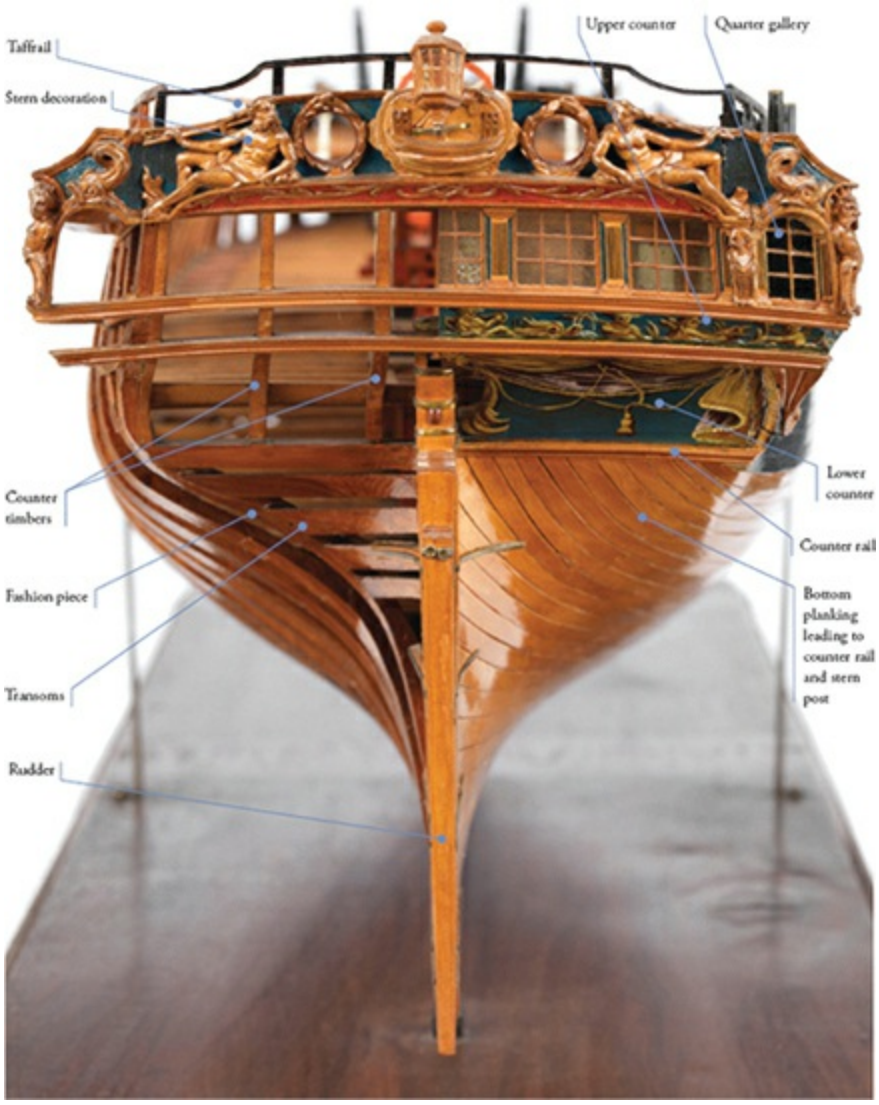
The basic shape of the stern was more complex than the bow. It had to be particularly narrow underwater to allow the water to reach the rudder with full effect, while above the waterline it widened rapidly to provide space for guns and for officers' cabins. This led to a much more complicated structure using at least four different elements, all constructed differently. The central part was made up of the transoms, which were unique in the frame in that they were horizontal rather than vertical. In *Britain's Glory*, William Sutherland wrote of them, 'The reasonableness of such pieces is only for creating large accommodation in the after parts of the ship …' There were about nine of them in a typical ship of the line, varying in shape to match the widening of the hull. At the highest level, the wing transom was almost straight, though with its ends curved in. According to the *Shipwright's Vade Mecum* it was 'the foundation upon which the whole stern is built; (and therefore should always be of the best timber that can be procured)'. The lowest transom was closer to an equilateral triangle, though its apex had concave curves to meet the stern post. The transoms were all bolted across the sternpost, and below the lowest one were short vertical timbers known as filling pieces. The ends of each transom joined the fashion piece, as the aftermost cant timber was known. It was important as it had to carry a great deal of structure beyond its own weight. Below the lower transoms were vertical filling pieces when extended down to the rising deadwood.

SLR0405 The stern of the 1715 model, showing the older system on the left, with the newer method of cant frames to the right. Strangely, the models shows the modern closed wales turning into open wales towards the bow and stern, which can be seen here. There is also a vertical timber just to the right of the sternpost, apparently an extension of the filling pieces, a method which which was not adopted as standard.

The stern framing of a frigate, clearly showing the system of cant frames, transoms, deadwood, counter timbers etc, held in place by ribbands before planking. (Courtesy of the Charles Miller Gallery)



SLR0525 The stern of a structural model of the 64-gun *Intrepid* of 1770, also made for George III on the orders of Lord Sandwich. Some of the individual timbers are marked with their names, though some are difficult to read. It shows the role of the deadwood in forming the shape of the extreme stern, and the weakness of the hull above the transoms.



SLR0316 The stern of the *Winchelsea* model made for George III, showing much of the elaborate decoration. One side is left unplanked to show something of the structure and interior, as with its pair, the more famous *Royal George* model. Of course the decorations under the taffrail would not normally have been fitted until the planking was in hand but they are presumably added to the model for symmetry.

SLR2908 The stern of the *Caledonia* of 1808, showing the old system of closed square stern to the right and Seppings's new round stern to the left. The older system shows the 'closed' stern without the open galleries which were abolished in 1795. The closed galleries can be seen today on HMS *Victory*. Paradoxically the round stern reintroduced open galleries, but otherwise it was unpopular with officers.

Above the wing transom was a very light structure shaped more for elegance and comfort than for operational necessity. Its after face was almost flat with only a slight outward curve. As seen from the side, the structure began with a sharp outwards curve, known as the counter. After that it outward projection was lessened and that was known as the upper counter. That was followed until the 1790s by an even lighter and almost vertical structure which allowed for the windows of the wardroom and the galleries and windows of the captain's and admiral's cabin. It was not recognised as a major source of weakness while ships fought rigidly in the line of battle, for

their sterns were rarely exposed to gunfire; but after Nelson and others began to adopt more aggressive tactics, it eventually became necessary to change it. Frigates had only one deck with windows and had no galleries, but in their case the weakness was more important. In a single-ship action, the aim of every frigate commander was to ‘rake’ the enemy by getting across his stern and firing through the weak structure with devastating effect.

At the extreme stern, the side counter timbers formed the edges of the upper structure and followed its general shape – a concave curve just above the wing transom, a slightly smaller curve just above that to form the edges of the upper counter, then a straight part angled slight aft. The other counter timbers – four on each side of the sternpost in a typical ship of the line – followed the same curves but had a much shorter piece before the 1790s, as they reached the level of the stern gallery. The angles between the two curves and the straight piece were covered by decorated pieces and were known as the counters. All of the counter timbers rested on the wing transom. The side counter timbers were also the base for the side timbers aft of the fashion piece. These tended to follow the style of the rest of the framing of the ship, though they were pierced for doors from the officers’ cabins rather than gunports.

The Kelson

The keelson or kelson was a long, curved timber running the length of the ship, made up of several parts scarphed together. It was fitted over the floor timbers and rising deadwood and intended to lock the whole structure together. According to the *Shipwright’s Vade Mecum*, ‘In the navy, the keelson is bolted through every floor, and the bolts clenched on the underside of the main keel.’ Ollivier wrote, ‘The keelson in the English ships is not scored down over the floors as in our ships; only in certain places is it scored down over the floors when they are not correctly faired. It is certain that this timber binds the ship better together when it is scored down over the floors, as in our method.’

At bow and stern, timbers were placed to fill the gaps and give extra strength. According to John Fincham the apron was ‘a timber conforming in shape, and fixed in the concave part of the stem, extending from the head to

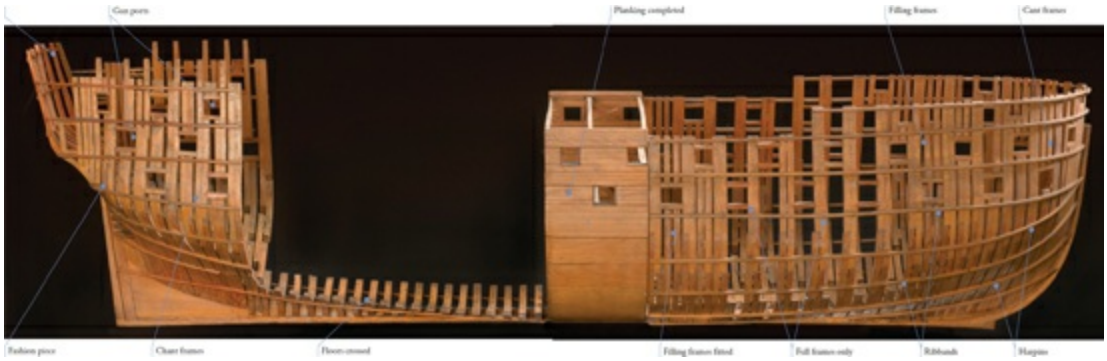
some distance below the lower scarph; it is for aiding the scarphs and maintaining its shape.' The stemson was 'a timber art the foremost extremity inside, united to the fore end of the keelson … and extending upwards to the upper deck, with its fore side contiguous to the apron. This timber is scarphed to the fore end of the keelson with a flat scarph, which has two or more circular coaks in it.' At the other end of the ship it was matched by the sternson, 'a timber placed at the after extremity in the exterior, scarphing to the after end of the keelson, and extending up to the lower deck …'.

Filling Frames

The frame itself was still skeletal: only the futtocks which were not interrupted by gunports were in place, about half the total. The next stage, Article 3 of task work, was to fit the sills above and below the gunports, and then put in the filling frames above and below them to make the frame almost solid before it was planked. The sills had a width to match the futtocks they were joined to, and on the *Bellerophon* the lower sills were to be were 11in deep, the upper ones 11½in. As well as forming the tops and bottoms of the ports, they had a role in keeping the adjacent timbers the correct distance apart, and receiving the ends of the filling frames, though apparently they were not recessed to receive them. These frames naturally followed the shape of the hull but were much shorter than the full frames. In the stern, the sills of the doors out of the admiral's and captain's cabins and the wardroom to the quarter galleries were fitted in the same way as the gunport sills, and filling frames were inserted between them. The frame was now complete and the men were paid £282 under Article 3 for 1151 man-days.

SLR0316 A model of the frigate *Winchelsea*, a typical early frigate, showing the full frame and

port cills fitted, but not the filling frames. Of course the ship would never really be at this stage, with the bow and stern decoration in place, and it is simply a device to allow a view of the interior, which is quite elaborately fitted.

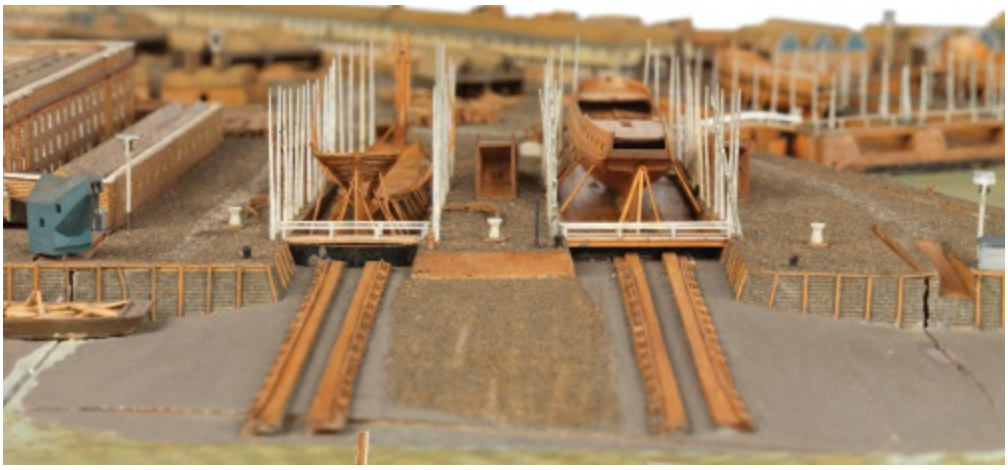


A model of a 74-gun ship showing different stages in the framing and planking, as done before the Seppings reforms apart from the bow, which is round and has a structure proposed by Richard Blake. That probably dates it to the period 1813–21. It emphasises the solidity of the standard system of framing. (© Science Museum, London)

SLR2151 A two-decker, second from left, in frame at Chatham with all the timbers and gun port cills in place. The deck beams have not yet been inserted and spalls are used to keep the timbers the right distance apart, while battens are fitted on the outside of the hull until the planking is fitted.

Dubbing

Now the hull was to be dubbed, that is, the shipwrights were to trim it to its final shape using their adzes. This was one of the profession's most skilled jobs, though there was less dubbing than in the past as timbers were cut more accurately to shape before assembly. The shipwrights worked from scaffolding round the frame, and some of them must have been aware of the danger – five years ago William Langstone, a shipwright, had fallen off the upper staging round the *Cumberland*. The Navy Board judged that 'as the hurt is so great as to be nearly equal to the breaking a limb' he was to be paid for his time off. This stage was finished by 1 July 1777, completing Article 4 after 1066 man-days.



SLR2909 Ships on the building slips at Deptford, showing the launching ways.

SLR0515 A model of the *Victory* of 1765, later Nelson's flagship at Trafalgar, in frame with the lower wales fitted. This is more realistic than some structural models and gives a view of the scaffolding and plank erected around the hull at the level where work was being done. It shows the cross spalls to hold the sides apart, but not the battens for some reason.

4: Outside Planking

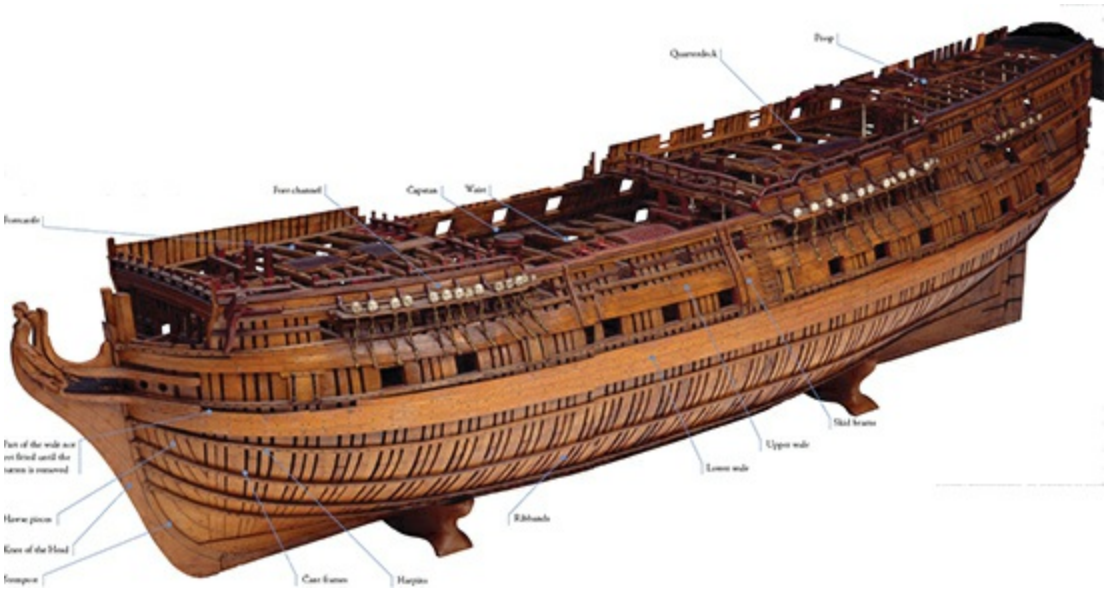
Standing orders demanded that the ship should ‘stand in frame’ for at least a year before decks and planks were fitted, to season the timbers, though this did not apply in wartime, for example in the Seven Years War of 1756–63, which led to rapid decay of ships afterwards. It was observed quite literally with the *Alcide*, work began again after a year and twelve days, perhaps indicating that she was now needed urgently as Britain and France had been at war since February and ships of the line were in demand. The shipwrights were back on the staging by 13 July 1777, fitting the wales or thick planks just under the lower deck gunports.

Wales

The wales were usually the first part of the planking to be fitted, perhaps to give rigidity to the frame. They comprised the thicker planking fitted just under each row of gunports and often partly cut by them towards the bow and stern. Since the orders of 1715 the lower wale, under the lower deck ports, had formed a single surface, either of three or four planks laid side by side, or a more complex method to give greater strength. Ollivier thought that the sheer of the wales was ‘so extreme that at the stern they are pierced by the aftermost gunports’.

Anchor stock construction was defined as ‘To work planks in a manner resembling the stocks of anchors, by fashioning them in a tapering form, from the middle, and working or fixing them over each other …’ The *Shipwright’s Vade Mecum* discounted it for wales, ‘as it occasions a greater consumption in the conversion, should only be used where particular strength is requires, as in the spirkettings under the ports etc’. However, an even more elaborate form of construction is shown in the frame model of the *Bellona*,

with a kind of scarph locking some of the strakes together. Presumably it was intended to compensate for the lack of longitudinal rigidity in the building system of the day, thought it would have been quite expensive in timber and labour, and it is not certain that it was applied.

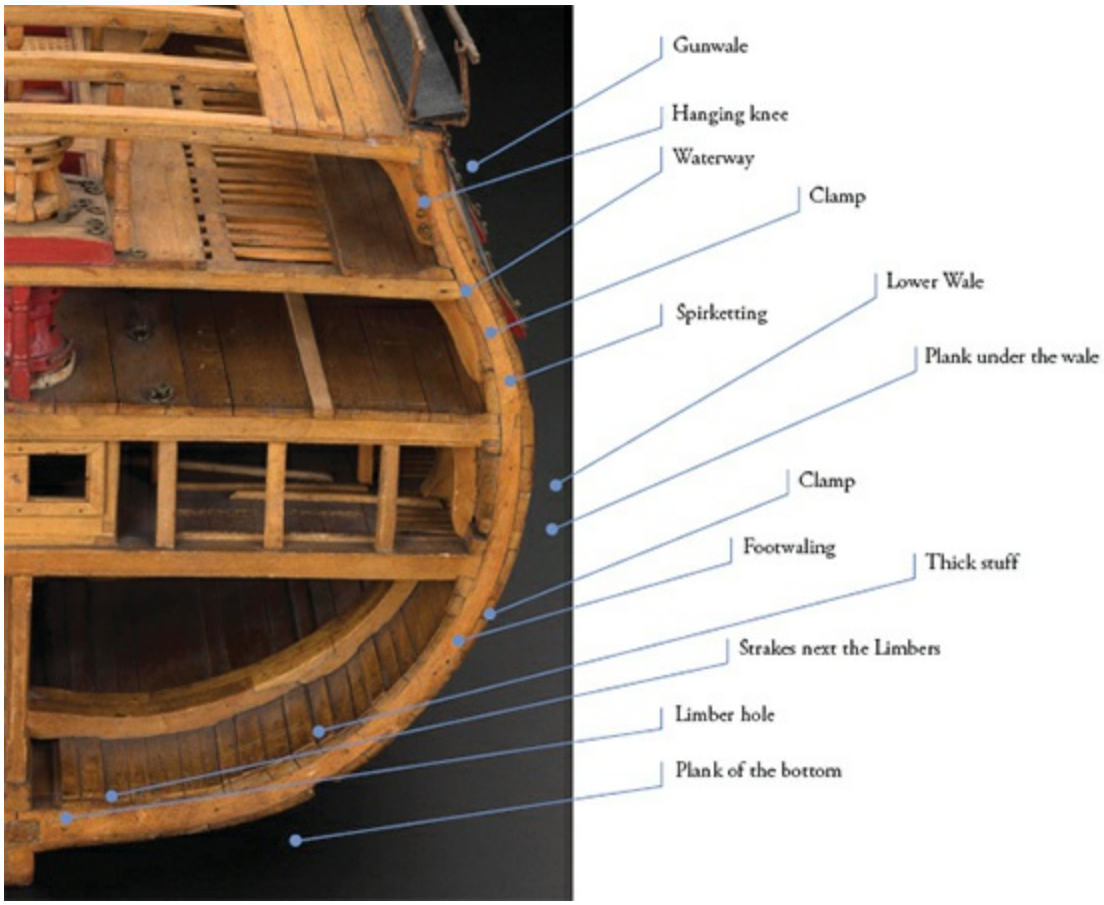


SLR0503 A model of the *Bellona* of 1760 showing some details of the construction, though as usual it is not completely realistic – the stern decoration and channels would not have been fitted at this stage. It does, however, show the main wale incomplete forward and the upper wale aft, waiting for the battens and harpins to be removed. The skid beams are used to protect the hull from wear while casks are hauled on board.

The strakes of the main wales were usually joined by means of ‘hook and butt’ construction which was defined by Fincham as ‘when the edges of the different planking work into each other, with a small abutment of an inch to about an inch and a ¾, sometimes called tabling’. Ollivier noted in 1737 that ‘The wales of English ships … are joined at the edge of the planking to the waterline hook-and-butt’. The main wales of the *Bellerophon* were to be made in two lower and two upper strakes, ‘to be locked into each other, with hook and butt, wrought in such lengths, and the butts properly disposed to give the strongest shift to the ports and to each other.’ Rees suggested that the wales ‘should be fastened with dumps only for the present, as the tree-nail holes, which are double and single alternately in every timber, and should be left open for as long as possible for the admission of air’.

