MODELING *LA BELLE*:

A RECONSTRUCTION OF A

SEVENTEENTH-CENTURY LIGHT FRIGATE

A Thesis

by

GLENN P. GRIECO

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF ARTS

May 2003

Major Subject: Anthropology

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Approved as to style and content by:

Donny L. Hamilton
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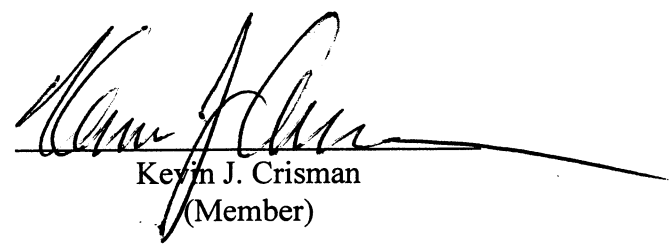

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May 2003

Major Subject: Anthropology

ABSTRACT

Modeling *La Belle*: A Reconstruction

of a Seventeenth-Century Light Frigate. (May 2003)

Glenn P. Grieco, B.S., Texas A&M University

Chair of Advisory Committee: Dr. Donny L. Hamilton

This thesis describes the construction of two models of *La Belle*, a light frigate constructed in France during the late seventeenth century. The archaeological remains of *La Belle* are important as a unique example of a little understood vessel type and as an informative example of several construction techniques that were in use in the French shipyards at the end of the seventeenth century.

Using data recorded during the excavation and conservation of the original ship's timbers, historical documents, and contemporary drawings and models as guides, various configurations of *La Belle's* structure were created to determine her probable appearance. Whenever possible, the original materials and construction techniques were closely approximated to determine their effect on the overall appearance of the ship. Many of the artifacts excavated from the original vessel were reproduced in scale and incorporated into the model to determine their influence on the layout of the ship's structure.

The resulting model provides not only a picture of a specific ship type, but also, a glimpse into the technologies that existed at the time *La Belle* was

constructed. The vessel may have been small in comparison to other naval vessels of the 17th century, but her contributions to our knowledge of shipbuilding and ship design are immense.

To My Mom, Dad,

and Samantha

ACKNOWLEDGMENTS

Because of the size and importance of the *La Belle* Shipwreck Excavation, any project related to it will inevitably involve many people. I'd like to take this opportunity to thank all the individuals and organizations that contributed both information and materials to this project.

First and foremost, I'd like to thank Dr. Donny Hamilton for his support and patience over the last several years, and for providing me with so many wonderful opportunities. Equally, I would like to thank the other members of my committee, Dr. Kevin Crisman and Prof. David Woodcock, for their support and encouragement.

This project would not have been possible without the contributions from the staff of the Conservation Research Laboratory. A special thanks to Dr. Helen DeWolf, Peter Hitchcock, and Peter Fix for taking the time out of their busy schedules to track down artifacts for me. To Amy Borgens for all her help with the photographic documentation of the model. I'd also like to thank Jim Jobling for always getting me the materials I needed, when I needed them.

Much of the data used in the reconstruction of the hull came from the field notes and photography of the *La Belle* excavation. I greatly appreciate the permission of the Texas Historical Commission for the use of this data.

I have been fortunate to work in an environment filled with so many knowledgeable and helpful individuals. The suggestions and questions of many of the students in the Nautical Archaeology Program were extremely helpful and often inspired ideas that I would not have come up with on my own. Thank you to Dr. Filipe Castro,

Dr. Cemal Pulak, and Taras Pevny for the afternoons and evenings of brainstorming that contributed so much to the final outcome of the models.

I am extremely thankful to Mr. J Richard Steffy, the father of archaeological ship reconstruction. His presence has been an inspiration and a indispensable source of data on ship construction.

To all my friends who have provided moral support and comic relief when I needed it. Although the project itself was exciting, it was the people around me who made it most rewarding.

Finally, I am greatly appreciative to Erika Laanela for her time and expertise in editing this thesis. Without her help this would have been a much more formidable task.

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CHAPTER I

INTRODUCTION

The last quarter of the seventeenth century was a transitional period in shipbuilding. Many of the design and construction techniques that were used for the next three centuries were developed at this time. Significantly, France was at the forefront of the shipbuilding industry; its shipyards and naval architects were considered the best in the world and would eventually have a tremendous influence on ship construction in many other nations. Unfortunately, few shipbuilding treatises have survived from the period and those that exist document earlier techniques that had become obsolete by the early eighteenth century. For this reason, archaeological remains from contemporary vessels are invaluable for creating a clear picture of these transitions.

In April 1997, the Texas Historical Commission completed the excavation of a small French ship named *La Belle*. Built in 1684 and possibly given as a gift to Robert Cavalier de la Salle from King Louis XIV of France, the little ship *La Belle* was one of four vessels that left France in an ill-fated attempt to found a colony at the mouth of the Mississippi River. In 1686, two years after leaving France, the vessel was run aground in Matagorda Bay on the Gulf Coast of Texas. The wreck of *La Belle* not only provides a unique example of a poorly-documented ship type, but also serves as an early example of many new design and construction techniques in use in the French ship

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This thesis follows the style and format of *The American Neptune*.

yards. Although only about a third of the hull has survived, sufficient information can be extracted to reconstruct the appearance of the original vessel. The archaeological evidence, in conjunction with naval documents, contemporary models and drawings, and firsthand accounts of her appearance, can be used to answer questions about her assembly and the shipbuilding practices of the seventeenth century. What type of ship was she? How was she designed and built? How was she rigged and outfitted? For an oceangoing vessel, *La Belle* was very small, but the techniques used to build her were analogous to those used for larger ships, providing a concise and manageable example for the period.

Research models have always played an important role in nautical archaeology. As the field matures, new tools and techniques have made the recording of archaeological ship remains more detailed and accurate than in the past. Much of this information can be represented in two-dimensional drawings or computer reconstructions. However, to truly understand the features and peculiarities of certain ships, it is necessary to understand the mechanics and behavior of the materials used in their construction. The fair run of a plank or the interaction of multiple rigging elements in three dimensions are difficult to determine without the use of a model. The sequence of assembly provides valuable insight into the construction of a vessel and, in many instances, can only be determined through the process of rebuilding the ship.

This thesis documents the construction of two models of *La Belle*. The first model, constructed during the early phases of the reassembly of the archaeological remains, was used to determine the correct lines and arrangement of the hull. As conservation of the remains has progressed, new discoveries have been made that

contribute to our knowledge of her appearance. The second model incorporates these new findings. The purpose of the models is not only to represent the overall appearance and layout of the original ship, but also to recreate the methods and sequence of her construction.

The original vessel was designed by a naval architect and built by a shipwright. She can therefore be reconstructed in two ways: as a theoretical reconstruction in which the geometrical tools and formulas employed by the naval architect of the time are reproduced to determine the planned hull shape; or as a practical reconstruction using the surviving hull remains. The first method is valuable as a study of the naval architecture of the period, but does not provide a picture of the vessel as the shipwright actually built her. It merely provides a generic model that incorporates the general features of a ship of this design type from this period. The shipwright's trade relied heavily upon experience, and this is reflected in the actual construction of the ship. At times, even rules for construction established by the French navy were ignored. For example, the French Naval regulations of 1673 stipulated that all vessels were to be constructed with the newly-developed round tuck stern; however, the square tuck stern continued to be used into the early eighteenth century. In addition, a theoretical reconstruction does not account for modifications that were made to the vessel in the form of repairs or to improve sailing qualities. A generic model does not depict the specific type of hatches, hinges, blocks, and other ship fittings. Therefore, the present reconstruction relies primarily on the existing hull remains and known dimensions of the timbers and recovered hull related artifacts.

CHAPTER II

DISCUSSION OF SOURCES

The information used for the reconstruction of *La Belle* is derived from five major sources. The most important source are the archaeological remains of *La Belle*. Field notes, photographs, sketches, timber drawings, and AutoCAD reconstructions of the lines and certain hull structures provided by the Texas Historical Commission were invaluable in the construction of the models. Because many of the artifacts are still undergoing conservation, detailed dimensions for certain objects are not yet available. Whenever possible, direct measurements provided by the staff of the Conservation Research Laboratory at Texas A&M University were used. One of the long term goals of the Texas Historical Commission is the conservation and display of the vessels remains. To accomplish this goal it was necessary to completely disassemble the hull for transport some 100 miles inland to the conservation lab in College Station, Texas. Once at the lab, the timbers were cleaned and recorded, and the reconstruction of the hull is nearly completed. The systematic disassembly in the field, followed by careful analysis during the initial cleaning and then the actual reassembly of the hull has provided a large amount of data that wouldn't have been available otherwise.

The second major source of information is a manuscript from the shipyard at Rochefort (fig. 1).[1] This single-page document is the only historic source providing the dimensions of *La Belle*. Written on 15 December 1684, and signed by the builder, Pierre Mallet, the list gives the tonnage and eighteen principal dimensions for the "barque named *La Belle*." Table 1 provides a translation of the document.

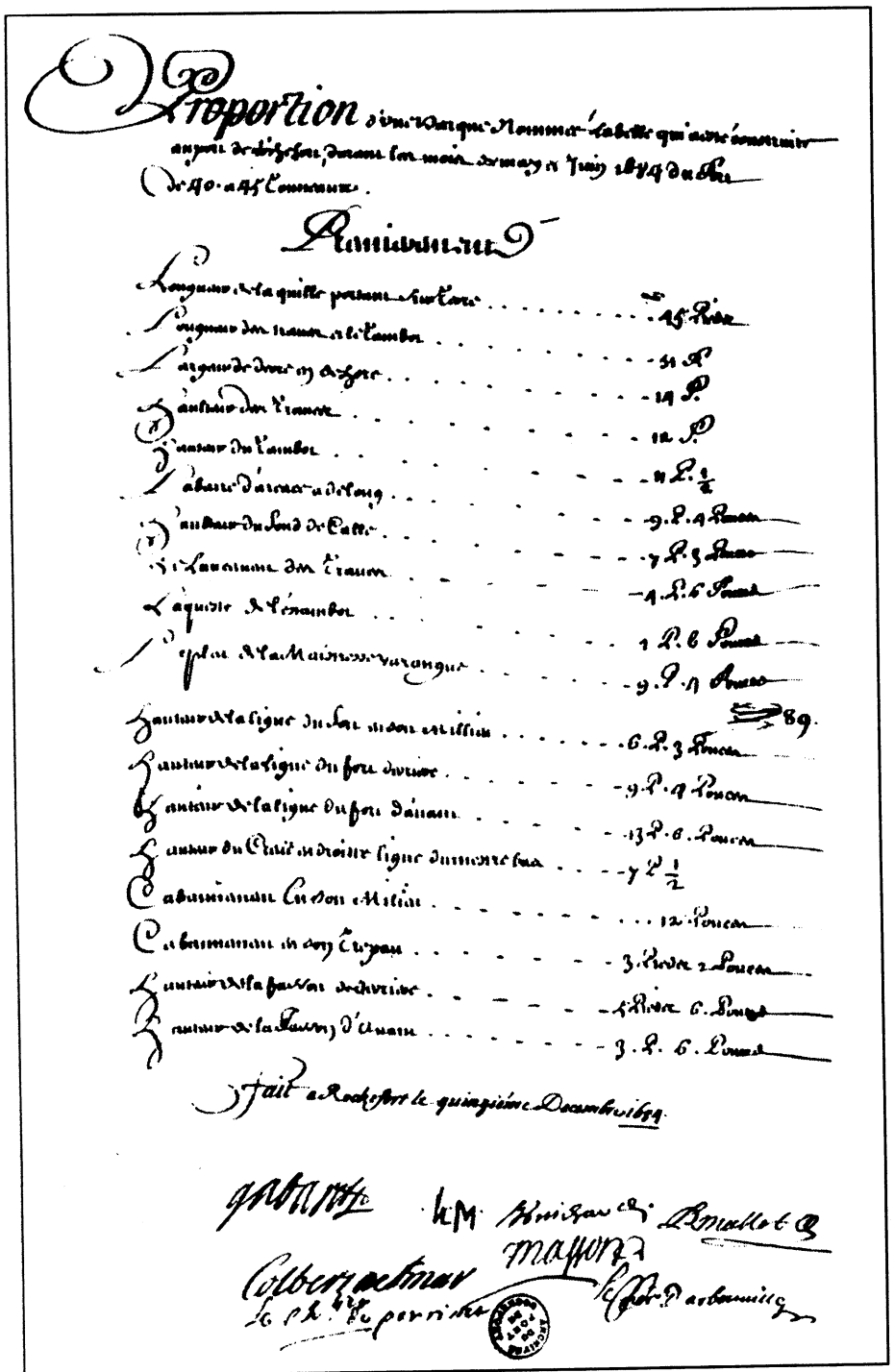


Figure 1. Manuscript from the dockyard at Rochefort, France, dated December, 1684, providing 18 major dimensions for a "barque named *La Belle*." Anonymous manuscript, Port of Rochefort Archives.

Proportions of a barque named *La Belle* that was built at the port of Rochefort during the months of May and June 1684 of 40 to 50 tons.

Length of the [footprint of the] keel on the ground	45 feet
Length from stem to sternpost	51 feet
Breadth	14 feet
Length [height] of stem	12 feet
Length [height] of sternpost	11 feet ½
[Wing] transom	9 feet 4 inches
Height [depth] of hold [from top of keelson]	7 feet 3 inches
Rake of stempost	4 feet 6 inches
Rake of sternpost	1 foot 6 inches
Flat of master floor	9 feet 4 inches
Height of the line of extreme breadth amidships	6 feet 3 inches
Height of the aft line of extreme breadth	9 feet 4 inches
Height of the forward line of extreme breadth	13 feet 6 inches
[Depth of] hold in straight line with master beam [to top of floors]	7 feet ½
Tumblehome amidships	12 inches
Tumblehome [offset between max. beam and wing transom]	3 feet 2 inches
Height of narrowing of the forward tail frame	5 feet 6 inches
Height of narrowing of the aft tail frame	3 feet 6 inches

Done at Rochefort the fifteenth of December 1684

[signatures]
GABARET HM [Honoré Mallet] *GUICHARD* *P. MALLET*
COLBERT de ST. MARS *MASSON*
LE CHEVALIER de PERRINET *LE CHEVALIER D'ARBOURVILLE*

Table 1. Transcription of a portion of dockyard manuscript.

A third source of information consists of contemporary treatises. Few treatises on seventeenth-century French shipbuilding exist, possibly because many techniques were considered state-of-the-art trade secrets at the time. In addition, most

manuscripts that do exist focus on the theoretical aspects of hull design rather than practical construction techniques. A notable exception is the series of engravings showing the building and outfitting of as ship known as the *Album de Colbert*.[2] Although the author or authors of this work remain unknown, the degree of detail contained in the plates indicates that they were produced by someone with extensive knowledge of the shipbuilding practices of the day. There are many parallels between the fabrication of the timbers of *La Belle* and the depictions of timbers in the plates. This work proved particularly useful in the reconstruction of the main deck and upperworks of *La Belle*. Although written somewhat later, the works by Juan José Navarro (1711)[3] and Blaise Olivier (1737)[4] also provide detailed descriptions of elements that may be similar to those that existed onboard *La Belle*.

Fortunately, two eyewitness accounts describing the appearance of *La Belle* have survived. The first was written by Henri Joutel.[5] A commander in the La Salle expedition, Joutel documented the ill-fated voyage while onboard the warship *Le Joly*. Several references to *La Belle* in Joutel's journal are helpful in determining the rig of this small vessel. The second account was written by a Spanish sailor named Juan Enriquez Baroto, who encountered the remains of *La Belle* several years after she ran aground.[6] Passages in his journal describing items salvaged from the wreck, including rigging, spars, and armament, contributed to the reconstruction.

The final source of information includes contemporary drawings, illustrations, drafts, and models. *La Belle* is described in contemporary documents as a barque longue, but unfortunately the few representations of barques longues that do exist from the late seventeenth century offer little indication that she was this type of vessel.

Drawings and models of closely related ship types have survived that provide insight into the appearance of *La Belle*. Although hull shapes developed rapidly, the design of ordnance, fittings, and deck furniture remained standard for decades and even centuries. Styles of carved decoration, in contrast, seem to have gradually changed over the decades. The designs are sufficiently well-defined to permit dating of a vessel based on the style of her carvings. These factors were considered during the construction of the models.

CHAPTER III

HULL REMAINS

Sometime after running aground, *La Belle* came to rest on her starboard side. Although the hull's upperworks were lost over the centuries, her position on the bottom and the accumulation of silt ensured that a significant portion of the starboard side of the ship was preserved, along with the contents of her hold. Although the remains represent only 20 to 30 percent of the vessel, it is possible to get a reasonable impression of the appearance of up to 60 percent of the vessel.

The following discussion presents the hull timbers in the order in which they are presumed to have been assembled. The principal unit of measurement used in constructing *La Belle* was the French foot of twelve French inches. The French foot is about 7 percent larger than the modern English foot. All measurements presented in this thesis are expressed in French feet and inches, with the metric equivalent provided in parentheses. A conversion factor of 2.71 centimeters to 1 French inch was used. Although the full scale measurements of the timbers are used when discussing the model, it should be pointed out that the models were built at a scale of one to twelve and the individual measurements should be scaled accordingly.

Unless otherwise specified, all the fasteners joining components of the keel, stem, apron, sternpost and deadwood, as well as the fasteners securing the frames to the keel and keelson, are 1-inch (2.7 cm) diameter iron bolts. All longitudinal fasteners securing floors to futtocks and futtocks to futtocks are iron fasteners measuring .8 to .9 inches (2.2 to 2.4 cm) square in cross section.

This chapter is not intended to provide an exhaustive study of the timbers of *La Belle*; a complete study of the hulls remains is currently being prepared for the Texas Historical Commission. This thesis is intended to give a general overview of the elements that make up her construction. All of the timbers in the vessel were fabricated to standardized dimensions of feet, inches, halves of an inch, and, occasionally, quarters of an inch. Dimensions within 5 percent of a standard unit were rounded. Nevertheless, even after three hundred years underwater, few of the measurements taken off the timbers had to be rounded, indicating a remarkable degree of accuracy in the original construction of the vessel. The surviving timbers were remarkably free from wear with crisp edges and visible tool marks, indicative of the fact that she was a new vessel on her maiden voyage.

Keel

The keel of *La Belle* is composed of two timbers. The forward timber, which incorporates the forefoot, has a length of 18 feet (5.854 m). The after timber appears to be damaged, as it ends about 20 cm short of the aft face of the sternpost. The surviving portion measures 33 feet, 9 inches (10.976 m) long. Just forward of midships is a 3-foot (97.6 cm) long flat scarf joining the two timbers. Four 1-inch (2.7 cm) diameter bolts spaced evenly down the centerline of the scarf secured the joint. The entire keel assembly has a length of 47 feet, 9 inches (15.528 m) with a footprint of 45 feet (14.634 m). The sided dimension of the keel assembly is 6 inches (16.3 cm) along its entire length. The molded dimension of the keel is 8 inches (21.7 cm) for most of its length, but gradually increases in the forefoot to a height of 13 inches (35.2 cm) before

terminating at the after end of the stem scarf (fig. 2).

Only a small fragment of the stem survives, joined to the 3-foot (97.6 cm) long scarf in the forefoot of the keel with three evenly spaced bolts. Still adhering to the forward face of the forefoot is a small fragment of wood that is probably the remnant of a gripe which is indicated by the letter "G" on the left side of figure 2. Bolted to the inner face of the forefoot and keel is the apron. The remains of this timber measure 8 feet, 6 inches (2.764 m) long and follow the inside curve of the forefoot and stem. Sided 6 inches (16.3 cm) and molded between 6 and 7 inches (16.3 and 19 cm) along its length, the apron is notched at intervals of 18 inches (48.8 cm) for the crotches of the bow frames. The apron is fastened to the keel and stem with twelve iron bolts.

Roman numerals indicating the position of each frame are chiseled into the port face of the keel along its entire length. These are spaced at intervals of approximately 18 inches (48.8 cm), corresponding with the spacing of the frames. A * mark located 27 feet, 6 inches (8.943 m) forward of the after end of the keel designates the location of the midship frame or master couple (fig. 3). Forward of this mark are eleven divisions marked IA through XIA and aft of the mark are fourteen divisions marked ID through XIIID. The letters A and D stand for *avant* (forward) and *derrière* (aft) respectively.

Approximately 1 inch (2.7 cm) below the upper face of the keel is the upper edge of a V-shaped rabbet measuring 2 inches (5.4 cm) wide and a little over 1 ½ inches (4.1 cm) deep at midships. The rabbet begins to widen and deepen as it approaches the apron and deadwood in order to compensate for the increased angle at which the planking meets the keel in these areas.

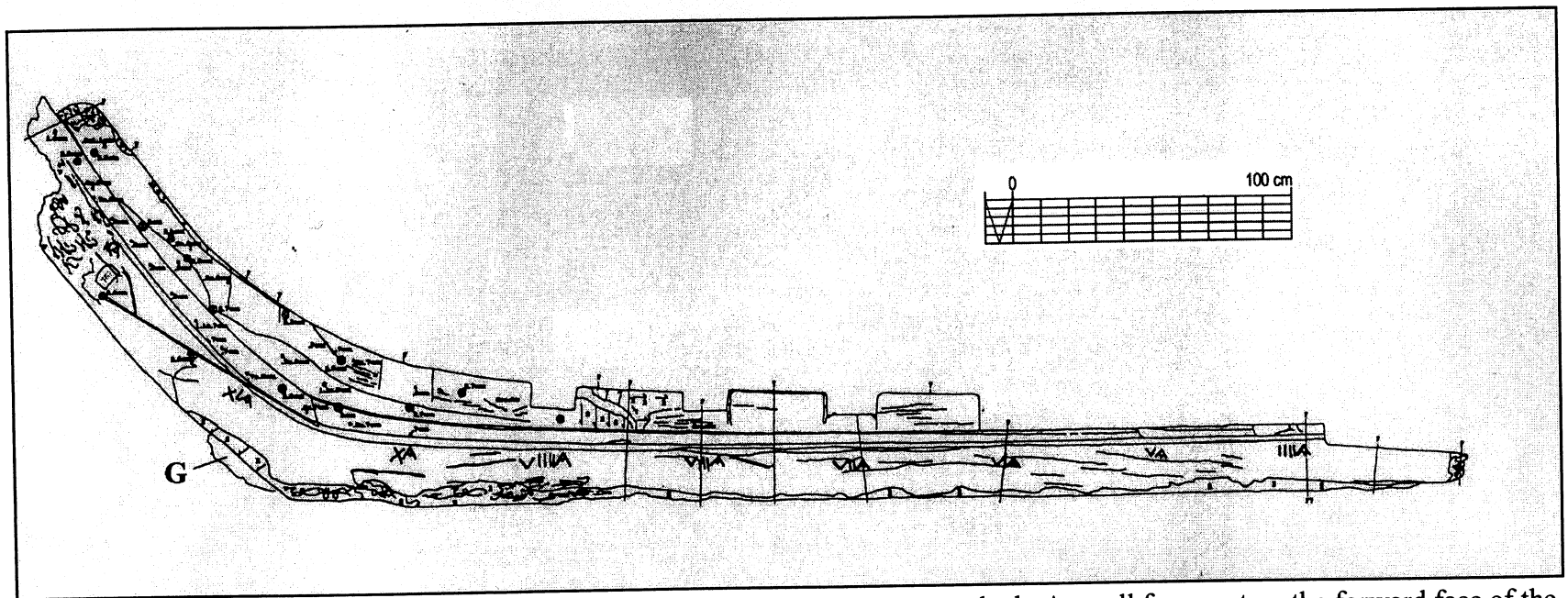


Figure 2. Forward section of keel timber with portions of the stem and apron attached. A small fragment on the forward face of the forefoot may be the remains of a gripe. Courtesy of the Texas Historical Commission.

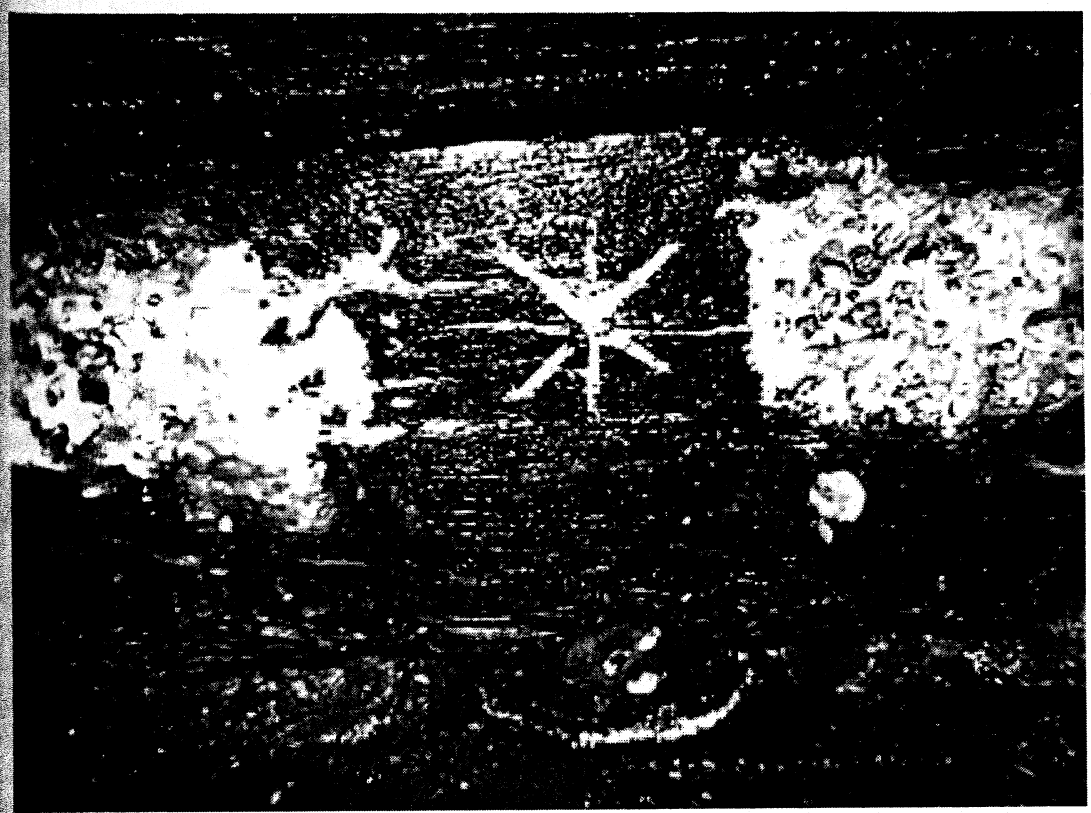


Figure 3. One of the marks on the port face of the keel designating the locations of the frames. Identical marks were found on the floors of the corresponding frames. The * symbol marks the location of the midship frame. Courtesy of the Texas Historical Commission.

