Ships and Shipbuilding

Recent Advances in Ship History and Archaeology, 1450–1650: Hull Design, Regional Typologies and Wood Studies

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Résumé

Des recherches récentes s'appuyant sur des écrits et des épaves modifient nos connaissances sur trois questions relatives à la construction navale de la Renaissance : la conception des carènes, les typologies d'épaves et le bois en tant que matériau archéologique. À propos de la conception des carènes, deux synthèses divergentes, puisant à des sources atlantiques et méditerranéennes, ont été publiées. En matière de typologies, les archéologues distinguent désormais des signatures régionales pour lesquelles ils avancent des explications historiques. Quant au bois comme matériau archéologique, la dendrochronologie en révèle aujourd'hui la provenance géographique. D'autres recherches indiquent que de jeunes arbres destinés à la production de membrures ont été forcés en cours de croissance d'adopter une morphologie spécifique, ce qui réduit les nouveaux modèles de carènes à des styles régionaux.

Abstract

Combining the study of texts and shipwrecks, new research is changing our knowledge of Renaissance shipbuilding on three subjects: hull design, shipwreck typologies and wood as an archaeological material. On hull design, diverging syntheses have been published using Atlantic and Mediterranean sources. On shipwreck typologies, archaeologists now recognize regional forms for which historical explanations are advanced. On wood as an archaeological material, methods of tree-ring dating now also reveal the geographic origin of timbers. Other research indicates that frame timbers were “trained” as samplings to attain a specific shape, thus limiting new hull designs to regional styles.

In the last two decades, the study of ships and shipbuilding before Jean-Baptiste Colbert, Anthony Deane, Antonio de Gastañeta and Nicolaes Witsen has grown exponentially and is transforming our knowledge of a period that was formerly understood only in the most general terms. In this paper, we are interested in the research gains, approaches and current issues that have seen significant progress in the last few years. We shall concentrate on three research issues. The first concerns hull design, which combines manuscript and archaeological sources and has resulted in a new interpretation of Renaissance shipbuilding. The second issue concerns the typology of shipwrecks, which has identified regional characteristics of ships from the period circa 1450 to 1650. The third issue concerns the study of wood as an archaeological material, and describes what inferences researchers are drawing from this approach. In conclusion, we shall evaluate the contribution of these issues to a larger picture of maritime history.

Hull Design and Construction

The study of ship history has always been interdisciplinary. The strategy of combining manuscript and archaeological evidence is especially apparent in the gains that have been made in understanding the obscure shipbuilding treatises of the Renaissance and in applying this new knowledge to the study of archaeological ship remains. The treatises form a relatively small corpus of texts dating to about 1410 to 1620, and may be divided by date and...
provenance into three groups. The oldest group derives from Venice and consists of four rather elliptical texts dating to circa 1410 to 1594. Subsequently, two contemporaneous groups of texts appeared in Iberia and England in the period from circa 1570 to circa 1620. The Iberian group consists principally of four Portuguese and six Spanish texts, while the English group also contains six principal manuscripts. There is also a later group of ten related texts in French and Spanish, from 1680 to 1783, that are more accessible in style and have been used to shed light on the earlier texts.

The essential information contained in these texts, whatever their origin, is similar and seems to suggest a common origin. Three major steps made up the ship carpenter's process of designing a hull. First, he worked out the four basic dimensions of the hull: its breadth, its keel, its length from stem to sternpost and its depth of hold. These dimensions mirrored those used by ship surveyors to gauge a ship's tonnage and, in practice, allowed a carpenter to convert to a merchant's desire to build a ship able to carry a certain tonnage of goods into real measures.

Second, within the parameters of the breadth and the depth of hold at midship, the carpenter worked out the shape of the master frame, using as his fundamental elements a series of five tangent lines and arcs: the floor line, the bilge arc, the futtock arc, the arc at the greatest breadth and the tumblehome line. He then devised a master mould from this shape, and marked off the points on the mould at which his lines and arcs touched.