Diminishing Plank

By the middle of the eighteenth century the wales no longer stood several inches proud of the rest of the planking, but only a few inches. This was not because the wales were significantly thinner, but because the thickness of the planks above and below the wales was gradually tapered. The black strake was the one immediately above the main wale and was ‘for graduating between the thickness of the plank of the top-side, immediately above it, and these strakes’. On the *Bellerophon* the ‘thick stuff upon the main wales’ was to be a foot broad, diminishing in thickness from 6½in (2in less than the wales) to 4in. Under the wales were the diminishing strakes, which were tapered more gradually to avoid interfering with the fairness of the hull planking. Fincham wrote that they were ‘in general composed of from two to six strakes, or a sufficient number to prevent, by their diminishing too fast, their forming an angle with the plank of the bottom.’ On the *Bellerophon* the ‘thick stuff under the wales’ was to consist of six strakes, ‘the upper edge of the upper strake to be 6 ½ inches in thickness, the lower edge of the third to be 5 ½ inches, and the lower edge of the sixth strake to be 4 inches in thickness’ – that is, to match the plank of the bottom. According to Rees, ‘The wales and diminishing strakes are then dubbed down fair …’. This comprised Article 5 of task work and it was carried out on the *Alcide* between 13 July and 14 August 1778, with a total of 990 mandays and a payment of £236.10.6

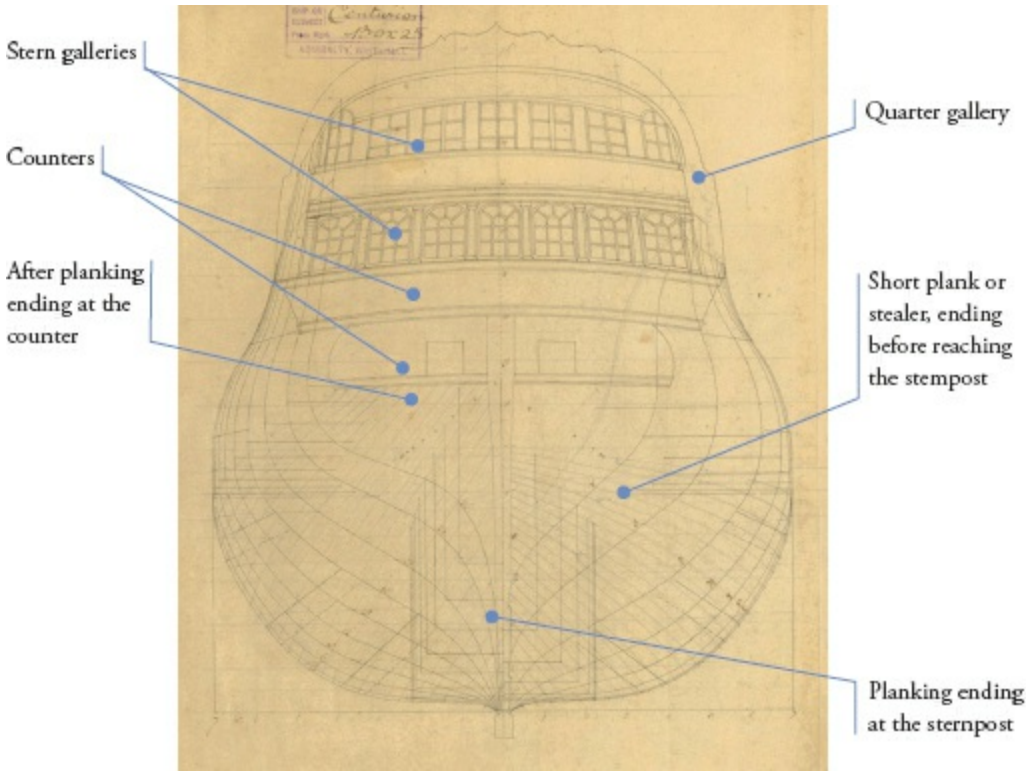


A midship section of a 74-gun ship probably made around 1795, show-ing many details of construction. Before being acquired by the Science Museum it was in the possession of the Duke of Leeds at Hornby Castle. (© Science Museum, London)

BOTTOM PLANKING

The shipwrights began to cover the bottom with 4in plank. In 1805 the Surveyor of the Navy Henry Peake described the most unpleasant work as ‘bringing in wales, clamps and even planking in general, particularly under the bilge where boring the trenail holes is dreadfully laborious’. It was ‘a notorious fact’, he went on, ‘that the indifferent workmen will muddle through more rough and dirty work than the good workman’. No plank was long enough for the whole of a ship of any size, so the joins or butts were staggered. In the *Bellerophon,* no plank was to be less than 24ft in length and the builder was ‘… to have three strakes between every two butts on the same timber, and none less than 6 feet scarph’. Planks were normally 12in wide, but towards the bow and stern they might require to be narrowed. According

to Fincham, ‘The strakes are not parallel, but of such a breadth as the form, the places where they are situated, and the circumference of the body, at any given distances upon them, may require; narrowing at some places, and widening, technically called fanning, at others.’ This was more of a problem towards the bow where all the timbers ended on the stempost, rather than at the stern where they finished on the sternpost and the counter. Some of the planks near the bow, known as steelers, were slightly shorter and ended before meeting the stempost. Planking diagrams were drawn out later in the eighteenth century, but they were probably beyond the capacity of most shipwrights who preferred to work by hand and eye in this matter. The *Shipwright’s Vade Mecum* describes the process of preparing the planks, using wooden pins known as spiles. ‘… After the strakes are lined out on the ship’s side, and the butts shifted, some spile for each plank with a flat batten called a rule staff, which is tacked to the ship’s side where the plank is intended to be worked … then, upon the staff, the length of the plank is marked, and as many spilings taken as may be thought necessary, or about three feet distance, to the line the plank is intended to be worked to’.



ZAZ1689 This detail from the plan of the *Centurion* of 1733 gives a rare glimpse of the

underwater planking of the hull. At the stern each plank ends at either the stern post or the counter, at the bow short planks called stealers are needed, ending before reaching the stempost.

SLR0228 The model of the 20-gun *Tartar* of 1734 is unusual in revealing the frame construction by leaving out some of the underwater planks. The lower hull is painted white as is common on models, though in reality most hulls were painted in the less attractive ‘black stuff’, a mixture of pitch and tar. ‘White stuff’ was used on ships for foreign stations.

SLR0342 The stern of the *Diana* frigate of 1794 shows the planking ending at the counter, as well as the counters themselves and the windows above them. It also shows the typical decoration of a frigate of the period, though less elaborate than the *Winchelsea* model. The metal gudgeons which support the rudder are also seen, as well as chains to retain it if it is swept away.

SLR0456 A model of a 60-gun ship of around 1740. Restoration work on the lower bow highlights the planking and the ends of individual planks. The channels are in the lower position below the upper deck gunports. The rudder is missing.

Bending the Plank

If plank had to be bent a great deal, it was treated in long brick kilns or ovens,

as Ollivier observed at Chatham in 1737. '… I also saw them bend with all the success one could desire planks of [3½] inches and 4 inches which had been heated therein to plank the counter and bow of a ship … I noted that it is with fresh water that the planks are damped; that they use a small pump to draw up this water from the vessel in which it is boiled; and that they leave the plank in the stoves about an hour and a quarter for every inch of thickness.' This system was soon superseded by one in which the timber was treated with steam rather than boiling water.

SLR2906 A steam kiln for heating planks before bending them, one of many revealing details on the 1772–4 Deptford model. Other types were also used and can be seen on some of the models.

A wrain stave from Blanckley's Naval Expositor, used to hold planks in place when bending was needed.

In 1822 a steam kiln was defined in the *Shipwright's Vade Mecum* as

> … a trunk composed of deals, grooved neatly into each other, which is generally from there to four feet square, and from forty to sixty feet in length, having a door at each end. It is confined together by bolts driven through it at certain distances, which answer for the bearers to rest the plank upon, and it is supported upon brick-work. Beneath it, in the middle, is a large copper boiler, or sometimes two boilers, which are then fixed near each end, the steam from which, issuing into the trunk, enters the pores of the plank and makes them pliable.

If the plank was to be bent *in situ*, the wrain-tackle might be used. It consisted of two iron bolts attached to rings, through which were passed staves, 'tapered so at each end that they may go through the ring of the wrain bolt, and are from bringing to planks or thick stuff to the compassing part of the ship's side', as Thomas Blankney wrote in his *Naval Expositor* of 1750. The bolts passed between the frame timbers above and below the plank in question, and were fixed by chocks inside the hull, with wedges between the plank and the stave to force it into position. This was only suitable when both edges of the plank were available. In places here there was leverage against scaffolding or part of the slip or dock, a hand screw might be employed. It was described in Burney's *A New Universal Dictionary of the Marine* as 'A box of elm containing cogged iron wheels of increasing powers; the outer one, which powers the rest, is put in motion by a winch on the outside …' The fore and after ends of each strake were known as the hooding ends and were fitted into the rabbets on the stempost and sternpost.

The garboard strake was the lowest part of the planking, fitting into the rabbet of the keel in midships. It was often left out until later. The contract for the *Bellerophon* instructed the builder to 'leave at least two strakes open to the keel next to each side, for room for chips and water to come through, and not to stop the same until near launching, or that the upper deck is caulked, and then the strakes remaining are to be brought on'.

FASTENING

In 1737 it seems that each plank was fixed by means of two trenails spaced diagonally on each frame. Ollivier emphasised that no iron nails or bolts were used in this, and that 'I believe the English shipwrights act more wisely than we'. By the beginning of the next century the picture was much more complex. Fincham wrote 'the fastening that connects the planking to the frame of the ship is distinguished by trenail and metal. When the planking is trenail fastened, the stakes are either double, double and single, or single fastened; that is, to have in each strake, when double, two trenails in every timber … Formerly large frigates and all upwards were double fastened, and smaller ships double and single from the blackstrake down. Above, the large ships were double and single, and the smaller ships single.'

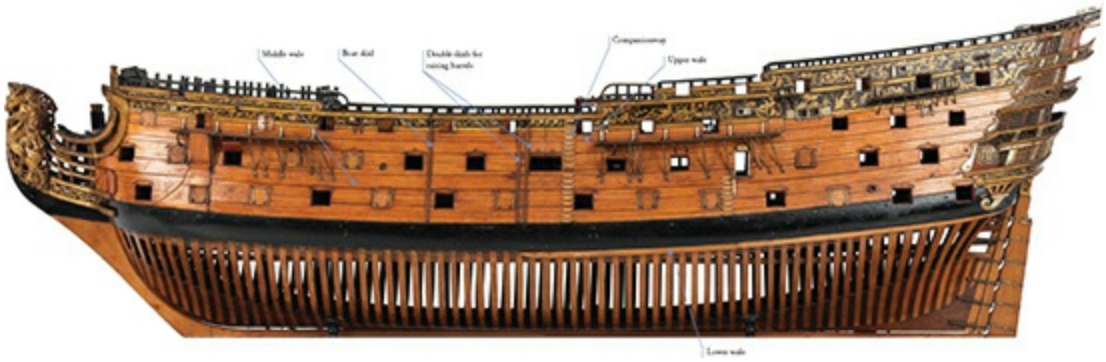
SLR0479 A model of a 50-gun fourth rate of around 1747, also showing the lower hull part-planked. This was perhaps a transitional stage between the Navy Board style model in which the lower hull was completely unplanked, and the 'Georgian' style in which it was fully planked. It gives further detail of the planking under the wales, and just above the keel.

SLR2908 A two-decker at Woolwich with the wales and lower planking in place. This is a block model and is much simpler than the Sheerness example, because the Woolwich officers were ordered to complete the model quickly so that it could be presented with the others. The pile of timber in the foreground is unusually chaotic, and may also represent the speed at which the model was completed.

According to Fincham in 1821,

> The treenails that fasten the exterior planking pass likewise through, and form the principal fastening of the interior, but as the exterior and interior planking cannot be placed on the timbers at the same time, the exterior is brought on first, and the holes for the treenails bored through it and the timbers, but to secure the frame till the treenails can be driven though both: there were formerly one bolt placed in every fourth timber in each strake, called hanging or fastening bolts; but now the outside planking is held to the frame by a temporary fastening, consisting of screw eye bolts…. When the interior planking is brought on, the holes for the treenails are bored through it, and the screw bolts are removed as it becomes necessary to drive the treenails.

This was Article 6 of task work, though the times and costings are missing from the records of the *Alcide*. It was clearly not done in one go, the garboard strake on each side and the strakes immediately above them were not fitted until February or March 1779, after the men had been paid for the rest of the work.



SLR0422 As well as showing the layout of the wales and the planking between them, this model of a 90-gun ship of around 1725 shows the boat skids use to protect the hull when a boat is hauled on board, the companionway for climbing on board.

The Rest of the Planking

Three-decked ships had middle wales just below the level of the middle deck gunports, and often cut by them towards the bow and stern, just like the main wales. The orders of 1715 had hinted that they too might become single wales, and that tended to happen in most ships during the early years of the century. The next level of wales in three- and two-decked ships, the channel wales, were of course under the upper deck ports. They were named after the channels which held the chains, which in turn held the deadeyes of the rigging. In the *Bellerophon* they were to be in three strakes, 2ft 9in broad and 5½in thick, with 3in thickness forward and 2in aft.

The waist rail ‘extended the length of the ship on the topside, and was

placed, in amidships, about halfway up the upper deck ports, and carried parallel to the sheer'. It was obsolete by the time Fincham wrote in 1821. Sheer strakes 'lie between the upper deck ports and what is called the toptimber line, or the upper boundary of that part of the side that ranges the whole length of the ship.' In the central part of the *Bellerophon* it was to be 12½in broad and 4in thick, towards the bow it would reduce to 3in, and 2in near the stern. The uppermost part of the side was formed by the planksheer or gunwale, described by Fincham as 'planks lying horizontally upon the heads of the upper extremity of the timbers, and edges of the exterior and interior planking; they form the upper boundary of the longitudinal section, and are covering planks for the top-side.' From about abut 1800 the sides of ships were built up higher and solid bulwarks replaced hammock rails and netting. '… now, to shelter the crew, by presenting a more complete barrier against small shot, in the time of action, the planking and timbers are continued up a sufficient height to form a barricading to the quarter-deck and forecastle'.

All this comprised Articles 9 and 11 of the task work (and also Article 10 if a three-decker was involved). The shipwrights of the *Alcide* completed both of these articles – fitting and trimming the channels and the space between them and the black stake, and the fitting the planking above that – between 26 October and 29 December 1778. They worked on Article 12, fitting the upper deck, at the same time and were rewarded with a total payment of £392.13.0.

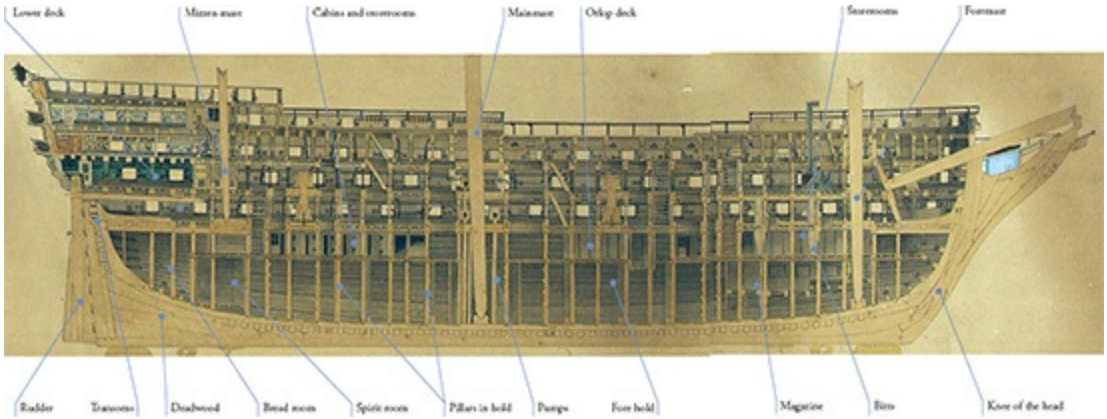
5: Inside the Hull

The Orlop Deck

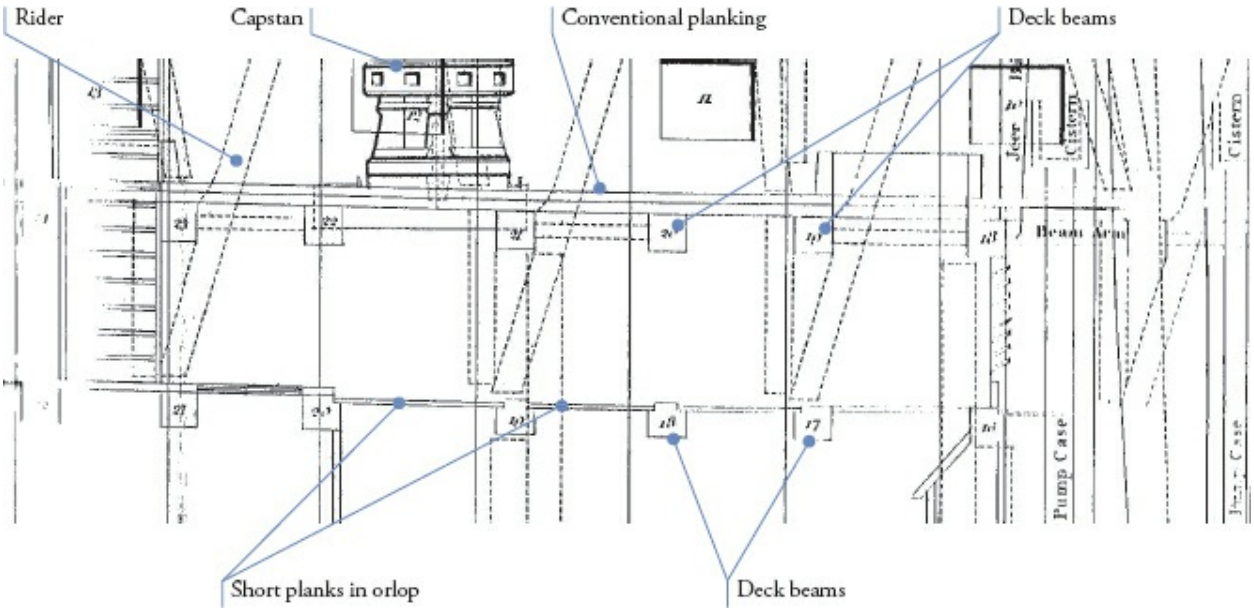
The construction of the decks was closely linked with the internal planking of the hull, especially with the clamps, thick planks which supported the ends of the beams.

The structure of each deck largely depended on the weight of guns it was to carry, though their beams also had a vital function in preventing the hull being compressed by the water. In that respect the orlop deck was different from all the others, in that it was fitted close to the waterline and was not expected to carry guns. Only the largest ships had a full orlop deck, frigates usually only having three platforms in the hold. The orlop still needed a good deal of strength in its beams, partly because of its function in resisting the pressure of the water. The beams of the *Bellerophon*'s orlop were to be 1ft 3¼in square, compared with those of the gundeck which were an inch thicker, and the upper deck beams which were only 1ft 2in deep and 1ft wide, though they had to carry 18pdr guns and their carriages, each with a total weight of around 2½ tons. In midships the main function of the orlop was to support the hemp cables for the anchors, and to allow them to dry out after use. As a result the structure of the deck was different, with short planks. As Ollivier put it,

> The decking of this orlop … is formed of twoinch planks which run only from one beam to the next, the butts of which rest on ledges placed next to the orlop beams, so that instead of being laid over the beams as is the practice with the planking of the decks, the planks lie flush with the top of the orlop beams. The English shipwrights have two reasons for laying the planks of the orlop deck in this manner: the first in order not to forfeit the two inches of headroom which the thickness of the plank would make them lose if they were to lay them over the beams, and the second in order that the planks may be easily removed whenever it is necessary to shift them in certain places for the stowage of the hold.



PAH9223 A detail from a very elaborate view of the *Nelson* of 120 guns, launched at Woolwich in 1814 and one of a class of three. She was begun in 1806 and did not incorporate the Seppings system at first. This detail shows the hold and includes features such as spirit room, storerooms, magazines etc as well as showing much of the structure.



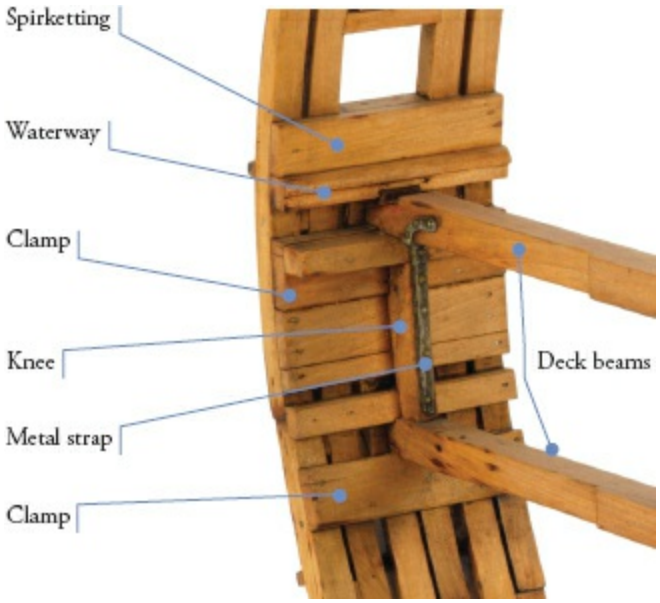
A section of the orlop deck from Rees' *Naval Architecture*, showing the differences between the planking of the orlop compared with the other decks.