Stern Assembly

The stern assembly is composed of a sternpost, supported on its forward face by a deadwood knee, and protected on its after face by a false post (fig. 4). The upper end of the sternpost and false post have eroded, leaving less that 2 feet (65.0 cm) of their original height. The sternpost is molded 14 ¾ inches (40.0 cm) at the base and tapers 1 ½ inches (4.1 cm) per foot (32.5 cm) of length. The forward face of the sternpost rakes aft at an angle of 72 degrees and the after face is raked at about 74 degrees. Both sternpost and false post have sided dimensions of 4 ½ inches (12.2 cm). Removal of the sternpost from the keel revealed a tight fitting tenon 5 ½ inches wide (14.2 cm), 2 inches (5.4 cm) thick, and 4 inches (10.8 cm) long that reinforced the attachment to the keel.

The stern deadwood is composed of two timbers. The after piece served as a knee to support the sternpost. The horizontal arm of the timber is 4 feet, 4 inches (140.9 cm) long and was secured to the keel with five bolts. A 2-foot (65.0 cm) length of the vertical arm of this knee survives, fastened longitudinally to the sternpost and false post with two bolts. Butted against the forward end of the knee is a second, 8-foot (260.2 cm) long, timber fastened to the keel with eight bolts. The sided dimension of the forward timber is 6 inches (16.3 cm) along its entire length. The edges of the lower face begin to taper 4 feet, 6 inches (1.463 m) from the forward face of the timber as the bearding line of the rabbet rises into the deadwood. At the after end of the timber, the lower face diminishes to 4 ½ inches (12.2 cm). The upper face of the stern knee measures 6 to 6 ½ inches (16.2 to 17.6 cm) over most of its length but tapers aft at a downward angle to 4 ½ inches (12.2 cm) at the sternpost and keel. The molded

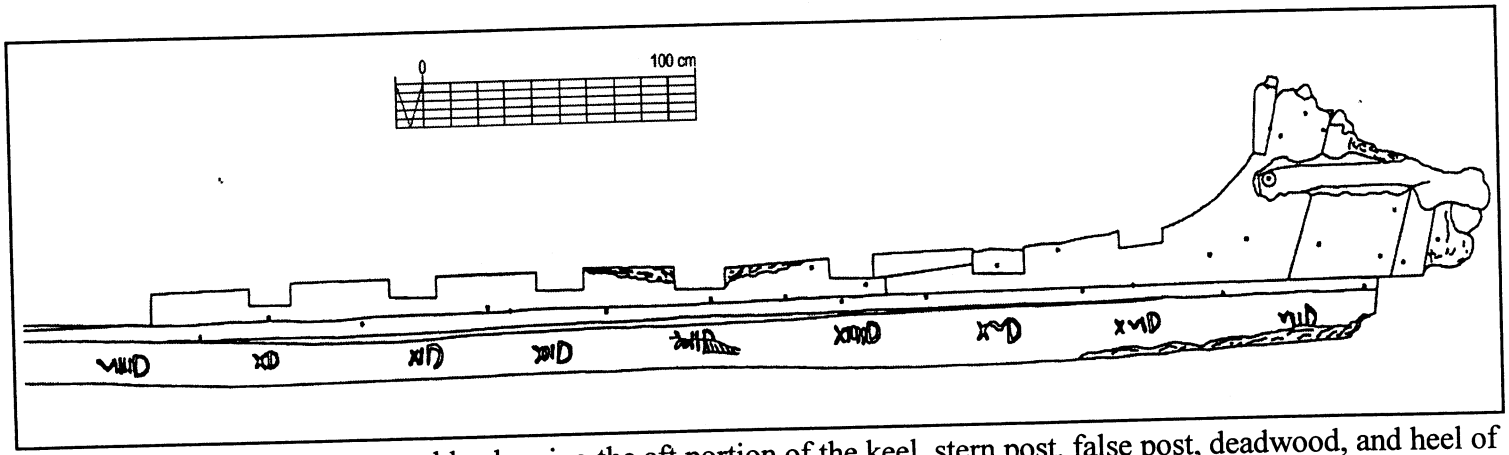


Figure 4. *La Belle*'s stern assembly showing the aft portion of the keel, stern post, false post, deadwood, and heel of frame XVIID. The remains of one gudgeon can also be seen. Courtesy of the Texas Historical Commission.

dimension of the forward segment increases gradually from about 4 ½ inches at the forward end to about 5 inches (13.6 cm) at after end. The rise increases in the knee from 5 inches (13.6 cm) to about 10 inches (27.1) at the crotch. The upper face of the deadwood assembly is notched at intervals of about 18 inches (48.8 cm) to hold the aftermost frames. A final notch is found high up on the vertical arm of the knee for frame XVIID.

Eighteen inches (48.8 cm) above the bottom of the keel and running parallel to it, a single iron gudgeon was fastened to the false post, sternpost and deadwood knee. Each of its straps is 2 feet long (65.0 cm) and a little over 2 inches (5.4 cm) wide. Although only one bolt was recorded in figure 4, the straps were fastened through the deadwood and the sternpost by two iron bolts.

Frames

Once the keel, stem and sternpost were assembled, the next step was to raise the frames of the ship. The remains of thirty frames were found at approximately 18-inch (48.8 cm) intervals along the keel, each fastened with a single iron bolt. Each floor is marked with a roman numeral corresponding to the appropriate mark on the keel. At the bow and stern, many of the frames have eroded, leaving, in some cases, only the stump of a crotch timber. Closer to midships enough of the structure remains to determine that the frames were composed of a floor with overlapping first, second, and third futtocks. At midships, a more substantial frame called the master couple was employed (fig. 5). In this frame, the floor and futtock are reinforced by a pair of second and fourth futtocks on either side. Forward of midships, the first futtock was

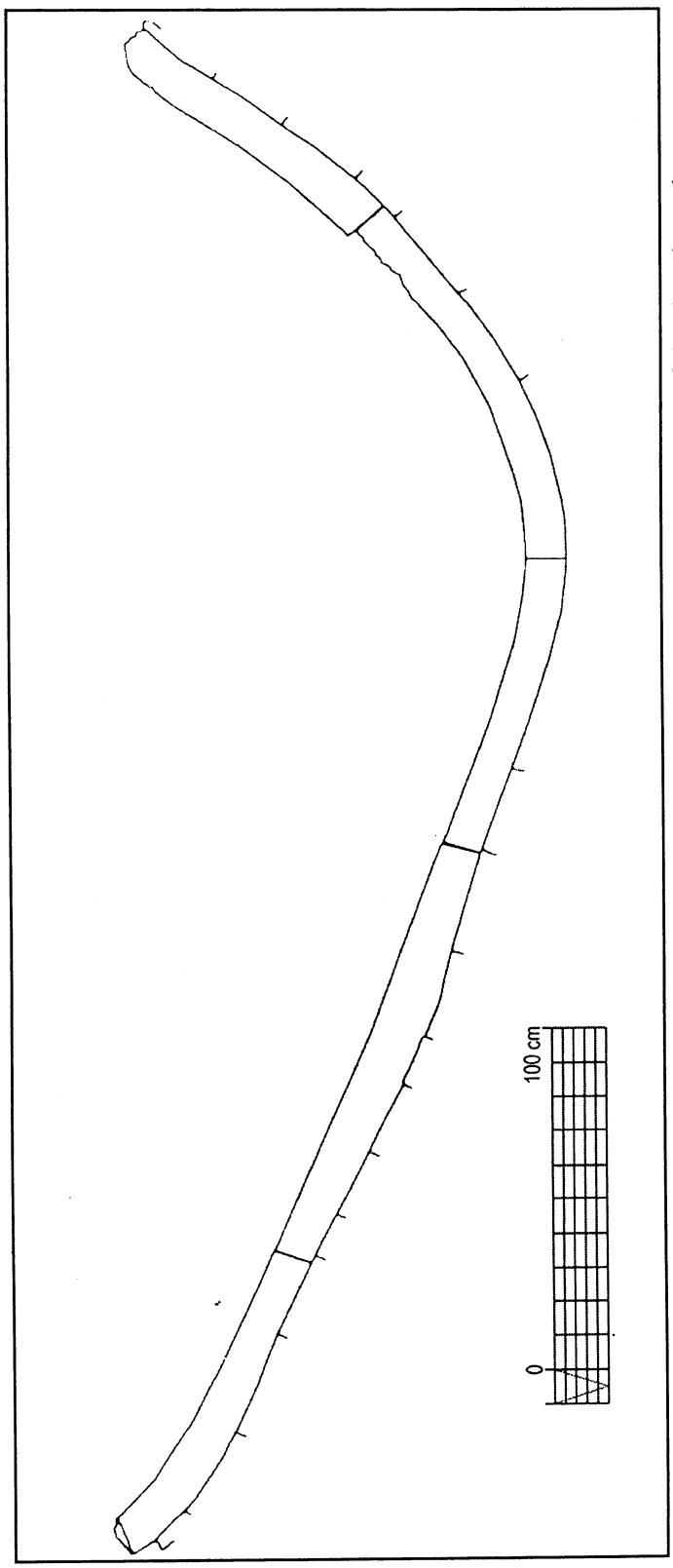


Figure 5. The midship frame or "master couple" of *La Belle*. This drawing is representative of the drawings that were recorded for each of *La Belle*'s frames. Courtesy of the Texas Historical Commission.

fastened to the forward face of the floor, while aft of midships the first futtock was fastened to the aft face of each floor. Each floor-to-futtock and futtock-to-futtock attachment was secured with three evenly spaced iron bolts. All the frames between VIA in the bow and VIIIID in the stern were not notched over the keel but simply positioned on top of it. The forward face of the floor VIA abuts the after end of the apron and the after face of floor VIIIID abuts the forward face of the stern deadwood. Forward and aft of these frames, the rising of the deadwood and apron required crotch timbers shaped to fit into notches in the deadwood and apron. In several instances, the crotches are built up from two timbers, scarfed together to form a sharp V-shape.

All floor timbers averaged between 5 ½ and 7 inches (14.9 and 19 cm) sided, the wider floors being notched down to 5 ½ inches (14.9 cm) where they overlap with the first futtock. At midships, the molded dimension of the floor over the keel is 5 ¼ inches (14.2 cm), decreasing to 4 inches (10.8 cm) at the head of the floor. The molded dimensions of the floors increase considerably over the apron and deadwood, with an abrupt rise at frames VIIIA and XIID. The purpose of this unusually sharp increase is described in the discussion of the keelson. The molded dimension of the heads of these timbers continues to average around 4 inches (10.8 cm). The futtocks average between 5 and 6 inches (13.6 and 16.3 cm) sided throughout the vessel. The remaining futtocks show little taper and average between 3 ¾ to 4 inches (10.2 to 10.8 cm) in their molded dimensions.

No limber passages were cut in the floors to allow water to flow to the lowest point in the bilge. Instead, there is a gap between the garboard and the bottom of the floor due to the 1-inch (2.7 cm) distance between the top edge of the rabbet and the top

of the keel. The resulting gap was sufficient to permit the flow of bilge water to the pumps.

Keelson

Bolted over the floors and sandwiching them to the keel, the keelson was constructed of three timbers fastened together with 3-foot (97.6 cm) long hooked scarfs. An unusual feature of the keelson is that, instead of following the rise of the floors in a gradual curve at the bow and stern, the timber runs directly into the after face of floor VIIIA and ends just short of the forward face of XIID (fig. 6). Shorter timbers are scarfed to the keelson and are notched over the remaining frames. In other words, the keelson timbers are not supported at their ends and simply float between the floors. The main section of the keelson measures 31 feet, 6 inches (10.244 m) in length. The forward section is 7 feet, 7 inches (2.466 m) long and the aftermost piece is 7 feet, 4 inches (2.385 m) long. All three timbers are sided between 6 ½ and 7 ½ inches (17.6 and 20.3 cm), molded between 6 and 6 ½ inches (16.3 and 17.6 cm), and notched about 3 inches (8.1 cm) over the frames.

Planking

The order in which *La Belle* was planked is not entirely understood. Through fasteners running through both the external hull planking and the ceiling suggest that she was planked inside and out simultaneously. Observations made while planking the model are discussed in subsequent chapters. The order in which the planking is described in this chapter may not reflect the actual construction sequence. Since

Figure 6. Forward scarf of the keelson. Note the interesting way in which the forward end of the timber butts into the aft face of floor VIIIA. Courtesy of the Texas Historical Commission.

significantly less planking has survived on the port side of the vessel, this discussion focuses on the remains of the starboard side.

The external hull planking averages between 1 ¾ and 2 inches (4.7 and 5.4 cm) in thickness throughout the vessel and varies in width from as much as 12 ½ inches (33.9 cm) to just under 7 inches (19.0 cm). The wider planks are used amidships below the turn of the bilge, while the narrower planks are found around the turn of the bilge. Individual planks range between 11 feet (3.577 m) in length to over 26 feet (8.455 m). All plank ends were scarfed and securely fastened to the frames with a combination of spikes, 1-inch (2.7 cm) treenails and through bolts with their ends peened over roves (fig. 7). Between the scarfs, each plank was fastened to each futtock using one treenail and one spike in an alternating pattern.

The archaeological remains provide evidence for at least thirteen strakes of hull planking (fig. 8). Two stealers appear in the stern in the second and third strakes and a possible third example is seen in the ninth strake. A drop strake was used in the upper edge of the sixth strake between frames IIA and VID. Graving pieces or patches appear in four locations, indicating possible repairs or the replacement of knotted or cracked wood.

Nearly all the ceiling has survived on the starboard side of the vessel (fig. 9). The thickness of the ceiling planks range from 1 ½ to 2 inches (4.1 to 5.4 cm). At midships, there are eight strakes, varying in width from 6 ¼ to 10 ½ inches (16.9 to 28.5 cm). The first strake immediately adjacent to the keel is one of the widest. However, between frames VA and XD, 4 ½ inches (12.2 cm) of the inboard edge has been cut away to provide an opening for the limber strake next to the keel. Possibly

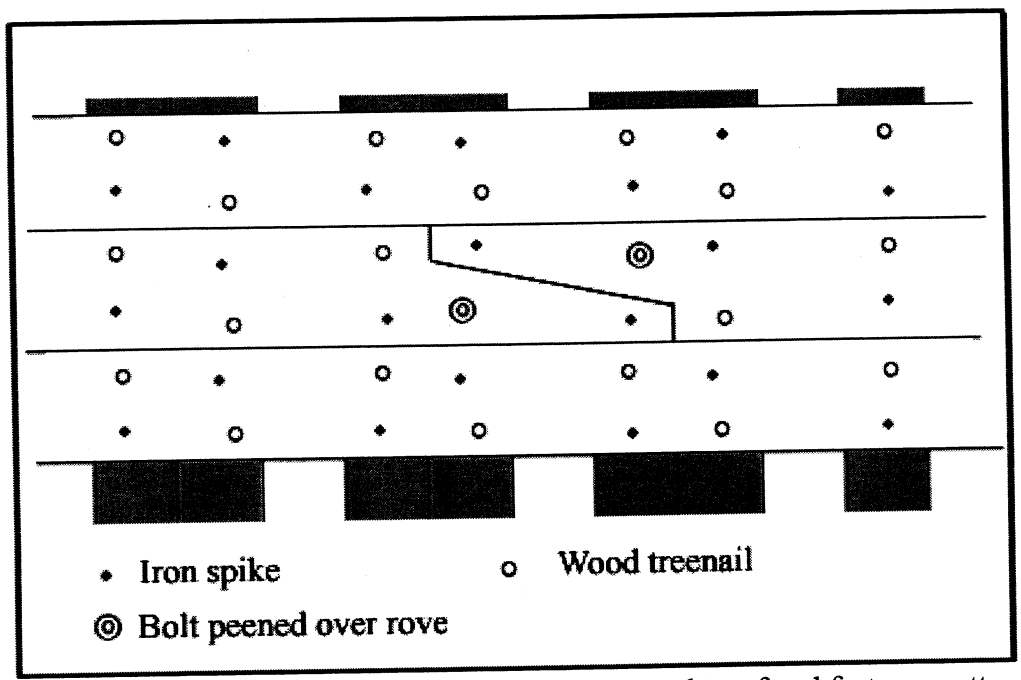


Figure 7. Schematic diagram illustrating the general scarf and fastener pattern used in the construction of *La Belle*. Drawing by G. Grieco.

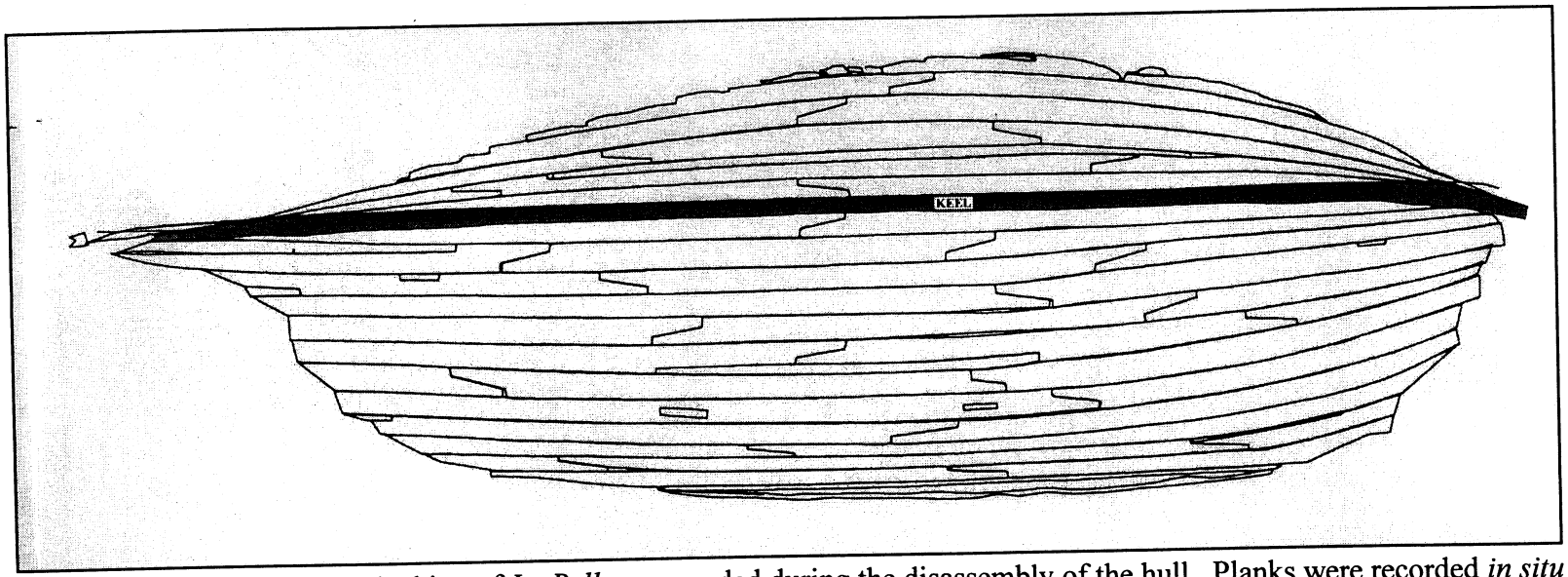


Figure 8. Plan of the outer planking of *La Belle* as recorded during the disassembly of the hull. Planks were recorded *in situ* after the frames were removed, resulting in a plan of the inside faces of the planks. Courtesy of the Texas Historical Commission.

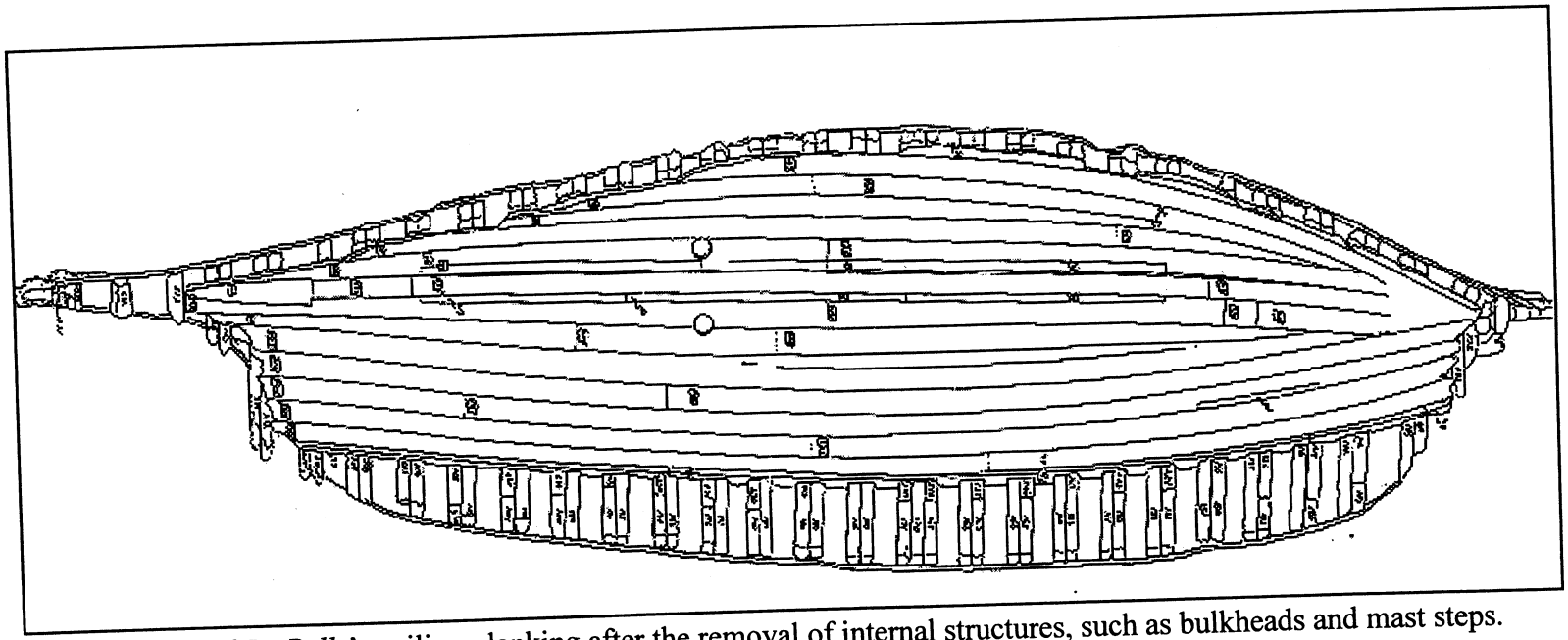


Figure 9. Plan of *La Belle*'s ceiling planking after the removal of internal structures, such as bulkheads and mast steps. Courtesy of the Texas Historical Commission.

related to the limber passage, a small hatch or accessway 10 inches (27.1 cm) wide by 18 inches (48.8 cm) long has been cut in the first strake between frames VIA and VIIA. A small piece of planking was cut to cover the opening. The remains of two small nails in the center of the board may mark the location of a small handle or lifting cleat.

The fifth and eighth ceiling strakes are thicker than the rest. Averaging 3 ½ to 4 inches (9.5 to 10.8 cm), they are notched to fit tightly over the frames so that the exposed face is flush with the rest of the planks. All planks within the strakes are simply butted together without the use of scarfs. The primary fasteners used to fix the ceiling are iron spikes. These are spaced roughly two per plank per frame, and are supplemented with an apparently random scattering of treenails.

Along the entire length of the hull, a 2-inch (5.4 cm) thick filler piece butts tightly against the outer edge of the eighth ceiling strake. Notched to fit tightly into V-shaped scores in the forward and aft faces of the frames, the filler piece extends down to the external planking, effectively sealing the spaces between the frames to prevent debris from collecting in the bilges.