Third, using the master mould, he worked out the shape of frames fore and aft of the master frame by means of three systematic adjustments to the master mould, namely: the rising of the floor, the narrowing of the floor and — here the English and Ibero-Mediterranean texts differ in the details — adjusting the aspect of the frame from the bilge upwards. While the English method achieves the modification of the three tangent arcs by adjusting the length of adjacent cords, known as "hauling down" and "hauling up" the arcs, the Ibero-Mediterranean method was based on tilting the frame outward from a pivot point at the bilge, a method called legno in ramo in the Venetian manuscripts. The English and Ibero-Mediterranean variants appear, however, to converge over time. The English shipwright Matthew Baker mentioned "linoramo" as a novelty in England about 1580 while the Ibero-Mediterranean texts used a limited version of "hauling down" the bilge arc in order to fair out the kink left at the bilge by the outward tilting of the futtock mould. In the later French manuscripts, the two methods appear to have fused into one.

The appearance of the English and Iberian manuscripts in such a short period of time raises questions about their role within the shipbuilding establishments. All of the texts were generated by individuals close to the royal courts of their countries, in an era of increasing state interest in shipbuilding and navigation. After an initial surge of interest in shipbuilding at the turn of the sixteenth century in all the Atlantic states, including France, a second wave of royal involvement gathered momentum during the third quarter of the century in Portugal, Spain and England. One effect of the appearance in the sixteenth century of perma-

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Material History Review 48 (Fall 1998) / Revue d'histoire de la culture matérielle 48 (automne 1998)
nent shipyards, both private and state, with large work forces and stockpiles of material, was to separate the tasks of designing and building ships. Schooled sons of privileged families took over the role of design from the artisanal carpenters who had risen in their trade by following a traditional professional development from apprentice to journeyman to master. The cleavage generated legal resistance by carpenters and polemic affirmations by designers.11

Some of the self-styled “architects” who left works on ship design were the sons of prominent carpenters, such as Matthew Baker and the Coulombe family of Toulon, while many such as João Baptista Lavanha, Fernando Oliveira, Diego García de Palacio and John Wells were attracted to the mysteries of hull design only after shipbuilding became an avenue of professional advancement in the state hierarchy. These authors embedded their work in the trappings of classical architecture including references to Greek and Latin writers, discussions on the relation between hull design and the laws of nature as observed in the shape of fishes, and symbolic imagery such as the architect’s compass displayed in their right hand and the architect’s square and the illustrated pages of a learned treatise exposed on a desk.12 In a similar Renaissance spirit, Baker began his Fragmentos with a voyage to Greece and Venice while Oliveira ennobled his Livro by referring to current Italian writers. Snatched from its medieval guild context of visual and oral knowledge, hull design became a modern paper subject, reproduced in text and two-dimensional representations. Without doubt, the birth of “naval architecture” once attributed to the great builders of the seventeenth century — the aforementioned Colbert, Deane, Gañámeto and Witsen — can now be placed in the context of the Renaissance shipbuilding treatises.

More troubling are questions relating to the apparently common origin of the information contained in the treatises, and it is here that archaeology has contributed to the debate by demonstrating the prior existence in shipyards of these concepts. Underwater archaeologists, once confined to raising manageable artifacts and drawing a plan of in situ architectural remains, now regularly disassemble shipwrecks for surface recording. The design of the frame timbers can thus be learnt and compared to information gleaned from the Renaissance treatises. The best known application of this method was at Red Bay, Labrador, where a Biscayan whaling ship that sank in circa 1565 was reconstructed at a 1:10 scale and studied in detail.13 Other wrecks at Red Bay, Cala Culip (Catalonia), Bermuda, Cavalaire-sur-Mer (Provence) and Matagorda Bay (Texas), have also been dismantled with a view to contributing archaeological evidence to the debate on the origins of Renaissance ship design. Built by anonymous hands as much as a century before the earliest treatise, these naval structures confirm the widespread use of all the design concepts recorded by the first ship “architects.”