The supporting pieces of the orlop deck – the carlines which ran fore and after between the beams and the ledges running thwartships between the carlines – were to be the same dimensions as those of the gundeck above in the *Bellerophon*, though they did not have to bear any guns.

Clamps

As defined by Burney, clamps were 'Thick planks on the inner part of a

ship's side, used to sustain the ends of the beams, and extending from stem to stern, including the whole range of the side. They are placed close under each deck, so as to be securely fayed to all the timbers, to which they are fastened by nails driven through the clamp, and penetrating two thirds of the thickness of the timbers.' They were 'substantial strakes worked within side the ship, upon which the ends of the beams are placed'. Those supporting the orlop deck of the *Bellerophon* were to be in two strakes, 26in broad in total and reducing from 7¼in thick to 6¼in. According to Fincham in 1821, 'The orlop clamps are in two strakes, wrought top and butt; the lower strake was formerly one inch less in thickness that the upper, but is now of the same thickness.' The orlop was completed by mid-October, while the gundeck was also being fitted.



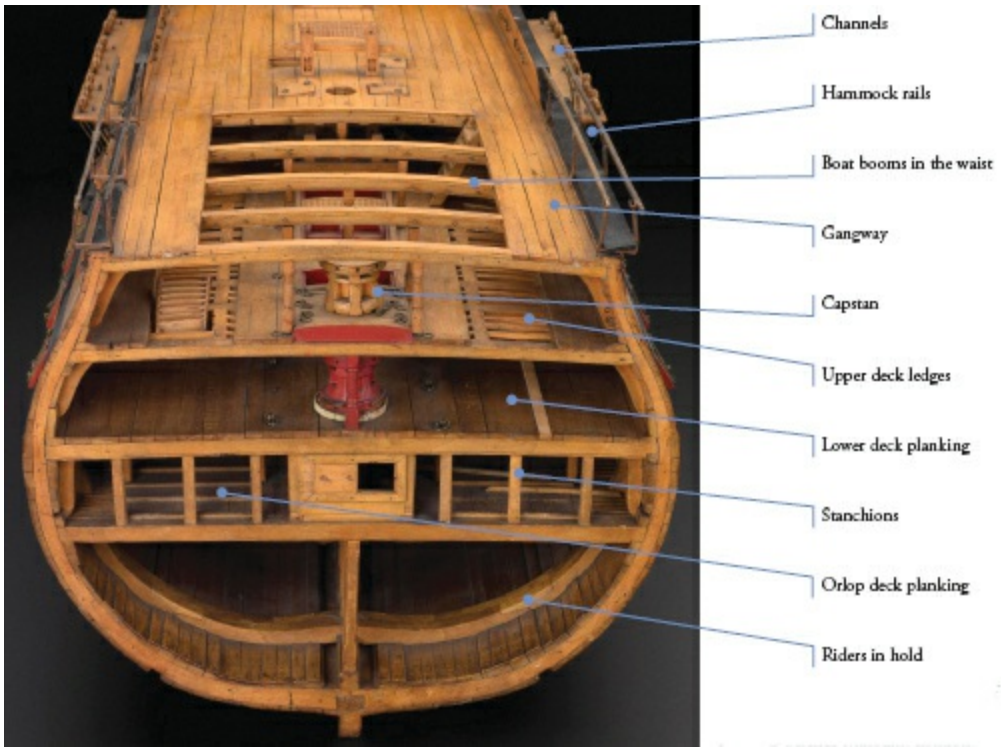
SLR2216 This model of the midship section of the *Caledonia* is experimental to some extent, but it shows something of the method of supporting the lower deck and the orlop, and the increasing use of metal ties and brackets, and smaller knees – though rarely as small as the one shown here.

The Gundeck

The gundeck, the lower or the main deck of the ship of the line, was in some senses the most important, carrying the main armament and accommodating most of the crew as well as providing essential structural support. Its function was different in a frigate; although it was still referred to as the gundeck, it

carried no guns in ships built after about 1755 but was still used for accommodation. The clamps of a ship of the line's gundeck had to bear much greater weight than the orlop, and according to Fincham, 'the lower deck clamps were formerly in two, three, or four strakes, according to the class of ship … When in four and two strakes, they were wrought top and butt, and their edges sometimes tabled into each other with an 1 ¾ inch tabling. When in three, two were wrought top and butt, either tabled or plain, and the single strake was either placed above or below them…. the number of strakes was always reduced to one less at the extremities, and reduced in thickness …' The *Bellerophon* was to have three strakes, reducing vertically from 8½in to 7¼in.

SLR0440 A view of the lower deck of a 70-gun ship of around 1730, with planking left out to show the ledges and some of the deck beams. It also shows the bitts just aft of the mizzen mast, a hatchway, a round capstan step, another hatchway, the pumps round the mainmast, then the other capstan and a hatchway and ladderway. Among other things it emphasises how much was fitted along the centreline of a ship.



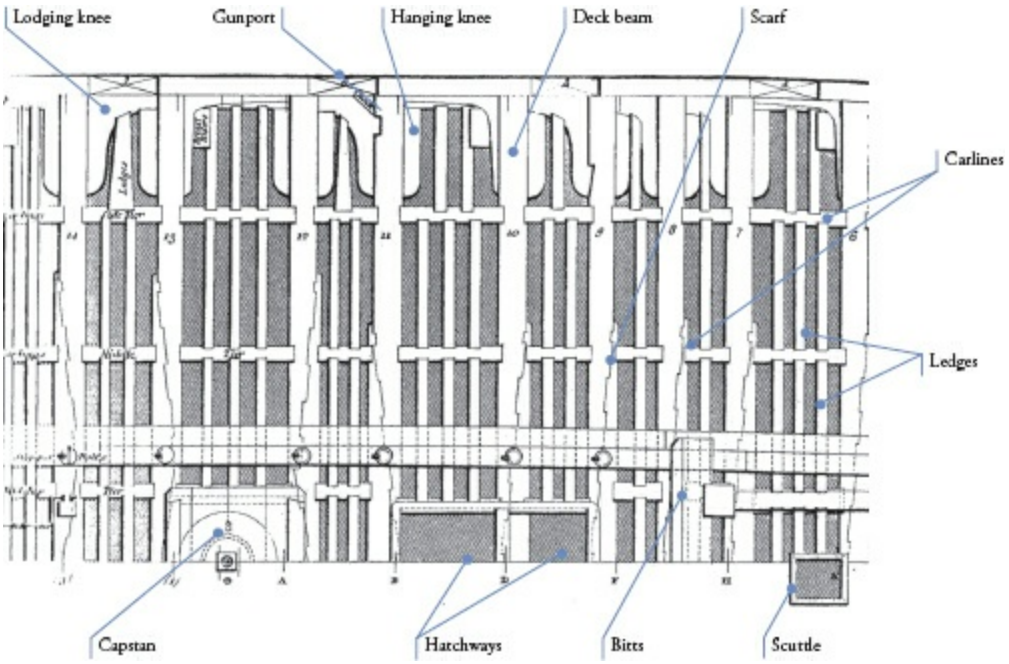
The midship model of a 74-gun ship of c1795, showing details of decks and hold. (© Science Museum, London)

Deck Hooks and Beams

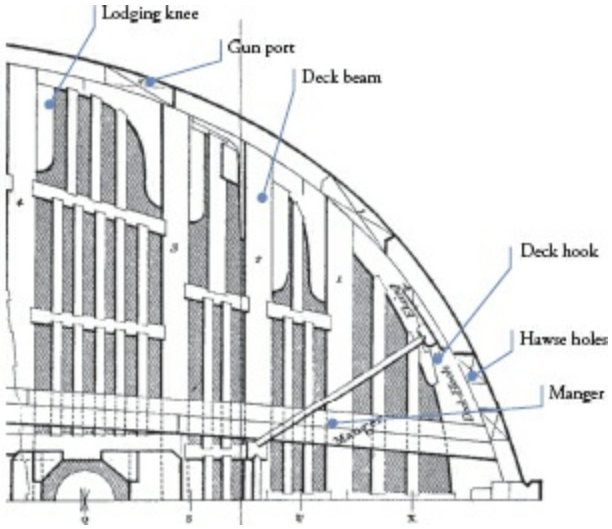
The lower deck beams of the *Bellerophon* were to be 1ft 4½in square. Unlike the orlop beams, but like almost every other beam in every ship of the day, they were cambered, that is curved upwards to allow the water to drain from the deck. The beams were mostly made in several pieces. According to Robert Seppings in 1814, '… the beams were in one formerly; necessity obliged us to have them in two, still the thickness was the same, then in three, and in some instances in four'. This is not entirely borne out by plans and models, which show beams in three sections long before Seppings started his apprenticeship in 1782; but he was convinced that 'certainly beam timber is stronger in one'. Most deck beams were made in three pieces by that time, with scarphs one third of the length of the beam. According to Rees, beams in three pieces, 'have the middle pieces and the end pieces each half the length of the whole beam, the middle piece having a scarph each way to take the arms'. They were, 'either tabled or dowelled, and bolted together at the scarphs'. Their ends were 'mouthed and charred, and then let down about one

inch into the clamps at their several stations at right angles to the middle line’.

Some of the timbers discovered at Chatham. The piece on the left is part of a deck beam and shows the scarf used to join two parts. (Author’s photo)



The structure of a 74’s lower deck in midships, from Rees’ *Naval Architecture*. The distances between the deck beams varies, to accommodate features such as hatches and mast partners. It shows something of the scarfs of the deck beams, and two planks are fitted showing where the ringbolts of the train tackles of the guns are fitted.



Another view from Rees, showing the construction of the deck near the bow, with the deck hook scarfed into an ‘ekeing piece’. The main function of the manger was to restrict water coming in through the hawse holes, but as its name suggests it could also be used to keep live animals.

It was necessary to have certain apertures in the centre of the deck, for the main hatchways and the partners which supported the main and fore masts. These were longer than the normal spaces between the deck beams, so half beams were fitted. These started against the side of the ship in the normal way, but curved sharply to meet an adjacent beam well before reaching the central part of the deck. The ends of the decks were supported by deck hooks, which fitted in with the run of stout timbers such as riders and breast hooks which reinforced the hull internally, but the deck hooks also had and additional function in relation to the decks.

Carlines and Ledges

Carlines were defined in the *Shipbuilder’s Vade Mecum* as ‘pieces of timber, above four inches square, which lie fore and aft in tiers, from beam to beam, into which their ends are scored’. There were three rows on each side of each deck, usually reducing to two towards the bow and stern. The inner row served as the edge of various features of the deck, such as the partners which supported the capstans and masts, and the sides of the hatchways and ladderways. Those on the lower deck of the *Bellerophon* were to be 9in broad and 8½in deep. The guns were mounted on wheels or trucks and could be moved to any part of the deck, so plank was not enough to support them,

more structure was needed underneath. This was provided by the ledges which were scored into the carlines and ran parallel to the beams. In the *Bellerophon* they were to be between 12 and 9in apart, 5½in broad and 5in deep.

Knees

The deck beams were supported by several different kinds of L-shaped timbers known as knees. As well as supporting the deck, they aided the rigidity of the hull and were considered among the most important pieces in the structure. Lodging knees were fitted horizontally in the angle between each beam and the futtocks, with the upper face directly under the deck planking and shaped to receive it. Hanging knees were fitted under the deck, with one arm attached to the ship's side and the other to the side of a deck beam. Standards were fitted above the deck and were used more sparingly, perhaps to avoid interrupting the deck too much.

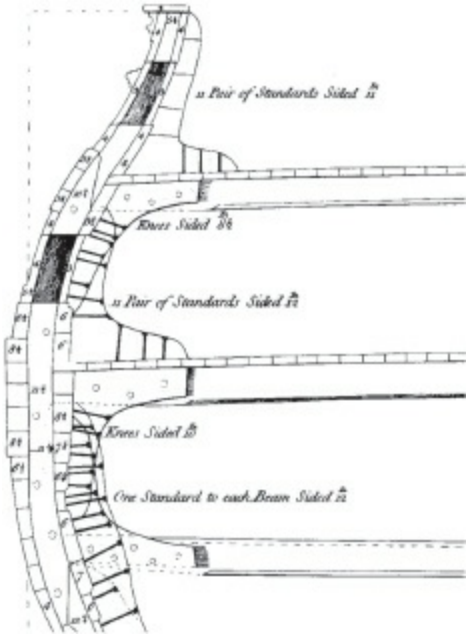
Knees were among the most difficult pieces of timber to find, even more difficult than compass timber for the frame. According to the *Shipwright's Vade Mecum*, knee timber was 'That sort of crooked timber which forms, at its back or elbow, an angle of from forty-five to twenty-four degrees. The more acute this angle is, the more valuable the timber is on that account. But of their angle be more obtuse, they are said to be raking, and are proportionately less valuable, being of less utility in the formation of knees etc.'

Rees described the process of preparing the knees. 'The knees are sawn or trimmed to their siding, and fayed to the side, taking as little wood as possible out of the throat the moulding way, as the greatest strength of the knee is there. Each knee tapers towards the toe to which it is sided; and the substance in the throat should be about twice and a half the siding, as not to admit any chock that would reduce the knee at any part less than the siding.' He went on, 'Each knee should have two dowels in the beam-arm, and from three to four bolts; and the two upper bolts in the side-arm of the hanging knees should be kept up as high as possible, and the others equally spaced to the toe, and bored as square to the side as the seams outside will allow.'

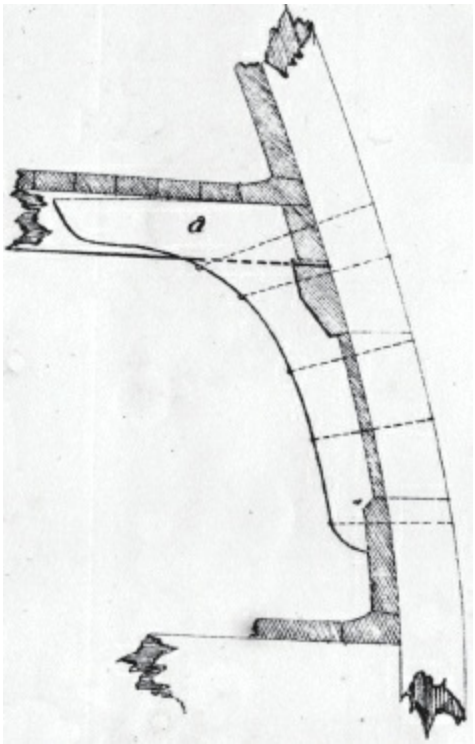
As knee timber became scarcer towards the end of the eighteenth century,

iron was adopted either as replacement or reinforcement. The French had used bracket-shaped iron knees for some time but these were regarded with suspicion on Britain. The author of the *Shipwright's Vade Mecum* was sceptical about the use of iron knees, claiming they could not be depended on like wooden knees 'because they cover less surface, are by no means flexible, nor can the bolts be driven in so tightly in the iron as in the wood'. Instead it was more common to fit a triangular hanging knee under the beam rather than alongside it, and to reinforce it was an iron frame bolted to it.

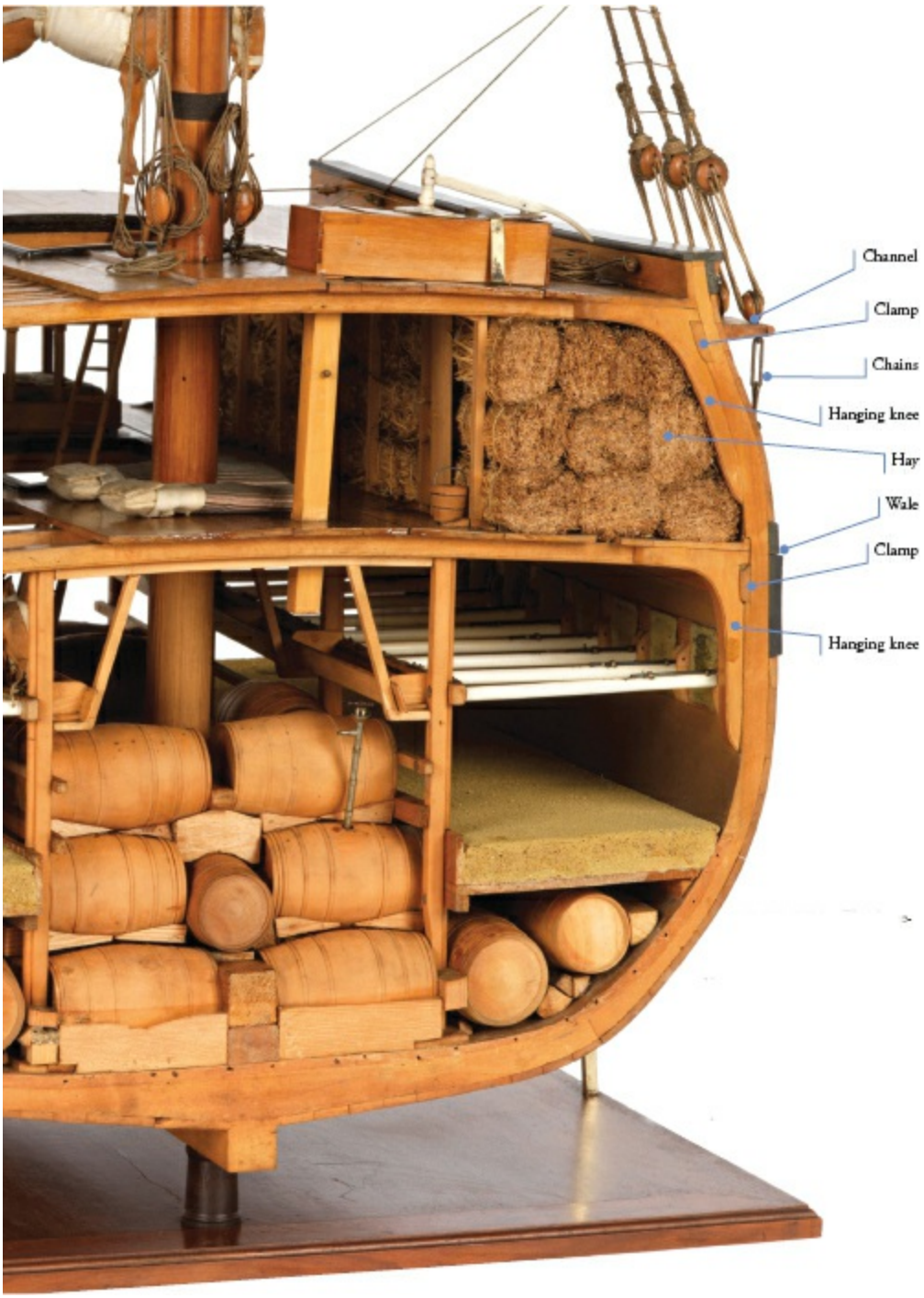
A hanging knee incorporated in a building in Chatham Dockyard, as old ship timber often was. This shows something of the run of the grain which was important in selecting the piece. (Author's photo)



A drawing in a report on timber for the navy (1771) shows the usual method of construction as a contrast to the proposals of Gabriel Snodgrass of the East India Company, which were not fully implemented. It gives much detail on the fitting of hanging knees and standards, and the methods of bolting them to the sides of the ship and the deck. It also shows the thicknesses of planking around the wales.

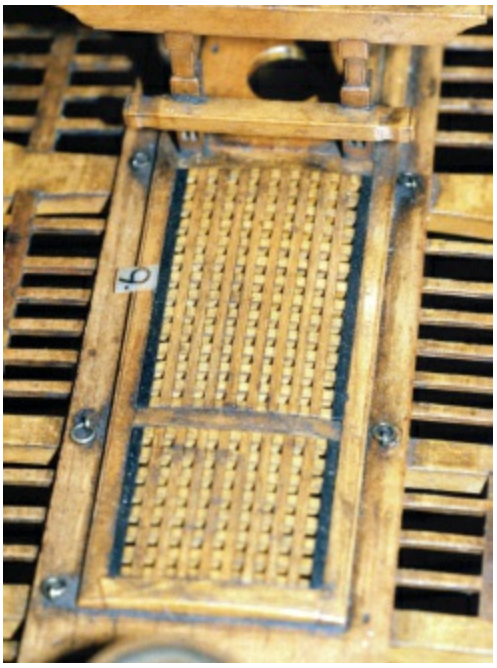


Hanging and lodging knees from Fincham's *Outline of Shipbuilding*, giving more detail on how they were bolted to the decks and sides.



SLR0508 This largescale (1:16) model made around 1760 is intended to show the method of hoisting horses into a ship and accommodating them on board, hence the hay being stored. Incidentally it shows something of the structure of a small ship, including hanging knees and clamp to support the decks.

SLR2287 This sectional model shows improvements of the early 1800s, when triangular knees tended to replace the L-shaped ones, and were fitted under the beam rather than alongside it, being braced with iron brackets. It also shows something of the clamp which supported the deck, and the waterways which were intended to keep deck water away from the sides.