Stringers

Running the entire length of the interior of the vessel are two heavy stringers measuring 9 inches (24.4 cm) sided and 4 inches (10.8 cm) molded (fig. 10). These timbers are notched over the frames by about half their thickness, considerably increasing the longitudinal strength of the hull. The stringers run nearly parallel to each other and to the last strake of ceiling. The lower edge of the first stringer is 10 ½ inches (28.5 cm) from the top edge of the filler piece, and the lower edge of the second

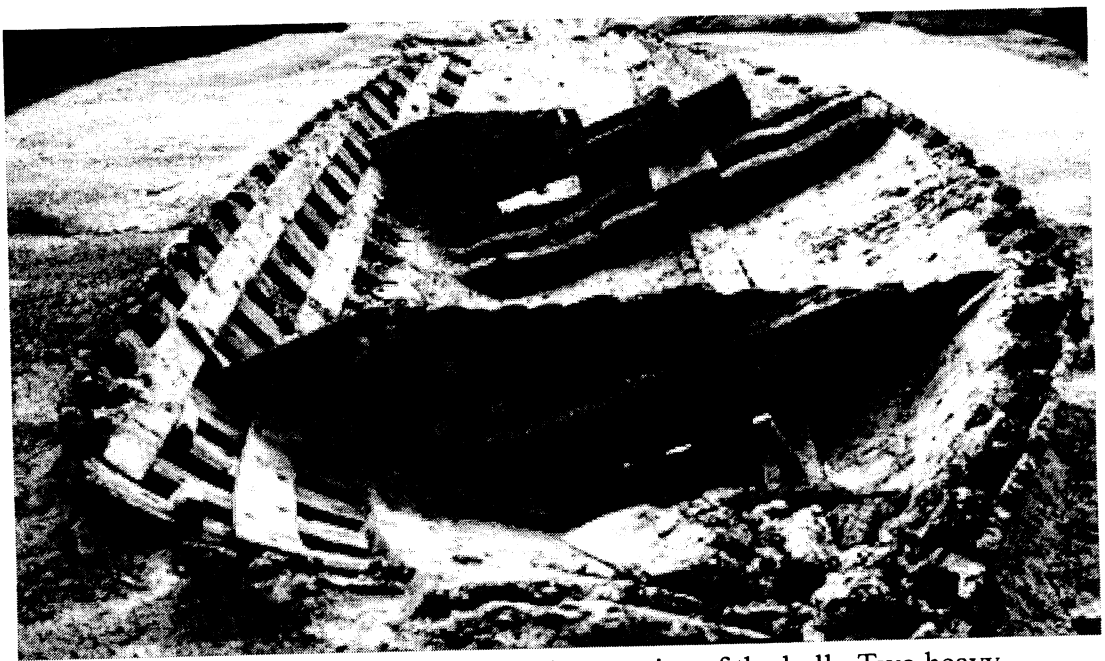


Figure 10. View from the bow of the entire remains of the hull. Two heavy stringers are visible on the left side of the photo. Courtesy of the Texas Historical Commission.

stringer is 10 ½ inches (28.5 cm) from the upper edge of the first.

Mast Steps

The remains of two mast steps have survived. In the bow, a breast hook also serves to support the heel of the foremast (Fig.11). Sided between 5 ½ and 6 inches (14.9 to 16.2 cm), the timber serves as a knee to join the two sides of the vessel in the bow. It was bolted through the planking to the frames about 10 inches (27.1 cm) above the keelson. The starboard arm of the knee has eroded away, but the port arm is intact. A 2-inch (5.4 cm) wide notch is cut on the inside face of the arm just below its tip. A matching notch would have been cut in the face of the opposing arm. A 2-inch (5.4 cm) thick plank was driven into these notches, forming an aft partner for the mast step. Only 13 inches (35.2 cm) wide and flush with the top of the knee, the bottom edge did not reach all the way to the ceiling and the top of the keelson. A small filler piece was inserted into this gap. Although nothing of the heel of the foremast has survived, three wedge-shaped chocks remain in place, where they were used to square the front and sides of the step.

The remains of the mainmast step are more substantial. The elaborate construction is illustrated in figure 12. Two heavy riders are bolted over the floors IID and IIIID. These timbers were carefully worked underneath to fit snugly against the ceiling and over the top of the keelson. The starboard arms of both timbers have eroded, but their original length would have been close to 9 feet (2.927 m). With a sided dimension of 8 inches (21.7 cm), they are probably the heaviest timbers in the vessel, aside from the keel and keelson. From their midpoint to about 22 inches

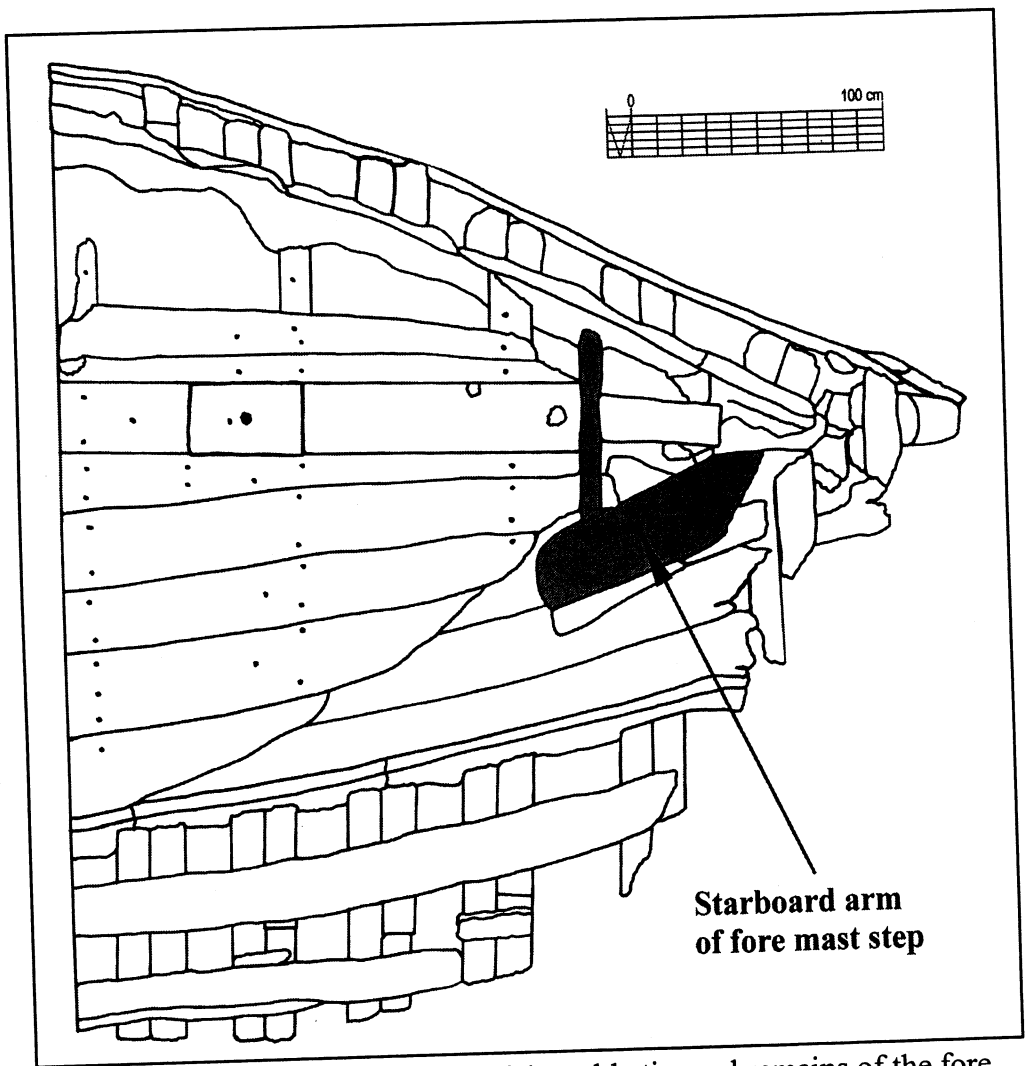


Figure 11. Illustration of planking of the cable tier and remains of the fore mast step. Drawing by Wendy van Duivenvoorde after Texas Historical Commission.

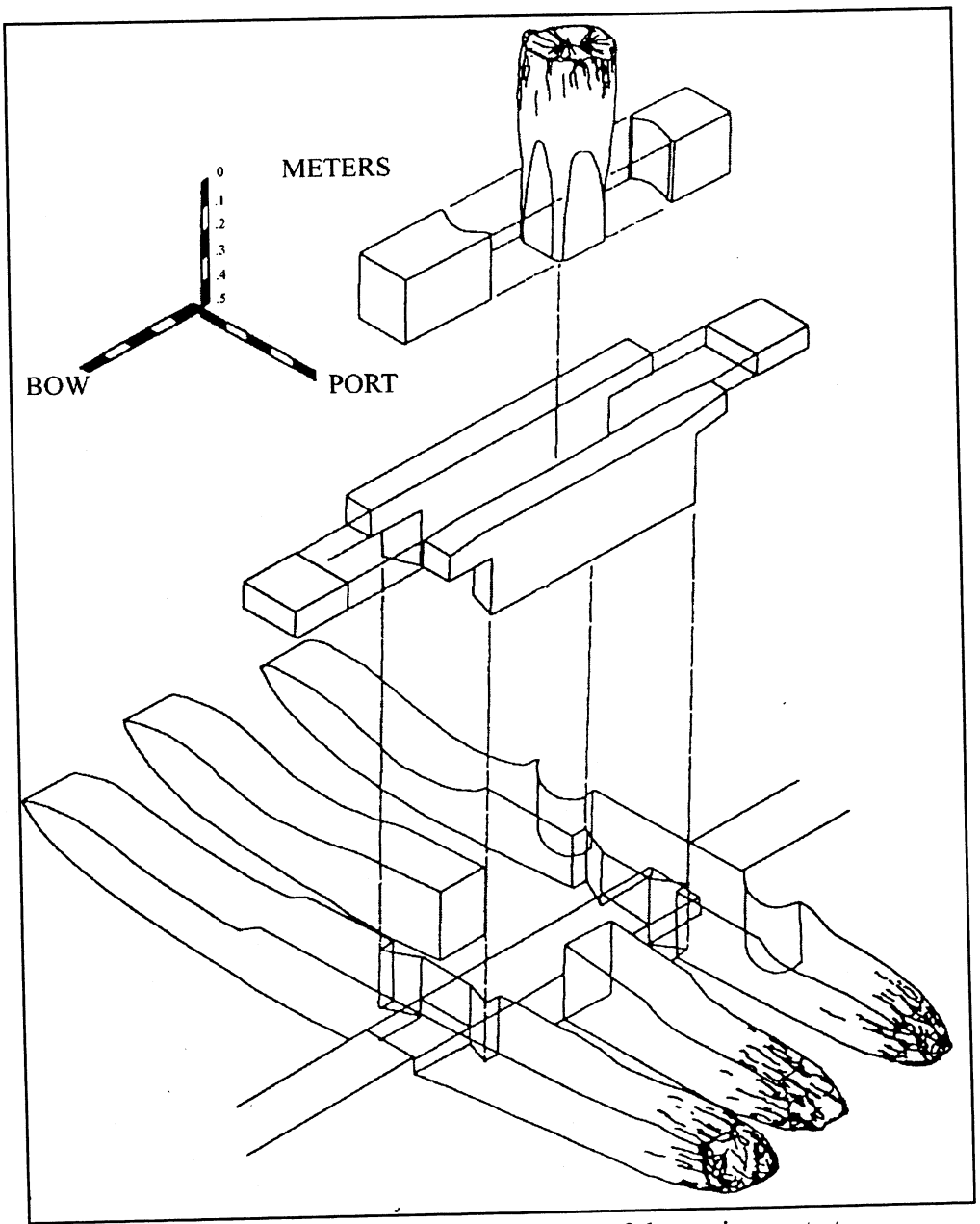


Figure 12. Exploded view of the components of the main mast step. Courtesy of the Texas Historical Commission.

(59.6 cm) on either arm, they are molded 9 inches (24.4 cm). This dimension suddenly drops to 7 ½ inches (20.3 cm) and then gradually decreases toward the ends of the arms. All exposed edges are neatly chamfered. On the inside faces of the two opposing timbers, 4-inch (10.8 cm) wide beveled notches are found. These notches held the beveled ends of two longitudinal mast step partners. Extending from the ceiling on either side of the keelson to 4 inches (10.8 cm) above the tops of the riders, these timbers formed a box to support the heel of the mast. Projecting arms on the top edge of the partners continued forward and aft over the width of the riders. Midway between the two riders, buttress timbers with similar sided and molded dimensions were bolted, providing support to the middle of the partners. To complete the structure, two chocks 8 inches (21.7 cm) wide, 4 inches (10.8 cm) thick, and 6 inches (16.3 cm) long were inserted between the arms of the partners that extended above the riders. Each rider was secured with twelve bolts driven in a staggered pattern and each buttress was fastened with four bolts.

Wedged tightly into the mast step between two blocks is the squared heel of the main mast (fig. 13). The short stump, now only 27 inches (73.2 cm) long, has a diameter of 11 inches (29.8 cm) at its widest point. The lower 17 inches (46.1 cm) of the mast taper to a roughly rectangular shape measuring 9 inches (24.4 cm) fore and aft and 7 ½ inches (20.3 cm) from side to side.

Figure 13. Surviving stump of the main mast after removal from the mast step. Courtesy of the Texas Historical Commission.

Pumps and Pump Well

Just aft of floor IIIID, two holes are cut through the ceiling on either side of the keelson. On the port side, the hole has a diameter of 9 inches (24.4 cm), with its center approximately 16 ½ inches (44.7 cm) from the centerline of the keelson. On the starboard side, the hole is just under 7 inches (19.0 cm) in diameter, with its center offset approximately 13 inches (35.2 cm) from the centerline. Semicircular notches were cut into the aft face of the aftermost rider, where this timber sat over the edges of the holes. The extra bearing surface of these notches provided additional support to the lower ends of the pump tubes. A short length of the heel of a common pump was found still fit tightly into the starboard hole (fig. 14). Once removed, the segment of pump was found to have a perforated sheet of lead beaten and tacked over the lower end to serve as a sieve.

A closet-like well formed from four upright posts boxed in with planks surrounded the pumps and protected them from debris and shifting cargo (fig. 15). Two of the posts were fastened just forward of the after rider and the other two were placed approximately 1 foot (32.5 cm) aft of it, creating an enclosure measuring roughly 2-foot-by-4-foot (65.0 by 130.1 cm). Each post was 3 ½ by 5 ½ inches (9.5 by 14.9 cm) in section, with the wider surfaces oriented longitudinally and supported at their bases by a roughly cut beveled molding 3 inches (8.1 cm) wide and 1 ½ inches (4.1 cm) thick. The planking of the pump closet is 1 ¼ to 1 ½ inches (3.4 to 4.1 cm) thick and between 8 to 11 inches (21.7 to 29.8 cm) wide.

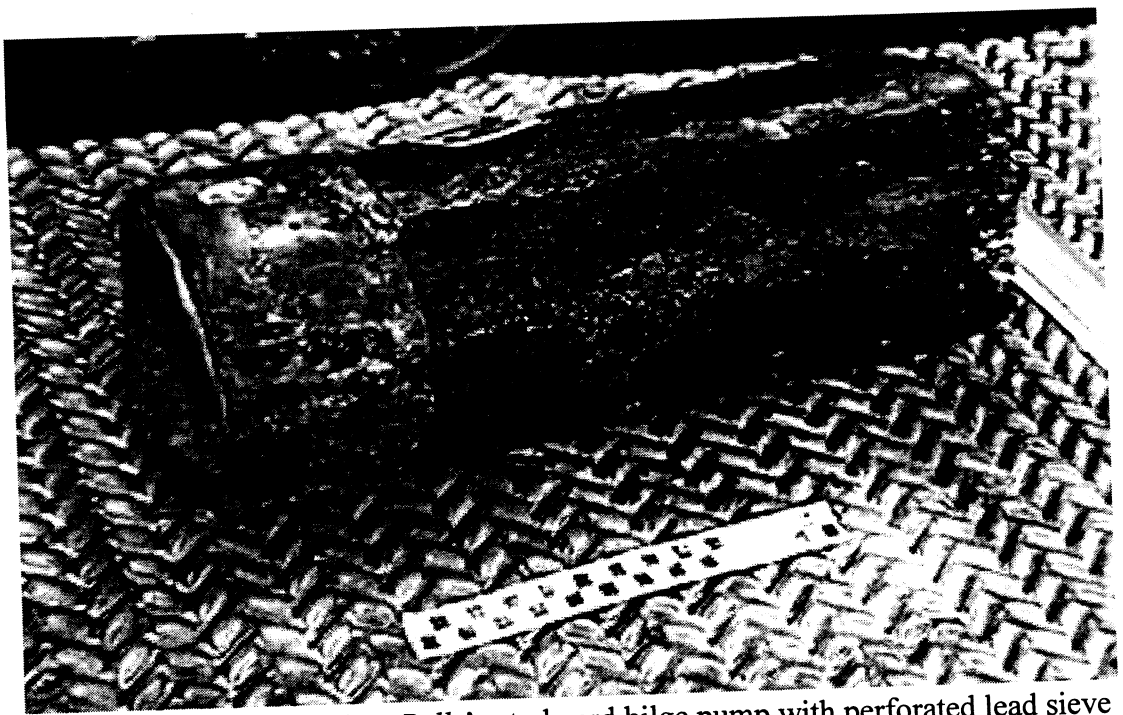


Figure 14. Lower end of *La Belle*'s starboard bilge pump with perforated lead sieve still attached. Courtesy of the Texas Historical Commission.

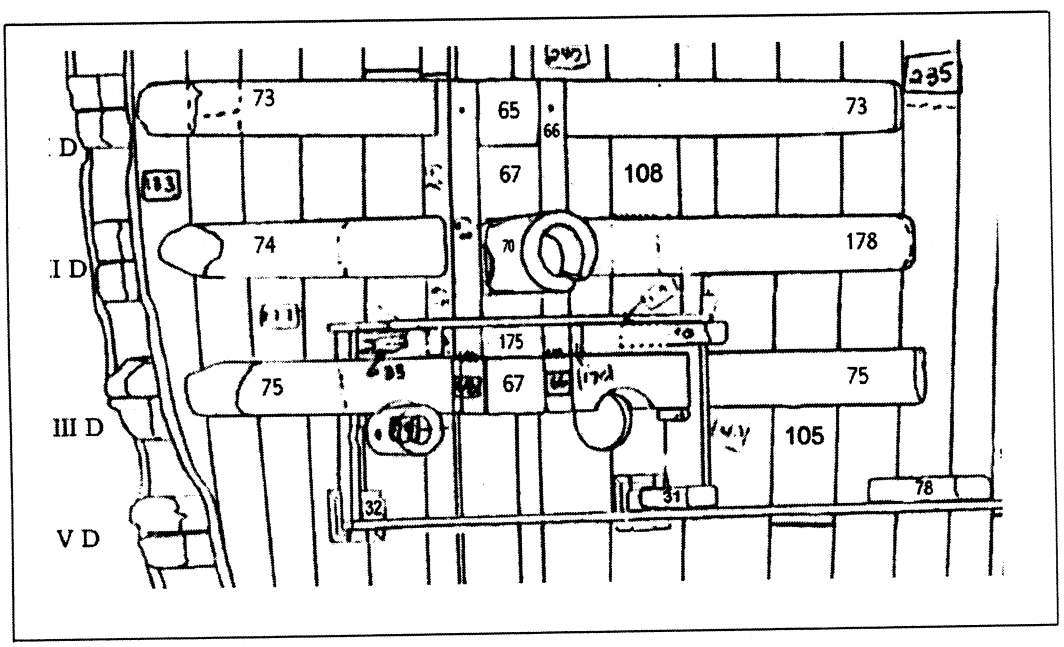


Figure 15. Sketch of *La Belle*'s mast step assembly. Four posts support the remaining planks of the pump well. Courtesy of the Texas Historical Commission.

Bulkheads

The remains of three bulkheads were found within the hold. All three were constructed from planking 1 ¼ to 1 ½ inches (3.4 to 4.1 cm) thick. Even the nailers, or small blocks of wood that were tacked to the ceiling and frames as a backing for the bulkhead timbers appear to have been cut from the same stock, possibly scrap cut from the full planks. The typical plank measured between 8 and 12 inches (21.7 to 32.5 cm) in width.

Bulkhead 1 sits over the forward face of frame VA (fig. 16). Interestingly, the limber strake ends just short of this bulkhead. Sections of four bulkhead planks survive on the starboard side of the vessel, providing a projected height over the keelson of 3 feet, 4 inches (1.084 m). The planks are supported on their aft faces by nailers and by two 3-inch-by-3-inch (8.1 cm by 8.1 cm) stanchions, one set on the keelson and the second offset 3 feet, 8 inches (1.192 m) to the port side of the keelson.

Bulkhead 2 extends the aft face of the pump closet to the sides of the hold. Nailers were tacked to the port and starboard sides of the pump closet 1 ½ inches (4.1 cm) forward of the aft face. End-to-end nailers continued laterally from the pump closet up the sides of the hold to support the short lengths of planking.

The forward face of Bulkhead 3 lies flush with the aft face of frame XID. Segments of three planks survive, supported on their forward side by a continuous line of nailers. The aft side is supported by a short stanchion and a small lateral beam.

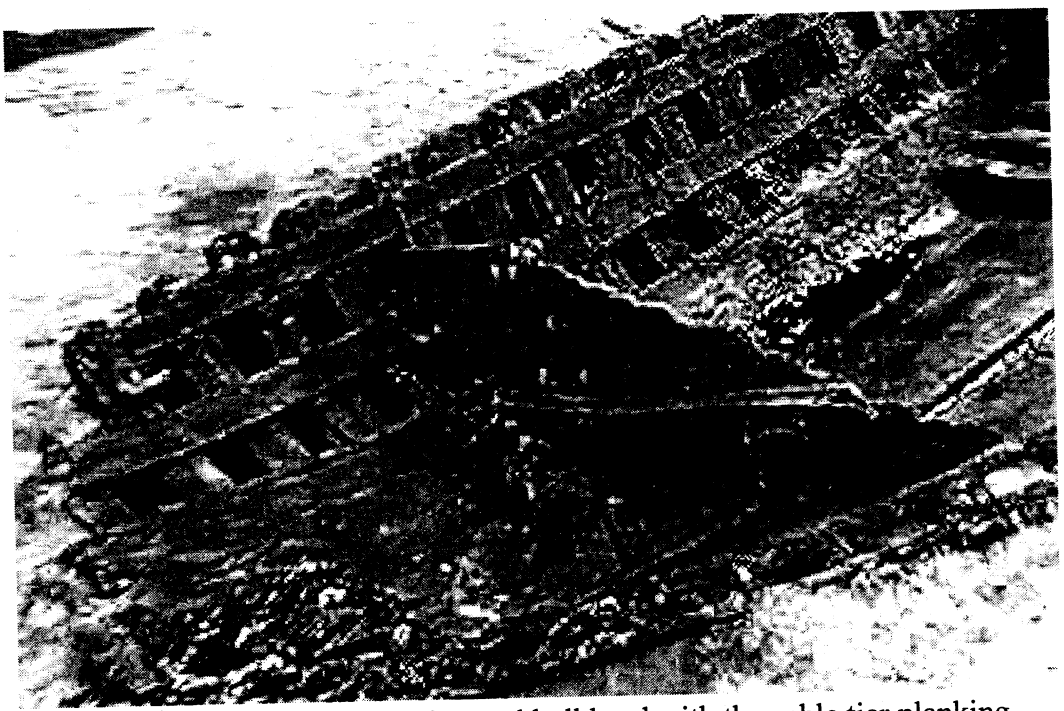


Figure 16. Photo of *La Belle*'s forward bulkhead with the cable tier planking removed. One of the deck beams of the cable tier and the short post that supports it can also be seen. Courtesy of the Texas Historical Commission.

Decks

None of the components of the main deck survive, although the remains of two small deck platforms were identified within the hold. Forward of the first bulkhead, a simple platform served as the floor of the cable tier (fig. 17). Three beams, measuring 6 inches (16.3 cm) sided and 4 inches (10.8 cm) molded, were beveled at their ends and nailed to the ceiling in the bow. The aftermost beam fit snugly against the bulkhead and was supported in the center by a short 3-inch-by-3-inch (8.1 cm by 8.1 cm) post. What remains of the deck is planked with eleven 1 ½-inch (4.1 cm) thick planks. The widths of the planks appear to be random, but all taper toward their forward ends. The edge planks abut the ceiling and are beveled to fit snugly against it. A small accessway has been provided in the planking of this deck directly over the small hatch in the ceiling.

Only a single beam and supporting post have survived aft of the third bulkhead. These hint at a possible deck platform. The beveled ends of the beam indicate the same type of construction as in the bow.

The remains of a small notched stanchion are mortised into the top of the keelson at midships (fig. 18). The post measures 4 inches (10.8 cm) thick longitudinally and 5 inches (13.6 cm) thick laterally. Only about 23 ½ inches (63.7 cm) of its length have survived, but opposing notches about 12 inches (32.5 cm) apart on the port and starboard faces suggest it was probably notched on alternate sides at 1-foot (32.5 cm) intervals over its entire length. Used as a ladder, this timber suggests the presence of a hatch in the deck just forward or aft of it.

Figure 17. Photo of *La Belle*'s cable tier. The small hatch in the deck lies directly over a similar hatch in the ceiling below. Courtesy of the Texas Historical Commission.

Figure 18. The remains of a notched stanchion, still mortised into the keelson, that served as a ladder to a hatch in the deck above. Courtesy of the Texas Historical Commission.