While the prior existence of these design methods can not be doubted, the problem of their origin remains. Some see a sole Mediterranean source that spread into the Atlantic in the fifteenth century with the advent of carvel planking, while others see the design variants contained in the English texts as a vestige of an Atlantic or Nordic tradition that was in place well before the arrival of carvel planking.

**Shipwreck Typologies**

The question of origins in ship history has led archaeologists to develop tools that are geared to place anonymous shipwrecks in a specific cultural and geographic context. In the 1980s, archaeologists working simultaneously on several sixteenth-century wrecks, all with a presumed “Iberian” origin, began noticing a series of structural features that were common to all, thus giving rise to a preliminary “Ibero-Atlantic” shipwreck typology.14 This recognition

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The typology of Ibero-Biscayan shipwrecks has since been refined by explaining several of the characteristics through historical research and associating several of them with the more precise geographical basin of Biscay, one of the early cradles of Atlantic shipbuilding. Other researchers have used the typology to define a series of contrasting features that appear on Mediterranean sites.

The most important characteristic of Ibero-Biscayan shipwrecks is the abundance of oak, used for the frames, the planking of the hull, ceiling and decks, the treenails and for all major timbers such as the keel, the stem, the stern post, the knees, the keelson, the rudder and even sometimes for the masts. On the Basque coast, laws governing oak plantations specialized in the production of naval timber date to the Middle Ages, and sixteenth-century state programs encouraged the planting and cultivation of oaks in Biscay as a part of Spanish naval policy.

The second characteristic is the use of both oaken and iron hull fasteners. The treenails are about 25 mm in diameter and the iron nails are about 10 to 12 mm square in section. At each joint of a frame timber and a plank, two iron nails and two treenails are typically found. The use of both iron and wooden nails distinguishes Biscayan shipwrecks from more northerly wrecks, such as the Mary Rose, which have only treenails and from more southerly wrecks, especially from the Mediterranean, which have only iron nails. J. B. Lavanha stated, around 1610 to 1620, that treenails were used in countries whose ships sailed in cold waters, while iron nails were favoured in countries whose ships sailed in warm seas, where wooden nails were quickly tunnelled by the taredo worm and thus, each treenail became a leak. In Biscay, a land of oak plantations and iron working, both materials were readily available as fasteners and their combination helped speed up construction. Analysis of the Red Bay ship has shown that the iron nails were used first to quickly assemble the planks and frames, and later, the treenails were installed to solidify the hull. The head of each fastener is typically surrounded by a countersink made with a small adze, which served to start the drill and keep it from slipping or splitting the wood. Later, when a waterproofing agent based on pitch and whale oil was applied to the hull, the cavity around the head collected the agent and protected the fasteners from sea salt and the taredo.

The typology of Ibero-Biscayan wrecks puts a great emphasis on timber measures, or scantlings. The floor timbers are typically 19 to 20 cm square in section, while the futtocks decrease in section from 19 to 20 cm square at the floor to about 14 cm square at the upper deck. There is little difference between the scantlings of large and small ships, suggesting that the timber supply was relatively uniform. The width of the hull planks falls in a range of 33 to 38 cm. Their thickness is about 5.5 to 6 cm below the water line, and about 4.5 cm in the upper hull. The deck and castle-wall planks measure 17 to 19 cm in width and from 3 to 3.5 cm in thickness. The maximum length of all the plank types is in the range of 10 to 11 metres, which seems to represent the original length of the planking stock that arrived at the shipyard.