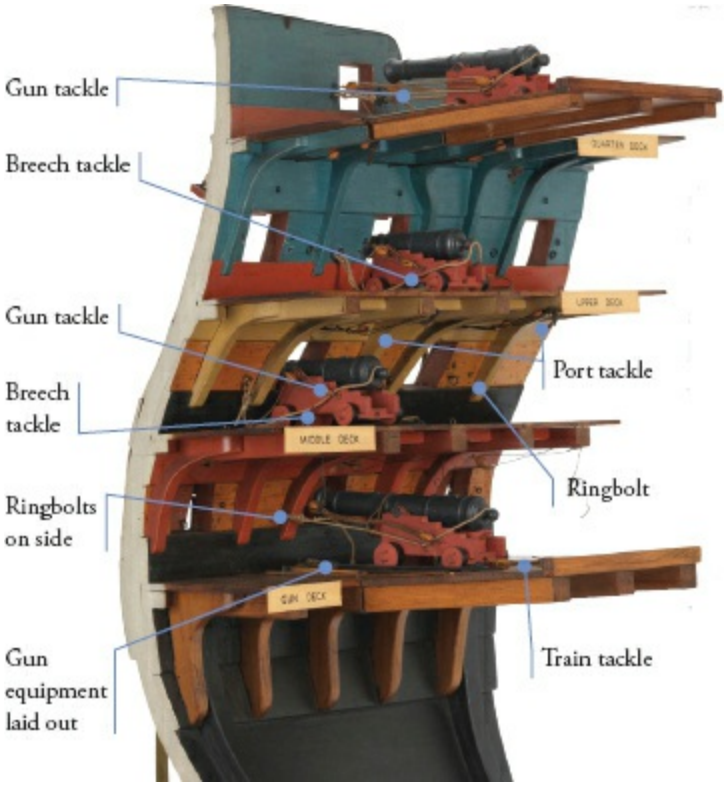


SLR0444 A hatchway on a model of 1730, with the comings surrounding it – these were intended to prevent unwary seamen falling down when the grating was removed. It also shows something of the deck structure, with a crutch to support the ship's boats behind.

Flat of the Deck

Waterways formed the edge of each deck where it joined the side of the ship. According to Ollivier in 1737, 'The English ships have on their gundeck only a very wide plank as a waterway, one and a half inches thicker than the planning of the deck and the spirketting. This waterway touches the frame timbers, and a part of its width is covered by the spirketting, so that there is in this area a seam which is very difficult to caulk.'

The main planking of the *Bellerophon*'s gundeck, known as the flat, was to be 5in thick for the five strakes nearest the waterways, and scored 1in down into the beams and ledges. It was to be fastened by $^{5}/_{8}$ in bolts. The rest of the deck was assumed to be of 4in plank, 'either English, or the best East country crown plank, fastened with two nails in each beam, and one trenail in each ledge'.



SLR0495 This model of the internal detail of the *Royal George* was mainly intended to

demonstrate the guns and tackle, but it also shows some details of the decks and especially the hanging knees, and how they sometimes had to be angled to avoid gunports and other features.

Fincham wrote,

> To the lower or gun deck of ships of the line, the flat was formerly laid with four-inch Dantzic oak, extending in strakes, curved as they approached the side, the whole length, with the second and third strake from the coamings on each side, forming binding strakes, for which purpose they were one inch thicker, and scored over the beams and ledges the additional thickness; this flat was fastened with two three-quarter inch short bolts in each beam, and one deck trenail in each ledge, in every strake.

Hatches, Coamings and Head Ledges

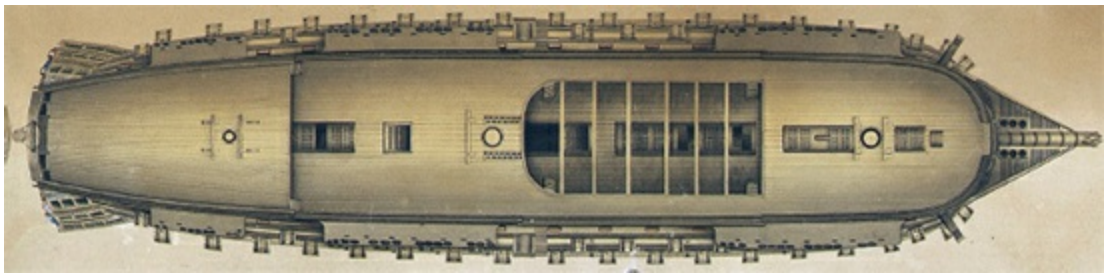
The centre of each deck was interrupted for about half its length by various features. Starting from the bows on a typical gundeck, these consisted of the partners of the foremast; a pair of small hatchways or scuttles with spaces between them and surmounted by the massive frame of the riding bitts; a hatchway and a ladderway, followed by a substantial gap; the main hatchway for lowering goods into the hold; the mainmast partners with pumps on either side; and another gap then a hatchway and ladderway, with another scuttle offset to one side towards the stern.

Each of these features was surrounded by coamings and head ledges to raise it from the deck. In the case of ladderways which were usually left open, and hatchways which might be opened for the movement of stores, they served to prevent an unwary seaman falling down the hole. Coamings were defined by Fincham as ‘the pieces that lie fore and aft on each side of the hatchways, etc. There is a carling let down between the beams immediately under them into which they have two or three circular coaks and are fastened to them with two or three trenails.’ In addition, ‘the pieces that lie athwart and form the framing of the fore and after part of the hatchways and ladderways, are called head-ledges; these pieces lap and tail over the coamings and are faced into their sides about ½ an inch, and are bolted with one bolt at each end …’

Spirketting etc

The sides above the various decks were also planked in. The clamp of the deck above formed the uppermost part of this, the rest being known as the spirketting. The practice for the earlier period was described by Ollivier, who wrote, ‘The spirketting placed between the gundeck and the lower sills on the gundeck ports is also assembled hook-and-butt. This strengthening seems to me good, it opposes the tendency to hogging …’ Later, according to Fincham,

> The spirketting is composed of thick strakes lying immediately above the waterways; where there are ports, they fill up the space from the waterway to the port-sill. This assemblage is in general composed of two strakes worked anchor-stock, with the middle of each plank as wide as possible, for giving strength in the wake of the butts; formerly their edges were worked with a hook between each butt…. the spirketting has one bolt passing through it, driven from the outside, through the timber next to the one upon which the butt is placed; and has likewise two through each port sill.



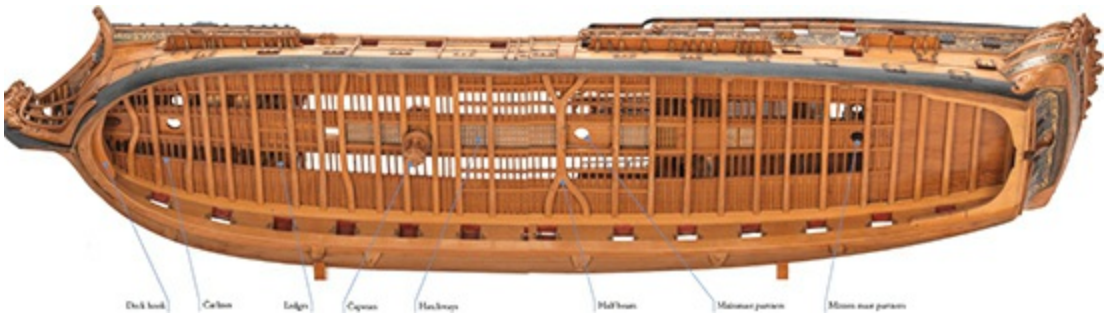
PY9223 A view from above of the 120-gun *Nelson*, another detail from the print cited above. From left to right it shows the poop deck and the quarterdeck. In the centre is the waist which was gradually filled in over the years, It now has gangways on each side to allow fore and after movement but it is not fitted with guns. Forward of that is the forecastle, the round bow, and then the beakhead.

Scuppers

Scuppers were defined by Burney as ‘certain channels cut through the waterways and sides of a ship, at proper distances, and lined with sheet lead, in order to carry the water off the deck into the sea’. According to Ollivier, ‘The English ships have only round scuppers, and they are also very small. The square scuppers cut at the level of the middle deck in most of our ships would be of scant purpose here, since their pumps discharge on the gundeck … I have seen in most of the English ships two scuppers on either side of the manger, one 8 to 10 inches above the other.’ They were usually straight in the eighteenth century and curved early in the nineteenth. The heads were fitted

just inside the waterways to collect water from the deck.

The Upper Decks



SLR0440 A view from below of the upper deck of the of the 70-gun ship of around 1730 described above. Among other things it sows the half beams which did not go all the way across the hull to leave space for hatches etc. It also gives a good view of the beams, carlines and ledges which formed the structure of the decks

The middle and upper decks of ships of the line generally followed the practice of the gundeck, though with slightly lighter construction. According to Fincham,

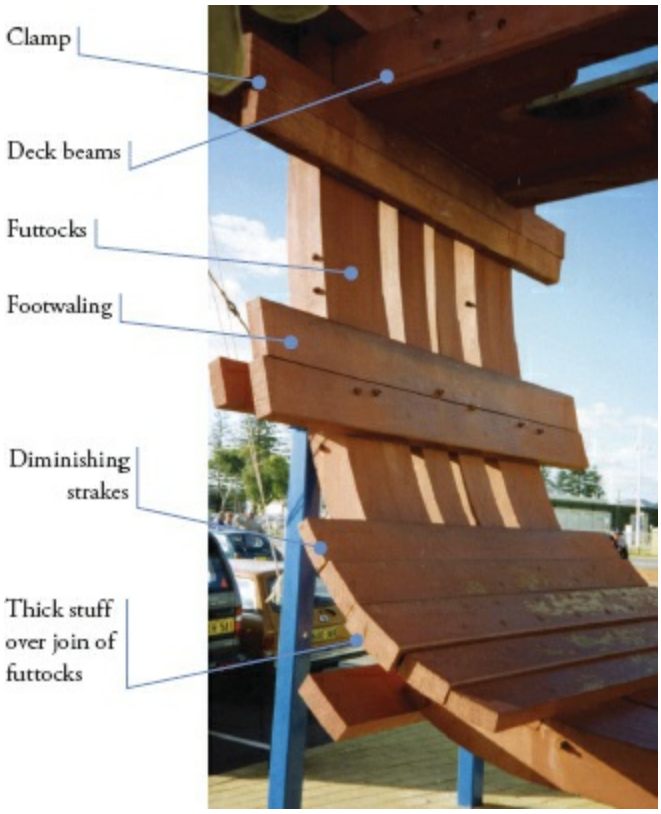
> The flat of the other decks were mostly of Prussian or Dantzic deal, with the strakes extending fore and aft, excepting two strakes next the coamings, which were oak for binding strakes, one inch thicker than the common flat, and scored over the beams and ledges as before described, and frequently between these strakes in midships was oak, especially to the upper and middle deck, with the stake at the middle line one inch thicker, to place the pillars upon … The flats in this manner were fastened with deck nails in general, two in each beam, and one in each ledge, in every strake.

The Upper Works

The upper works of a ship – the quarterdeck and forecastle, and poop (sometimes known confusingly as the roundhouse) on ships of the line – formed an integral part of the main structure. Their decks were lighter in construction that the lower, middle and upper decks because they carried lighter guns and naval architects naturally preferred to reduce weights high in the ship to aid stability. The quarterdeck and forecastle beams of the *Bellerophon* were to be 9½in by 8in in section, the poop beams were 7in by 5½in. They were not fitted with carlines and ledges like the beams of the

other decks, and those of the upper deck, quarterdeck, forecastle and poop were to be ‘planed and struck with a bead’ to improve appearance in areas mostly used by officers.

Work on the *Alcide* intensified in the early months of 1779, often with two gangs overlapping – perhaps with one cutting out its timbers while another was fitting its own pieces on the hull. Article 13, constructing the upper deck, was executed from 4 January to 5 February 1779, while Article 14, the quarterdeck and forecastle, was started on 15 January and completed on 6 March, by which time work had been proceeding for five days on the poop. The internal planking of the hold was fitted, with pieces known as ‘thick stuff’ covering the joins of the futtocks. Stout curved timbers known as riders were fitted on top of this to compete Article 17. Between 20 March and 19 May the gangs worked on Articles 19 and 24, finishing the orlop deck now that the structure under it had been completed, and fitting the structure under the figurehead ready for the carvers and joiners. Other gangs worked on the heavier deck fittings such as capstans, bitts to hold the anchor cable and the partners which would support the masts as they passed through each deck. The fixed gear for operating the rigging, such as blocks and pinrails, was fitted along with Article 15, and the final Article, 25, was executed alongside 20 and 22, finishing on 5 July.



A full-size replica of part of the structure of Captain Cook's *Endeavour*, set up when the replica of the ship was under construction at Fremantle, Western Australia, in the early 1990s. It shows something of the internal planking of the hold. (Author's photo)

In the Hold

The interior planking of the ship did not have to be faired to reduce water resistance, so it was made in different thickness according to its function. This produced its own and sometimes confusing terminology. The planking followed several different paths. The limber strake ran parallel to the keel a small distance (perhaps 11in) away from it to allow water to drain towards the pump in the centre of the ship. It could be covered up by the limber boards to prevent waste matter entering it. These were short and removable pieces of plank which were fitted diagonally from a rabbet in the limber strake to the upper edge of the keelson. The thick stuff followed an entirely different route, covering the joints of the floor timbers and second futtocks, and the first and third futtocks. It was usually in three or five strakes. In the *Bellerophon*, the three central strakes of the 'thick stuff at the floor heads' were to be 8¼in thick and 1ft 3in broad, with a 6¾in strake above and below

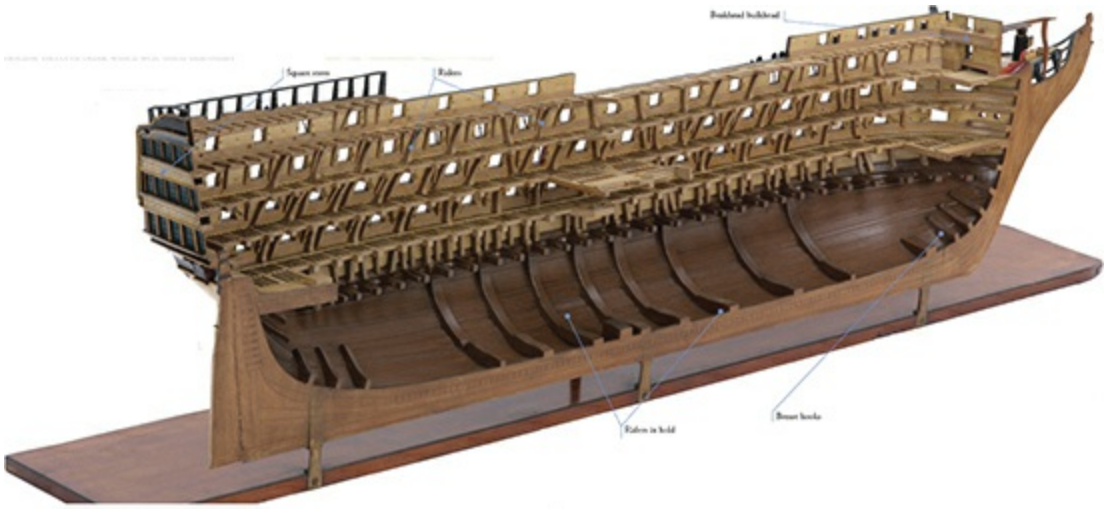
that. The ‘thick stuff at the first futtock heads’ consisted of three strakes, a central one 7in thick and the outer ones of 6in. The clamp of course followed the line of the orlop deck. The space between these was filled by footwaling, 4in thick like most of the planking but reducing to 3in near the bow and stern in the case of the *Bellerophon*. Collectively it was known as the ceiling.

According to the scheme of task work the internal planking was fitted quite late in the day, as Article 16. The information is missing for the *Alcide*, but work on the similar *Goliath* in 1781 suggests that it was not necessarily done in that order – in that case Article 16 was completed between 1 May and 1 June, before Articles 11 (outer planking), 14 (quarterdeck beams, clamps and knees) and 15 (roundhouse or poop) were finished. It would have been simpler to do it earlier before the decks above were completed, to leave space to get in the materials.

Riders

That was even more important in the next stage of the internal work, fitting the large hooks and riders in the hold as a supplement to the main structure provided by the frames and planking. According to Fincham in 1821, riders were ‘inferior timbers placed upon the inside planking for giving additional strength; … they are placed to some extent in the full part of the ship for giving support to the body when it takes the ground, and against the pressure of the fluid, especially the vertical pressure in the neighbourhood of the keel.’ Writing in the past tense since they had been superseded by the Seppings system, he went on,

> The floor riders were mostly placed over the first futtocks in the frame, and extended from 12 to 16 feet on each side of the middle. The first futtock rider was placed to the side of the floor, when there was one connected with the bend, and had its lower end from two to four feet from the keelson, and extended from seven to nine feet above the head of the floor rider. The second futtock rider scarphed or abutted on the head of the floor rider … The third futtock rider scarphed or abutted upon the first, and extended to the gun deck beams …



SLR0120 A model of the 120-gun *Caledonia* showing the standard system of interior structure before Seppings' reforms, including riders in the hold and breast hooks.

The breast hooks were 'large compass timbers, lying across the apron or stemson inside, at an equal distance on each side, for uniting and supporting the bows. They are in length from about 10 to 18 feet, and bolted through both bows with from about 7 to 13 bolts …' The breast hooks under the lower deck were 'placed nearly square with the body', meaning that they formed radii to the curve of the stem post. Those above the deck were placed parallel to the deck itself. Fincham's description of these pieces as 'inferior timbers' presumably referred to their importance in the ship rather than their size – the three floor riders of the *Bellerophon* were to be 1ft 5in by 1ft 4in in section, several inches bigger than the first futtocks.

Seppings' Reforms

Robert Seppings served many years in the Royal Dockyards and had many criticisms of the system of ship construction as used in his time, even though it had worked well enough through the long wars with France and the arduous blockades, patrols and convoys. He was well aware that 'all the materials composing the fabric of a ship are disposed nearly at right angles to each other', which contradicted the principle 'well known to the meanest mechanic' that a triangle was far more rigid than a quadrilateral. He introduced a system of diagonal bracing, replacing the riders in the hold with diagonal pieces crossing one another. That was only part of his reform: he

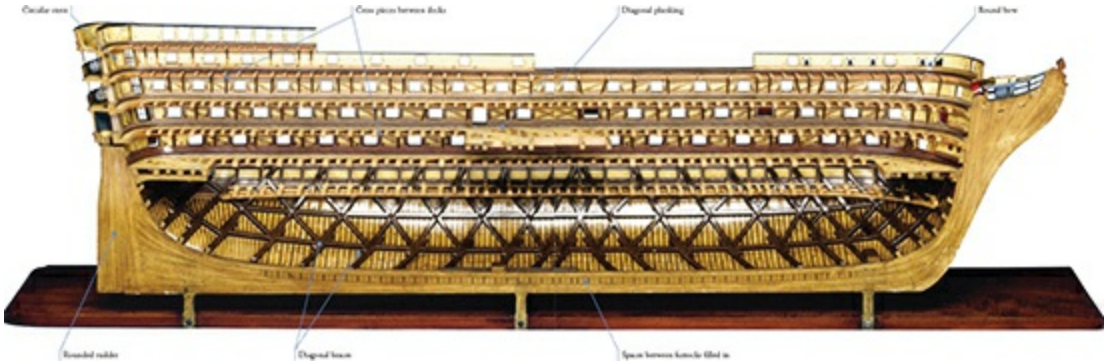
used diagonal decks and spirketting, and filled up the spaces between the floor timbers and lower futtocks. He first tested it on the old 74-gun *Tremendous* in 1811 and eventually convinced the cautious sea officers that it provided a much stronger hull.

Fortunately for historians, he and his supporters, such as John Fincham, tended to produce 'before and after' descriptions, drawings and models which give us some of our clearest pictures of shipbuilding practices during the Royal Navy's greatest age – for the ships which served under Nelson and defeated Napoleon were practically all built to the older system, and Seppings' reforms, important as they were, only affected the relatively peaceful post-1815 navy.

Caulking

If the sawyers were the first to work manually on the hull of a new ship, the caulkers, who filled the seams between the planks on the sides and decks of the ship, were the last. According to Burney's *Universal Dictionary of the Marine*, to caulk was 'to drive a quantity of oakum, or old ropes twisted and pulled asunder, into the seams of planks in order to prevent the entrance of water. After the oakum is driven very hard into these seams, it is covered with hot melted pitch or tar, to keep it from rotting.' It was unpleasant work which offered none of the satisfaction of a shipwright in seeing a huge and beautiful hull take shape.

Caulkers often had to work in uncomfortable positions and in 1724 the Deptford officers reported that 'they cannot in the winter season see to perform their days' work in the dock as it ought to be unless they work their dinner time, it being so dark under the ship's bottoms between three and four o'clock in the afternoon …'.



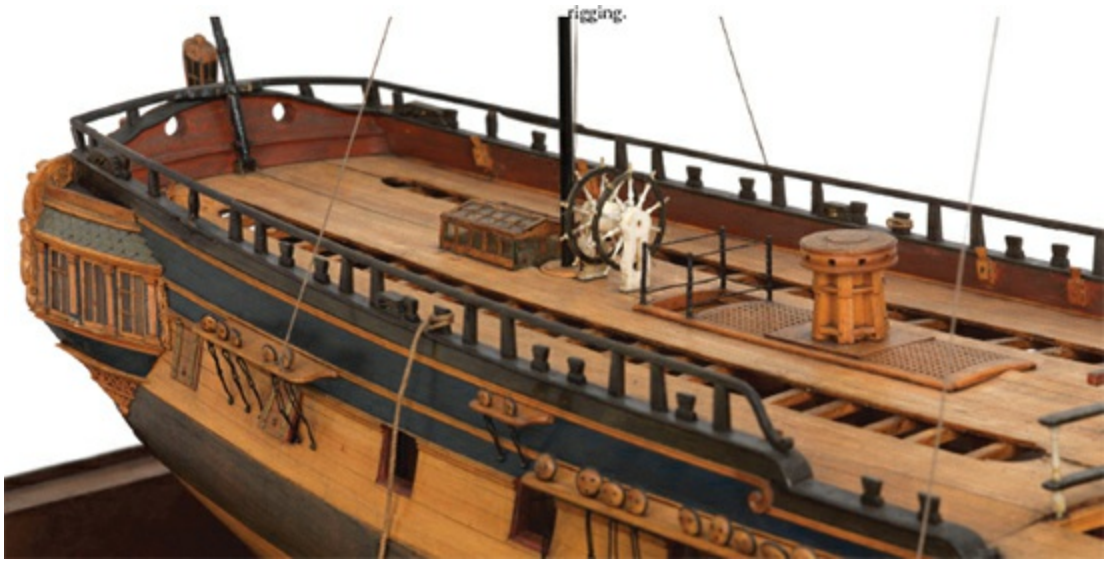
SLR0120 Seppings' model shows the main features of his new system. The diagonal braces were the most prominent and successful, but other features included diagonal deck planking, braces on the sides between the gunports and filling in the space between the futtocks and floor timbers in the lower hull. The model also shows the round bow and stern.