CHAPTER IV

EVOLUTION OF THE BARQUE LONGUE

Before an accurate set of lines could be reconstructed, it was necessary to determine the type of vessel represented by *La Belle*. It is widely believed that *La Belle* is an example of a vessel type called a *barque longue*, but what was a barque longue?

The term barque longue applies to a range of small vessels first recognized as a distinct type by the French navy in 1675. Although the classification of barque longue was replaced by *corvette* in 1676,[7] the vessels included in this class range in size and complexity. Between the 1670s and the mid-eighteenth century, the barque longue grew and evolved into what was later considered a sloop of war or light frigate.

Perhaps the earliest representation of a barque longue is from the album of Jean Jouvé dated 1679.[8] This small, undecked vessel carried only a simple two-masted rig and, at most, a few swivel guns as armament (fig. 19). This was certainly not a vessel intended for a transatlantic crossing. Eventually, with the addition of a deck, these ships began to carry light four-pounder carriage guns. Although *La Belle* is not included, a list compiled by Jean Boudriot of barques longues in the service of the French navy between 1671 and 1750 includes a number of contemporary vessels with dimensions and tonnage identical to hers (table 2).[9] Included in the list is a vessel of 50 tons, built by Pierre Mallet at Rochefort in 1689, named *La Belle II*. Boudriot defines the barque longue as a small vessel carrying four to eight four-pounders and two masts.[10] Figure 20 shows a barque longue at this stage of development.

The only official record of *La Belle* refers to her as a barque of 40 to 50 tons.[11]

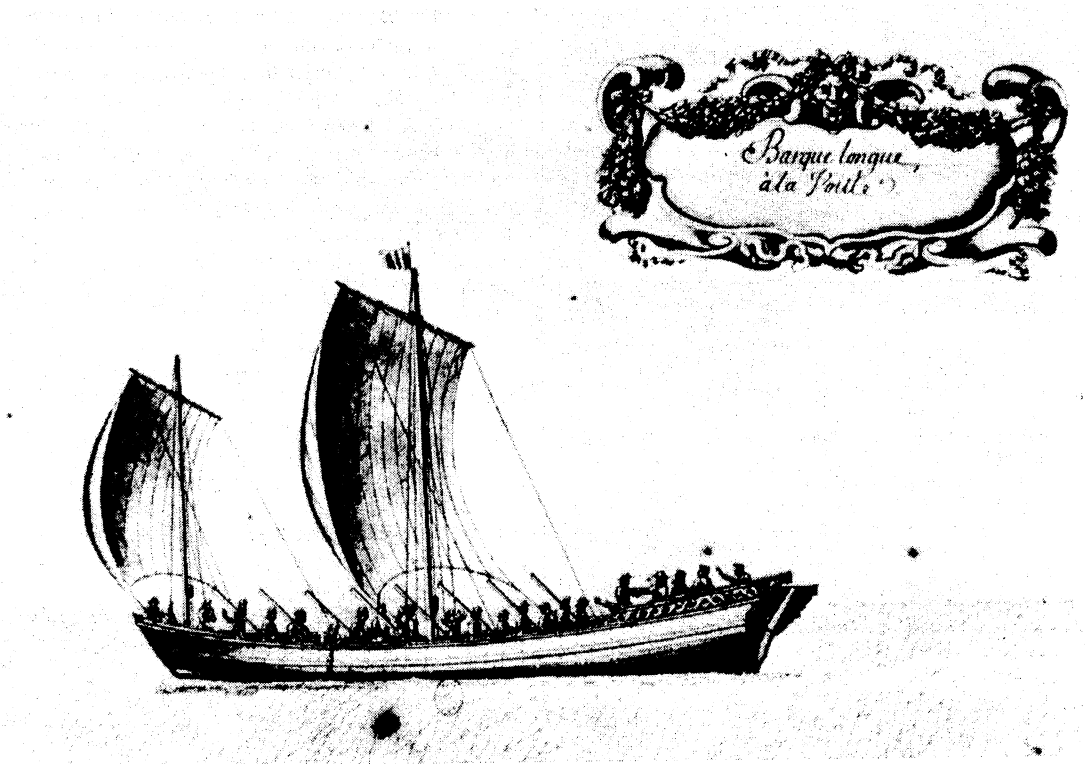


Figure 19. Early representation of a *barque longue* from the album of Jean Jouvé dated 1679. (Jouvé, 1971)

French Barques Longues

Name of Vessel	Date of Construction	Place of Construction	Constructor	Armament	Length	Beam	Depth	Displacement	Crew
Inconnue	1671-1691	Dunkerque	*Hendrick*	4 of IV				40 tons	28
Pouponne	1671-1680	Dunkerque	*Hendrick*	4 of IV				40 tons	28
Fine	1671-1682	Dunkerque	*Hendrick*	2 of IV				30 tons	28
Entreprenante	1671	Brest (1)		4 of IV				40 tons	28
Adroite	1671-1677	Brest		4 of IV				40 tons	28
Hardie (Belle)	1671	Brest		4 of IV				50 tons	28
Assurée	1671	Brest		4 of IV				40 tons	28
Fidèle (Méchante)	1672	Dunkerque	*Hendrick*	4 of IV				40 tons	28
Surprenante	1672	Dunkerque (2)	*Hendrick*	4 of IV				40 tons	28
Ferme (3) (Lutine)	1672	Dunkerque	*Hendrick*	4 of IV				20 tons	28
Corvette (Folle)	1674	Rochefort	*Chaillé*	8 of IV				36 tons	28
Inconnue	1674-1691	Dunkerque	*Hendrick*	4 of IV				20 tons	28
Fine	1674-1682	Dunkerque	*Hendrick*	4 of IV				30 tons	28
Mignonne (Rochelaise)	1675	Le Havre	*Hendrick*	4 of IV				25 tons	28
Subtile	1675	Le Havre	*Hendrick*	6 of IV				30 tons	28
Espérance	1675-1677								
Agathe	1675-1692	Dunkerque	*Hendrick*	6 of IV				35 tons	28
Effrontée	1677-1698	Dunkerque	*Hendrick*	6 of IV (4)	17,55	4,38	1,78	36 tons	28
Assurée II	1677	Dunkerque	*Hendrick*	6 of IV				40 tons	28
Rieuse	1678-1694	Dunkerque	*Hendrick*	8 of IV				55 tons	28
Belle II	1689	Rochefort	*P. Mallet*	6 of IV				50 tons	28
Utile	1689-1710	Dunkerque	*Hendrick*	8 of IV				30 tons	40
Sans Peur	1689-1697	Dunkerque	*Hendrick*	8 of IV (5)	17,87	4,22	1,62	30 tons	40
Méchante II	1689-1699	Brest	*Brun*	10 of IV				50 tons	38
Blonde	1689-1699	Havre	*Chaillé* (6)	8 of IV (6)	21,12	4,55	1,62	50 tons	40
Entendue	1689-1694	Havre	*Salicon*	8 of IV				50 tons	40
Prompte	1689	Havre	*Salicon*	6 of IV				40 tons	35
Levrette	1689-1695	Havre	*Chaillé*	6 of IV				40 tons	35
Sybile	1689-1693	Dunkerque	*Hendrick*	6 of IV				40 tons	30
Rochelaise II	1689-1697	Dunkerque	*Hendrick*	6 of IV				40 tons	30
Fine II	1689-1700	Brest	*Brun*	4 of IV				45 tons	28
Surprenante	1689	Brest	*Hubac*	4 of IV				20 tons	28
Pouponne II	1690-1693	Dunkerque	*Houvens*	6 of IV				50 tons	30
Bonne	1690-1707	Dunkerque	*Houvens*	6 of IV				50 tons	30
Brune	1690-1703	Dunkerque	*Houvens*	6 of IV				50 tons	30
Flatteuse	1690-1696	Dieppe	*Blondel*	2 of I	15,65	3,90	1,62	20 tons	28
Choquante	1690-1702	Dunkerque	*Hendrick*	10 of IV	22,75	5,52	2,43	60 tons	50
Assurée	1690	Dunkerque	*Houvens*	8 of IV				50 tons	30
Rusée	1691-1707	Dunkerque	*Houvens*	6 of IV				48 tons	36
Commode	1691-1697	Dunkerque	*Houvens*	8 of IV (7)	20,15	5,20	1,70	50 tons	36
Flèche	1691-1697	Dunkerque	*Cochois*	6 of IV (8)	19,50	4,55	2,27	50 tons	40
Boussole	1691	Dunkerque	*Cochois*	6 of IV				50 tons	40
Trompette	1691-1703	Dunkerque	*Cochois*	8 of IV (9)	19,50	4,55	1,62	45 tons	40
Biche	1691-1698	Dunkerque	*Houvens* (10)	6 of IV	19,50	4,87	1,78	50 tons	40
Vedette	1691-1702	Dunkerque	*Houvens* (11)	8 of IV (11)	19,50	4,55	2,27	50 tons	40
Emeraude	1691-1702	Dunkerque	*Cochois* (12)	10 of IV (12)	22,75	5,52	2,43	60 tons	50
Dorade	1691-1702	Dunkerque	*Houvens* (13)	8 of IV (13)	21,45	5,03	1,78	50 tons	40
Joyeuse	1691-1702	Havre	*Salicon*	10 of IV				50 tons	50
Utile III	1691-1710	Bayonne	*Masson*	8 of IV	22,53 (14)	5,36 (14)	2,11 (14)	80 tons	35
Nymphe	1692-1698	Dunkerque	*Guillou*	10 of IV	19,50	5,03	1,78	50 tons	50
Prompte	1692-1698	Dunkerque	*Guillou*	8 of IV (15)	19,50	5,03	1,62	50 tons	50
Hautaine	1693-1702	Dunkerque	*Hendrick*	12 of IV	20,80	5,85	1,95	60 tons	50
Volage	1693-1703	Dunkerque	*Vasseur* (16)	12 of IV (16)	20,80 (16)	5,85 (16)	1,95 (16)	50 tons	50
Fouine	1693-1698	Dunkerque	*Guillou*	12 of IV (17)	20,15 (17)	4,71 (17)	1,78 (17)	50 tons	50
Discrète	1693-1702	Dunkerque	*Guillou*	6 of IV (18)	18,52 (18)	4,55 (18)	1,78 (18)	40 tons	40
Allumette	1693-1696	Dunkerque	*Hendrick* (19)	6 of IV (19)	18,52 (19)	4,55 (19)	1,78 (19)	40 tons	40
Fine III	1693-1700	Dunkerque	*J. Houvens*	8 of IV	19,50	4,87	2,27	60 tons	50
Subtile		Dunkerque		6 of IV	19,98	6,47	2,68	50 tons	35
Gentille	1701-1702								
Curieuse	1701-1707	Havre	*Cochois*	6 of III	16,81	4,25	1,97		
Fine	1702-1710	Dieppe	*Blondel*	8 of III	18,20	4,87	1,73		
Gracieuse	1703	Dieppe	*Drouillard*					40 tons	
Turbulente	1703-1707	Brest	*Blaise*	2 of II	16,25	3,20	1,46		
Active	1703	Brest	*Blaise*	2 of II	16,25	3,20	1,46		
Insensée	1703-1707	Brest	*Blaise*	2 of II	16,25	3,20	1,46		
Diligente	1703-1712	Dieppe	*Cochois*	6 of IV	17,22	4,87	2,11		
Marie-Francoise	1703-1716	Havre	*Cochois*	6 of IV	16,90 (20)	5,20 (20)	2,27 (20)	45 tons	60
Trompette	1706-1717	Brest	*Blaise*	6 of III	18,20	4,71	1,78		
Levrette	1707-1708	Dunkerque	*Levasseur*	8 of IV	20,80	5,68	2,27		
Cigale	1707-1708	Dunkerque	*Levasseur*	8 of IV	20,80	5,68	2,27		
Vipère	1707	Dunkerque	*Levasseur*	8 of IV	20,80	5,68	2,27		
Agile	1707-1708	Dunkerque	*Levasseur*	8 of IV	20,80	5,68	2,27		
Étoile	1708-1718	Rochefort	*Masson*	8 of IV	21,45	5,20	2,60	78 tons	70
Agathe	1708-1718	Rochefort	*Masson*	8 of IV	21,45	5,20	2,60	78 tons	70
Driade (21)	1734-1745	Havre	*Geslain*	8 of VI (21)	24,37	7,47	2,92	90 tons	80
Naïade	1734-1745	Havre	*Poirier*	8 of VI (22)	22,10	6,22	2,43	70 tons	70
Badine	1744-1750	Brest	*Deslauriers*	6 of III	21,45	5,68	2,38	70 tons	60

Remarks:

A. This list has been drawn up in accordance with the successive establishments of the French Navy. These documents, relatively summary up to the last years of the 17th century, subsequently provide more precise information, particularly as regards the three major dimensions of the craft.

The exactitude of the establishments is not absolute; errors by scribes, differences as regards dimensions, displacements, armaments, changes in constructors' names, . . . these can be found in repeated instances!

As regards armaments, these can be changed from one establishment to the next, and the name of the constructor who designed can be confused with that of the constructor charged with the actual building.

The displacement is no more than a general guess. But variations in dimensions so well defined as beam and depth are involved; for one does concede that the length of a vessel may be taken in various ways. You have to be on the alert in general when you are working with the Navy establishments.

B. You will notice that no *Barque longue* was built in the East [i.e., on the Mediterranean coast]. This type of craft was in fact not used in the Mediterranean, its place being taken by lateen rigged boats, *brigantins*, and feluccas, etc. Captured or foreign-built *barques longues* do not appear in this table.

C. Lengths are given from outer edge of stempost to outer edge of sternpost. Beam is given at the midship frame, planking excluded. Depths are given from top of keel to straight line of midship beam.

Notes:

1. Also listed as built at Ostende.
2. Another built at Ostende in 1674.
3. Also called *Utile*.
4. Armament also given as 4 four-pounders.
5. Variant: armament of 4 four-pounders.
6. Variants: armament of 4 four-pounders, and constructor: Simon.
7. Variant: armament of 6 four-pounders.
8. Variant: armament of 4 four-pounders.
9. Variant: armament of 6 four-pounders.
10. Variant: Cochis as constructor.
11. Variants: armament of 6 four-pounders.
12. Variants: armament of 8 four-pounders, and F. Hendrick as constructor.
13. Variants: armament of 4 four-pounders, and Cochois as constructor.
14. Variant dimensions: 22.42, 5.52, and 2.43.
15. Variant: armament of 12 four-pounders.
16. Variants: J. Hovens as constructor; dimensions 19.50, 5.20, and 2.43; armament of 8 four-pounders.
17. Variants: dimensions 19.50, 5.20, and 2.43; armament 8 four-pounders.
18. Variants: dimensions 15.60, 4.22, and 1.95; armament 4 four-pounders.
19. Variants: Houvens as constructor; dimensions 15.27, 3.73, and 1.95; armament of 4 four-pounders.
20. Variant: dimensions 18.52, 5.68, and 1.95.
21. This vessel was to carry 12 four-pounders, and it may possibly have had 3 masts.
22. Variant: armament 10 four-pounders. It is possible that the *Driade*, considering its length, was rigged with three masts; that way we would no longer be dealing with a *barque longue*, and perhaps it ought not to appear in this list. In 1744 they were content to construct two craft, the *Palme* and the *Perle*, carrying 12 guns; these are no longer *barques longues*, but true corvettes.

Table 2. **Barque longues in the service of the French Navy between 1671 and 1750.** (In Boudriot, 1981)

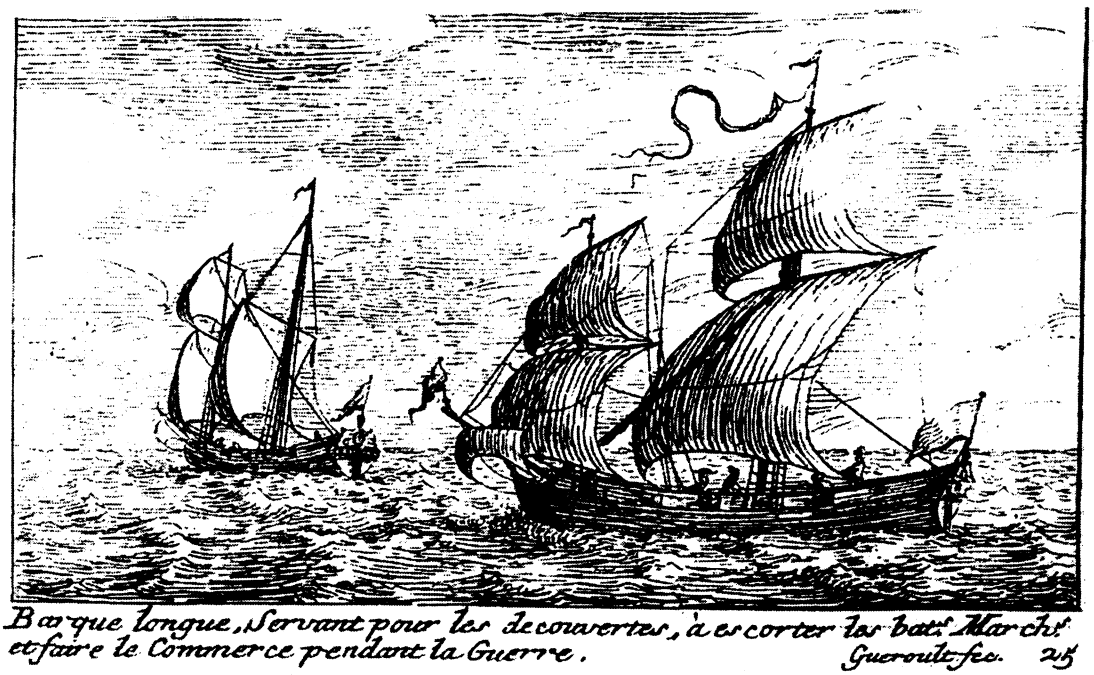


Figure 20. Drawing of a *barque longue* from the album of Guéroult du Pas. (In Boudriot, 1981)

Several definitions in Falconer's Marine Dictionary indicate that the word barque is a general term that was applied to a range of small ships.[12] Joutel's journal provides the most complete description of *La Belle*. Referred to as a *bark* throughout the journal, Joutel introduces *La Belle* as "a little frigate, carrying six guns."[13] Falconer defines a bark as "a general name given to small ships: it is however peculiarly appropriated by seamen to those which carry three masts without a mizzen top-sail."[14] It is difficult to determine whether the definitions and translations provided by Falconer's dictionary can be applied to a vessel built a century earlier. However, there is less ambiguity in Joutel's use of the word frigate. One of the defining features of frigates is the use of a three-masted ship rig. Joutel later mentions a collision between *Le Joly* and *La Belle* in which "the vessel *La Belle* would have been in danger of perishing, but escap'd with the loss of her mizzen, which came by the board."[15]

Another eyewitness account from the Spanish sailor Juan Enriquez Barroto provides further evidence that the vessel had three masts. Coming upon the remains of *La Belle* in 1687, one year after she ran aground, Barroto states: "On the beach was found the other gun carriage and the main yard, which was measured and found to be 16 cubits. We brought this yard and that of the fore topsail for making oars, and from that of the foresail boom was made four oars. Captain Pedro de Yriarte took that of the mizzen also."[16] The mizzen yard would have carried a lateen sail and would be easily distinguishable from the yards for the fore and main masts.

If these eyewitness accounts are accurate, it is difficult to refute the assertion that *La Belle* carried three masts. As a commander on board *Le Joly*, Henri Joutel had sufficient knowledge of French ships to give a reliable description of the rigging of *La*

Belle. This is significant, for it provides the only evidence that the barque longue had evolved into a form that could be considered a light frigate.

What evidence do the archaeological remains hold to indicate how *La Belle* was rigged? Remains of mast steps for both the foremast and the main mast have survived. However, the absence of a mizzen mast step among the recovered material does not rule out the possibility of a mizzen mast. Traditionally, the mizzen of a frigate is not stepped on the keel as are the other two masts, but is supported on the lowest deck. Indeed, there is evidence for a small platform in the stern hold of *La Belle*. Contemporary models place the heel of the mizzen anywhere from one third to just short of one half of the distance between the taffrail and the main mast.[17] Dassié places it approximately four-ninths of this distance.[18] This ratio situates the heel of the mizzen on *La Belle* close to the forward end of this small platform (fig. 21).

Taking into consideration the steep rake of her sternpost, the proposed reconstructed length of *La Belle* places the main mast slightly forward of the longitudinal center point. No reliable contemporary representations of two-masted vessels place the main mast so far forward, suggesting that a third mast was needed to balance the rig. This would be particularly true if the main mast was square rigged, as indicated by Baroto's reference to the main yard. Thus the preponderance of evidence, both historical and architectural, points to *La Belle* being a three-masted vessel.

From Joutel's journal, it is known that *La Belle* was armed with six guns. This corresponds with the data in the table compiled by Boudriot. It appears that six four-pound cannon composed the typical armament for a barque longue of this size. Four 4-pounder bronze guns intended for the colony La Salle hoped to establish were placed

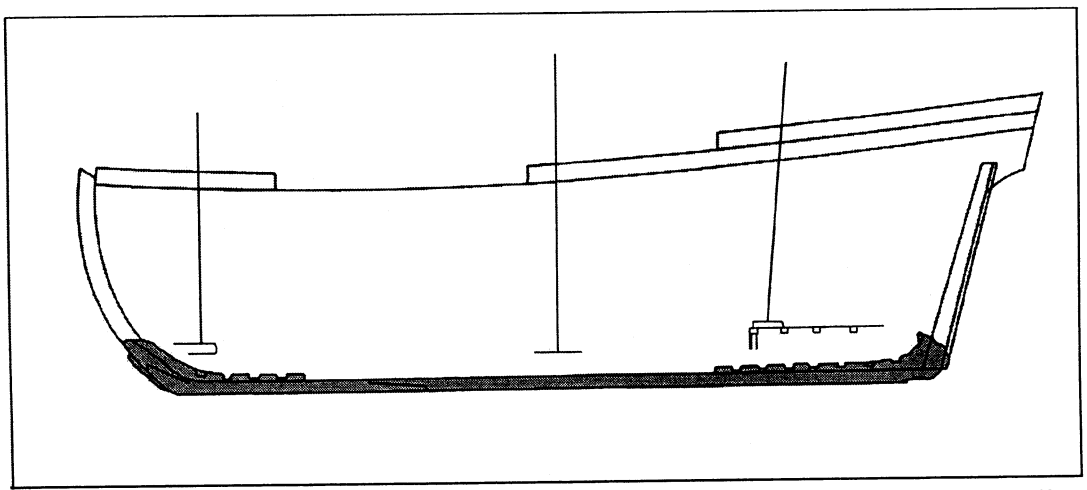


Figure 21. Longitudinal profile showing the reconstructed orientation of *La Belle*'s three masts. Drawing by G. Grieco.

within the hold of *La Belle*. However, only a single gun carriage and one swivel gun have survived of the weapons carried on deck.

When the remains of *La Belle* were first encountered by two pilots from Baroto's ship, they reported finding "a lost ship that has 3 fleurs-de-lis on her poop; six pieces of artillery, mounted, woolded, and hove down; two iron swivel guns without chambers, which they brought in our canoe."[19] From this description, it appears that there were six carriage guns on deck secured with lashings. Baroto himself observed five swivel guns the next day "that fire a ball up to four pounds... still upon their carriages, lashed to the side of the ship."[20] The discrepancy in the number of observed carriage guns may indicate a misuse of the term carriage in the second passage. One swivel gun recovered from the wreck had a bore diameter close to that of a four pound ball. It is possible that the swivel guns would have been lashed to the sides of the vessel when not in use. While discussing the ordnance, he states that the hull has "eight portholes and as many other flues."[21] If the word *flue* indicates the pipe or post attached to the side of the vessel to support a swivel gun, then seven of eight guns were accounted for at the time. The single swivel gun recovered by the Texas Historical Commission could be the eighth gun that fell from the side of the hull before the ship was found by Baroto.

But what of the eight portholes mentioned by Baroto? It was common for vessels to have more gunports than the actual number of guns on board. Guns could be moved from one side of the vessel to the other to increase the firepower of a broadside or to transfer weight to adjust the vessel's trim while sailing. Baroto may have also been referring to other types of ports, as it was common to have ports for hawsers or

for light and ventilation in the stern cabin. These problems will be discussed in greater detail in the discussion of the gunports.

All evidence indicates that *La Belle* was a frigate, just as Joutel described her. Her appearance would have been similar to a light frigate illustrated by Guéroult du Pas in 1710 (fig. 22).[22] Except for the extra gunports, the hull shape and rig are probably similar to those of *La Belle*.

In a memorandum written in 1743, Blaise Olivier discusses the design of frigates, light frigates, and sloops of war. He states: "In the event that we should build sloops of war of ten, eight, six, or four guns, they should be fitted out like those of twelve guns."[23] Although this description was written many years after *La Belle* was built, Olivier's description of the sloop of war provides further insight into her appearance.