These frame and plank dimensions correspond to the metrology used historically to measure timber in the forestry trades of coastal Biscay. Surveyors gauged timber after sawing, in order to calculate the sawyers' pay, in three different ways depending on the type of timber, all of which are reflected in sixteenth-century shipwrecks. First, the codo de maderamiento, or the cubit of framing-timber, equalled 8 pulgadas (19.1 cm) square by 1 codo (57.5 cm) in length. Second, the codo de tabla, or cubit of planking, measured 16 pulgadas (38.3 cm) wide, 1 codo long and 7/8 of a codo in thickness. Third, the castle planks, ledges and other smaller pieces were gauged according to the formula dos por uno, or two for one, because they were only half as great as the major pieces (9.5 cm for the timbers, 19 cm for the planks).

Material History Review 48 (Fall 1998) / Revue d'histoire de la culture matérielle 48 (automne 1998)
Fig. 4
The characteristic Atlantic keelson, showing the “swollen” central area with its mast step cavity, the buttresses on either side and the semi-circular pump well. Beyond the keelson are the runs of ceiling planks, the last of which is the elaborately-carved albaola with its crene­lated appearance and small inserted planks to deflect moisture and refuse onto the ceiling.

and thus required twice the amount of sawing. In the shipwrecks, the surfaces of the planks are adzed to a smooth finish after the sawing, which had the effect of reducing their thickness and breadth to something less than the standard dimensions.

Another characteristic of sixteenth-century wrecks is called the “lateral assembly” of selected frames. The floor timbers and first futtocks of a limited series of frames including the master frame are joined by a dovetail mortice-and-tenon joint. In the case of the Red Bay ship, this assembly occurs on 14 frames, 6 forward and 7 aft of the master. Generally, the number of assembled frames is greater aft than forward of the master. The dovetail morphology of the mortice is the only shape found so far on Basque ships from this period, however it also occurs in some Mediterranean shipwrecks. Archaeologists distinguish the Biscayan assemblage by the presence of both iron nails and treenails securing the joint, while in the Mediterranean, only iron nails have been found. It has been hypothesized that this central group of mortised frames corresponds to the “calculated frames” (maderas de cuenta) described in the shipbuilding treatises of the period. Fore and aft of the mortised frames are non-assembled frames in which the various timbers are not directly linked. The floor timbers, first futtocks, second futtocks, etc., are independent and fastened only to the hull planks and the internal longitudinal structures such as the ceiling planks, deck clamps and waterway wales. Archaeologists refer to this feature as the “floating futtocks.”

A few other typical features have been catalogued, but still lack an historical explanation. For example, the keelson is a massive timber that is swollen in the middle in the area of the main mast step and buttressed on each side against the bilge clamps. As well, just aft of the mast step, on one or both sides of the keelson, a semi-circular cavity is notched into the timber where the pump was seated. Several pumps have been recovered and they too have a typical style. Another diagnostic feature is the morphology of the outermost ceiling plank, known in Spanish records by its Basque name of albaola, which was elaborately carved and complemented with insets to ensure a watertight joint between the hull, the futtocks and the ceiling.

The typology has known several avatars since it was first described by the American archaeologist as “Ibero-Atlantic.” French archaeologists have concentrated on its “Atlantic” character, and have used it as a basis for developing a contrasting “Mediterranean” typology. Canadian archaeologists have refined the “Basque” association of these archaeological features based on their research at Red Bay. In truth, little data from other Atlantic regions, in Iberia or elsewhere, has been systematically compared to the corpus of wrecks that makes up the typology. Some English sites excavated before the 1980s, for example, are believed to contain some comparable features, while recent Portuguese findings are bound to generate valuable comparative data. Eventually the parameters of the typology can be better understood.

Wood as an Archaeological Material
The archaeological interest in materials, such as ceramics, metals or glass that are commonly well preserved in various sub-soil contexts, has spurred ship archaeologists to approach their subject from the point of view of wood as a material. Our interest here is to provide a resume of two approaches that are based on the anatomical study of the wood itself. The first approach, called dendrochronology, is able in certain circumstances to date the year of the tree’s felling and to narrow down the geographical area of its growth, sometimes to within a single watershed. The second approach compares several indices to discover the forestry practices related to the production of naval timber.