6: Fittings

The main structure was now complete, but many features were fitted to the hull before the launch. Ollivier commented on the difference between British and French practice in this respect.

> The English finish their building on the stocks; they compete the apartments of the hold and the upper works before the ship is launched: they fit out the head and fashion the quartergalleries. They caulk the upper works as soon as they are planked, and also the upper deck and quarterdeck and forecastle, before the caulk the bottom…. As for us, we launch a ship as soon as her middle deck is planked or even with but her binding strakes in place, and as soon as her upper works are finished to the height of the middle deck gunports.

SLR2372 Robertson's patent rudder of 1820 is shown on the right, far more streamlined in form than the conventional model to the left. The model came in a carrying case to allow it to be taken to demonstrations, but the model on the left is far more representative of the rudders of the great age of naval warfare. Its after surface is curved rather than stepped, as in earlier models.



SLR0318 The wheel of the *Mermaid*, a typical frigate, is much more exposed to weather and gunfire as there is no poop to protect it. Again the binnacle was not shown, and it was usually removable in any case. The skylight of the captain's cabin can be seen just aft of the wheel, with a capstan forward. The rails around the quarterdeck have timber heads for belaying the standing rigging.

Ollivier claimed that this helped prevent hogging, or sagging at the ends, but probably the most important reason was that material was far easier to bring to a ship on the stocks than afloat, so British shipwrights preferred to carry on the work as far as possible before launch.

Steering

The rudder was straight on its fore edge and fixed to the stern post. Its width tapered on its rear face and was reduced in steps after that until it had a square cross section at its head, with a hole to receive the tiller. From about 1800, the size was reduced in a curve. The rudder was usually made in several pieces scarphed together. It was attached to the stern post by means of gudgeons or rings fixed to the post itself, and pintles attached to the rudder which fitted into the holes. The steering wheel was universal in all but the smallest vessels by 1715, though the method of linking it to the end of the tiller was rather crude. The geometry of the system demanded a certain amount of slack which could cause delays in turning, and more serious problems if a rope became twisted. In 1770 Thomas Pollard wrote, '… the present method of steering His Majesty's ships being attended with may

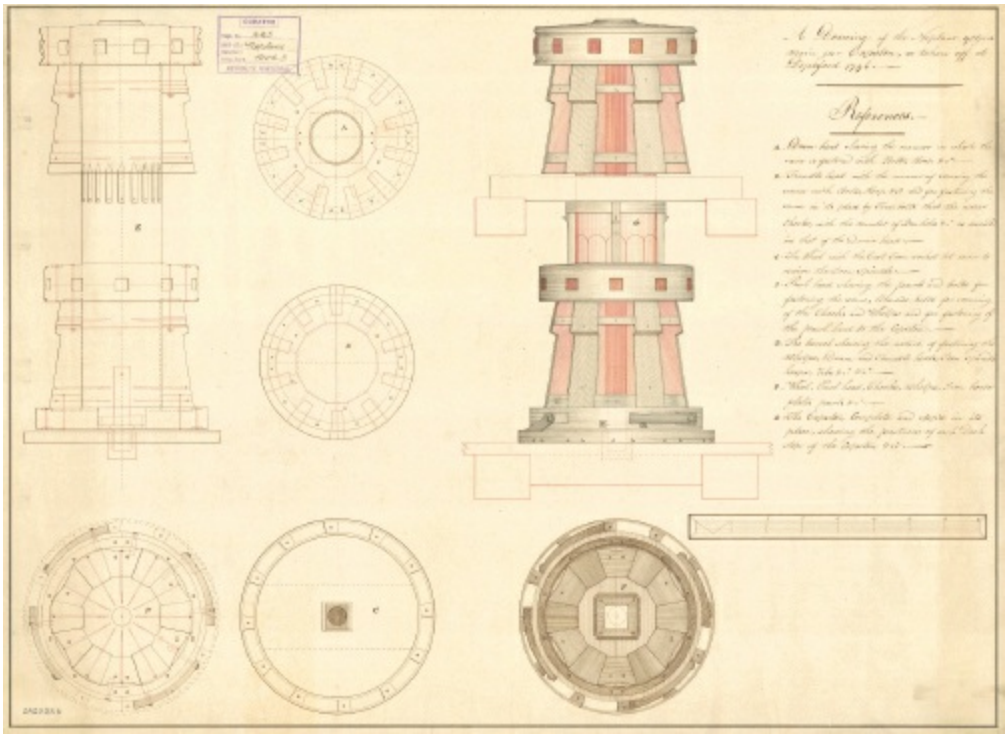
inconveniencies and fatal accidents that have happened … by the unavoidable slack rope when the tiller is near its greatest angle, by which the men at the wheel are often thrown from the steering wheel, the tiller in danger of being broke, the rudder head, pintles and braces work loose, the tiller ropes are in the way of working the guns and are in danger of being shot away.' He invented a system using a large curve fitted with rollers, which allowed the rope to be kept tight all the time. The wheel itself was usually double so that up to four men could operate it at once, and fixed on the quarterdeck, under the break of the poop and just ahead of the captain's cabin in ships of the line and in a more exposed position on frigates.

Anchor Gear

The riding bitts were vertical pieces of timber which would retain the anchor cable and they had to be very strong. According to Thomas Blanckley in 1750, they were 'Two perpendicular pieces of timber in the fore part of the ship, bolted to the gundeck and orlop beams, their lower ends stepping in the footwaling, the heads of which are braced with a cross-piece, and when several turns of the cable are taken over them, is for securing the ship at an anchor; there are generally two pair of them …'. Their construction was an essential part of the main assembly of the ship, the vertical parts rested on the structure in the hold and passed through several decks where they were fixed to the after side of beams.

SLR0440 The main bitts on the lower deck of a 70-gun ship of around 1730, showing the verticals which went down to the bottom of the hull, and the cross pieces. Knees were fitted to brace them against the pull on the cable, which could be very strong in rough weather. The bitts were used to restrain the anchor cable by winding it round them, and perhaps securing it further by lashing.

Capstans were vital on board ship for raising anchors and for other heavy work which was beyond the normal hauling power of a team of men. They were also used on shore, particularly for hauling ships in and out of dock. The main capstan fitted to the 98-gun *Neptune* in 1797 was drawn in some detail and shows the drumhead into which the bars fitted when it was in use. It was ‘fastened with bolts, hoops etc’. Below that was the trundle head, which fulfilled a similar function on the deck below. The whole thing was centred on a barrel and under each or the head were the whelps which formed a wider circle for hauling the cable and were shaped to prevent it riding up. Pauls were fitted round the rim near the deck to prevent it surging backwards. Most capstans were double, with a head on the upper and lower deck so that two teams of men could push on the bars if needed. They were held in place by the partners, situated between the deck beams and carlines.

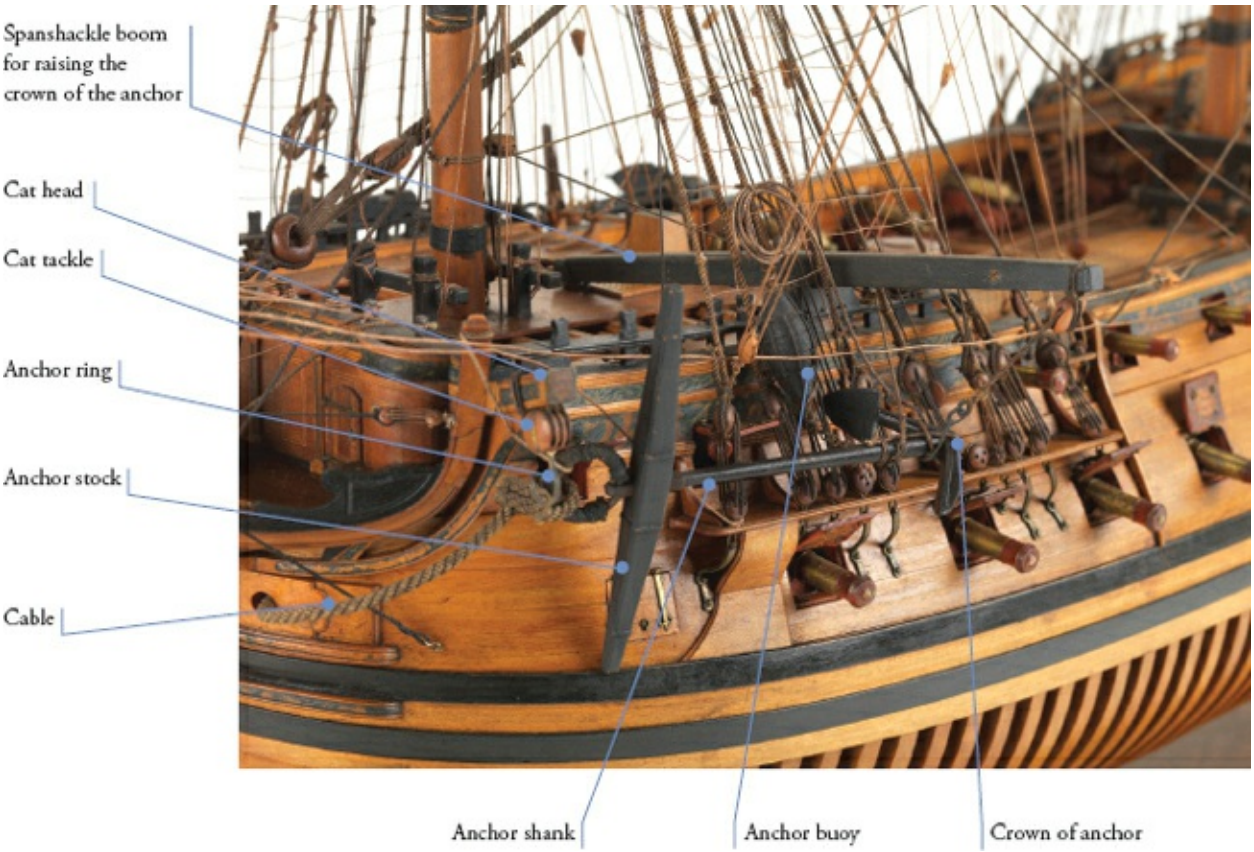


ZAZ032E A plan showing the capstan of the *Neptune*, 98, of 1797, in some detail. It shows the iron pauls which would prevent it surging backwards, the construction of the drumhead with its holes for the capstan bars, and the whelps which extended the circle round which the rope in

question was wound, and the projections to prevent it from riding too far upwards.

The capstan of the *Bellona* showing the holes for the bars in the drumhead, and the iron paul pivoted on the deck. The model also shows the capstan partners, solid rectangular timber situated between deck beams and carlines to hold it in place. (Author's photo)

SLR0412 The capstan on the upper deck of a 60-gun ship of about 1720, showing the bars which will provide leverage in place in the drumhead. The model also shows some detail of deck beams, carlines and ledges as well as hatch and ladderways.



SLR0454 The anchor gear of the *Yarmouth*, 70, of 1745. When not in use the anchor was hoisted up to the cathead as far as possible, then the spanshackle boom was rigged on the appropriate side to raise the crown so that the shank was horizontal. This was intended to prevent it from moving about and damaging the hull.

Each ship had a cathead on each side, projecting at an angle from each corner of the forecastle. It was used as part of a crane to haul the anchor out of the water after it had broken surface. According to Blanckley in 1750 they were, 'Pieces of timber projection over the ship's bow from the forecastle at the after end of the upper rail of the head, so as to clear the fluke of the anchor from the ship's side, in order to lodge it on the fore channel, that it may the more freely be let go again to anchor the ship in any road or harbour. At the one end of which shivers are let in …' The supporter or bracket under the cathead had a complex curved shape, and were 'generally trimmed, as the side-arms curve very much, by a mould made to the aftside', according to the *Shipwright's Vade Mecum*. The *Bellerophon*'s cathead was to be,

> … fore and aft 1 feet 5 ½ inches, up and down 1 feet 4 ½ inches, of sufficient length without board, and with three shivers in each, with iron pins … the catheads to be outside the timber, in

upon the beam, not less than 8 feet 6 inches: to have a piece of oak wrought on the inner ends of them, and to be bolted to the forecastle beam, with bolts of 1 ¼ inch diameter, and to be in length from side out 7 feet, and to have a knee on the after side of 7 ¼ inches sided; fore and aft arm 4 feet 9 inches, thwartships 3 feet, bolted with bolts 7/8 inches diameter.

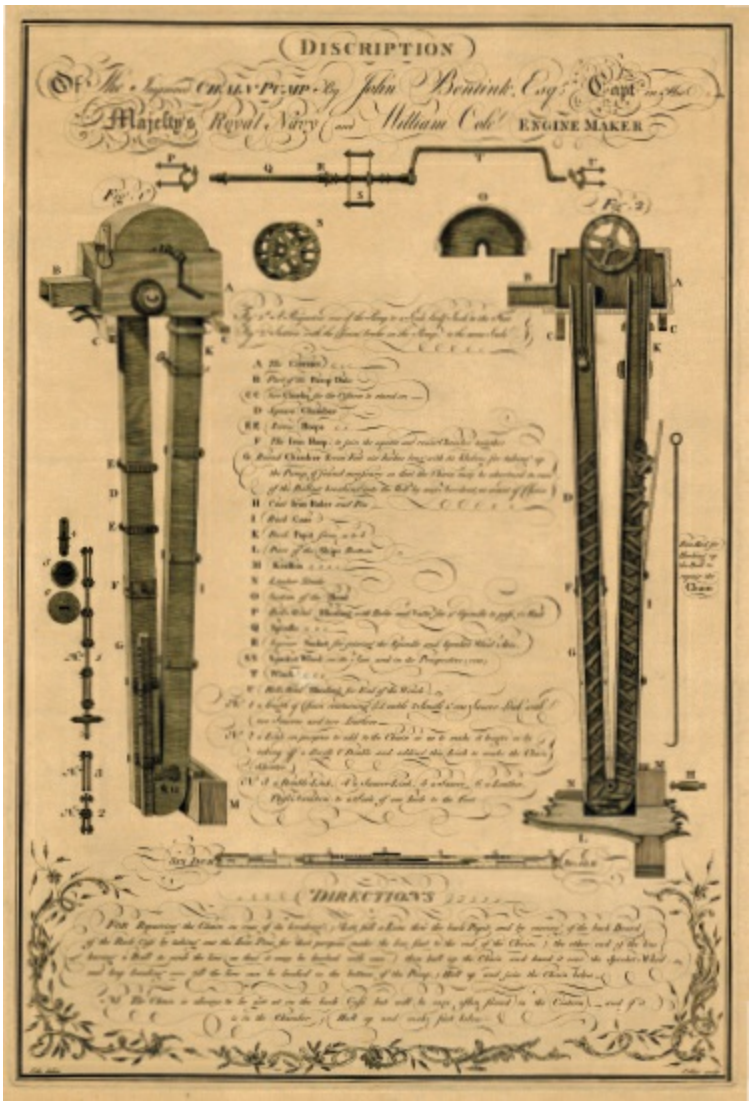
Pumps

It was inevitable that some water would enter the ship, whether from rain, human activity such as washing the decks, or through the bottom and sides. The drainage system caused it to exit through the scuppers or fall into the hold, where it was channelled towards the centre of the ship, where the main pumps were installed inside a square wooden well. They were usually chain pumps, which used saucers inside tubes to bring the water to the lower deck, from where it could be allowed to drain through the scuppers. Ollivier commented, 'There are but four pumps in English three deck ships, and only two in their ships other than those of three decks.' They were 'each composed of two pipes, placed side by side; one of these pipes is square and the other is bored round. Through the former passes an iron chain fitted with leather plates which have been cut circular, and placed at intervals of 12 to 15 inches. This chain runs up through the other barrel and in so doing pulls with it the water which is at the snifting hole of the pump. This water discharges into a wooden cistern which surrounds the pumps 18 inches away on the gundeck.'

Captain Coles's chain pumps had been developed by 1768 and eventually he convinced the naval authorities that they would work. The main advantage was the chain itself, rather like modern bicycle chain, which could be recovered from the tube far more easily if it broke. It was fitted in many ships from 1770 but troubles continued and in November 1772 a test was made on board the *Bedford* hulk at Deptford. The carpenters of thirteen ships reported, 'We broke the chain on the wheel and it did not drop above eight inches so that we could always take hold on both ends in the cistern. We then broke it in several other different heights in the pump and always found the chain fell about the same distance and stood nearly erect, which removes the difficulty in hooking the chain.' It was also found that it did not tend to jam, and that the cast iron chain did not break when it fell, unlike earlier ones. It was felt that all objections had been removed. In 1774 the Navy Board admitted that

‘several material defects’ had been discovered in the Coles pump but they had been ‘entirely remedied’ and the pumps were ‘now preferable to those that have hitherto been used’ so all ships were to be fitted with them. Any remaining examples of ‘Mr Coles chain of his first invention’ were to be redeployed in new pumps.

SLR0317 A model of the *Minerva*, a 38-gun frigate of 1780, shows the pumps on the upper deck, with the long handles, which could be worked by several men, over a ladderway which would probably have to be closed when the pumps were in operation. The power is transmitted to the wheels under the quarterdeck, then down to the bottom of the ship by the pump chains.

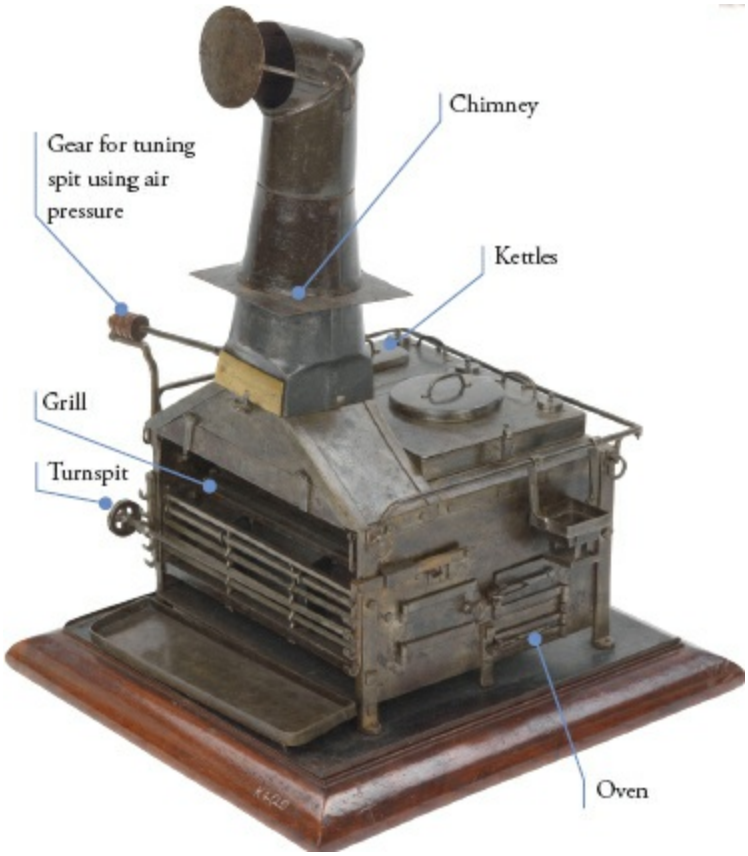


Instructions on the repair of the Coles chain pump, as issued to ship's carpenters. One of its claimed virtues was that a broken chain could be recovered more easily. The pump head and dale, to hold the water, can be seen at the top of both of the main diagrams. On the bottom left are elements of the chain and the saucer-like discs which haul the water up. (Author's collection)

The Galley

The ship's galley was centred on a cooking stove which was usually placed forward on the upper deck, under the forecastle deck on a two-decker and on the middle deck on a three-decker. Early in the eighteenth century it consisted of two large copper kettles installed in a brick furnace. Ollivier commented that the kettles were never removed during a commission and must have been difficult to keep clean; he also remarked on the absence of the bread ovens

which were to be found on French ships. Iron stoves were fitted from about 1750, partly because the weight of the brickwork was ‘overloading and straining some of the small sloops’. Each had a single rectangular kettle still made of copper and divided into two parts.



MDL0025 A type of iron stove which replaced the brick stoves around the middle of the eighteenth century. The crew’s cooking was done by boiling meat in the kettles to the rear, the more sophisticated facilities of grill, oven and turnspit usually being reserved for the officers.