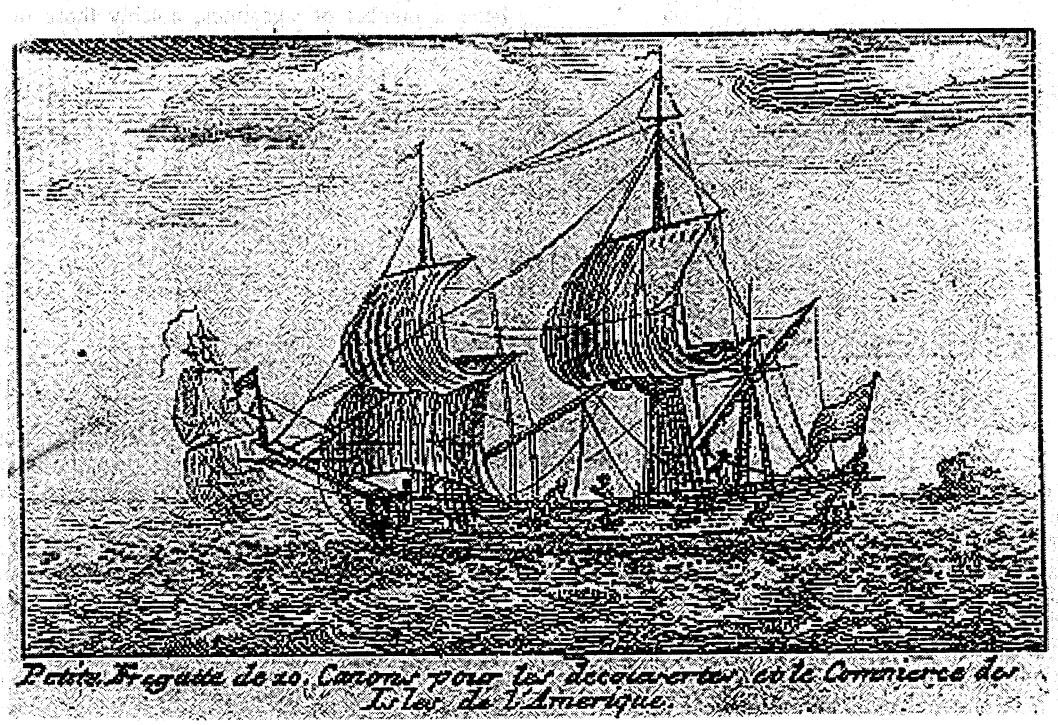


Figure 22. Drawing of a light frigate from the album of Guéroult du Pas. (In Boudriot, 1993)

CHAPTER V

RECONSTRUCTING A SET OF LINES

A large amount of data is available for a reconstruction of the lines of *La Belle*. The dockyard manuscript prepared in December 1686, two years after she was built, gives many of the overall dimensions needed for her reconstruction, and a set of reconstructed lines based on the archaeological remains, drawn by Greg Cook for the Texas Historical Commission (fig. 23), provides a good first impression of the shape of her hull.

The first step in producing a set of lines for *La Belle* was to determine the shape of the midship section. Fortunately, a large portion of the starboard side of the hull at midships has survived. Adjusted so the centerline of the frame is vertical, the remains of the midship frame form the basis of the reconstruction. In Joutel's description, the draft of *La Belle* is given as 7 feet (2.268 m). If this is accurate, the archaeological remains represent almost the entire midship section up to the waterline. Figure 24 shows a representative section near midships that combines the archaeological and archival data.

The beam of *La Belle* is recorded as 14 French feet (4.553 m). Typically, beam measurements are taken to the outside of the widest point of the midship frame. However, in this case, this measurement does not fit the reconstructed lines. In fact, measured to the outside of the frame, the beam of *La Belle* is close to 15 feet (4.878 m). This indicates about 6 inches (16.3 cm) of outward deformation near midships on the starboard side of the remains. However, four frames aft of midships, the remains of

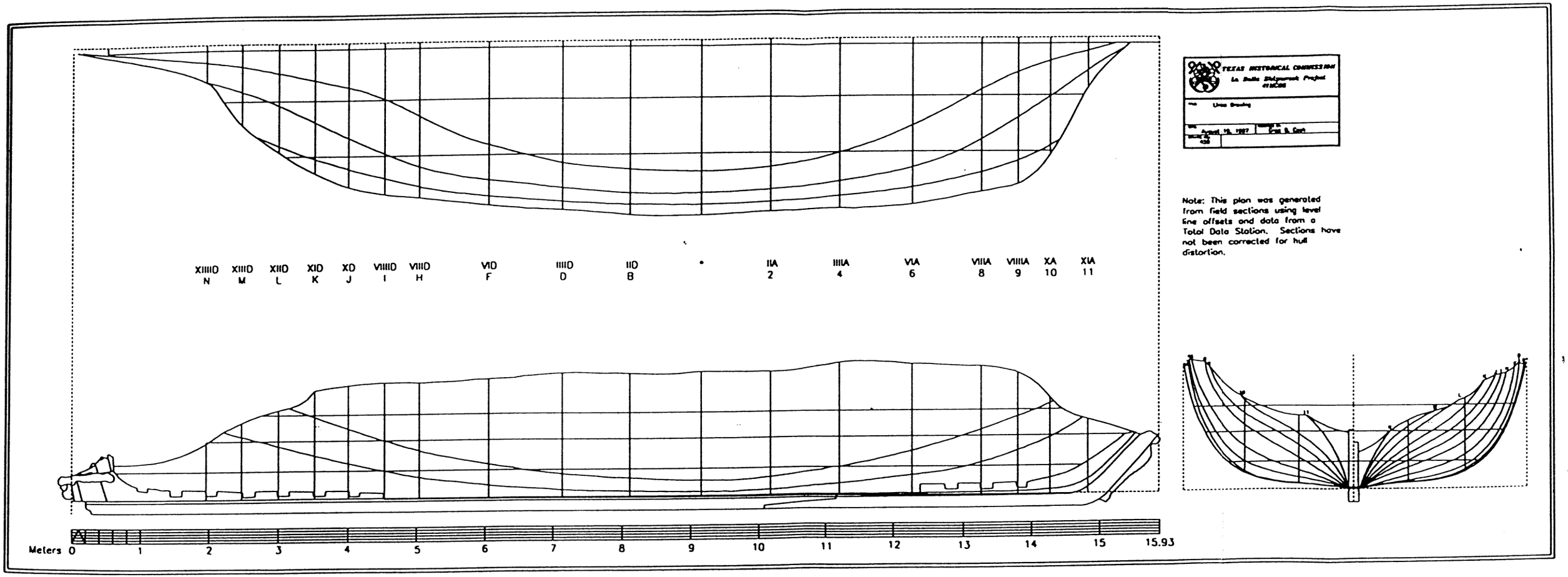


Figure 23. Reconstructed lines of *La Belle* created from data gathered during the excavation and disassembly.
Courtesy of the Texas Historical Commission.

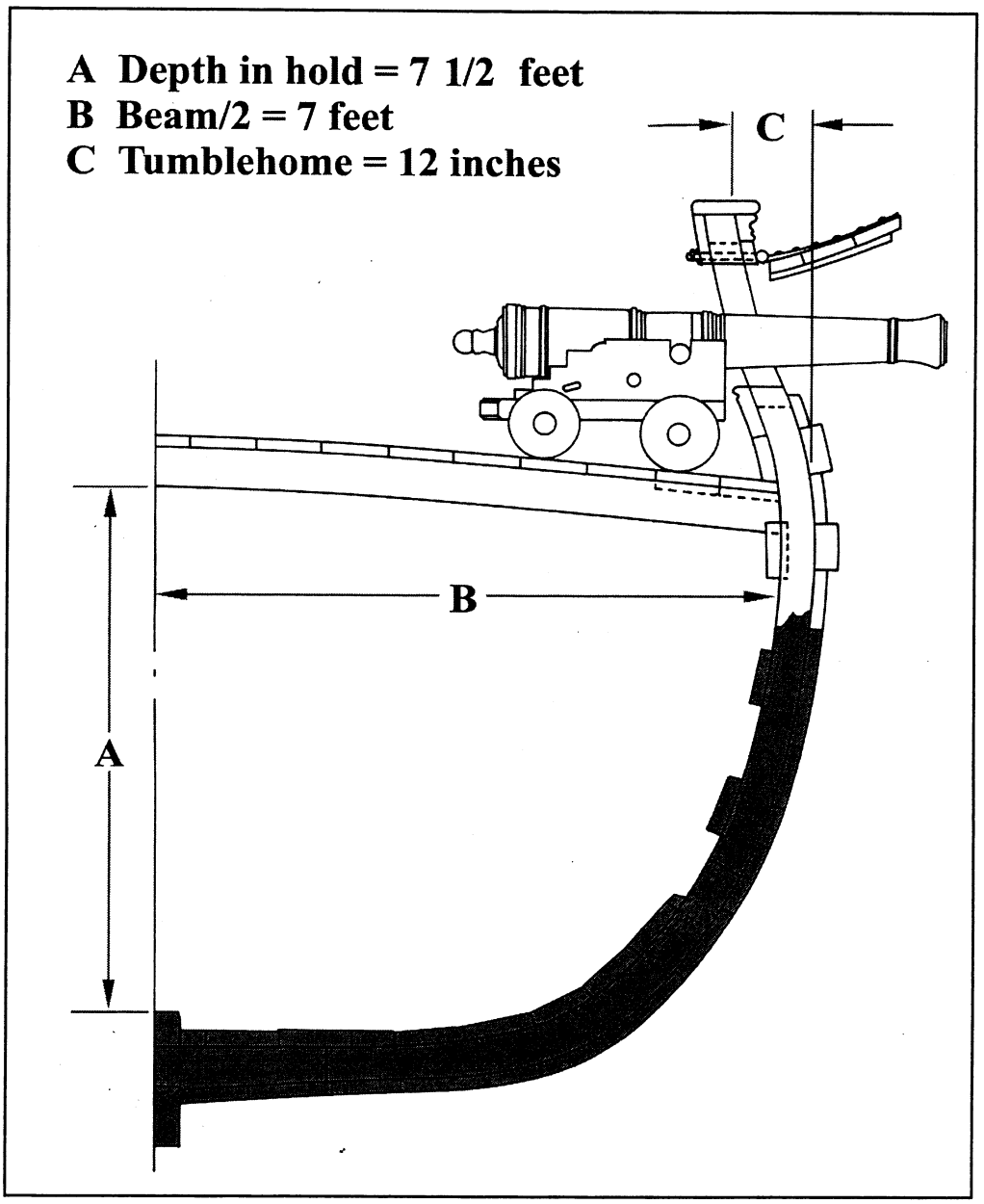


Figure 24. Reconstructed midship section. Existing remains of the hull are shaded. Drawing by G. Grieco.

the second bulkhead still fit tightly within the interior of the hull. If the beam was reduced by a foot, the bulkhead would not fit. The date of the manuscript provides a clue for resolving the discrepancy. Dated December 1684, it appears the dimensions were taken off the completed vessel. Actual measurements to the widest part of the midship frame on a planked vessel would have been difficult to obtain. In such cases, it is easier to measure to the inside of the bulwarks at the widest point of the vessel. The 4-inch (10.8 cm) molded dimension of the futtock and 2-inch (5.4 cm) thickness of the plank immediately above the waterway account for the 6-inch (16.3 cm) difference on each side. This dimension gives the width of the deck at midships. Some seventeenth-century formulas for masting a hull relied on this internal dimension. It is also possible that this dimension was used for fitting out the vessel and that the measurements were taken for such purposes.

Using the beam measurement of 14 feet (4.553 m), a height of maximum beam amidships of 6 feet, 3 inches (2.033 m), and a tumblehome of 12 inches (32.5 cm), the remaining shape of the frame was reconstructed.

Before this shape could be accepted, it was necessary to ensure that it corresponds with the actual construction details. These details are mentioned here only to describe their contribution to understanding the lines of the vessel. They will be described in greater detail in the discussion of the construction of the model.

According to the dockyard manuscript, *La Belle* had a depth in hold of 7 feet (2.276 m). This dimension is measured from the top of the keelson to the underside of the deck beam. The camber of deck beams has varied through time. It also varies among different ship types and among different decks on a single ship. A number of

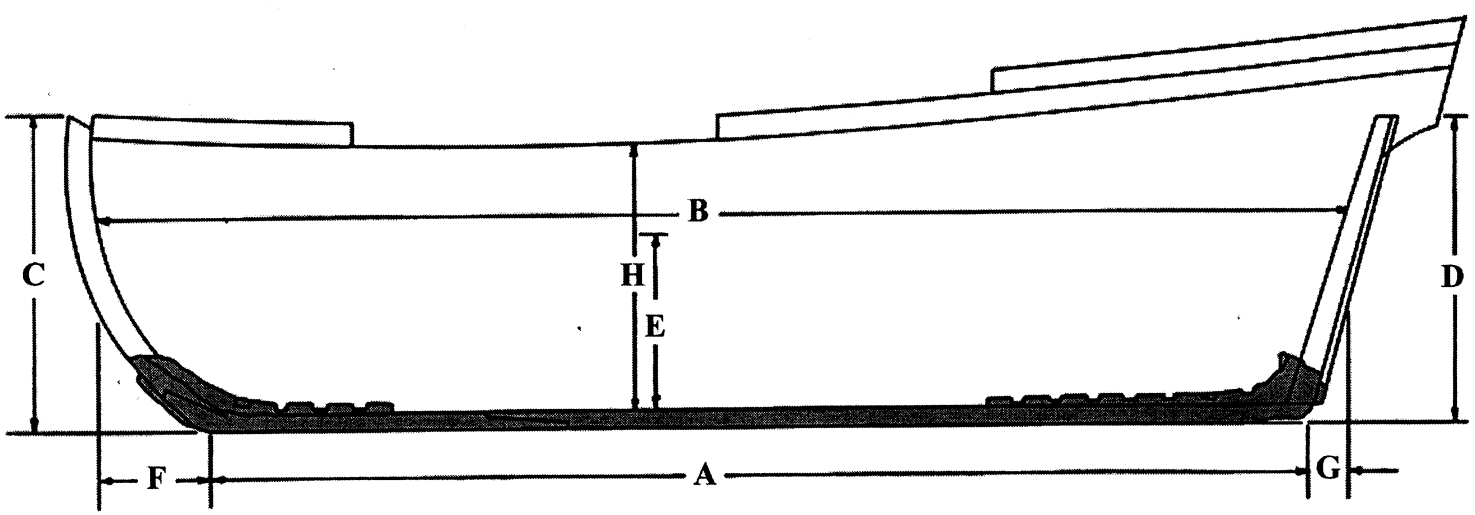
drafts from the late seventeenth and early eighteenth centuries were examined and a camber of 4 inches (10.8 cm) in 14 feet (4.553 m) was concluded to be appropriate for this hull. There is little scantling information available for vessels as small as *La Belle* . Deck beams of 8-inch-by-8-inch (21.7 by 21.7 cm) or 8-inch-by-10-inch (21.7 by 27.1 cm) sections are common, but these are too large for a vessel of this size. Beams measuring 6 inches by 6 inches (16.3 by 16.3 cm) are often seen in the forecastle and quarter decks of larger vessels and seem more appropriate for a vessel the size of *La Belle*. Using beams of this size, a camber of 4 inches (10.8 cm), and deck planking 2 inches (5.4 cm) thick, it was possible to lay out the deck structure, complete with clamps and waterway. Interestingly, if a clamp of the same dimensions as the two lower stringers is used, all three timbers are placed at even intervals from the end of the ceiling plank. This configuration also supports the apparent lack of hanging knees.

If *La Belle* carried cannon, she also needed gunports. There are many good references to the established dimensions for gunports. However, at the time the models were constructed, the smallest caliber gun for which gunport dimensions could be found was an eight-pounder. The four-pounders that *La Belle* carried were 25 percent smaller and sat significantly lower than an eight-pounder. To determine the height of the gunport sill, the dimensions of the gun and its carriage were reconstructed. Luckily, a single gun carriage survived from *La Belle*. Several of the iron cannons carried on board the *Amiable* during La Salle's voyage were excavated by the Texas Historical Commission in 1996 and recorded by Curtis Tunnell.[24] The eight cannon, ranging in caliber from three- to six-pounders, were the typical pattern used aboard French ships of the 1670s and 1680s.[25] Using dimensions for one of the four-pounder

barrels and the drawings of the disassembled gun carriage, a mock-up was built to test the clearance of the barrel over the sill and the top of the port. The remains of a single gunport lid hinge provided further evidence that the vertical dimension of the outer face of the lid is around 19 inches (51.5 cm). Using these dimensions, the probable arrangement of the wales, gunports, planking, sheer molding and caprail was determined. The height of the sheer amidships was calculated to be approximately 11 feet, 2 ½ inches (3.645 m).

Once the shape of the midship section was determined, the next step was to define the longitudinal profile of the vessel (fig. 25). The length of the keel was known from both the archaeological remains and the dockyard manuscript, and the rest of the hull was reconstructed from the remaining dimensions provided in the document. It appears that the overall length of the vessel was measured from the rabbet of the stem to the rabbet of the sternpost at about the height of the deck. The value for the rake of the stem describes the distance between the forward end of the keel and the forward end of the overall length. The rake of the sternpost is measured from the after end of the keel to the aft perpendicular of the vessel. Knowing that the after face of the sternpost is raked 74 degrees and that the rake measures 1 foot, 6 inches (48.8 cm), it was calculated that the height at which the length was taken was approximately 8 feet, 3 inches (2.683 m). This corresponds closely to the height of the deck. By transferring this height to the stem and using the known value for the rake of the stem of 4 feet, 6 inches (1.463 m) at this point, the curve of the bow was established. The profile of the bow was completed by continuing the curve to a height of 12 feet (3.902 m).

To complete the lines of the stern, the shape of the transom was determined.



A Length of keel = 45 feet
B Length from stem to stern = 51 feet
C Height of stem = 12 feet
D Height of sternpost = 11 feet
E Depth in hold = 7 feet 6 inches
F Rake of stem = 4 foot 6 inches
G Rake of sternpost = 1 foot 6 inches
H Height of midship section = 10 feet 6 inches

Figure 25. Reconstructed longitudinal profile incorporating dimensions from the Rochefort dockyard manuscript. Drawing by G. Grieco.

The height of the wing transom is given as 9 feet, 4 inches (3.035 m), but no other dimensions are provided. In order to determine the length of the wing transom, the French naval regulations of 1673[26] were examined. The document mandates that the wing transom should be two-thirds of the extreme breadth, or 10 feet (3.252 m), if the extreme breadth is measured to the outside of the midship frame.

For the reconstruction, the shape of the vessel was assumed to be a sloop or light frigate. The main deck ran from the bow to just aft of the mizzen, where a break in the deck of 2 feet (65.0 cm) forms the floor of a small stern cabin. A short quarterdeck in the stern and a forecastle deck in the bow were located 3 ½ feet (1.138 m) above the main deck.

Based on these data, a set of lines were created. Sections provided in reconstructed lines drawn by Greg Cook were used to guide the process. There was some concern about the accuracy of sections VIIIA and XA in the reconstructed lines; however, extra weight was given to those sections that corresponded to bulkheads within the vessel. These bulkheads served as internal templates and provided a means of checking the curvature of these sections. A series of lines were drawn and manipulated until a fair hull was established, conforming closely to the reconstructed lines of the vessel. After the models were completed, slight alterations necessary to accommodate construction features were added to the lines. The final set of lines is presented in figure 26. A preliminary set of construction drawings and a drawing of the disposition of the frames were prepared based on the set of lines. From these drawings, the shapes of individual timbers for the construction of an accurate frame model could be determined.

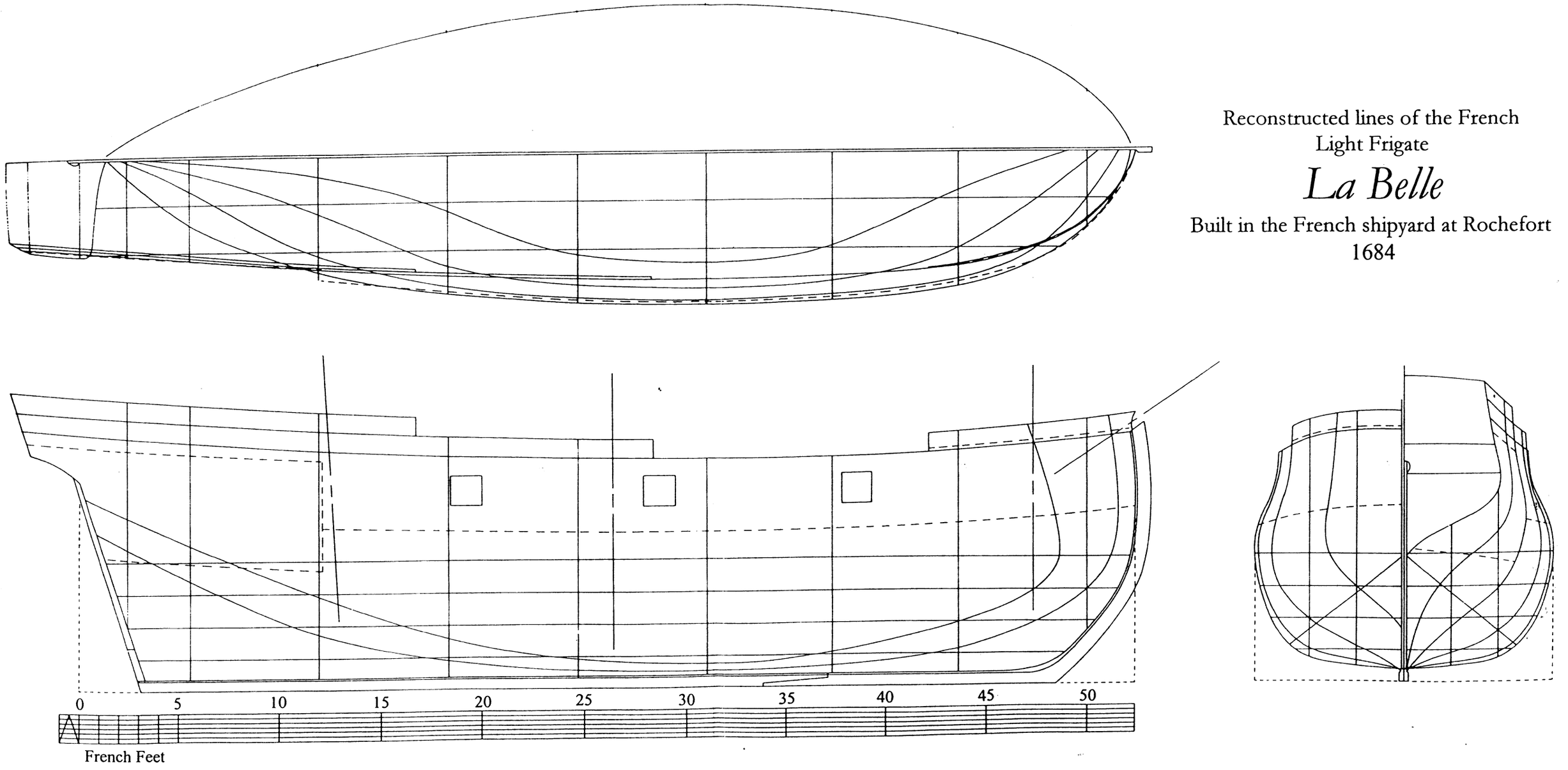


Figure 26. Reconstructed lines used to create the two models of *La Belle*. Drawing by G. Grieco.

CHAPTER VI

MATERIALS

This chapter provides a brief description of the original construction materials and how they are represented in the model. Materials were chosen not only for their appearance but, more importantly, for the similarity of their mechanical characteristics to those of the original materials. One goal of the modeling process was to determine the structural characteristics of the original ship by reproducing the construction techniques used to build it.

An inspection of contemporary Navy Board ship models provided many ideas regarding possible materials for the models built during this study.[27] These models were typically built by the same shipwrights that were later responsible for building the full-sized vessels. Occasionally, riggers and sailmakers also contributed their skills to the models. The resulting models are not only accurate representation of specific ships, but also provide valuable information regarding the building techniques used by contemporary shipyards.

Wood

Of the many species of oak found throughout Europe, the most widespread species during the seventeenth century was the white oak (*Quercus robur pedunculata)*. Its availability throughout France made it one of the most commonly used woods in French shipyards. Preliminary investigation of timbers from *La Belle* indicates that she was built predominantly of white oak, although it appears that pine

was used for the planking of the three internal bulkheads.[28]

All Navy Board models were built almost entirely of either pearwood *(Pirus communis*) or boxwood (*Buxus sempervirens*). Chosen for their fine grain, these woods have the appearance of oak relative to the scale of a model. Both of these woods are relatively expensive and boxwood is now nearly impossible to obtain in pieces of the size required to construct a 1:12 model of *La Belle*. Therefore, it was initially decided that both models would be constructed of American cherry (*Prunus serotina*). This wood was used successfully for the heavier timbers such as the keel, stem, sternpost, deadwood, and frames, and was used to construct the frames of both models. The first hull was built almost entirely of cherry wood. Although the results were satisfactory, some problems were experienced when planking the hull. The open grain of the cherry wood tended to split around the tight curves of the model, and any attempts to steam the planks greatly distorted their dimensions. Problems were also encountered in achieving the desired detail in moldings and decorative features. Overall, the coarse, open grain of the wood was inappropriate at this scale. Cherry was abandoned in favor of pearwood for the planking of the second model. The tighter-grained wood conformed to the curves of the model with considerably less effort and allowed a degree of detail that would not have been possible using cherry.

On both models, white poplar (*Populus alba*) was used for masts and spars. The fine, straight grain of this species of hardwood makes it ideal for long, narrow timbers. Another type of wood used in this model that is not typically used in constructing models is lignum vitae (*Guaiacum officianale*). This hard, oily wood normally has a greenish-yellow color, and has a visible grain that makes it undesirable

for model making. A small amount of lignum vitae was recovered from the sunken city of Port Royal, Jamaica, where it was buried during an earthquake in 1692. Submerged for three hundred years, the wood has a dense black color that was considered desirable for use as deadeyes on the model.