The current wave of interest in dating archaeological objects by dendrochronology dates to the 1970s. Anomalies in radio-carbon dating results had been detected by American
researchers on the basis of comparison with wood from extremely old bristlecone pines, whose age could be precisely known by counting the annual growth rings. Tree-ring researchers in Northern Ireland and in Germany reacted to the announcement of the unexplained anomalies by proposing to duplicate the study using European oak samples. Instead of vainly searching for trees of great age, they developed methods of transferring their ring count from one tree to another, and thus progress backwards over time. Called "interdating," these methods were quickly recognized by archaeologists as having immense potential for dating wooden findings. As suspected, it was soon confirmed that "interdating" worked only between trees that had grown within a limited geographic area ranging, according to regional climatic gradients, from less than twenty to a couple of hundred kilometres in radius. This constraint has been seized by ship archaeologists as a method of ascertaining the provenance of wrecks discovered far from their point of construction.26

Several case studies illustrate the impact of dendrochronology on ship archaeology, which has often forced researchers to take surprising new data into account. In the mid-1980s, the tree-ring patterns from the Dutch ship *Amsterdam*, a well-documented wreck of 1748, were analysed in order to discover the origin of the timbers. Initial comparisons were fruitless, but as more local chronologies were published, the origin of the timbers could eventually be situated in the lower German Rhine.27

In another research question, it was hoped that the felling date of the timber from the Red Bay wreck could help narrow down the identity of the vessel. It was thought to be the *San Juan* that sank at this place in 1565 until it was discovered that a second Basque whaler of similar size and description, the *Magdalenine*, was lost in the same harbour in 1574, although in different circumstances.28 A tree-ring chronology built from the hull planking was compared to Basque chronologies constructed from the wood of sixteenth-century buildings, but no relation was found. Related research helped understand the reasons for this initial failure. On the one hand, the steep climatic gradients on the Biscayan coast prevented "cross-dating" from one narrow valley to the next.29 On the other, ship's timbers were typically cut in the same valley where the construction took place, and within a radius of about ten kilometres from the rivermouth. Usually, two or three private forests measuring a few hundred yards across supplied all the frame timbers and planking for one ship.30 This information has obliged tree-ring studies on the Basque coast to become more precise and more patient, but the knowledge gained meanwhile of the repercussions of sixteenth-century naval forestry practices upon dendrochronology has been immense.

In a third case, a precise datation was possible. The Cavalaire-sur-Mer (Provence) wreck had been dated initially to the later fifteenth century by associated ceramic and cannon finds, and typological analysis situated the construction of the wreck on the Atlantic coast, probably in Biscay. However, the growth patterns of its oaken timbers and hull planks did not match any available tree-ring series from the Mediterranean or the Atlantic. Only a short ceiling plank, a recent repair made of fir that included the bark, matched several series from Savoy and its ultimate ring could be dated to 1470, making this anonymous ship the earliest Atlantic wreck to be found in Mediterranean waters.31

Finally, tree-rings studies on the timbers of the *Mary Rose*, another well-documented wreck, have been used to establish which timbers dated from the original construction in 1509-1511 and which ones were added in a major refit in 1536.32 Sophisticated research strategies such as these are bringing ship archaeology increasingly closer to the scientific standards of land archaeology.

Another approach to wood as a material has yielded initial results that place hull design and forestry in intimate proximity. The approach is based on comparing three kinds of data. First, the age of the frame timbers is calculated by counting the growth rings. Then, the researcher evaluates the correspondence between the tree's grown shape (curvature and diameter) and the finished shape and dimensions of the frame. Finally, the shape of the frame timbers as a group is analysed, to discern the use of common arcs and a systematic progression of shapes, in order to ascertain the use of a mould in shaping them. These data can reveal relationships between forestry practices such as planting and pruning, and the ship carpentry practices of designing and moulding frames.