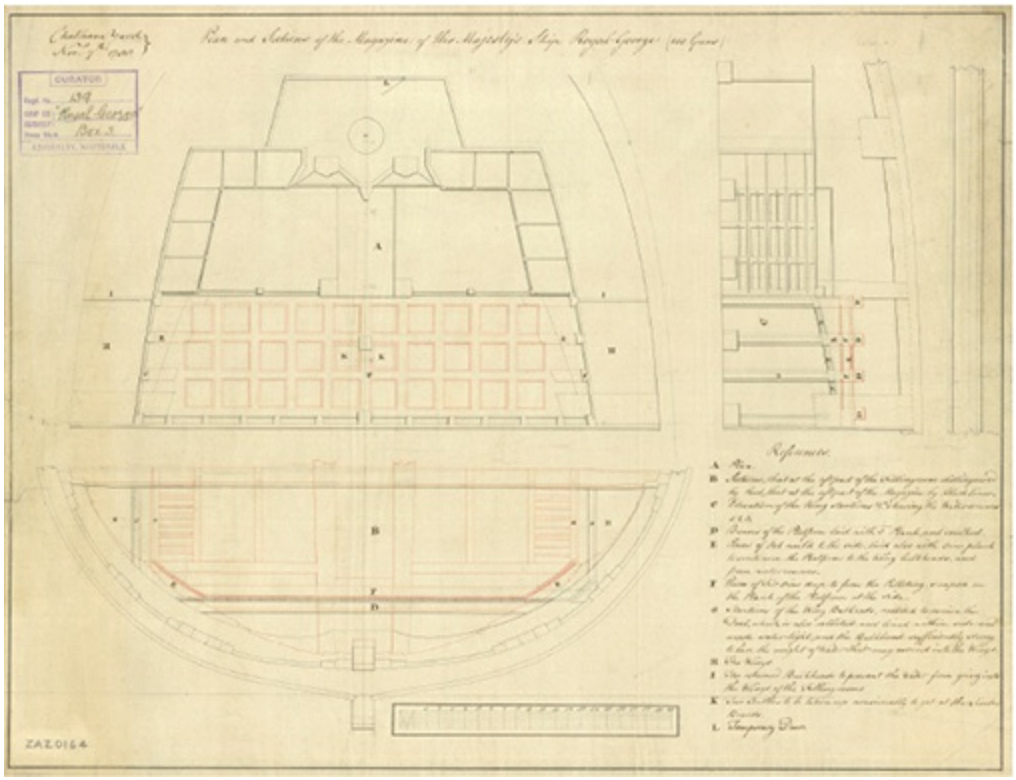
A galley chimney, with the belfry just aft and a grating forward to allow team to escape. Galley chimneys came in many different forms, often adjustable to carry the smoke away from the wind. (Author's photo)

In 1787 the Navy Board directed that the new stoves ordered from Mr Brodie should have 'a firehearth of the new construction, with kitchen range, a folding top bar, 2 sliding racks for spits, a trivet bar, and 2 swing cranes with a stay to each, 2 ovens which are heated without any extra fuel, 2 square iron boilers with 2 covers to each, 2 brass cocks with set screws to plugs; a circular plate with 2 sliding rods and socket for the mouth of hearth funnel.' Though the shipwright did not make the galley stove, he had a role in its placement – the *Bellerophon* contract demanded the builders 'have a long carling under the upper deck beam 12 inches broad, and 12 inches deep … it is to be let up between the beams and furred from thence to under the side of the ledges …'.

Gun Equipment

Carrying a suitable gun armament was the main function of a ship of war, but in some cases, such as a Deptford Yard, the shipwrights hardly ever saw the guns as they were invariably fitted downriver. However, fittings associated with them were definitely part of their remit. Apart from the gunports, these consisted mainly of ringbolts for fitting the ropes to restrain the gun while firing, loading or at rest. Each gun needed an eyebolt on each side of its port

to restrain the breeching rope, another above and slightly outside of that and two above the port to hold the muzzle when the gun was stowed. In addition each gun had a ring bolt aft of it just outside the line of hatches, partners and so on along the centreline of the ship. This held the train tackle which kept the gun from running out accidentally while reloading.

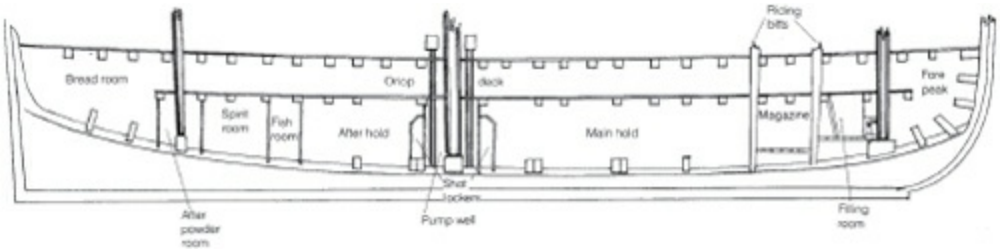


ZAZ0164 The views of the magazine of the *Royal George* of 1788 – the longitudinal section to the right is shown vertically instead of horizontally. The squares are pallets of charcoal to absorb liquid and the light room, at the top of the right-hand diagram, contains a lantern which is completely separate from the magazine itself, to prevent the risk of fire. Below it are racks for stored cartridges.

Fincham wrote that the gunport lids were ‘made of fir in two thicknesses; the inner thickness is called the lining, and is placed with the range of fibre up-anddown, and of about two inches in thickness, with its inner part bedding or faying close to the back stops. The outer thickness, called the outside stuff, lies fore and aft, and is of substance sufficient to be well the outside of the outside planking, at the thinnest part.’ They were ‘hung with two hinges, which have in their lower end one shackle on each for the port ropes, and one on each inside for the port fastening’.

Compartments in the Hold

Though the greatest part of the hold was open and used for the stowage of food and drink, certain compartments were sealed off for various reasons. The magazine in the bows was the most elaborate compartment, quite a sophisticated construction which was designed both to keep the powder dry and to protect it from sparks. There had been several accidents before 1715, as well as loss by damp, and in that year it was ordered that 'the floor of the bread room and powder room should be made of palleting, 'in the nature of hatches, to lay loose, so as to be take up without tearing them to pieces, when there is occasion to clean and water passages under them, to give air and search these parts'. In 1734 the palleting was raised higher and filled with charcoal to take up the damp. The builders of the *Bellerophon* were to 'part off a bulkhead for a magazine … the said bulkhead to have its seams lined on the aft side, with slit deal battens plastered, and cants and plaster at the sides and bottom; the fore side to be plastered wholly over, and covered with whole deal 1 ¼ inches thick' there were to be cants 'proper for the powder barrels to stow, and to be kept free from wet'. Fincham describes a system which was obsolete by 1821. 'Beams were laid about two feet apart across the magazine, called palletting beams, and between them carlings at the same distance apart, called palletting carlings; these beams were nailed to the flat, and had a rabbet taken out of their upper edges, to receive scuttles …' It was illuminated by means of the light room, a separate compartment with a different access route, fitted with a pane of glass to let the light through. Just forward of the magazine was the filling room, 'a place parted off and lined with lead in the magazine, wherein the powder is started in order to fill the cartridges'.



The compartments in the hold of a 74-gun ship of around 1760. The bread room is raised slightly above the others to keep it clear of bilge water, the spirit room is separated to prevent theft, and the fish room because of the smell. Powder is kept in the magazine and powder rooms until needed, shot in the

lockers around the mainmast. The rest of the hold is usually filled with casks of water, beer, meat, butter, etc. (Author's drawing)

The main hold extended for most of the length of the ship, interrupted by the rectangular pump well and shot lockers round the mainmast step. The shot for the guns was stowed there to help keep the centre of gravity low, and in order that a sudden expenditure of it in action would not affect the trim of the ship, as it would do if stowed forward or aft. The part aft of that was sometimes known as the after hold, though it was not fully separate from the main hold. The spirit room was a narrow compartment aft of that, because brandy and rum needed a high level of security from the seamen, much more than beer which could be kept in the main hold. Next came the fish room, separated because the smell from its contents had to be contained. It might be interrupted by a rectangular after powder room where made-up cartridges could be stowed for the aftermost guns. Right aft, in the round-sided compartment where the hull narrowed towards the sternpost, was the breadroom, which extended to the deck above. It was slightly higher than the other parts of the hold, helping lift its contents above the bilge water, for bread was stowed in bags rather than casks.

Cabins on the Orlop Deck

Since the orlop deck never carried guns, it was possible to fit it with permanent cabins and storerooms. In the extreme bows was the fore peak which was considered too small, damp and irregular to be used for stores. Next came the storerooms of the three standing officers of the ship, the boatswain, gunner and carpenter, who were respectively responsible for maintenance of the rigging, the guns and their equipment, and the wood of the hull and masts. According to Fincham, 'The carpenter, gunner, boatswain and captain's wardroom, with the marine storerooms, slop rooms, etc, are in general built up with 1 ¼ [inch] rabetted deals …'. They were secured with bulkheads and locks, as their contents were liable to embezzlement. In a typical twodecker of the 1790s the boatswain's storeroom was on the port side with a sail room forward of that. There was an angled passage which was the only route to the light room in the hold, and on the starboard side were the

carpenter's and gunner's stores. Just aft of them were cabins for the carpenter and boatswain, who were expected to live on board even when the ship was out of commission.

The wings (or carpenter's walk) covered most of the length of the orlop on each side and were defined in the *Shipwright's Vade Mecum* as 'the places next the side upon the upon the orlop, usually parted off in ships of war, that the carpenter and his crew may have access round the ship, in time of action, to plug up shot holes etc' – for one of the greatest dangers was that a shot might penetrate 'between wind and water' and cause the ship to founder. Their boundaries were often formed of latticed deals, known as lattice bulkheads. The centre of the ship aft of the storerooms was filled with hatches and another sail room and the pump well. The space between these and the wings was largely used to stow the anchor cables and let them dry out. Aft of that came another set of cabins on each side, with a space known as the cockpit in between. it was used to accommodate midshipmen in normal times, and as an operating theatre in battle – Nelson famously died in the cockpit of the *Victory*. On the port side were the marine's store, the slop room for seamen's clothing, the purser's cabin and the steward's room where provisions were kept ready for use. On the other side were the surgeon's cabin, and a substantial storeroom for the captain. Midshipmen's berths were often built forward of these cabins. Aft, the space was occupied by the upper part of the bread room.

Cabins on the Gundecks

The cabins above the orlop deck – even the admiral's and captain's – had to be removable so that they could be cleared away to make room for the guns when the ship went into action.

Dockyard joiners spent a large part of their time working on ships' cabins and other fittings and their work overlapped with that of the shipwright on one side and the carver on the other. Among the many items of task work described in 1774, a great cabin where an admiral or captain would live was to have 'screen bulkhead and balcony roofing, ship sides and gallery doors', sashes and frames right aft, 'bulkhead with wainscot doors and pilasters; middle bulkhead with pilasters; cabin, stateroom and steerage roofing, false

beams; corniche and grounding the ship's sides …'. The joiners would fit decorative rails on the outside of the ship and help make the rails which supported the figurehead, fit the stern galleries; they would erect the belfry which had a 'cap stuck with a cove moulding and arched fore and aft' and decorate the cathead used for raising the anchor which was 'planed and opened with raised panels on the side and end and beaded all round'. They could make more functional features such as shot racks and chests for arms, compasses, flags and many other items. They could make tables, for example 'wainscot with six legs, two flaps and hung with a rule joint'. In 1803 they worked on the 74-gun *Colossus*, 'refitting the wardroom, stern and galleries, gallery doorways, repairing the foremost bulkhead and aft side of the pantry, hanging stern sashes and shutters, locker tops and rudder case, repairing the great cabin bulkhead, pilasters and doors …'.

Officers invariably lived near the stern, on four different levels in a two-decked ship. Until about the 1740s the captain usually lived on the upper deck of a two-decker, with junior officers on the quarterdeck. The uppermost space gradually became more desirable as the hull was widened in that area, and more stern galleries were fitted. After that, the captain usually lived between the quarterdeck and the poop with the other officers in the wardroom below. This too developed gradually and the subdivision into separate cabins along the sides was only slowly recognised. In 1742 they were only sealed off by hanging canvas, then by canvas-covered frames later in the century. Orders of 1757 demanded,

> That all bulkheads … for parting off the great cabins, bed places, coaches, wardroom, and other such cabins and apartments therein proposed, with the cants prepared for receiving them, be fitted in such a manner as they may be taken down or disposed of out of the way of fighting the guns, or doing mischief by the enemy's shot, in the shortest time possible. That the said bulkheads be framed of deal panels, wrought strong, light and plain, and for the more convenient stowing of them out of the way when taken down, and the better to enable the panel part to bear the shock of the guns when they fire, none of them with the framing should exceed three feet from out to out, and those of them which are to form the bulkheads to be fitted with hinges and shifting pins through the joints thereof on the upper part, and below to fall on a rabbet prepared to receive them in the cant, with a batten before them, or small bolts, for their confinement in their places …

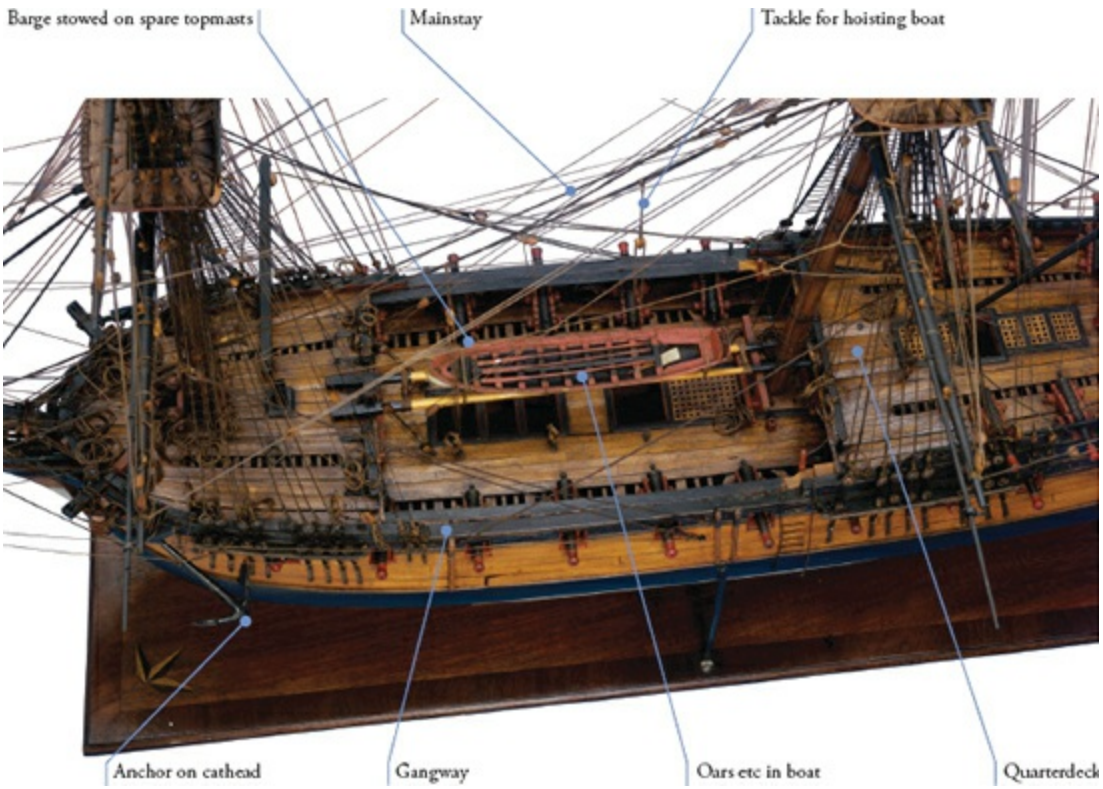
Masts and Rigging

The lower masts would rest on steps fitted in the hold. According to Fincham,

‘the main and fore step are fixed across the keelson; the main is made to shift forward and aft, according as it may be desirable to rake the mast; the fore is bolted through the bottom. The mizzen step is in general fixed on the lower deck beams.’ Each was cut with a square mortice to receive the heel of the mast. That of the *Bellerophon*’s mainmast was to be ‘sided 2 feet 11 ½ inches and 1 feet 5 inches deep on the keelson, and of a length to slide easily by the stations of the [pump] well’. The fore step was to be made of two crutches, or ‘as shall be directed, each to be sided 11 inches, and 3 feet 0 inches asunder in the clear, equally distant from the centre of the mast, and in length 12 feet 0 inches, with carlines and shifting chocks fitted to them …’.

Various items were fitted to the hull to receive parts of the rigging. The most obvious were the channels, which projected from the sides and spread the shrouds and backstays which supported the masts against sideways pressure. In 1737 Ollivier observed that ‘the channels in most of the English ships are placed as we used to place them formerly … By this I mean that the main and fore channels on three decked ships are fayed to the wale which lies beneath the upper deck gunports, and those ships of lesser rate likewise.’ The amount of tumblehome, or narrowing to the upper hull, tended to reduce over the years, which meant that the channels could follow foreign practice and be moved upwards, above the middle deck on three deckers and lower deck on other ships. Fincham describes them in some detail. ‘The channels are placed commonly with their lower sides about one inch above the lower edge of the upper sheer strakes of ships that have them; except the mizzen channel of two deck ships and upwards, which is placed above the quarter-deck ports, about an inch above the first seam. They are in general about 4 to 5 inches in thickness at the inner edge, and form one inch to one inch and a half less on the outer edge.’

SLR0338 The lower part of the port quarter gallery of the *Bellona*, used as toilets by the wardroom officers, with easy discharge into the sea. It also shows a characteristic style of decoration of the period, and the Georgius Rex symbol in the centre of the frieze under the gallery windows.



SLR0339 The waist of the 32-gun frigate *Lowestoft* of 1761. Though it only shows one of her boats, it indicates how it might be stowed in the waist, with tackle rigged from the mainstay to lift it. More tackle, not shown, was rigged from the yardarms to haul it outboard. And lower it into the water. The model also shows the narrow gangways fitted along the sides of the waist in this period.

These supported the standing rigging which was fixed in position except

for tightening and maintenance. The running rigging, used to manipulate the yards and sails, also had to be allowed for as the ship was built. Holes were left in the sides for the blocks which controlled the sheets for altering the angle of the lower sails. Many stations had to be provided for the numerous ropes of the running rigging. In the first half of the eighteenth century these largely comprised the timber heads in the forecastle, which ran up through the gunwale and were shaped to be used for belaying ropes. There were a few more specialised pin rails aft, and the sheets were belayed to stronger pieces fixed to the inner sides, known as staghorns or kevels, jeer bitts were used for heavy loads, such as belaying the blocks which held up the main yard. By the early nineteenth century pin rails were more common and often to be found in the forecastle and quarterdeck, with cleats at the foot of the masts and timber heads round the waist.

Sanitary Features

Sanitary arrangements on board were usually quite primitive, though the whole of the sea was available to get rid of the waste so it might be argued that no more was needed. For the officers, they were fitted in the quarter galleries in the stern, adjacent to the wardroom and the captain's and admiral's cabin. The *Bellerophon* contract demanded that the galleries have 'convenient places of easement'. Petty officers eased themselves in semi-circular roundhouses attached to the beakhead bulkhead, while common seamen had to use the far more exposed seats in the beakhead itself. Article 24 of the task work included making 'the roundhouses of ease in the head and seats of ease' – which were wooden seats on which the seamen sat to relieve themselves. Some ships had 'pissdales', basin-shaped objects near the ship's side, where the men could urinate with no privacy at all.

Boats

A ship carried a number of boats of different types, six in a ship of the line in 1805, five in a frigate and three in a smaller vessel. Shipwrights might work in the boat shop in their dockyards, though many of the boats were also bought from private contractors. Otherwise the shipwright's involvement in

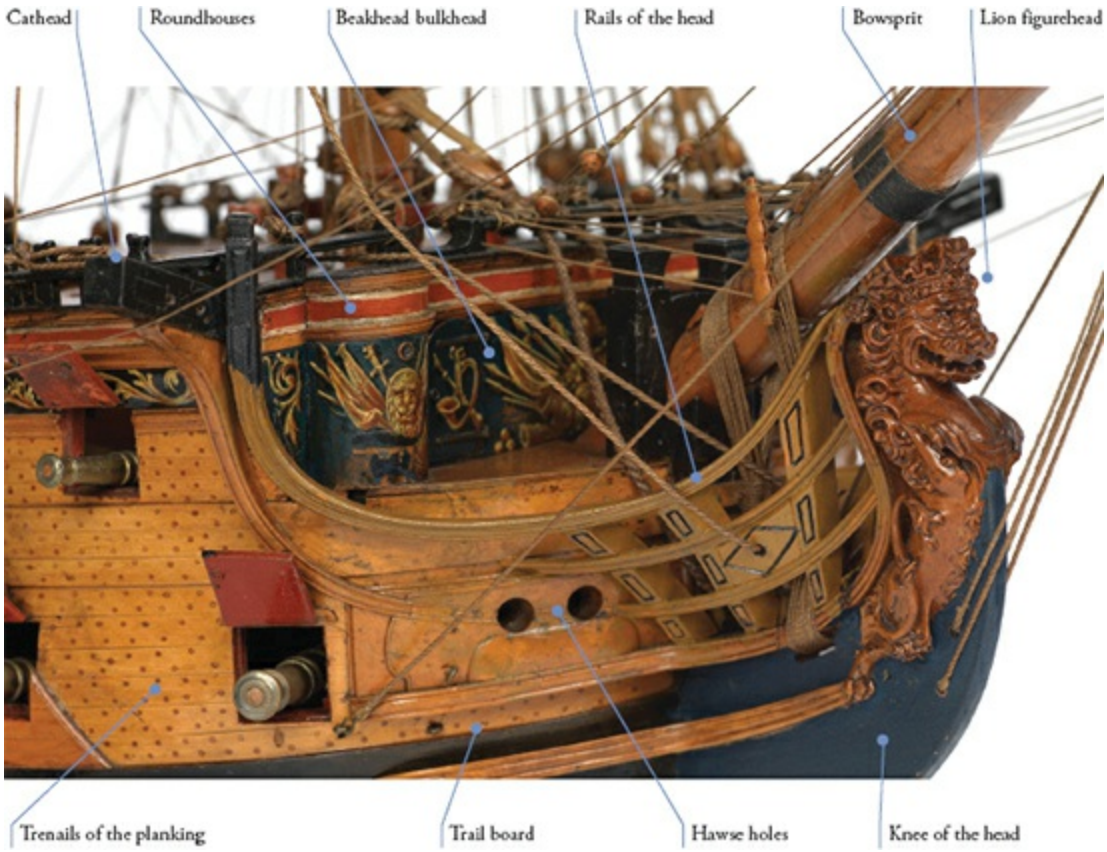
the boats was slight, as the fittings for them were minimal. Skids were fixed vertically to the external planking and followed the curved shape of the hull. They were intended to protect the sides against wear as boats or provisions were hauled up. Crutches were placed on the booms in the waist to store the boats, which were hoisted out using tackle attach to the yards so they needed no extra fittings. Later, boats were slung from wooden booms over the quarter galleries and stern.