Metals

The most common metal used on board the original *La Belle* was iron: all bolts and nails used in her construction were forged from iron. Numerous other structural fittings such as gunport hinges, deadeye straps and gudgeons were also made of wrought iron. Forging iron fittings for a scale model would be an extremely difficult task. Close examination of contemporary models reveals that their iron fittings are actually blackened brass. The malleable nature of brass allows it to be worked in small scale in a manner similar to full-sized wrought iron elements, with solder taking the place of forged welds. Using this technique, the iron fittings of *La Belle* were accurately replicated on the models. Two methods were used to blacken the brass. Smaller parts were soaked in a selenium dioxide solution until the desired appearance was obtained. For larger parts such as cannon barrels, where a more uniform graphite appearance was desired, the part was first sprayed with a coat of Krylon© clear acrylic. Powdered graphite was then rubbed over the entire surface of the part. Alternate applications of Krylon© and graphite were used to build up a convincing iron appearance. A final coat of Krylon© was used to fix the final application of graphite.

A lead hawse hole lining and a lead sieve for one of the pump tubes were found on the wreck. Both were reproduced in lead for the models.

Rigging

Most of the lines in the rigging of the original *La Belle* appear to be made of hemp.[29] For the model, the rigging was made entirely of linen bookbinding thread. In addition to its authentic appearance when stained, its behavior when twisted into scale rope is similar to the behavior of the full-sized original. Except for standing rigging, most rigging lines on a ship are allowed to hang slack under their own weight, creating gentle curves. This is not only an aesthetic concern, but is also a consideration when properly planning the run of the rigging. Bookbinding thread has the additional advantage of being acid free, reducing the risk of deterioration sometimes seen in some of the older contemporary models.

CHAPTER VII

RECONSTRUCTING THE HULL

The objective of this chapter is not to provide instruction in model building. In fact, many of the techniques used differ from those traditionally used by model builders. For those who are interested in traditional model building, there are numerous good books on the subject such as Charles Davis's *The Built-up Ship Model*[30] or Harold Underhill's *Plank on Frame Models*.[31] The goal of this study was not to produce an aesthetically pleasing model, but to build a model that reflects the craftsmanship, construction techniques, and flaws of the original vessel. For example, while planking the hull, it would have been easier to plan and lay out the runs of planking to create a fair and even pattern. However, by reproducing the uneven widths of the planking as recorded from the archaeological remains, valuable information was learned about their order of installation and the shipwright's use of available materials. The planking also helped to confirm that the reconstructed shape of the hull is accurate.

Many good references on model making techniques are widely available. For this reason, specific techniques will only be mentioned when they help to shed light upon the methods originally employed to construct the full-sized vessel. This chapter will concentrate on the insights provided by these techniques about the construction of *La Belle*.

As previously stated, the most valuable source of information for the construction of the models was the archaeological remains of the ship. The surviving frames and internal structure of *La Belle* provide the most reliable evidence of her

construction. For this reason, it was considered desirable to display as much of the internal structure of the model as possible. Planking the entire vessel would have obscured important information. In order to best exhibit the reconstruction of the actual archaeological remains, one side of the vessel was left unplanked, allowing the internal structure to be viewed within the hull. Because a significant portion of the starboard side of the ship has survived, this side was completely reconstructed. The port side was not planked, leaving the frames exposed.

Modeling the Frames

Before construction of the models could begin, accurate templates were required for each component of the keel, stem, sternpost and frames. Templates for the longitudinal timbers were derived directly from the construction drawings. In order to create molds for the thirty square frame timbers, additional drawings were required. Using a set of lines superimposed over the drawing of the framing plan, the curvature of each frame pair was lifted from the drawing and plotted as a section. Because each pair was composed of two overlapping timbers, three faces were plotted to establish the bevel of the external molded faces. Once the outline of the frame was plotted, the molded thickness, as measured from the actual timbers, was used to establish the internal bevels of the frames. To complete the drawing, the locations of the butt joints between each timber were marked. Using these drawings, templates for the individual floors and futtocks of each frame were obtained.

Paper copies of each template were affixed to pieces of wood, which were then planed to the appropriate sided dimensions. Each timber was then sawn to shape and

filed to obtain the correct bevel (fig. 27). Using the body plan of the hull as a mold loft, the frames were assembled from the individual floors and futtocks (fig. 28).

The construction of the keel, stem and apron was relatively straightforward. Fastened together using the appropriate scarfs, the only deviation from the original construction was the use of bamboo dowels in place of iron fasteners. Although the types of fasteners used on *La Belle* were known, data regarding their precise locations was not yet available at the time that the models were built. To avoid confusion, only those iron fasteners whose locations had been accurately determined were represented in the model. The remaining fasteners were represented by bamboo "treenails" using the general overall pattern of the original fasteners.

Once the stem and keel were in place, it was necessary to construct the stern assembly. Unfortunately, nothing remains of the transom of *La Belle*. During the late seventeenth century, French naval regulations required that all vessels be built with the newly-developed round tuck stern.[32] However, this regulation was frequently ignored until well into the first half of the eighteenth century. It is probable that a vessel the size of *La Belle* would have been constructed with a square stern.

The typical practice in French shipyards was to erect the sternpost with the transoms and fashion pieces already in place as illustrated in the *Album de Colbert* (fig. 29). The fashion piece was essentially the last frame and determined the contours of the lower stern. The wing transom was fastened between these timbers and rested with its center on top of the inner post. Below the wing transom, two or three additional transoms helped to reinforce the stern assembly and provided a framework for the stern planking. Figure 30 shows the stern assembly of the model, complete with fashion

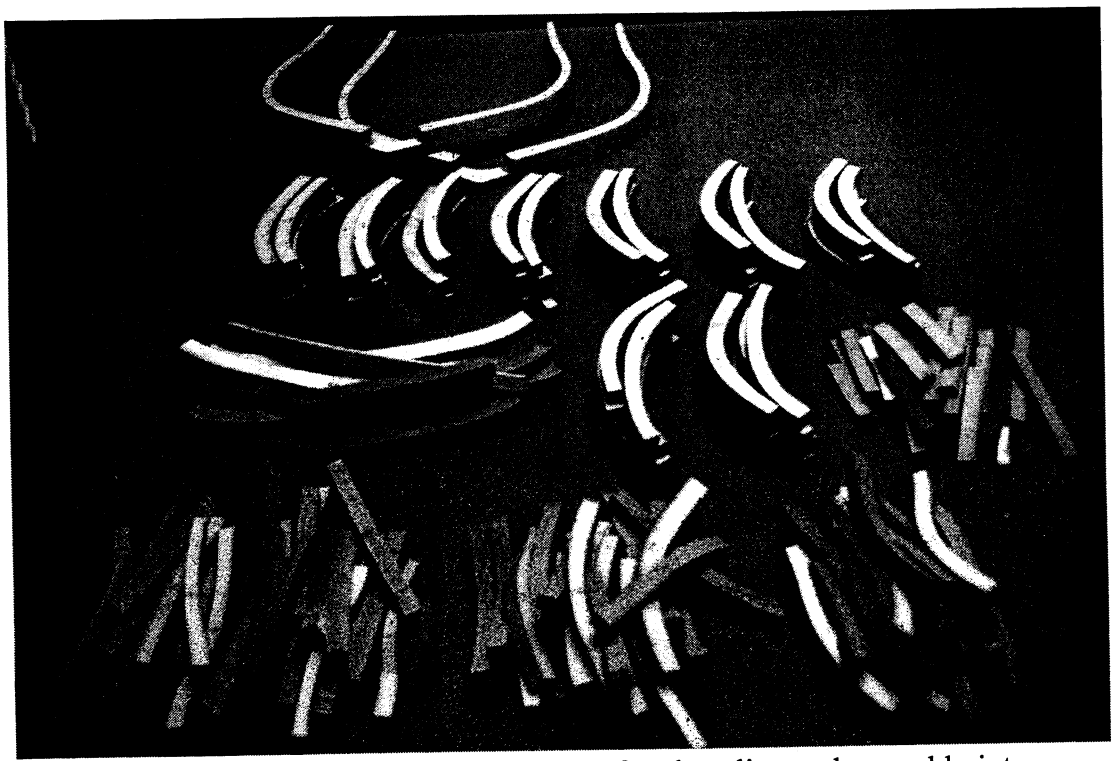


Figure 27. Rough cut model frame timbers before beveling and assembly into frames. Two completed frames can be seen in the background. Photo by G. Grieco.

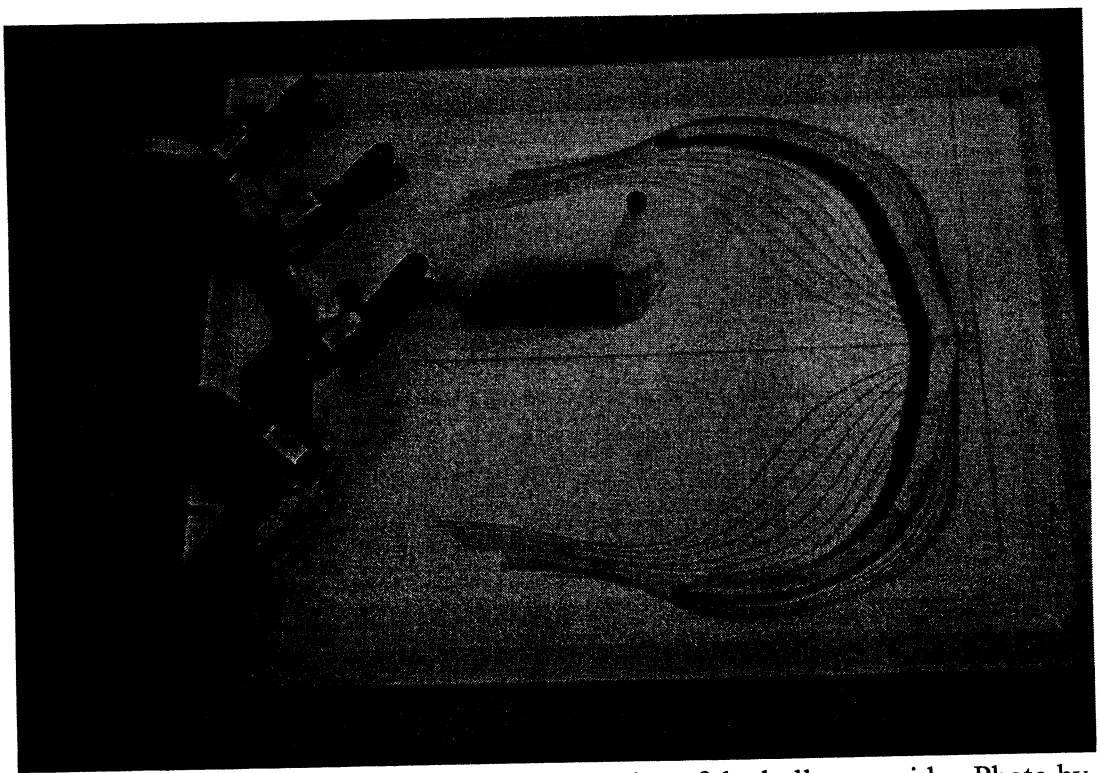


Figure 28. Lofting the frames using the body plan of the hull as a guide. Photo by G. Grieco.

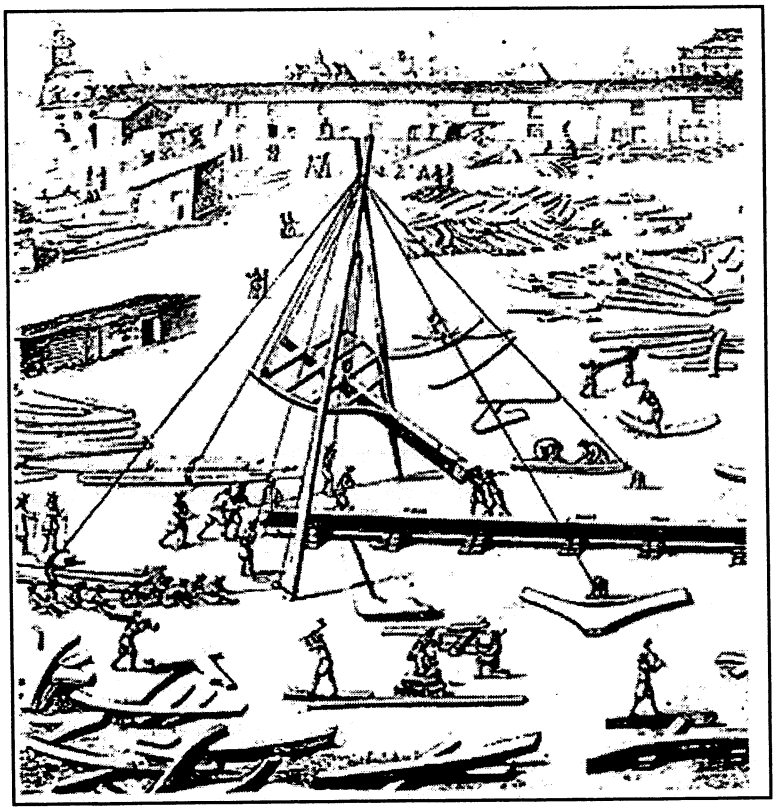


Figure 29. Detail from Plate 1 of the *Album de Colbert* showing the method of erecting the stern assembly. (*Album de Colbert*, 1988)

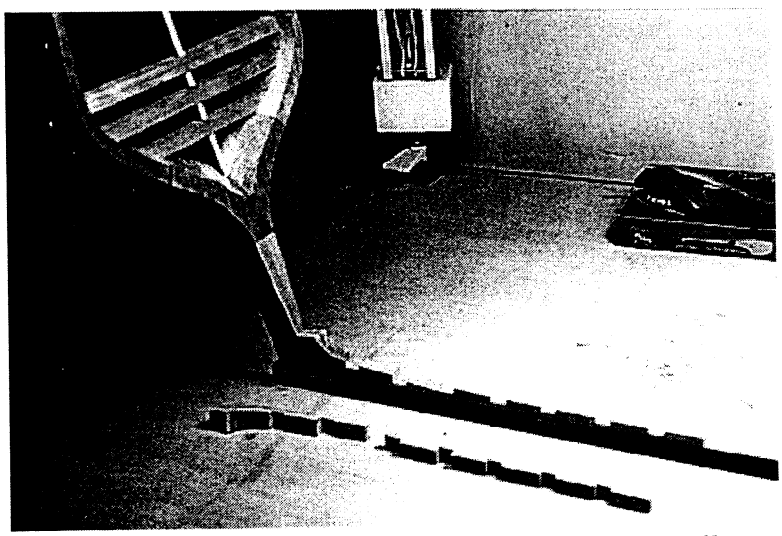


Figure 30. The stern assembly of the model of *La Belle* erected on the keel. The two deadwood timbers have also been installed. Photo by G. Grieco.

pieces and transoms, erected on the keel. The two stern deadwood timbers are also visible.

A characteristic feature of French ship construction is the absence of cant frames. In keeping with this tradition, the frames of *La Belle* are all square frames. To fill in the curvature of the bow forward of the first square frame, an assembly of hawse timbers creates a nearly solid wall of timber up to the stem (fig. 31). Bolted together laterally, and fastened at their heels to the forwardmost frame, these timbers were often reduced in their sided dimension over part of their length to permit air circulation between them.

The sequence of raising the frames on the models may be a bit of a departure from the actual sequence. While constructing the models, the midship frame was raised first. Then, every third frame forward and aft was fastened into position on the keel. After every third frame was erected, the intermediate frames were inserted. Recent observations of the remains of *La Belle* suggest that the floors and futtocks of the intermediate frames were installed separately after the other frames were erected.[33] Figure 32 illustrates the technique used to position the frames on the keel. Full scale construction would have required shores or timber posts to support each frame during construction. In a scale model, however, the weight of the individual timbers cannot guarantee a rigid structure. Instead, each frame was clamped to a board inscribed with the design face of each frame. The board was then braced to stand vertical to the keel and perpendicular to the centerline of the hull, assuring that each frame was properly positioned on the keel and was supported perpendicularly to it. This was particularly important because the majority of the frames of *La Belle* are not notched to fit over the

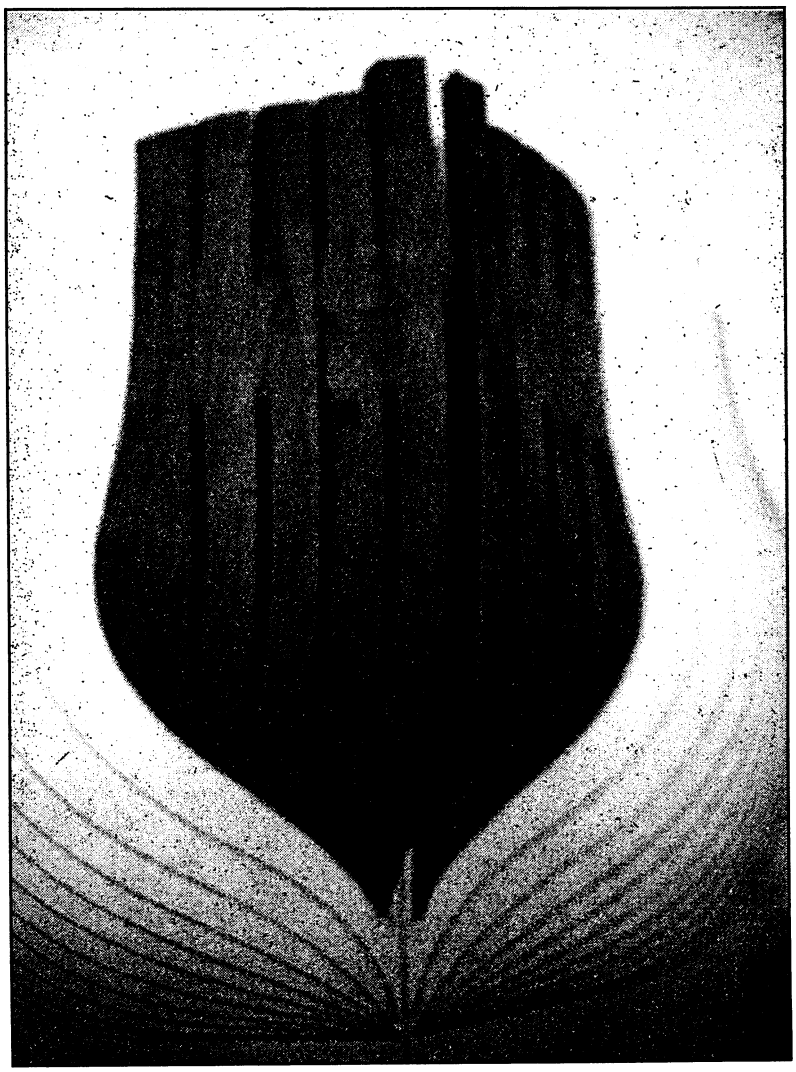


Figure 31. The hawse timbers preassembled and fastened to the forward most square frame. Photo by G. Grieco.

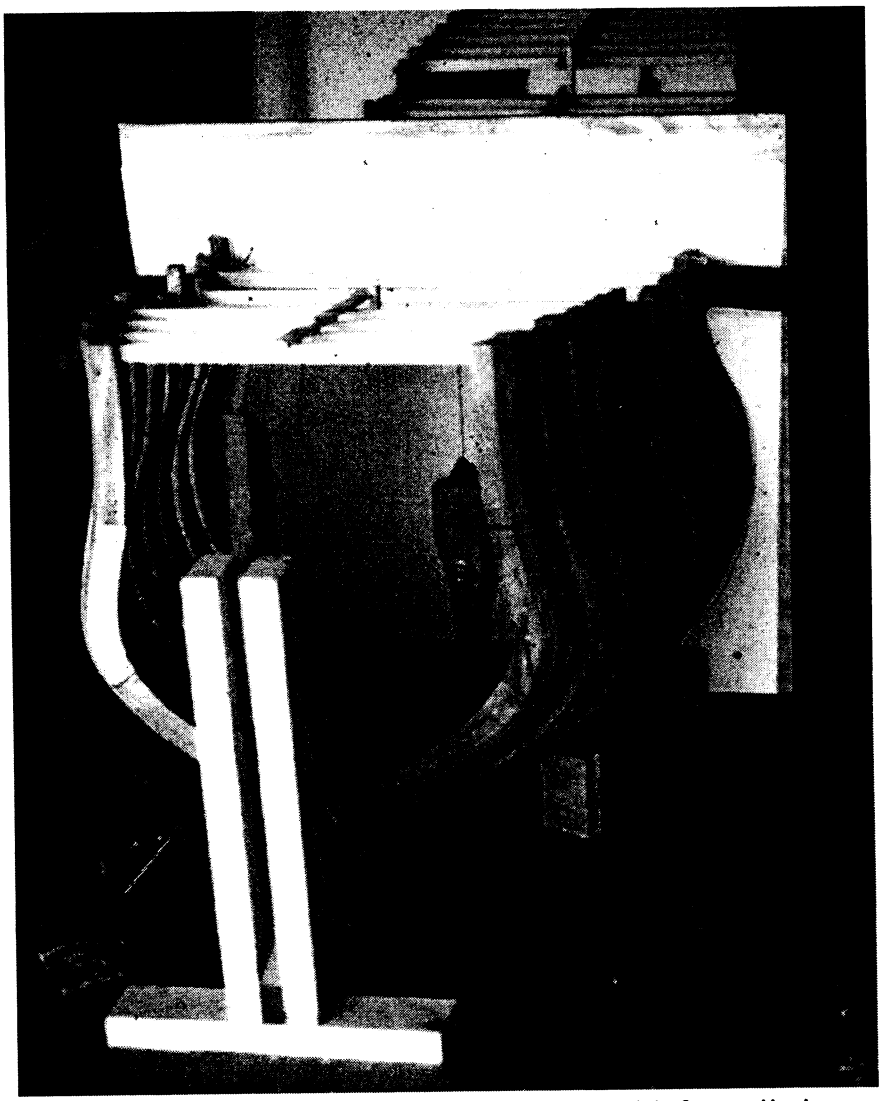


Figure 32. The nearly complete frame model with frame jig in place showing the method of properly positioning the frames. Photo by G. Grieco.

keel; proper centering of these frames on the keel was essential to maintaining the lines of the hull in the models.

Figure 33 shows the two completed frame models. From this point, the construction of the two models varied in many ways. A complete description of the construction of each of the models would contain many redundancies. Instead, this study will focus on the construction of the second model, highlighting the lessons learned from the construction of the first when appropriate.

Installing the Wales

It appears from contemporary drafts and sketches that French light frigates typically had a pair of wales roughly twice as thick as the hull planking.[34] These two wales, separated by a single plank of slightly increased width, ran parallel to each other along the entire length of the vessel. The lowest point of the wale at midships never dipped below the waterline. Thus, the height of the lower edge of the lower wale can be calculated to be at least 7 feet (2.276 m). The upper edge of the upper wale is typically flush with the upper edge of the wing transom. The lower wale runs under it, tying these important structural components into a continuous band of heavy timber encircling the entire circumference of the hull. The height of the wing transom is known and can therefore be used to indicate the location of the ends of the wales at the stern. Calculating the height of the wales at the stem was more problematic. A number of contemporary drawings and drafts were examined to determine the run of the wales. Using fixed points at midships and on the wing transom representing the underside of the lower wale, a batten was clamped to the frames and adjusted until a fair run was

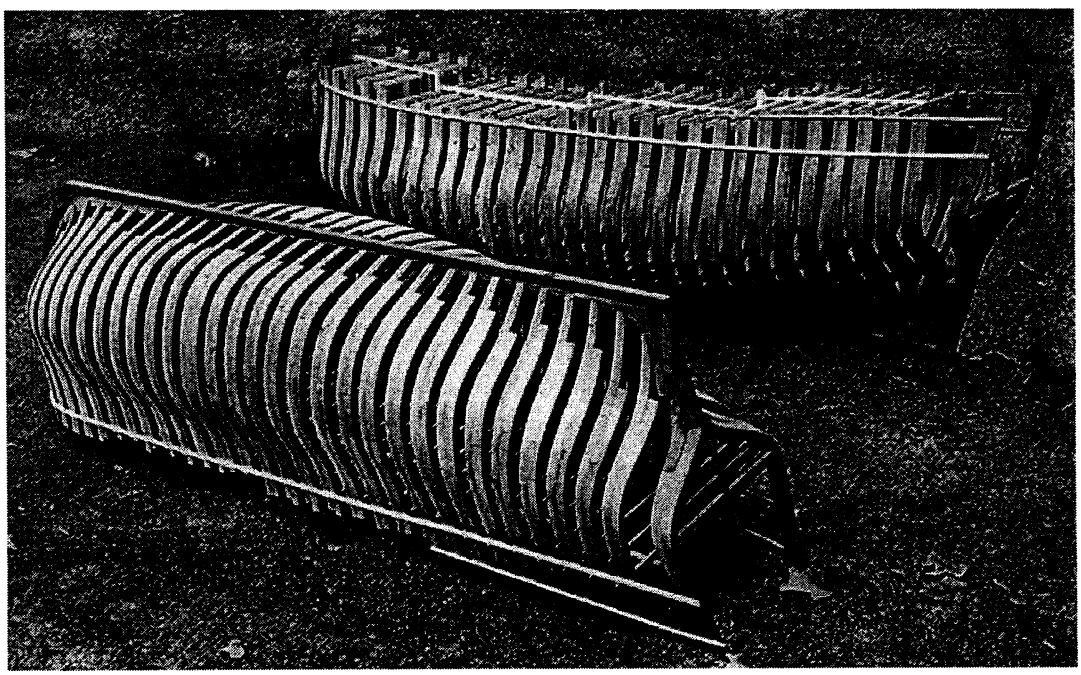


Figure 33. The two completed frame models. Photo by G. Grieco.

achieved from bow to stern. Once the location of the lower wale was determined, it was installed (fig. 34). The wales used on the model were 6 inches (16.3 cm) wide and 4 inches (10.8 cm) thick with a 2-inch-by-7-inch (5.4 cm by 19.0 cm) plank between them. Each wale was composed of a number of timbers joined with simple scarfs in the method typical of French shipbuilding.[35]

Hull Planking

The remains of at least fourteen strakes of planking were excavated on the starboard side of the shipwreck. The reconstructed midship section indicates the likely existence of one more plank below the wale. If this is the case, the seams of all the lower planks are represented at midships. The widths of the inner faces of the hull planking were recorded for nine frames at the time that the hull remains were disassembled. In addition, a diagram of the approximate location and orientation of the planks and their scarfs was created (fig. 8). Using the planking width, the seams of each plank were transferred to the appropriate frame on the model (fig. 35). The locations of scarfs, stealers, and drop strakes were marked on the outside of the frames. Using a batten, it was simply a matter of connecting the dots to determine the run of the individual strakes. The scarfs and plank ends then fell easily into place within the strakes. In reconstructed areas not represented by archaeological remains, the batten was allowed to run fair to complete the strakes. By allowing the shape of the hull to determine the run of the planking, remarkably uniform hood ends were obtained in the bow and stern (fig. 36).