The approach grew out the Red Bay project led by Parks Canada, and its conception may be worth recounting. During the excavation, preliminary tree-age information for the frames was gathered as a means of choosing timbers for dendrochronological study, which resulted in
the systematic rejection of futtock timbers because their typical age, about thirty-five to forty years, was well below the target age for the study. Attention was diverted to the planks, whose greater age made them suitable for sampling, and the tree-age information on the futtocks languished. However, when later research revealed the highly localised provenance of Basque framing timbers, the information acquired a new significance, as the uniformity of the tree-ages suggested that the frame-timber trees had been planted and harvested as a single crop. Subsequently, it was remarked that the futtock timbers, whose shape varied considerably according to their location in the hull, nonetheless exhibited a high degree of correlation between the morphologies of the tree and the finished frame, that is, the curvature and the diameter of the tree closely matched the final shape and dimensions of the futtock. Moreover, the arches found in the frame timbers do not naturally occur in the trunks of oaks. A hypothesis was thus developed concerning the training of a crop of trees to their required curvature; however, because the timbers had meanwhile been reburied at Red Bay, comprehensive tree-age data could not be obtained to validate the hypothesis.

Instead, the hypothesis was tested on the futtocks of the Cavalaire-sur-Mer wreck, built a century before the Red Bay ship and apparently also on the Basque coast. The test results were unequivocal. First, tree-ring counts, whose overall precision was estimated at ±5 years because of the occasionally-degraded condition of the timbers' ends, revealed that a large proportion of tree-ages at the time of felling clustered in the range of 65 to 70 (±5) years, and nearly all in the range of 60 to 75 (±5) years. Second, the correspondence between the tree-trunk and finished-frame morphologies was extremely close, as one tree produced only one frame and the final sapwood was regularly visible as "waniness" along the corners of the frame timber. Third, analysis of the futtock shapes revealed that the timbers had been sculpted on the basis of a single model, indicating the presence of a formal moulding process. Thus the practice of training a crop of trees to a shape established by ship designers and harvesting them at a uniform age, hypothesized from the Red Bay data, seems to be corroborated already for the period 1400 to 1470.

Conclusion

A correlation between timber growing practices and hull design has far-reaching implications for the study of shipbuilding. First of all, it opens a whole new range of historical sources, namely forestry records, to the historian interested in ship design. However it also sheds new light on the degree of creativity that was open to ship carpenters who had to work with timber that was grown to a specific shape and harvested as soon as it reached the required dimensions. Local hull design was locked into a conventional form, determined by foresters thirty-five to seventy years earlier, thus ensuring the longevity of regional ship-types. A carpenter was obliged to design all his ships, irrespective of their size, for an invariable timber supply; possibly, a single set of moulds could be adapted for ships of various sizes.

These possibilities are evoked here in part to suggest ways in which we may need to rethink the history of shipbuilding, but also to illustrate the efficient, yet rigid technological context in which Renaissance hull design operated. Instead of innovating, carpenters perfected. This stable context provided ample time for the woodworking trademarks that make up our regional shipwreck typologies to become ingrained. When change came, it was all-pervasive. As the case of Biscay reveals, the accelerated construction and the larger hulls in the second half of the sixteenth century put strains on local timber resources but, in so doing, they also pushed traditional hull design beyond its intended limits. The eclipse of the master carpenter as the author of his design and the rise of the "naval architect" are played out against this background of historic change.
Glossary

Arc. A segment of a circle.

Basque Country. The modern name for Biscay, translated from the Basque language.

Beam. One of several heavy transversal timbers that form the principal support for each deck, resting at each end on a lengthwise timber called a clamp or "shelf."

Bilge arc. The arc described by the master frame at the bilge, that is, where the master frame turns upward and the floor timber and first futtock overlap.

Biscay. The historic name for a region on the Atlantic coast of Europe, straddling the border of France and Spain, with a strong maritime industry dating to the later Middle Ages, and homeland of the Basque people. For Renaissance mariners, the principal ports of Biscay lay from Bilbao to Bayonne. See Basque Country.