Decoration

The decoration of warships was elaborate. Though it was constantly reduced in scale by Navy Board and Admiralty order, shipwrights tended to make it as dramatic as they could in order to glorify themselves. It was the work of the carver rather than the shipwright, and in contrast to France he was usually a common craftsman rather than an artist. It is of course well represented on ship models, in some cases it is the most striking feature. The contract for the *Bellerophon* demanded, 'a complete and handsome gallery on each side' and 'a handsome taffrail and quarter piece'. The decorations of the stern were almost part of the structure, but the figurehead stood alone. Until the 1750s it was usually a crowned lion except in First Rates. After that it was more likely to represent the name of the ship, and as such it might survive to commemorate it. Fincham described it as 'a carved ornament at the extremity of the knee, in general having an allusion to the ship's name'.

Article 24 of task work included the fitting of the knee of the head, the figurehead and other decoration. On the *Alcide* it was done by two gangs between 20 March and 19 May 1779, at the same time as the orlop deck was fitted under Article 19. The knee of the head was a flat structure fitted ahead of the stempost and in line with it and the keel. According to Fincham it was, 'an assemblage of pieces, tabled or coaked together, and brought on the fore part of the stem, projecting forward about 1–11th to 1–13th of the length on the deck … composed in general of three principal pieces, the stem piece, main or lacing piece, and bobstay pieces'. The figurehead was fitted ahead of and above it, while curved rails supported it on each side. Ollivier noted, 'The head of the English ships has two or three rails on either side, like the

head of our own ships; these rails are likewise supported by small hanging knees, and by head-beams running from one side to the other. Between the beams are gratings, and these gratings are pierced by either two or four soil pipes for the seats of ease of the crew.' The head rails originally had 'a sudden curve at the after end, and return against the fore side of the cathead, when they are called circular rails'. By 1821 Fincham wrote that they were 'called the main and small, or middle rails: the main rails extend from the back of the figure to the bow of the ship; sometimes to the supporter of the cathead or snapeing against the bow'. The cheeks were 'two or three on each side for supporting the knee of the head'.



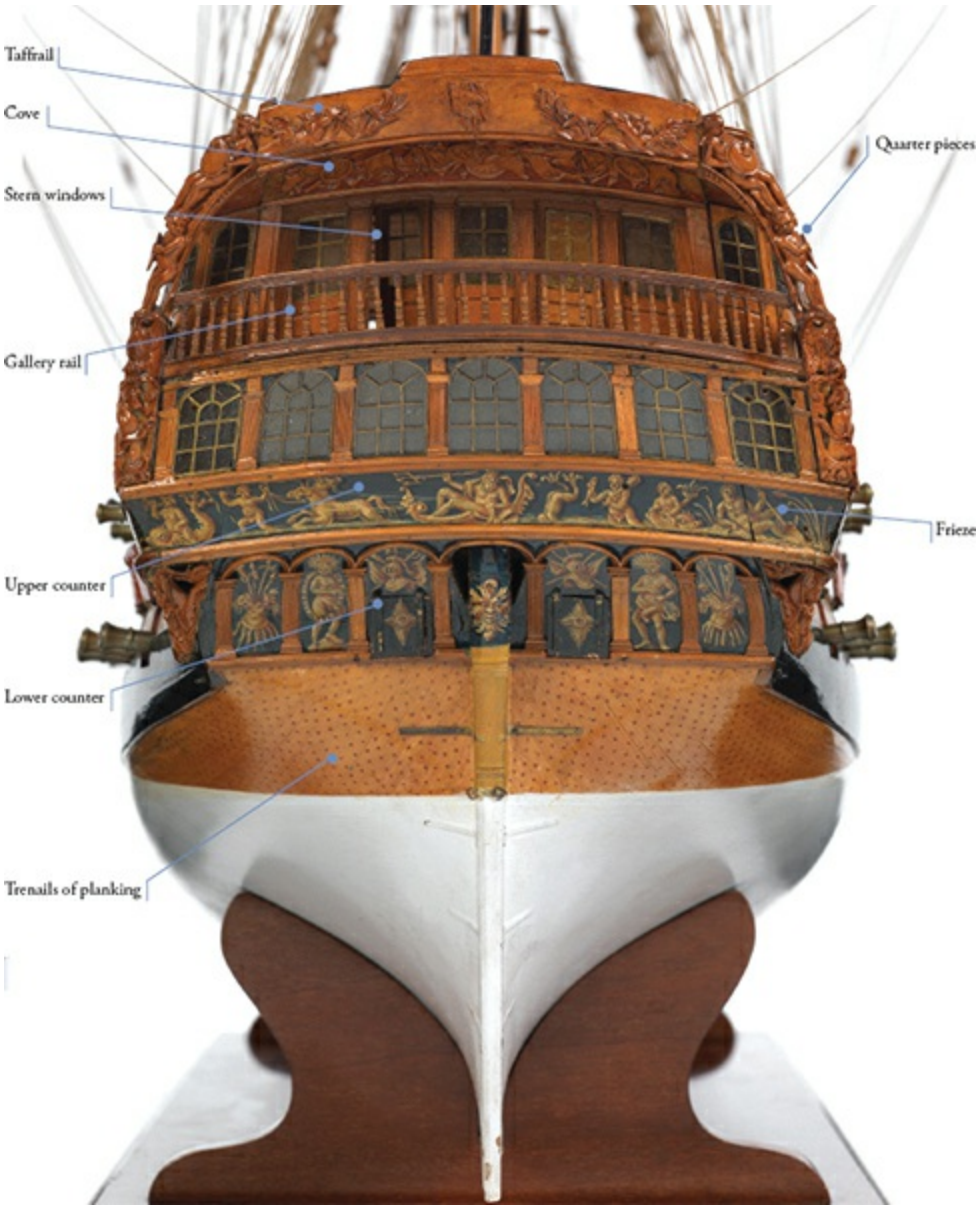
SLR0442 The very detailed model of the *Centurion* of 1733 even shows the trenails which hold the planking in place. The decoration is of conventional form for the period, with the standard lion figurehead supported by decorative rails under the bowsprit. The roundhouses on the beakhead bulkhead were used as toilets for petty officers.

False Keel

Underneath the main keel and similar to it in width it was a false keel which

would help protect the main keel against groundings and other hazards. It was ‘laid with tar and hair’ to keep shipworm away from the main keel, and ‘sufficiently fastened with nails and staples’ to the main keel. According to Ollivier, ‘It serves to preserve the caulking of the scarphs of the keel and prevents this timber from suffering damage when they dock their ships without laying them up on keel blocks. The English shipwrights claim yet another advantage from it; which is that their ships being thereby 4 inches deeper in the keel by virtue of this false keel, they ply better to windward.’ It had to be attached by different means from the other parts, and Ollivier noted, ‘I saw them shift a piece of false keel on the *Buckingham,* which they are repairing at Chatham, and since the distance between this false keel and the floor of the dock is not sufficient to enable them to drive spikes from below, … they fastened it with ragged staples….’.

It was one of the last pieces to be fitted during building, and the blocks under the main keel were knocked away leaving the ship resting on shores from the ground up. In the *Alcide* it was done between 27 April and 5 July 1779, along with fitting the rudder and gunports and completing the decoration. The ship was now ready for launch, which took place at the end of July.



SLR0442 The stern of the *Centurion* model showing the 'white stuff' favoured by modellers and artists. Again the decoration is conventional, with the open gallery at quarterdeck level which was common on twodeckers of the time. Much of the decoration consists of frieze work, usually of classical scenes.

7: In the Water

The Launch

There is no known description of the launch of the *Alcide*, one of nine warships launched in the Thames during 1779. For the technicalities we have to rely on a generic description provided in Burney's *New Universal Dictionary of the Marine,* the most comprehensive nautical dictionary of the day.

> … the ship is supported by two strong platforms, laid with a gradual inclination to the water, on the opposite sides of the keel, to which they are parallel. Upon the surface of this declivity are placed two corresponding ranges of planks, which compose the base if a frame called the cradle, whose upper part envelopes the ship's bottom, whereto it is securely attached. Thus the lower surface of the cradle, conforming exactly to that of the frame below, lies flat upon it lengthways, under the opposite sides of the ship's bottom; and as the former is intended to slide downwards upon the latter, carrying the ship along with it, the planes and faces of both are well daubed with soap and tallow.
>
> The necessary preparations for the launch being made, all the blocks and wedges by which the ship was formerly supported are driven out from under her keel, till the whole weight gradually subsides upon the platforms above described, which are according called the ways. The shores and stanchions by which she is retained upon the stocks till the period approaches for launching are at length cut away, and the screws applied to move her, if necessary.

SLR2151 A three-decker preparing for launch at Chatham. Though the launching flags are flying and the hull is propped up, the cradle which will support the hull during the launch has not yet been fitted – quite a common feature on models and paintings.

SLR0572 A model of the frigate *Diana*, showing her ready for launch. This time the launching cradles are in place at the bow and stern to support the hull as it slides down the wooden rails into the water. This was quite a common style of model in the late eighteenth century. The bollards

shown prominently forward of the bows were probably to hold the ropes which will restrain her at the end of her run.

A painting of the period shows the launch of the 74-gun *Alexander*, and it was clearly an important event, locally at least. Offshore, ships which were ‘laid up in ordinary’ are dressed with flags, including the royal standard at the main. Further inshore are dozens of boats filled with spectators, leaving only a small passage for the ship to pass between them. Perhaps the most striking symbolism was to be found in the huge flags which were hoisted in flagstaffs fitted to the holes for the ship’s masts – the union flag at the bows, the ‘hope and anchor’ of the Admiralty in the place for the foremast, the royal standard at the main (though a member of the royal family was not often present), the Navy Board flag at the mizzen and an ensign at the flagstaff on the stern. It was not yet common for a woman to launch a ship, and indeed they were not encouraged to attend until late in the century. A bottle of wine was broken over the bows but not attached by rope, until an accident at Plymouth in 1811 caused a change in procedure. Then, according to Burney, ‘The motion usually begins on the instant when the shores are cut, and the ship slides downward along the ways, which are generally prolonged under the surface of the water, at a sufficient depth to float her off as soon as she arrives at the farthest end thereof.’

For most of the eighteenth century First Rates were built in dry-docks as it was considered safer to float them out rather than launch them – but even that process was not without its risks. Hartly Larkin was the ‘foreman afloat’ of Chatham Dockyard, responsible for the workers on ships in the harbour and for setting up the ropes and tackle which would haul a new ship out of the dock. He could not sleep on the night of 6/7 May 1765 as he worried about the new First Rate *Victory* that would be launched that morning, for he was convinced that the ship would get jammed on the way out of the dock. She might be stuck there as the tide fell and part of her would be unsupported which would be ‘of the utmost consequence’. In the morning he went to the yard to measure the dock and the ship and soon found that he was right – ‘the ship at the upper breadth [was] broader than the dock 6 inches, and at the lower breadth broader than the dock 9½’. He alerted the master shipwright, who sent an assistant to check the figures. When they were confirmed he

exclaimed, ‘What must be done, the ship cannot go out today.’ He was answered, ‘If you will please to let as many shipwrights as can be employed on the dock and gates she may be got out.’ A party of shipwrights cut away parts of the gate before the tide rose and the ship began to float. They work was done quickly and the ship was hauled out into the river.

SLR0338 The *Bellona* model shows the launching quite accurately in some ways, in that the cradles are fitted on the rails, but it is unlikely that a ship would be launched already coppered, as that might damage the expensive material. This model was probably coppered later in its life specially to show it to the King to establish the value of coppering.

The 100-gun *Queen Charlotte* was the largest ship to be built at Deptford, and it was now more common to launch such large ships rather than float them out, although the River Thames was narrow at Deptford. Her hull dominated the skyline of the town and river from the beginning of 1807 when the futtocks were raised, but construction was slow due to lack of timber. It was May 1810 before she was ready to launch. The amount of ceremony involved in a launch, especially a large one, was also increasing over the years and the event was greatly anticipated in the town. Reverend John Theodore Barker of Deptford Congregational Church recalled, ‘The day is come; multitudes are assembled; and the bustle and clamour for awhile prevail.’ There was understandable nervousness, no doubt many of the workers and visitors remembered the delays and difficulties which had attended the launching of the 98-gun *Impregnable* in 1785–6. Around 20,000 people gathered to watch the event, the largest ship ever to be launched so close to London. Some were inside the yard, some on boats in the river, while a stage was erected beside the slip for some of the distinguished visitors. But

the most honoured place was on board the ship herself, even if the distinction was devalued when over 2000 people were invited. Reverend Barker imagined the scene on the poop and quarterdeck where most of them stood. ‘Some who now sit at the helm of our political affairs, and many others, saw the helm of the *Queen Charlotte*. Was there no profane oath? No obscene witticism? No impatient or angry word? No expression of envy towards those who had a better seat, and a fuller view?’ Then according to Barker,

BHC1875 The launch of the 74-gun *Alexander* at Deptford in 1778. The ship herself is seen in the distance just left of the centre of the picture, with a host of small craft gathered dangerously close to her path. The scene is dominated by other ships in the river, including two yachts and a bomb vessel, common types in the restricted space outside Deptford yard.

BHC3602 A well-known view by Cleveley, showing a three-decker being floated out from the dock at Deptford. It is very accurate in much of its detail, but no such ship was built or repaired in Deptford during this period.

PAD1035 The scene after floating out a ship from dry-dock is shown in this print of Chatham. A new 90-gun ship, still with launching flags, is seen to the right of centre. She is being towed towards the sheer hulk to the left, flying a red flag, to have her lower masts fitted. This was very similar to the scene after the *Victory* was launched in 1765.

> The moment approaches, expectation is all awake, the loud strokes of the axe become louder and more frequent; and as the props and shores are successively falling, hopes and fears alternately depress and elevate the whole soul. At length the signal is given, and the very last shore is

> ‘knocked away.’ She moves; and all the hearts of the spectators are moved with her. What solemnity; what concern; what solicitude is depicted on the countenances of the gazing thousands! But she enters the watery element; enters slowly, but safely and majestically…. The *Queen Charlotte* was ready, quite ready, even before the full time for launching; and the moment the signal was given, with what ease and dignity did she move and enter the untried element…

SHEATHING

The underwater bottom of a ship at sea was subject to two main problems. Weed and barnacles would grow on it, greatly reducing the ship’s speed, so that a fast ship needed to be docked every four months. Secondly, especially in the tropics, shipworm would enter the hull and eat their way along the planks, causing fatal weaknesses. For most of the eighteenth century the first problem was partly solved by covering the hull in black stuff, a mixture of tar and pitch, white stuff made up of train oil, turpentine and sulphur, or brown stuff which was tar, pitch and brimstone.

Shipworm or *teredo navalis* was prevented, or at least minimised, by covering the hull in light planks and separating that from the main planking. Sheathing was not normally fitted before launch but afterwards in dry dock, as the Deptford officers explained in February 1762:

> … from the sharpness of the bodies of ships of war and the oblique manner in which many parts of the cradle prepared for launching must press against the surface of the sheathing, which, together with bolting the spurs that confine the whole upon the thin surface thereof, may render launching large ships that are sheathed more insecure than without; and at the same time, as some part of the sheathing, by the oblique pressure of the chocks, will be stripped off in launching.

In addition, after launch, ‘without sheathing, this will give an opportunity of discovering accidental leaks, which new ships are more subject to than any other, and also of caulking the bolts above the light draught of water a second time, which every new bottom should have before it is sheathed’. Therefore a newlylaunched ship was put into a dry dock to be sheathed.

In 1727 the Deptford officers described the process of sheathing as they saw it:

> … after the ships’ bottoms are well caulked and payed with tempered stuff, that spun hair be named in the seams and butts, the whole bottom covered with thick brown paper, the board well dried, payed with boiling tar, and the hair laid on it pretty thick and smooth, to rows of holes to be bored at each butt, the board to be wrought rough (believing the planning of the sheathing to be no service if filled with nails) and filled with filling nails of 1 ¼ inches distance, which is preferable

to brads, and will preserve the bottom the better from worm.

SLR0677 The bows of the *Cornwallis* model showing the system of coppering, arranged in rows like brickwork but with a slight overlap between the individual plates. In this case the coppering is carried up to the lower wale, which was not common. In earlier days, wood sheathing was still used instead of copper just under the waterline and a vestige of this can be seen in the *Bellona* model on pp. 114–15.

Coppering

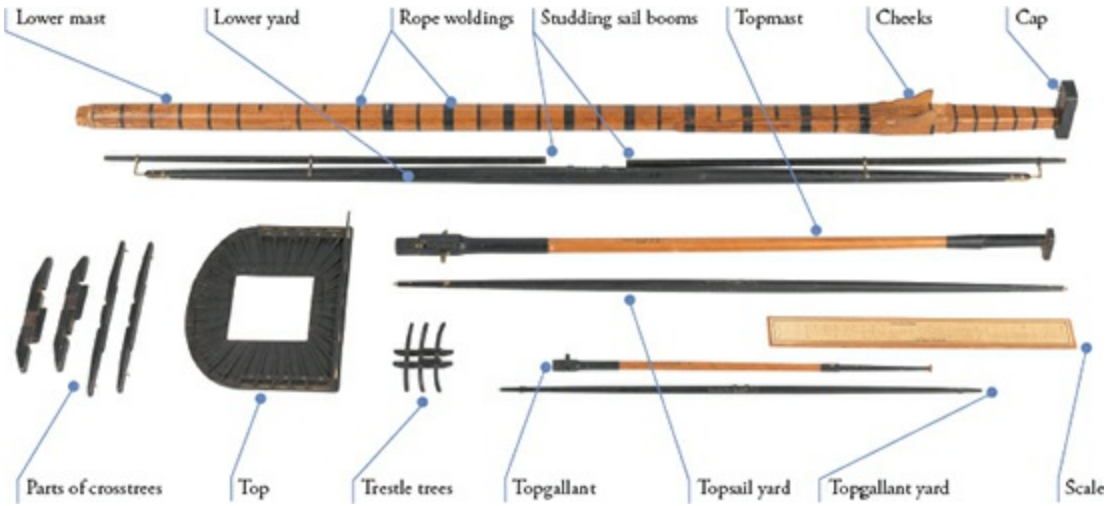
In 1761 the Admiralty decided to try a new remedy by covering the bottom of the frigate *Alarm* in copper. This could solve both the problems: it would seal the shipworm out while creating a slightly poisonous area round it to deter weed growth. There was, however, the fatal problem that the copper set up an electrolytic reaction with the rudder irons and the iron bolts in the lower hull, which would corrode both metals. Nevertheless, experiments continued. The decision to copper the whole fleet was taken in 1778 but it was not without its risks as the problem of electrolysis had not yet been solved. The only answer was to fit tarred paper between the copper and the hull to keep them apart. This kept the fleet going for a few years but it was in a poor state by the time the War of American Independence ended in 1783. It was decided to drive out every iron bolt below the waterline in every ship as it came in for repair and replace it was one made of copper alloy – a process which took about ten years but meant that the fleet was ready for the next war in 1793.

The standard copper plate was 4ft long and 14in wide. From 1779 three

thicknesses were used, weighing 32, 28 or 22 ounces per square foot, with the thickest in the most vulnerable areas such as the bows. Copper was laid in strakes which tended to follow the run of the planking, with the lowest strake out on first and the next one above overlapping its top edge. In the early days one piece was fitted directly above another, but by 1779 they were staggered like brickwork. Early copper sheathing stopped about a foot below the waterline and that area was covered with conventional wood sheathing.

Masts and Yards

Masts and yards were made by shipwrights, often the more mature ones – in 1800 the Deptford officers referred to 'the old men in the masthouse and boathouse'. Imported timber was generally used and according to Thomas Blanckley in 1750, '… the low ones are generally made out of New England growth, and the topmasts and topgallant masts out of those brought from Riga, Gottenburg or Norway'. Upper masts were quite light and could usually be made from a single piece of timber – they were known as pole masts. The lower masts were more complex in shape, with the widest point some distance from the foot, where it penetrated the upper deck. Most of these were 'made masts', constructed from several pieces of timber. Most shipwrights agreed that the made mast was stronger. Falconer's authoritative marine dictionary of 1769 claimed that lower masts were 'generally the most substantial parts of various trees' so a mast formed by this assemblage is justly esteemed much stronger than one consisting of any single trunk'.