One feature of the planking was characteristic of both Dutch and French

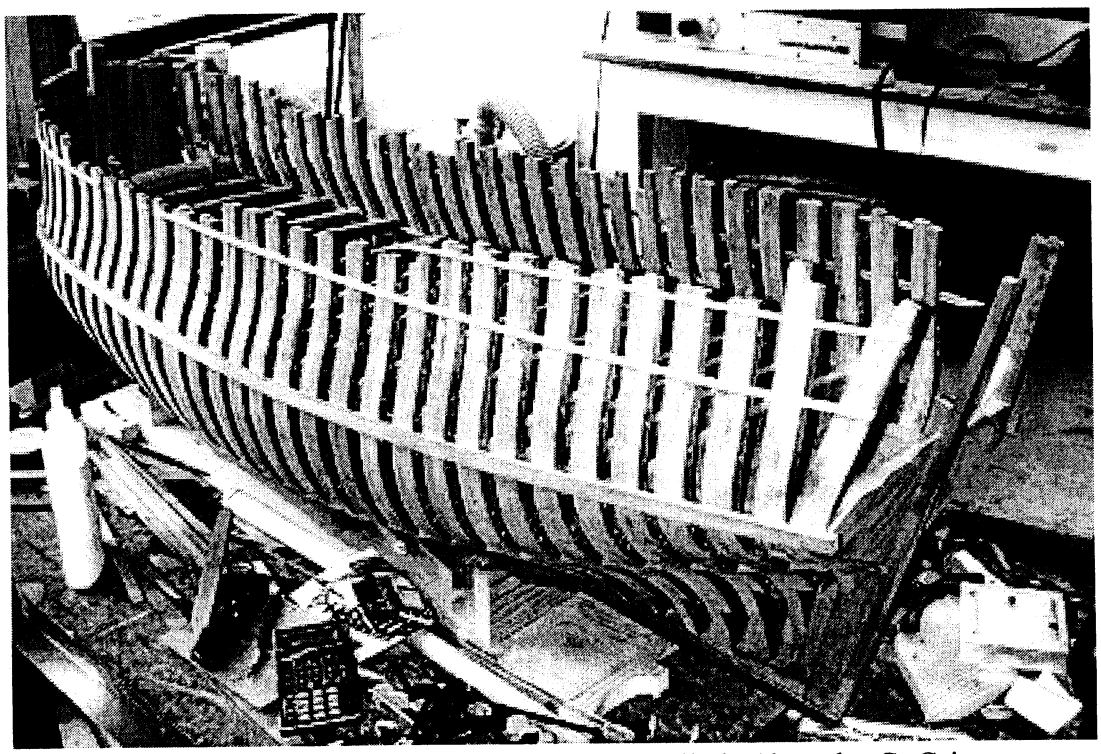


Figure 34. The frame model with lower wales installed. Photo by G. Grieco.

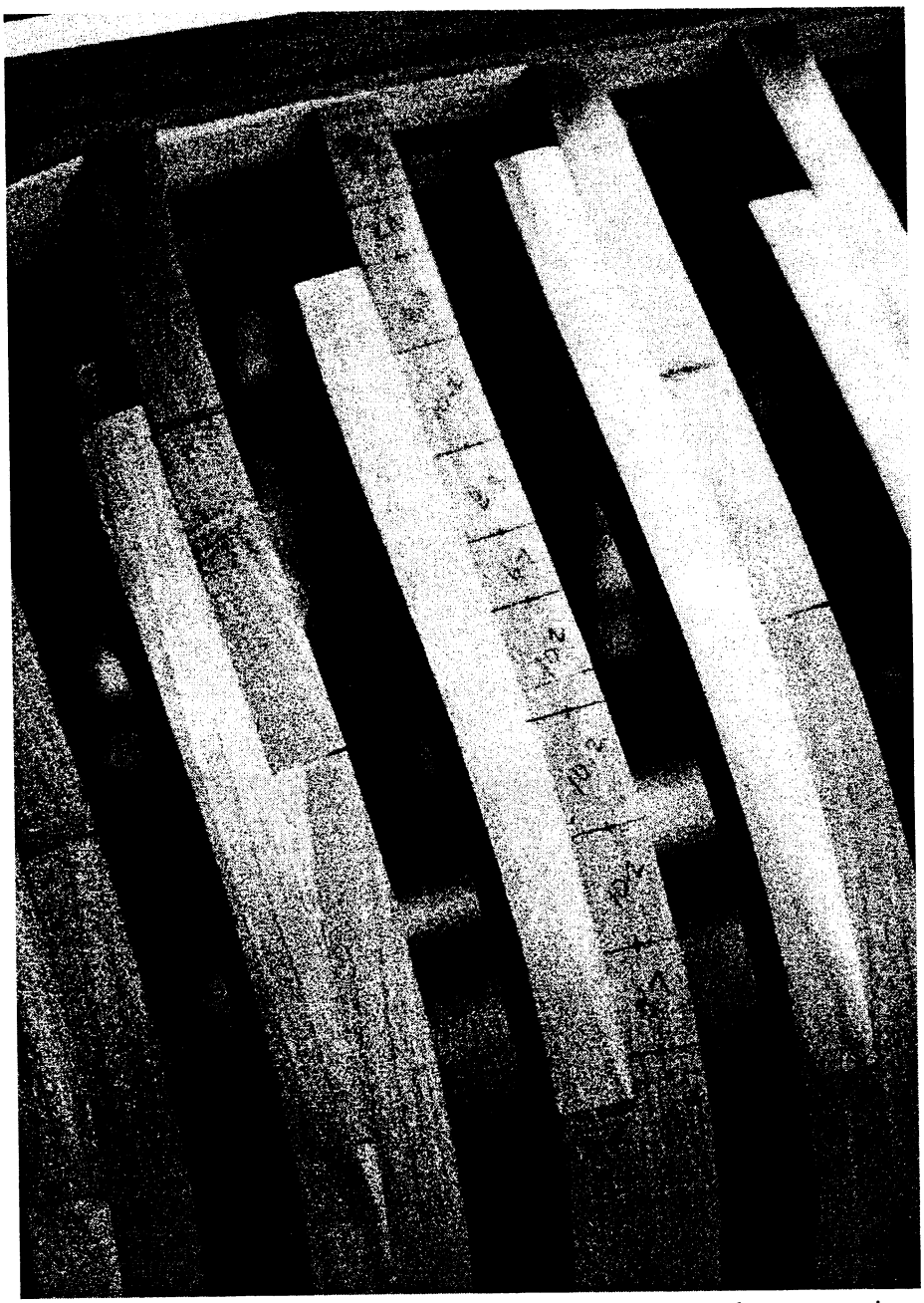


Figure 35 Transferring the known planking widths to the appropriate frames on the inverted model. Photo by G. Grieco.

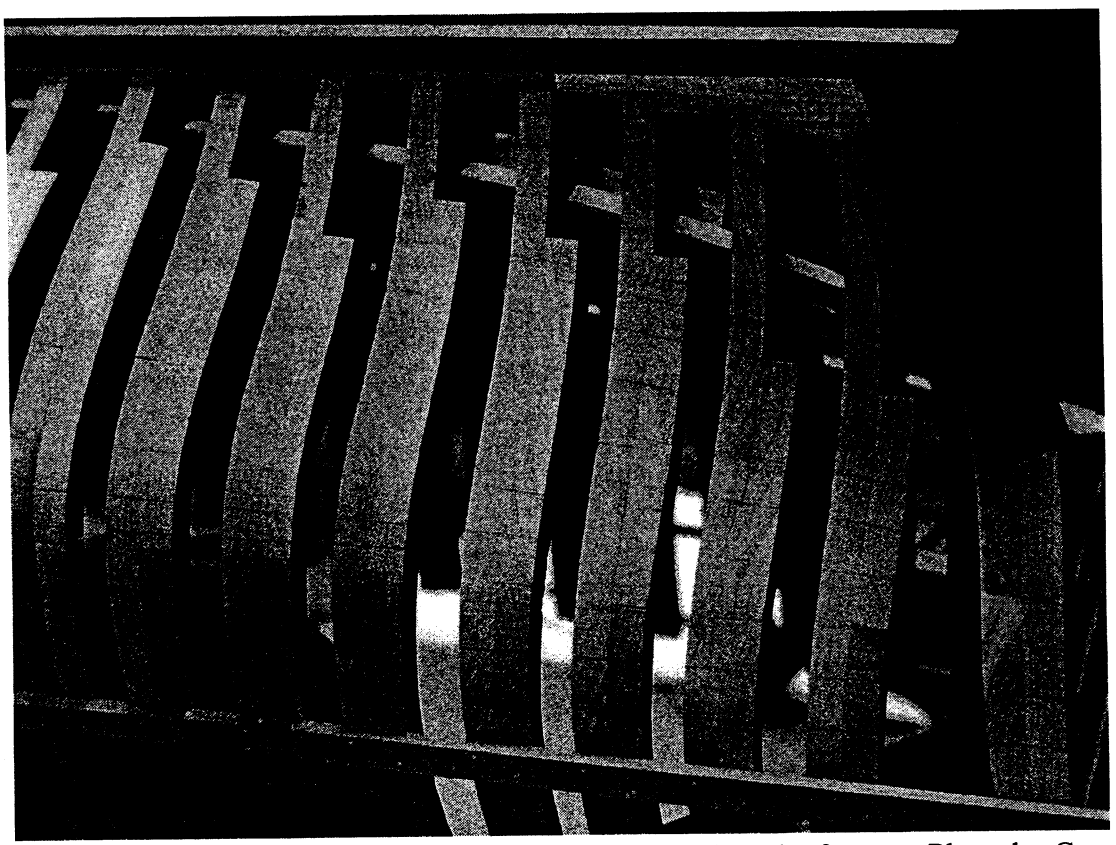


Figure 36. Fair lines drawn through the points marked on the frames. Photo by G. Grieco.

vessels. The two lowest strakes of planking or, in the case of *La Belle* the garboard and the stealer of the next strake of planking, run aft past the sternpost. They are notched into the side of the false post (fig. 37). The rest of the planks end flush with the aft face of the sternpost and abut the forward face of the false post.

Strips of poster board were used as spiling battens. With the batten clamped to the frames, the contour of the exposed edge of the previous plank was transferred to the batten using a compass. The batten was then used as a template for the next plank. Using this method, it was determined that the planking scarfs reflect the order in which the planks were installed. It was easier to spile to the scarf end of a plank when the forward arm of the scarf was adjacent to the previous plank. The contour was easy to scribe along one edge of the plank.

The fair run of the planking allowed the use of straight-sided planks. Where the edges of adjacent planks diverged, stealers were used. The capacity to use straight, almost parallel-sided planks minimized waste and increased the efficiency of the planking. The ease with which the hull was planked and the similarity between the shapes of the spiles and the original planks indicate that the reconstructed shape of the model is close to that of the actual vessel.

Ceiling

Some difficulties were encountered during the first attempt at installing the ceiling on the model. Although it had been assumed that the process began at the keelson and proceeded outward, it quickly became evident that this was not the correct sequence. The inner strakes feathered out to sharp points at the bow and stern, where

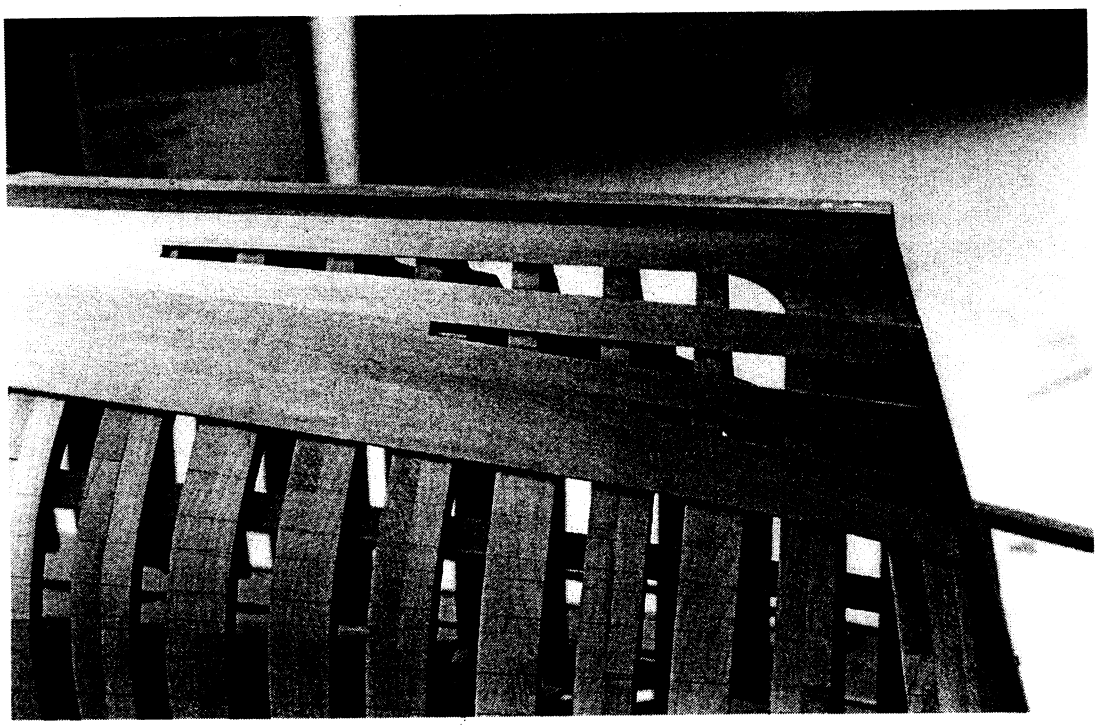


Figure 37. View of the stern of the model showing how the two lowest strakes are set into the sides of the false post. Photo by G. Grieco.

they encountered the four outer strakes, indicating that they were installed last. Two plates in the *Album de Colbert* provided insight into the proper planking sequence (fig. 38). Plate 8 shows the outer stringer installed first, notched tightly into position over the frames.[36] Only afterward were the inner strakes inserted. In the case of *La Belle*, the outer notched strake was inserted first, followed by two ceiling planks. A second stringer was then notched to fit like the outer timber. With these four strakes in place, the remaining planks were installed, working from the keelson outward (fig. 39).

The filler piece that sealed the edges of the ceiling was set into shallow beveled notches in the sides of the frames (fig. 40). Tool marks around the notches indicate that they were sawn using the outer edge of the ceiling stringer as a guide. This could not have been accomplished if the external planking was in place at this height. The hull was planked either ceiling-first or simultaneously inside and out. Only iron spikes were used to fasten the ceiling planks until the outer planking was attached. Treenails were then used to fasten the outer hull planking from the outside through to the ceiling. Because it was difficult to control the direction of the auger when boring holes for the treenails, the treenail pattern on the external planking is more uniform than that on the ceiling.

The tight fit between the filler pieces and the external planking indicates that either the filler pieces were installed prior to the planking and faired to the depth of the adjacent frames, or that the outer plank was attached after the notches were cut and considerable care was taken to shape the filler pieces to the complex contour of the inner faces of the frames and planking. Judging from the tight fit between the filler piece and the external planking, the first method seems more likely. Figure 41 shows

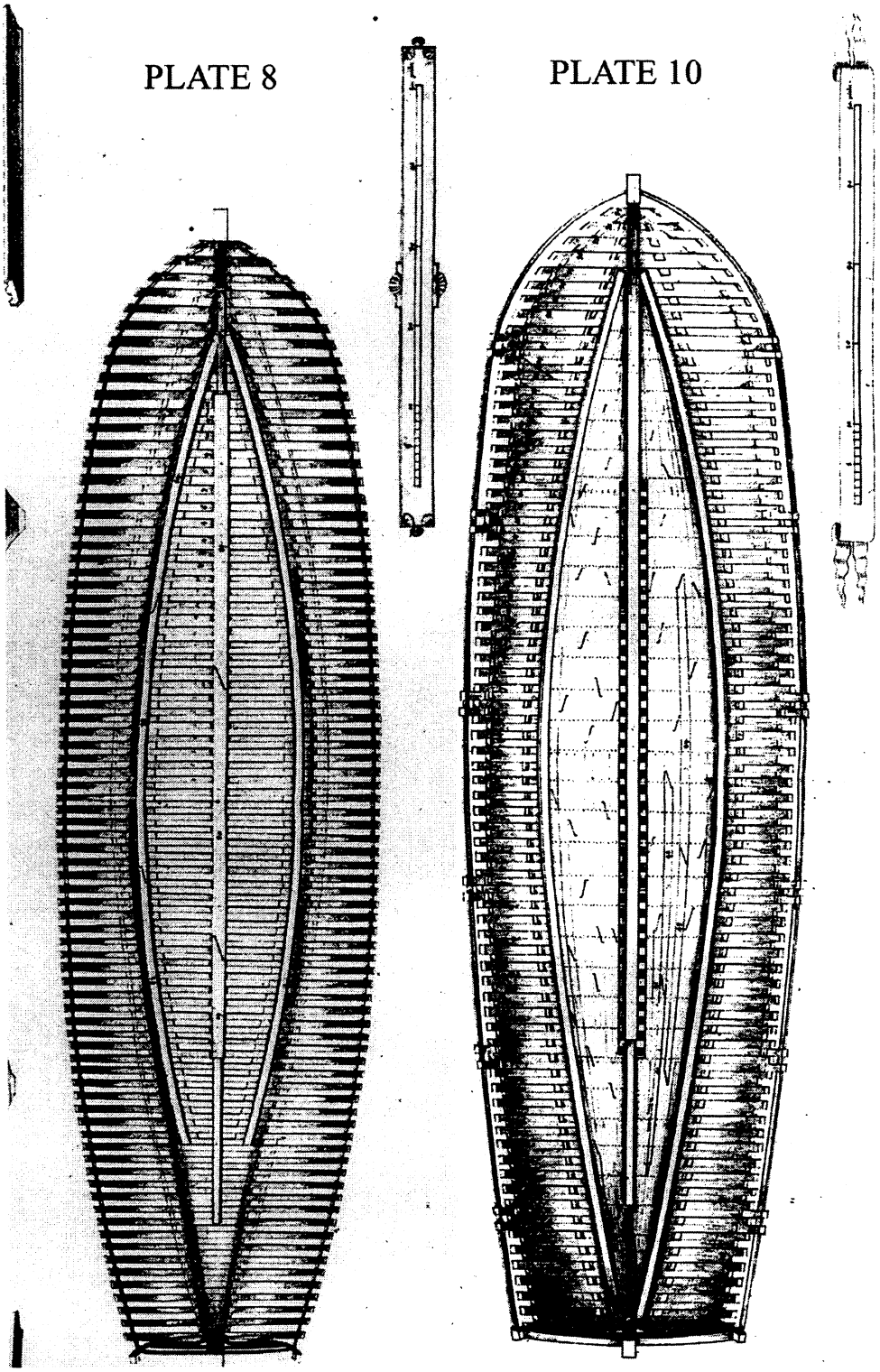


Figure 38. Two illustrations from the *Album de Colbert*. Plate 8 shows the outermost ceiling planks or stringers notched over the frames to provide a border for the rest of the ceiling. Plate 10 shows all the ceiling plank installed. (*Album de Colbert*, 1988)

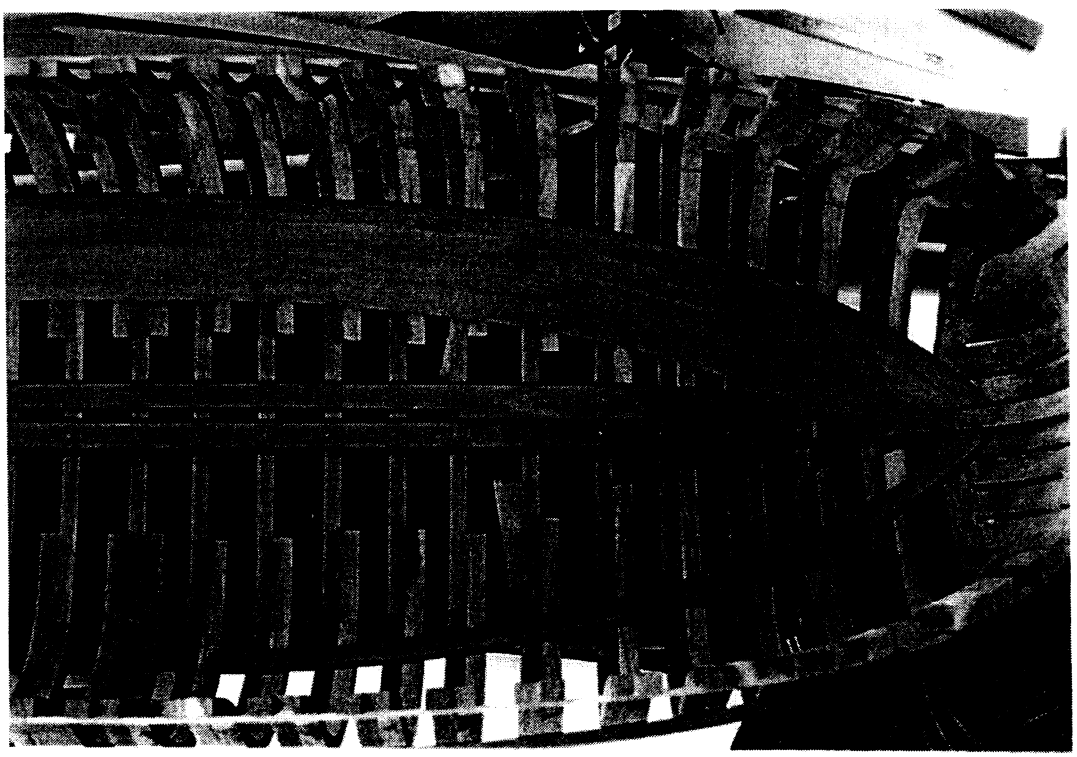


Figure 39. Installation of the ceiling on the model starting with the outermost plank or stringer. Photo by G. Grieco.

Figure 40. Notches cut in forward and after faces of the frames for the filler pieces. Photo by G. Grieco.

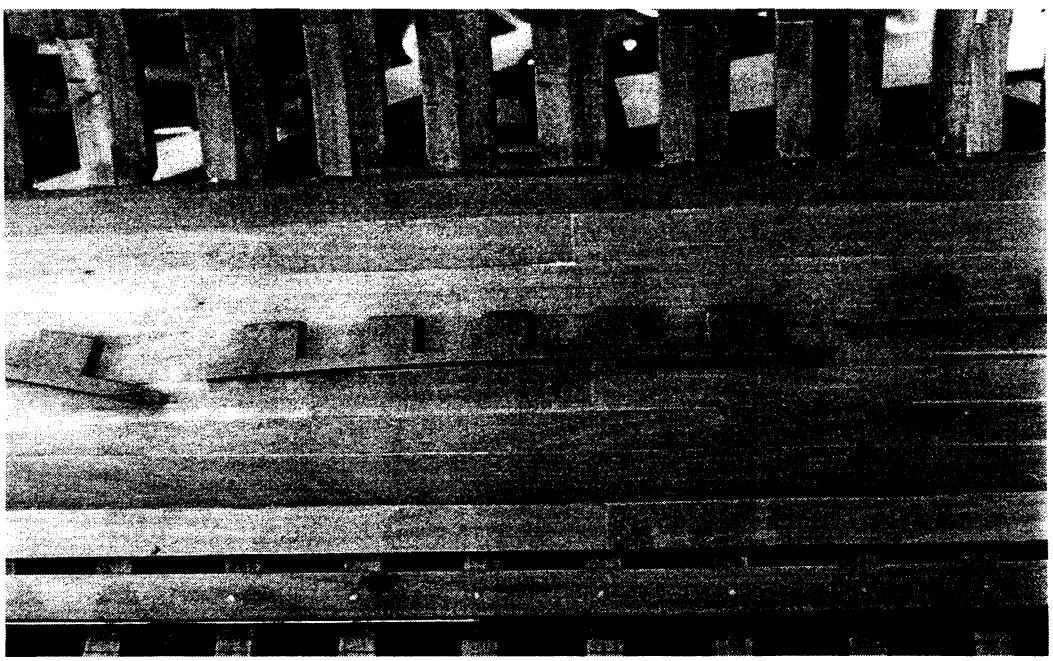


Figure 41. Filler pieces cut to fit around the frames. Photo by G. Grieco.

these filler pieces prior to installation, and figure 42 shows them in place, bordering the ceiling plank on the model. The riders of the mast step can be seen in the bottom right corner.