Breadth. The breadth of the hull at its widest point, at midship near the water line.

Carvel. An adjective used to describe hull planks laid edge-to-edge, as opposed to having the plank edges overlap which is called lapstrake or clinker planking.

Castle. The raised structures at the forward and aft ends of the ship, commonly used as shelter.

Ceiling. The ship's interior, lengthwise planking, often limited to the lower part of the hull.

Clamp. An interior lengthwise timber upon which all the other timbers are built.

Cord. The straight line between the two end-points of an arc.

Deck. Each of the ship's interior "floors," called "lower" (sometimes "orlop"), "main" and "upper" (sometimes "weather") in a three-decked ship.

Depth of hold. The height inside the hull from the ceiling to the main deck.

Floor line. The straight line, horizontal in many sixteenth-century representations, described by the master frame from the keel to the bilge.

Floor timber. A lowest component timber of each frame, resting immediately upon the keel.

Frames. Often compared to "ribs," these are the heavy, curved timbers that lie across the keel and arch upwards to the top of the hull, and to which the hull planks are fastened. One frame is composed of several timbers named, from bottom to top, floor timber, first futtock, second futtock, third futtock...and top timber.

Futtock. One of several rising component timbers of each frame, extending above the floor timber on each side of the hull. From bottom to top, the futtocks are called "first," "second" and "third" futtocks.

Futtock arc. The arc described by the master frame where it flares outward from the bilge to just below the water line, in the area where the first futtock is situated.

Hull fasteners. The treenails, iron nails and iron bolts which fasten the hull planks and internal structures to the frames.

Keel. The lowest timber of the ship, oriented lengthwise, upon which all the other timbers are built.

Keelson. A heavy, lengthwise timber placed over the floor timbers, parallel to the keel.

Knee. A heavy, angled timber made from the joint of a trunk and a branch, used to reinforce the joint of a horizontal deck beam and a near-vertical frame. Knees are also used in a horizontal position to reinforce the joint of two of the ship's walls, at the stern or the bow.

Lapstrake. An adjective used to describe hull planks whose edges overlap. Also called clinker as opposed to carvel planking.

Ledge. One of several light transversal timbers, laid between the heavier beams, that support the deck planking.

Master frame. The frame at midship, from which the hull narrows fore and aft. The shape of this frame corresponds to that of the master mould.

Master mould. The template, often in several pieces, used by the carpenters to give the correct shape to the hull timbers. The master mould has the same shape as the master frame. The component pieces of the master mould are systematically modified to produce the shape of the frames fore and aft of the master frame.

Midship. The section of the hull at its widest point, usually at the master frame.

Narrowing of the floor. The reduction in the breadth of the floor timbers from the master frame fore and aft. See rising of the floor.

Rising of the floor. The rising of each end of the floor timbers from the master frame fore and aft, as these timbers progress from a relatively "flat" shape at the master frame to a V-shape at the quarters of the hull and to a Y-shape at the stern and stem. See narrowing of the floor.
Rudder. A long, flat piece attached to the sternpost with hinges, allowing it to be angled left or right in order to steer the ship.

Scantlings. The dimensions of timbers used in shipbuilding.

Stem. The upward-curving timber or timbers attached to the forward end of the keel, forming the leading edge of the ship as it passes through the water. See sternpost.

Sternpost. The upward-oriented timber attached to the aft end of the keel, forming the aft extremity of the hull. The rudder is attached to the sternpost. See stem.

Treenail. A wooden dowel used to fasten planks to frames.

Tumblehome. The line described by the master frame where it angles inward above the water line.

Wale. A hull or ceiling plank of a thicker-than-normal dimension, used to reinforce the hull at certain levels.

Notes


The outward tilt is called espalhamento in Portuguese, desfaldar in Spanish and recoulement in French.

The smoothing-out of the kink is called cancomo in Portuguese, desfaldar in Spanish and recoulement in French.