LR2755 The various components of a fore or main mast in a model in a 100-gun ship of around 1775, showing how the lower mast is held together with rope woldings. The top is particularly prominent and was used to spread the shrouds as well as a base for men working in the rigging – though it was rarely used as a 'fighting' top as it is sometimes described by later writers.

The Deptford officers, like those of other yards, were forced to defend their practices in 1742 when Captain Lingen complained about the masts of the *Elizabeth* which had been fitted at Chatham. '… Our present practice in making the standing [i.e. lower] masts of his majesty's ships is to allow greater diameter than formerly [we?] would over the fishes to all the classes, and rather add than diminish the fastenings, by which the masts, when made, should be stronger than ever …' They were at one with the other yards in blaming the sea officers for 'want of care in setting up the standing rigging, stays and shrouds of the lower masts'.

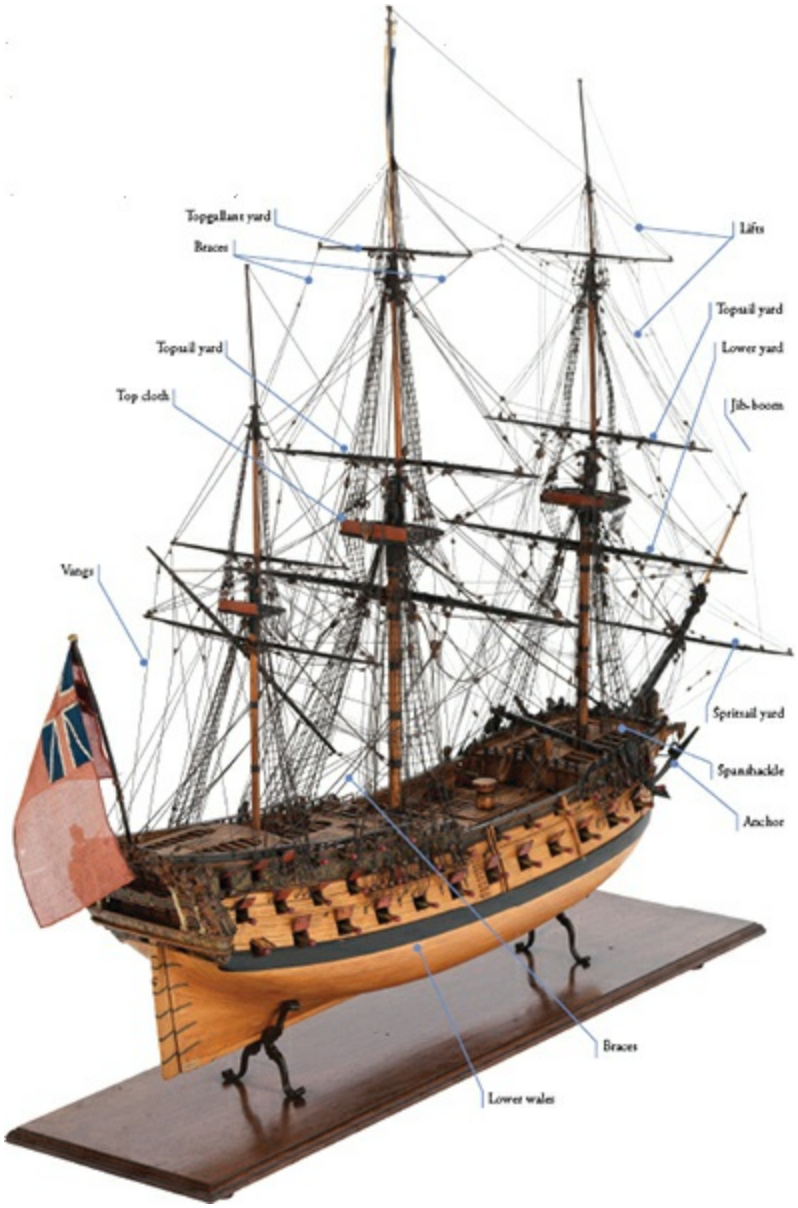
The made mast was centred on the spindle, usually square in cross section and made in two pieces, joined together by rectangles known as cloaks. It was brought to its circular shape by means of fishes which were held in place by rope woldings and later by iron hoops. There were cheeks to support the top above, and the head had a square cross section above the level of the top, where it overlapped with the topmast. By the late 1770s the American Revolution had cut off supplies of New England timber and new methods had to be considered. In 1779 Adam Hayes of Deptford sent the Navy Board two models of made masts, explaining that the first one 'is formed the spindle with two trees and six fishes and the other … the spindle with three trees, a fish on the foreside and one on the aft side with cheeks.' He believed the threetree spindle would be best 'if drove to necessity for want of large masts to form the common way …'. The lower masts of the new 74-gun *Vanguard* consisted as usual of the mainmast, foremast, mizzen and bowsprit. The mainmast was of course the largest and employed a dozen shipwrights for fifty days, along with £6.2.0 of sawyers' work, four caulkers for a day each, four riggers for twelve days and aa small amount of work by coopers. It was valued at £412, compared with £328 for the foremast, £151 for the much smaller mizzen, and £89 for the bowsprit which was apparently a pole mast.

SLR1807 Models of sheer hulks are very rare. This one shows the basic hull sketchily but it seems to be quite accurate in its portrayal of the sheers themselves, the angled spars, and the masts to which they are braced. Shrouds are only fitted on one side and the ship to be masted had to come alongside the other, which was protected with fenders. The height of the sheers could be varied to suit the ship in question.

The Sheer Hulk

If a ship was built in a private yard it was towed to the nearest Royal Dockyard by rowing boats. If built in the dockyard, it was a relatively a simple task to haul it over to the sheer hulk which would fit its lower masts. The sheer hulk was defined by Burney as ‘An old ship of war, cut down to the gun or lower deck, having a mast fixed in midships, and fitted with an apparatus consisting of sheers, tackles, etc, to heave out to in the lower masts of his majesty’s ships …’. This was more convenient than using derricks on shore, for the hulk would rise and fall with the tide alongside the ship being

fitted. Her upper decks had been removed and she was fitted with prominent wooden fenders which did not improve her appearance. The mast was taller than the lower masts in ordinary ships of that size, and the sheer which gave her the name projected at an angle from the vertical.



SLR0434 The rigging of the 70-gun *Ipswich* of 1730, done to a fairly standard pattern. Its complexity is easy to see, with both the fixed and tarred standing rigging and the running rigging which was manipulated to control the yard and sails. Accurate and contemporary rigged models of this period are rare, but that of the *Ipswich* is largely original.

PAH9712 Riggers at work on the foretop and maintop of a ship at Chatham, a detail of a well-known print of the dockyard.

The *Bedford*, an old 70-gun ship used at Deptford from 1766, was moored facing downstream with her stern opposite the entrance to the double dock, for she was often used in hauling ships out. She was manned by a boatswain, carpenter, twenty-eight seaman and seven apprentices, but when heavy work was involved she was sent ‘as many men as the master attendant has occasion for’.

Rigging

In peacetime most ships were ‘laid up in ordinary; off the dockyards, with no guns and only their lower masts – the scheme of task work assumed that they would be completed in that state. The *Victory* lay in the Medway for thirteen years before she put to sea. But Britain was at war for much of the eighteenth and early nineteenth century and ships could be fitted out quickly when needed. Riggers were usually former seamen, including a few who had served as boatswains. In 1788 the Deptford officers recommended a peacetime establishment of twenty-five riggers and twelve labourers. In 1764 they estimated that twenty riggers and ten labourers could rig a 74-gun ship in forty-six days bare time, forty days if allowed one tide of overtime, thirty-six days with two tides and thirtyone on double days. For a 32-gun frigate the

figures were thirty-two, twenty-eight, twenty-five and twentytwo days. But it did not always come to that, as often the riggers worked alongside the ship's crew in fitting out the ship. After that she might be taken to a suitable place away from the dockyard for her guns to be fitted, and then she was ready to face all the hazards of the sea, from natural forces and enemy action.

Appendix

A plan proposed for performing the shipwrights' work in building of the several rates in His Majesty's yards by task and for repair when the same can be reduced to task agreeable to the articles in this plan, viz;

	100 guns	74 guns	44 guns	32 guns	Sloop
Article 1st To trim, scarph, put together the keel, stern, stern frame, deadwood and floor timbers; cross, raise and bolt the same; get up the harpins and ribband at the floor sirmark and fasten and shore the same	£330.14.0	£207.11	£98.4.0	£93.6.0	£39.7.0
2nd To trim and put together the frame bends with dry plank or board (as may be directed) between them, bolt and raise the same, and bolt the respective floors and first futtocks together; cross paul and set the frame to rights; trim and get up all the false harpins and ribbands at the several sirmarks and properly shore the frame.	£595.5.0	£433.18.0	£213.5.0	£172.13.0	£72.16.0
3rd To trim, set up and fasten all the filling timbers, hawsepieces, bollard timbers and side and counter timbers of the stern that make the counter parts and wardroom lights, short timbers over the ports, and those that make the sides of gallery doors, the two counter rails, and entirely to complete the frame	£413.7.0	£269.14.0	£140.6.0	£107.6.0	£45.5.0
4th To dub the frame fair within and without board to its scantling; to chock the frame, let down and bolt the keelson	£314.3.0	£261.11.0	£109.9.0	£93.6.0	£39.7.0
5th To trim, get about and fasten the main wales and thick stuff above and below them	£324.12.0	£223.1.0	£98.17.0	£62.12.0	£24.0.0
6th To complete the planking of the bottom and fasten the same with such fastenings as are requisite	£389.10.0	£256.2.0	£138.8.0	£119.6.0	£50.8.0

	100 guns	74 guns	44 guns	32 guns	Sloop
7th To trim, get about and fasten the orlop clamps; trim and scarph the beams and bolt them, cut to a length, get on board and let them down on the clamps; trim, fay and bolt all the lodging knees and pillar the beams	£136.6.0	£99.2.0	£47.9.0	£23.17.0	
8th To trim, get about and fasten the gundeck clamps and strake on the ends of the orlop beams; trim and scarph the beams and bolt them, cut them to a length, get on board and let them down on the clamps; trim, fay and fasten the hanging and lodging knees and standard knees to the orlop beams, set them fair and pillar them where necessary	£285.12	£210.13.0	£112.14.0	£89.9.0	£36.0.0
9th To trim, get to and fasten the channel wales and shut in between and the upper edge of the black strake	£105.16.0	£78.18.0	£37.15.0		
10th To trim, get about and fasten the middle deck clamps and upper strake of lower deck spirketting; trim and bring to (but not fasten) the lower strake of spirketting; shut in and fasten the stuff between the lower deck spirketting and middle deck clamps; trim and scarph the beams and bolt them; cut to a length, get on board and set them down on the clamps; trim, fay and fasten the hanging and lodging knees	£259.13.0	£33.0.0	£15.16.0	£10.8.0	£4.4.0
11th To trim, get about and fasten the sheer wales (or strake); sheet in between them and the upper edge of the channel wales; bring about the sheer strake in the three deck ships, and all the stuff on the side above the sheer strake and fasten it	£175.5.0	£70.4.0	£33.12.0	£25.7.0	£14.8.0

	100 guns	74 guns	44 guns	32 guns	Sloop
12th To trim, bring to and fasten the upper deck clamps and upper strake of middle deck spirketting in the three deck ships, and upper strake of lower deck spirketting in two deck ships; trim, bring to (but not fasten) the lower strake of spirketting; shut in the stuff between the middle deck spirketting and upper deck clamps in three deck ships, and gundeck spirketting in two deck ships; trim and scarph the beams and bolt them; cut to a length, get on board and let them down on their clamps; trim, fay and fasten the hanging and lodging knees	£259.13.0	£185.17.0	£94.18.0	£74.11.0	£30.0.0
13th To frame the upper deck with carlines and ledges, lay the flat, let down the coamings and head ledges and fasten them; bring about and fasten the spirketting; get up and fasten the main, jeer and topsail sheet bitts; trim and fay the standards; con off and drive all the ring and eye bolts to the ports and on the flat of the deck; and to let out all such scuppers as shall be directed	£259.13.0	£185.17.0	£94.18.0	£89.9.0	£42.0.0
14th To trim, get about and fasten the quarterdeck and forecastle clamps, the string in the waist, shut in between that and the upper edge of the spirkett; trim and scarph (when required), cut of a length, get on board and let down on the clamps, the quarterdeck and forecastle beams; trim, fay and fasten the hanging and lodging knees, lay the flat of the decks, let down the coamings and head ledges; trim and get into their places the fore jeer and topsail sheet bitts; trim and complete the breastworks, gangways and belfry; trim and get about and fasten the quarterdeck and forecastle spirketting and prepare all the fixed blocks that are usually put in the fillings between the timbers and let on the planksheers in the waist and the drifts afore and abaft	£370.0.0	£268.10.0	£128.11.0	£110.7.0	£44.8.0

	100 guns	74 guns	44 guns	32 guns	Sloop
15th To get about the roundhouse clamps, get on board and let down the beams; trim, fay and fasten all the hanging and lodging knees, shut in between the clamp and the quarterdeck spirketting; lay the flat of the deck; get about the spirketting and fasten the same; trim and fasten the knees against the taffrail; trim and let on the timbers [of?] the transom at the height of the sheer and knee it; trim and fasten the bitts, stanchions or knees and rails for the breastwork, and put down the cants for the companion and to complete everything on the roundhouse, and get the planksheers on and fastened	£90.17.0	£55.6.0			
16th To bring on and fasten all the ceiling and thick stuff in the hold below the orlop clamps; get in the platform beams and knee them where directed	£389.10.0	£264.7.00	£124.11.0	£104.8.0	£36.0.0
17th To trim, fay and fasten all the riders, breasthooks, crutches, steps of the masts, knees (or sleepers) to the transoms below the gundeck and the fore and main riding bitts	£162.6.0	£103.5.0	£45.9.0	£19.7.0	£7.16.0
18th To rabbet or cypher (as may be directed) the plank for all the bulkheads in the hold, the after powder room, well and shot lockers, and build the same, put in the palletting beams for the magazine, filling and light rooms, put up the jambs for the powder room lights, and entirely complete eh works in this part for a state of ordinary	£129.10.0	£82.12.0	£39.11.0	£29.16.0	£12.0.0
19th To frame the orlop with ledges and carlines and lay the flat and fore and after platforms, put up the stanchions in the wings and for the store and sail rooms; to berth up and complete for a state of ordinary all the said store and sail rooms, and to complete the well above the orlop. In frigates as there is no orlop, it is for the fore and after platforms	£175.5.0	£128.0.0	£67.4.0	£41.15.0	£12.0.0

	100 guns	74 guns	44 guns	32 guns	Sloop
20th To trim, let aft and fasten the helm port transom; to frame with carlines and ledges the gundeck, lay the flat, let down and fasten the coamings and head ledges; trim and fasten the standards against the stern post and stem, trim, fay and fasten the standards against the stern post and stem, trim, rough fay and shoal all the standards at the side and fasten those against the main bitt, also the cross pieces to the main bitts, let down the carlines for the main and foremast partners, ser up the pillars under the middle deck beams in three deck ships, and under the upper deck beams in two deck ships; set the man and jeer capstans; bore off , draw and belay or clench all the stopper bolts, ring and eye bolts for the guns in the side and flat of the deck; trim, fay and fasten the wing transom knees; let down the cants and make the scuttles for the breadroom and lady's hole and all other scuttles on the flat of the deck, and to let out all such scuppers as shall be directed	£402.10.0	£293.6.0	£138.10.0	£82.0.0	£33.0.0
21st To frame the middle deck with carlines and ledges; let down and fasten the coamings and head ledges; lay the flat, trim; put together and fasten the partners for the masts and bowsprit; trim and fay all the wood standards; put up all the pillars under the upper deck beams; trim, let aft and fasten the stern timbers, the transom at the height of the port cills and knee the same; bore off and drive all the ring and eye bolts for the guns etc in the ship's side and flat of the deck; to lay the cants for the firehearth and all the cants for the cabins on this deck, and to let out all such scuppers as shall be directed	£292.3.0				
22nd To make all the gratings, ladders and staircases in the ship	£64.18.0	£41.6.0	£19.16.0	£14.18.0	£6.0.0

	100 guns	74 guns	44 guns	32 guns	Sloop
23rd To prepare, let into the ship's side and fasten the main, for and spritsail sheets and main tack block; prepare all the rails on the side for the joiners; let over the fife rails afore and abaft and fasten them'; put together and fasten to the ship's side all the channels and backstay stools; trim, fay and fasten the knees to them; prepare the skids, fenders and linings of the anchor and fasten the same if required; get up all the deadeyes; drive all the chain and preventer bolts and complete all the iron work of the channels and make and hang all the port lids and drive all the eye bolts for the standng part of the sheets, and all other bolts necessary on the side	£194.15.0	£136.6.0	£69.4.0	£44.15.0	£18.0.0
24th To make the knee of the head and gripe, bolt the same, prepare the block for the figure of the head, cheeks, rails, timbers, standard, cross pieces, knees, quoif and fasten them; put up the stanchions of the beakhead bulkhead, birth up the same, make the roundhouses of ease in the head and seats of ease; prepare and fasten the false keel rail, lay the flat of the beakhead and complete the whole works in the head	£129.16.0	£86.15.0	£41.10.0	£36.16.0	£13.4.0
25th To put the false keel under the ship and fasten the same; to make the rudder, put on and fasten the pintles and braces; trim and fit the tiller and sweeps; berth up the lower and second counters; make the counter port lids and hang them; to make and fasten the stools for the galleries; prepare all the rails and rims for the galleries and stern banisters etc; berth up the backing of the taffrail; prepare the taffrail and quarter pieces for the carver; build and entirely complete the stern galleries NB; It is intended by the foregoing articles that the ship shall be entirely completed for a state of ordinary	£240.15.0	£145.5.0	£67.18.0	£49.10.0	£19.7.0

Further Reading

Warship History

Gardiner, Robert, *Frigates of the Napoleonic Wars* London 2000)

——, *The Sailing Frigate* (Barnsley 2016)

——, *Warships of the Napoleonic Era* (Barnsley 2011)

Lavery, Brian, *The Ship of the Line*, Vol 2 (London 1984).

Lyon, David, *The Sailing Navy List* (London 1993).

Winfield, Rif, *British Warships in the Age of Sail, 1714–1992* (Barnsley 2007).

Contemporary Works oN Naval Architecture, Shipbuilding

Anon, *The Secret History of his Majesty's Shipyard at Deptford* (London 1717).

Anon, *The Shipwright's Vade Mecum*, 2nd Edition (London 1822).

Blanckley, Thomas Riley, *A Naval Expositor* (London 1750, reprinted Rotherfield 1988).

Burney, William, *A New Universal Dictionary of the Marine* (London 1815, reprinted New York 1970).

Falconer, William, *Marine Dictionary* (1769, reprinted Newton Abbott, 1970).

Fincham, John, *An Introductory Outline of the Practice of Shipbuilding* (Portsea 1821).

Lott, Yeoman, *An Account of the Proposals Made for the* Benefit of His Majesty's Naval Service (London 1777).

Ollivier, Blaise (ed. David Roberts), *18th Century Shipbuilding, Remarks on the Navies of the English and Dutch* (Rotherfield 1992).

Rees, Abraham, *Naval Architecture* (extracts from the *Cyclopaedia* of 1819–20) (reprinted Newton Abbot 1970).

Sutherland, William, *The Ship-Builder's Assistant* (London 1711).

_____, *Britain's Glory, or Ship-building Unvail'd* (London 1722).

Official documents

House of Commons, *Third Report of the Commissioners of Naval Enquiry* (1806).

Knight, R J B (ed.), *Shipbuilding Timber for the British Navy;*

Parliamentary Reports, 1729–1792 (1993). Reports from Committees of the House of Commons, Vol 62, *East India Affairs, Shipping and Trade,* 1813–17.

Biographies and memoirs

Harris, Daniel G, *F H Chapman, The First Naval Architect and his Work* (London 1989).
Lacy, Mary, *The Female Shipwright* (reprinted Greenwich 2008).

Modern Works on Naval Architecture, Shipbuilding

Goodwin, Peter, *The Construction and Fitting of the Sailing Man of War, 1650–1850* (London 1987).
Lavery, Brian. *The Arming and Fitting of English Ships of War, 1600–1815* (London 1987).
Lees, James, *The Masting and Rigging of English Ships of War* (London 1979).

Collections of Documents

Baugh, Daniel (ed.), *Naval Administration 1715–1750* (Navy Records Society Vol 120, 1977).
Knight, R J B (ed.), *Portsmouth Dockyard Papers, 1774–1783* (Portsmouth Records Series 1987).

Models

Franklin, John, *Navy Board Ship Models, 1650–1750* (London 1989).
Lavery, Brian, and Simon Stephens, *Ship Models, Their Purpose and Development from 1650 to the Present* (London 1995).
Waite, Arthur, *The National Maritime Museum, Catalogue of Ship Models*, Part 1, *Ships of the Western Tradition to 1815* (Greenwich c. 1980).

Manuscripts

National Archives

The Deptford Dockyard Letter Books, ADM 106/3289-3474, contain many deeply-hidden gems. Volumes used include 3072, 3300, 3307, 3308, 3313, 3314, 3330, 3332, 3390, 3469.
ADM 106/2507-8, Standing Orders to the Yards, 1658–1782.
ADM 106/3551, Navy Board precedents, 1695–1773.

National Maritime Museum

Portsmouth Progress of Works, POR/J/1, 2.
Navy Board to Admiralty, ADM/B series, is well indexed.
Visitation of the Royal Dockyards, SAN/V/1-11.
Timber Expense book of Charles Scammel, 1780–1801, LAD/25.