7. The ten texts in the later group are: (i) P. Arnoul, "Remarques faites par le Sieur Arnon sur la marine de Hollande et d'Angleterre ...," 1670 (Paris, Bibliothèque Nationale, Ms Cinq Cent Colbert 201); (ii) A. de Gazzaneta Yturribalzaga, "Arte de fabricar reales," 1687-1691 (Mutriku, Archives of the Casa de Arriortuak), reproduced and commented by C. Apestegui Cardenal in F. Fernandez Gonzalez, et al, eds. (Barcelona: Lunweg, 1992); (iii) "Traité de la construction de galères," ca 1691 (Vincennes, Service historique de la Marine, Ms SH134), transcribed and commented in J. Fennis, ed., Manuel de construction des galères, 1691 (Amsterdam, 1983); (iv) Barras de la Penne, "La Science des galères," 1697 (Paris, Musée de la Marine, Ms B1125); (v) La Madeleine, "Tablettes de Marine," ca 1712 (Paris, Musée de la Marine, Ms R711); (vi) B. Ollivier, "Traité de construction ..., " 1736 (Vincennes, Service historique de la Marine, Ms SH310; repr. Nice, 1992); (vii) P. Bouger, Traité du navire, de sa construction, et de ses mouvements (Paris, 1746); (viii) H.-L. Duhamel du Monceau, Éléments de l'architecture navale (Paris, 1752); (ix) Duranti de Lironcourt, Instruction élémentaire et raisonnée sur la construction pratique des vaisseaux en forme de dictionnaire (Paris, 1771; repr. Nice, 1868); and (x) G. Juan, Examen maritime théorique et pratique ... (tr. from Spanish with additions by M. Levêque, Nantes, 1783). For an overview see E. Kieh, Le maître-gabarit, la tablette et le trébuchet (Paris, 1996).

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18. J. B. Lavanha, “Primeiro livro da arquitectura naval” (ca 1620), op. cit.


20. P. B. Villareal de Berriz, Maquinas hidraulicas de molinos y govierna de los arboles y montes de Vizcaya (Madrid: Antonio Marin, 1736); A. de Gastañeta Yturribalza (c. 1686), op. cit.

21. The ca 1535 Studland Bay (Poole, Dorset) wreck exhibits a simple lap scarf.


25. L. Mott, “Identification of the Words ‘Singla’ and ‘Albaola’ and Their Relation to Timbers Found on Fifteenth-Century Spanish Shipwrecks,” IJNA 22, no. 3 (1993). The Basque word albaola was constructed from albo meaning “edge” (albo- when followed by a vowel) and ola meaning “plank.” Thanks to M. Egaña Goya for this explanation.


29. F. Guibal, Analyse dendrochronologique des épaves de Red Bay (Labrador), contrat : 1632/90-173 (Mar­seille: Laboratoire de botanique historique et palynologie URA 1152 CNRS, novembre 1995). This analysis succeeded in dating several cask staves from the wreck site to the period 1529–1563 by referring to a Breton chronology.


31. B. Loewen and M. Delhaye, op. cit; analysis carried out by F. Guibal, Marseille.


33. This research was conducted under the direction of M. Delhaye. Cf. B. Loewen and M. Delhaye, op. cit. (1997).


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*Material History Review 48 (Fall 1998) / Revue d’histoire de la culture matérielle 48 (automne 1998)*
La Base de données d’information sur les navires contient des renseignements sur

Navires
Capitaines
Propriétaires
Constructeurs navals
Voyages

La base de données contient des renseignements sur les navires qui ont navigué dans les eaux canadiennes. Bureau fédéral d’archéologie, Lieux historiques nationaux, Parcs Canada.

Photo courtesy: Yarmouth County Museum & Archives

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contains information on

Vessels
Masters
Owners
Builders
Voyages

The database contains information about ships that sailed in Canadian waters. Federal Archaeology Office, National Historic Sites, Parks Canada.

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