Mast Steps

Aside from slight erosion at the ends of the port arms of the floor riders, the main mast step has survived in its entirety. Figure 43 shows the two rider timbers prior to installation over the ceiling. The curvature of the lower face of these timbers was taken directly from the archaeological remains. Because they fit snugly against the ceiling in the model, these timbers helped to verify that the shape of the hull in this area was accurate. Figure 44 illustrates the way in which the beveled ends of the mast step partners locked tightly between the notches in the riders, preventing lateral movement of the heel of the mast. Figure 45 shows the complete mast step assembly with buttress timbers and filler pieces inserted between the ends of the partners.

Although only part of the foremast step has survived, the symmetry of the structure permitted a full reconstruction (fig. 46). A plank inserted between the notches in the opposing arms supported the aft face of the heel of the foremast. Three prism-shaped wedges were inserted in the three corners of the trianguiar opening to support the remaining three faces of the heel.

Bulkheads and Internal Deck Structures

Most of the compartments and bulkheads within the hull were not constructed until after the deck beams were installed. The upper ends of the stanchions supporting

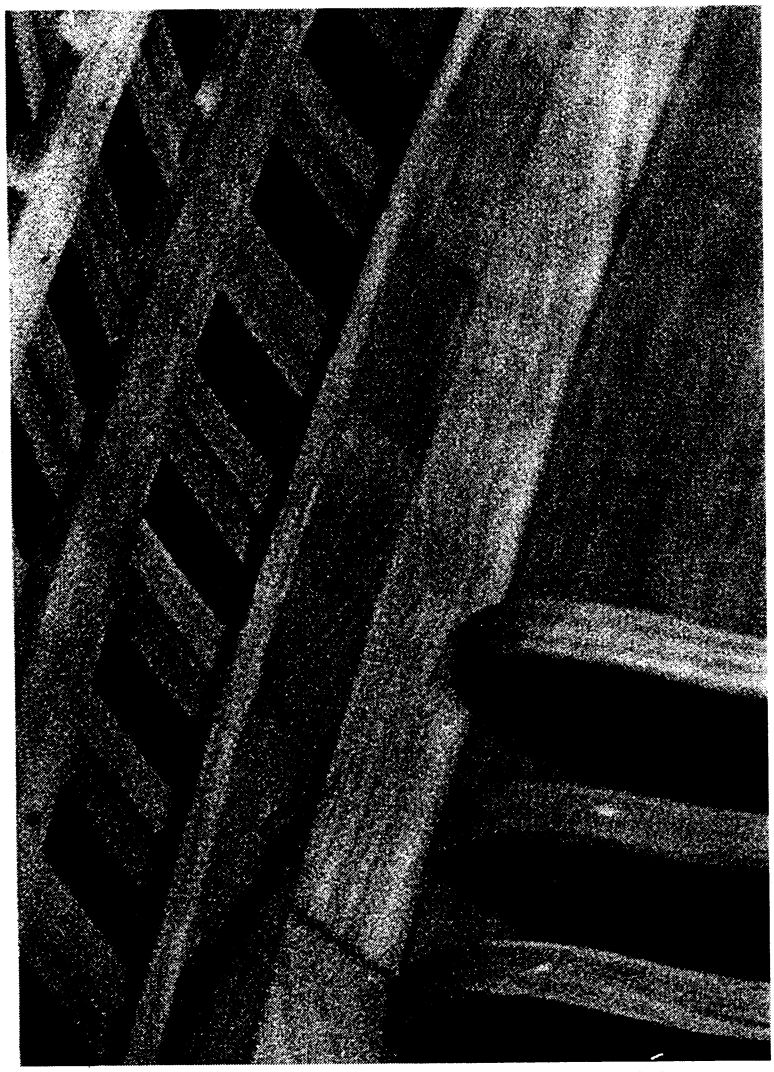


Figure 42. Filler pieces in place along the edge of the outermost ceiling plank. The riders of the mast step can be seen in the lower right corner. Photo by G. Grieco.

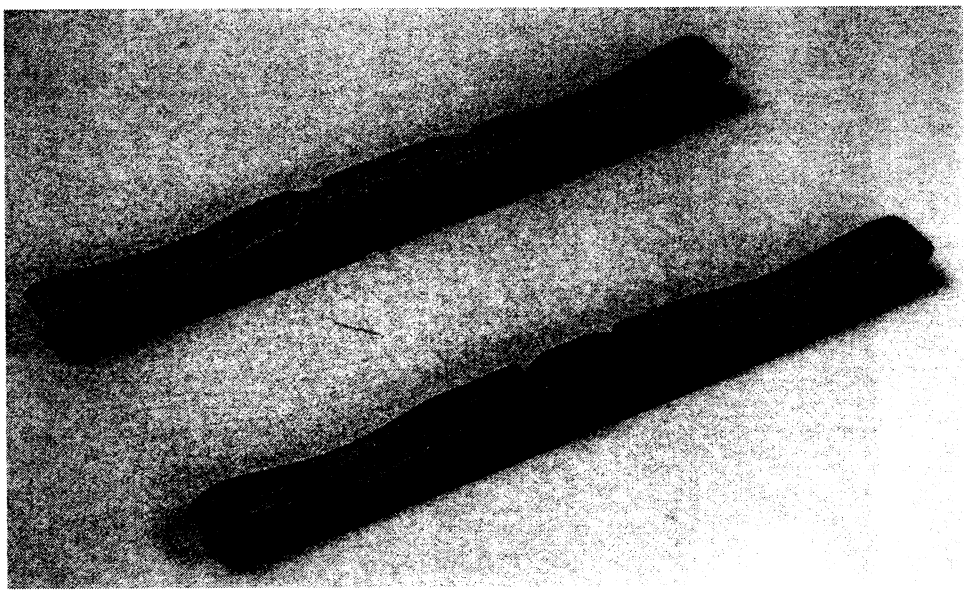


Figure 43. Forward and aft rider timbers of the main mast step. The notches in the faces of the riders will accept the ends of the mast step partners. Photo by G. Grieco.

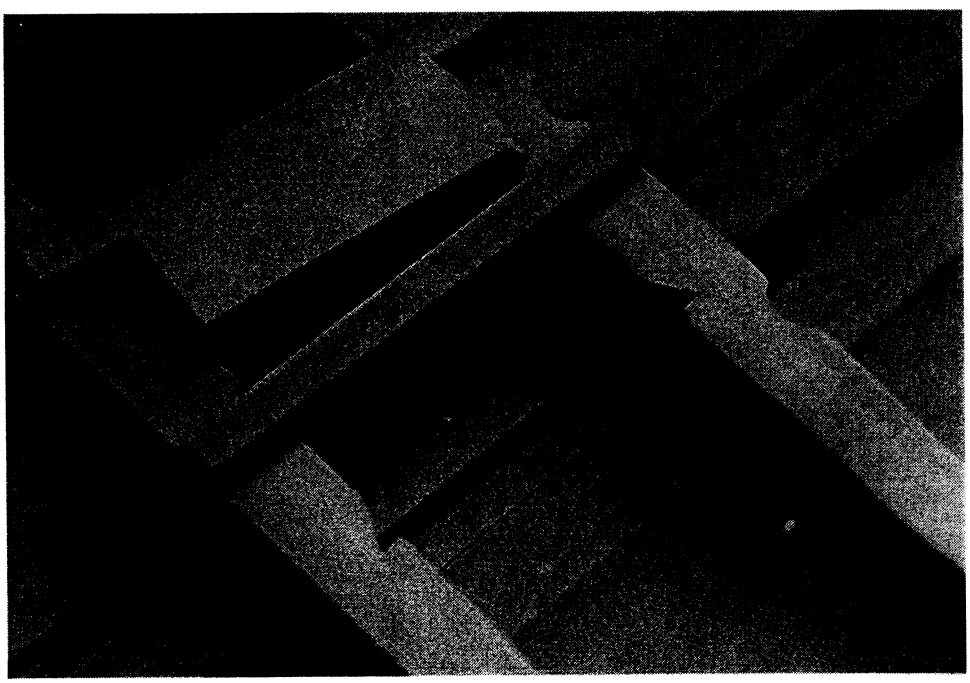


Figure 44. Installation of the mast step partners. Photo by G. Grieco.

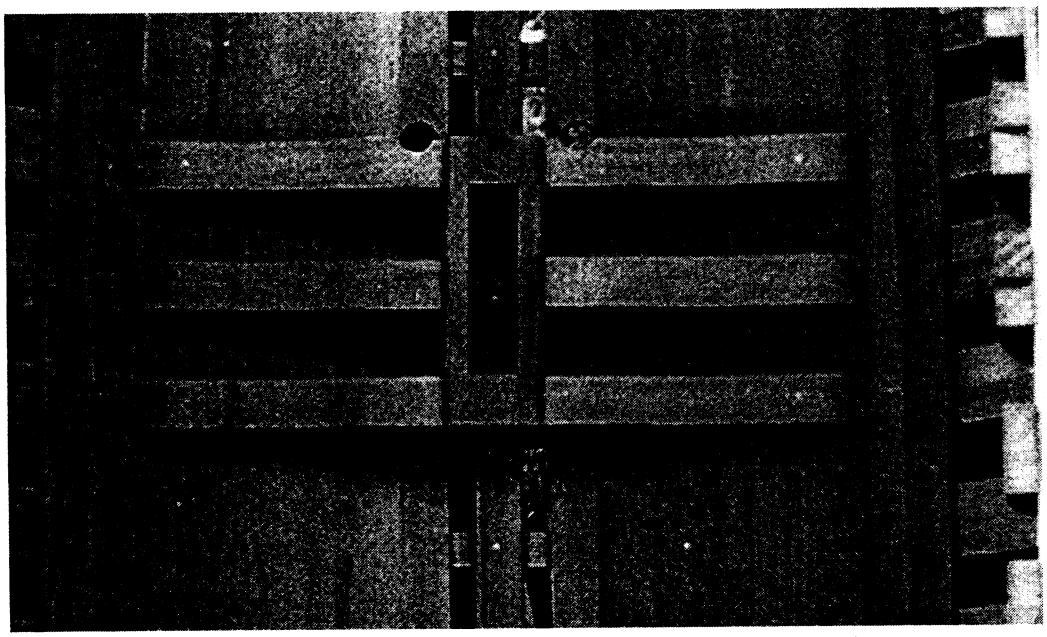


Figure 45. Completed main mast step assembly. Photo by G. Grieco.

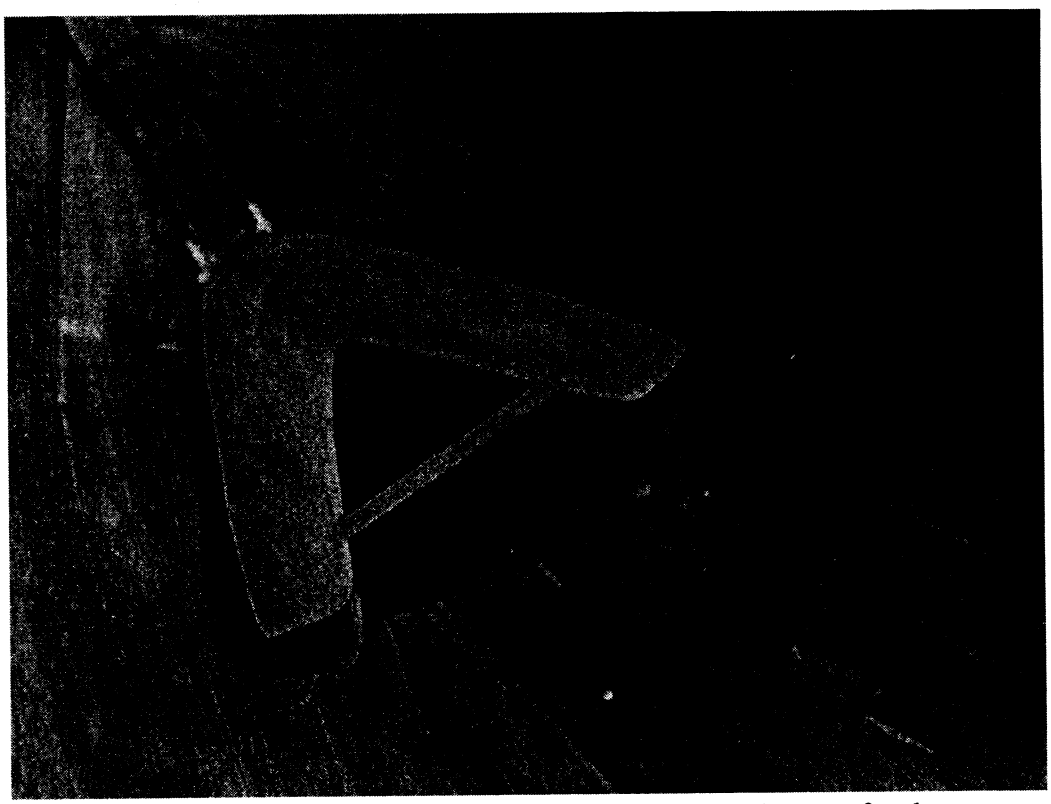


Figure 46. Heavy breast hook in the bow serving also as the step for the foremast. Photo by G. Grieco.

the bulkhead planking were probably mortised into the undersides of the deck beams. Unfortunately, it is almost impossible to install internal deck structures on a model once the deck is in place. The installation of the beam clamp and deck beams will be discussed in the next section. However, in order to construct the bulkheads, several beams first had to be installed.

It is possible that there were additional internal compartments in *La Belle*'s hold. It was common for ships to have hanging compartments under the deck beams. For this study, however, only structures for which archaeological evidence exists were reconstructed. The remains of these structures are discussed in chapter III, and here I will only look at the extension of the bulkheads to the level of the main deck and the deck features required by the reconstruction.

A sufficient portion of the forward bulkhead survives to indicate that it formed a simple partition originally supported by three stanchions (fig 47). Because there is no evidence for the framing of a door, access to this compartment was through a hatch in the deck located forward of the beam that supported the bulkhead. The cable tier forward of the bulkhead was a fairly active area of the hold (fig. 48). The bulkhead not only isolated the damp cable from the cargo, but also allowed secure storage of the contents of the main hold without hindering the operation of the vessel.

As with the forward bulkhead, the partition in the waist of the vessel appears to have prevented access between the compartments it separated. The forward wall of the pump well was blocked by the mast, allowing access to the pumps only from the aft compartment. A sliding panel door was employed in the reconstruction to allow access to the pump well (fig 49). An example of this type of door can be seen on a model of

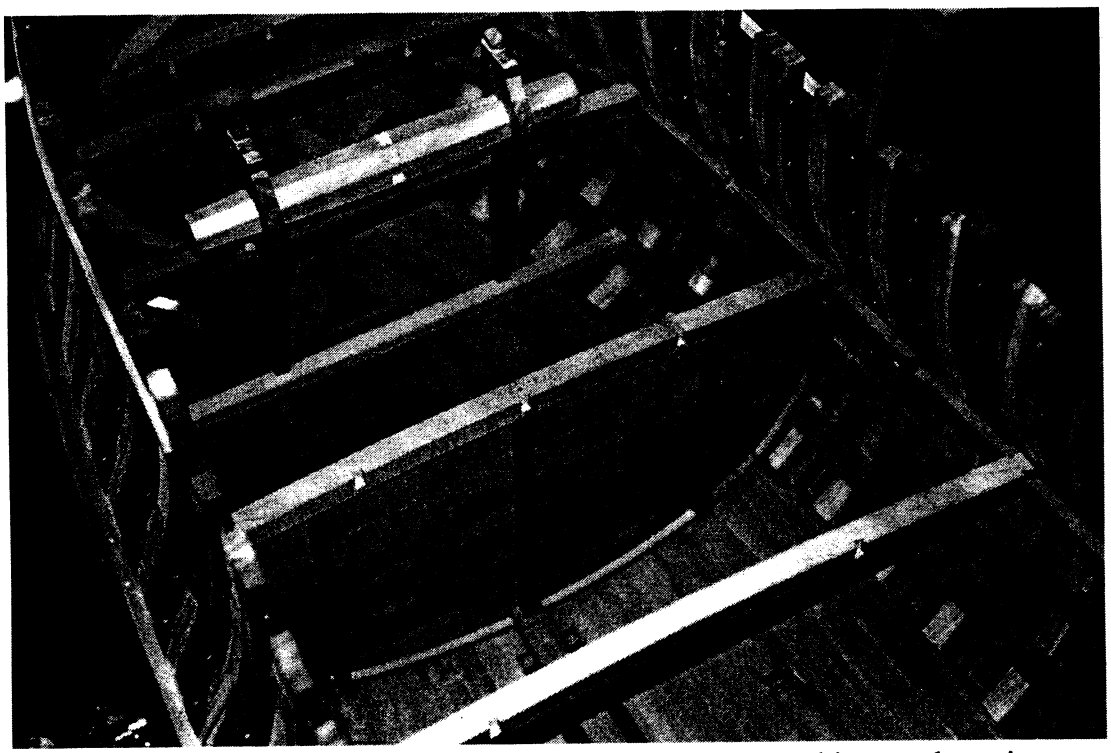


Figure 47. Forward bulkhead installed. Notice the three stanchions and continuous line of nailers supporting the planking. Photo by G. Grieco.

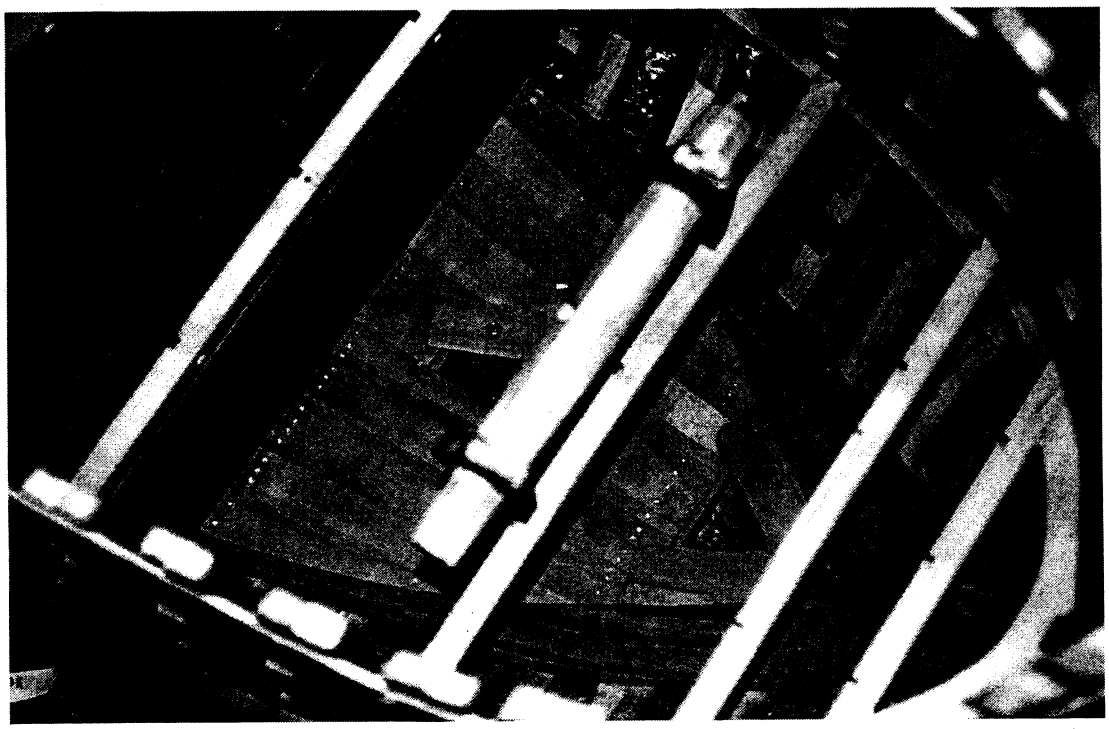


Figure 48. View of the cable tier. Notice the way in which the planking is cut to fit against the foremast step. Photo by G. Grieco.

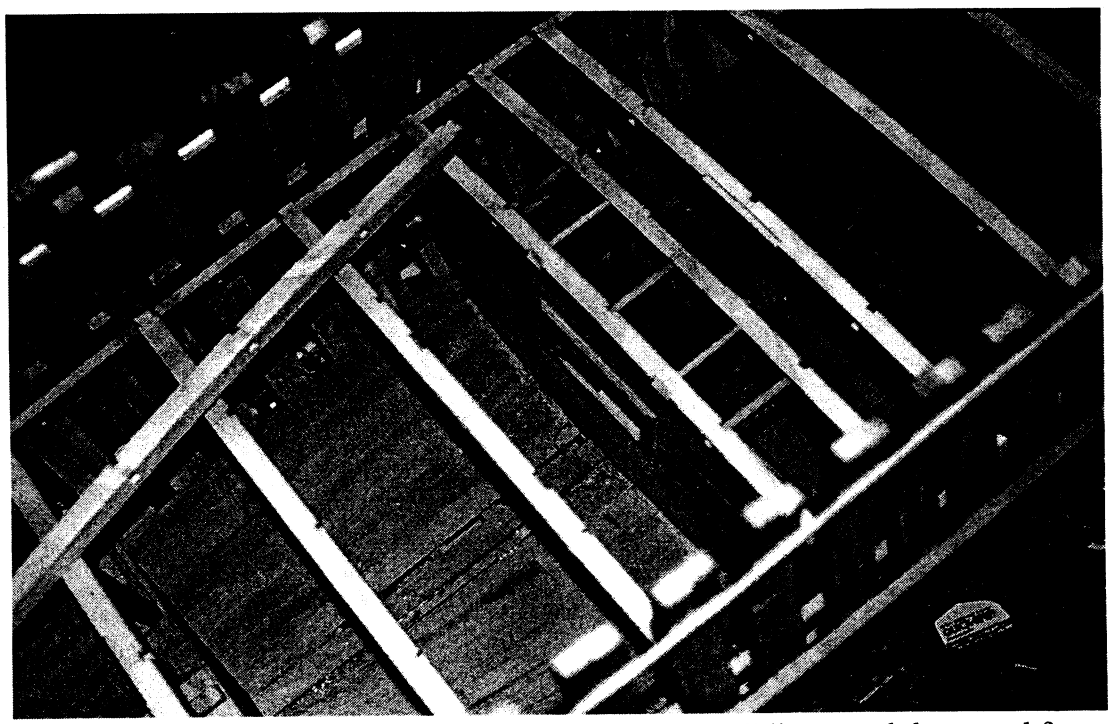


Figure 49. Photo of the midship bulkhead showing the sliding panel door used for access to the pump well. Photo by G. Grieco.

an early French 74 gun ship in the Musée de la Marine.[37] The sliding panel design eliminates the need for space to swing a hinged door and was commonly used in the cramped holds of French ships.

Not enough of the aft bulkhead survives to permit reconstruction with the same degree of confidence. The planking of this partition formed the forward limit of a small deck. The planking, however, does not appear to continue above the deck. There is some evidence that the spaces between the stringers were filled with light planking aft of the bulkhead. For the model, the bulkhead has been reconstructed only up to the level of the deck. The deck supported the step of the mizzen mast. At this point, the beams for the floor of the small stern cabin were installed 2 feet (65.0 cm) below the level of the main deck.

Counter and Transom

The length and height of the wing transom and the value of the tumblehome are provided in the dockyard manuscript. It was also necessary to determine the distance between the aft face of the sternpost and the forward face of the transom timbers. Sufficient clearance is required for the head of the rudder as it extends through the counter of the vessel. In this case, the sided dimension of the rudder stock where it passes through the counter is equal to the sided dimension of the sternpost of 6 inches (16.3 cm). The molded dimension would be similar, but a couple of additional inches were required to extend the tiller through the aft side of the tiller mortise. After examining several contemporary models, it was discovered that the inner face of the transom timbers were not always planked, providing additional clearance aft of the

rudder head.[38] These factors were considered as the lines were drawn. The transoms of ships were typically framed using smaller timbers than the rest of the hull. The counter timbers were shaped from timber with a sided dimension of 3 inches (8.1 cm). Figure 50 shows the installation of the six transom timbers.

Deck Framing

Nothing remains of the original deck structure of *La Belle*. Without the benefit archaeological remains, the scantlings of the timbers are difficult to determine. Careful examination of models, drawings and treatises such as the *Album de Colbert* and the *Album del Marquez de la Victoria* helped to determine the relative sizes of the individual timbers forming the deck framing. Once the sizes of the deck beams were estimated the scantlings of the other components of the deck were calculated. As mentioned in chapter V, the reconstruction assumes a deck beam scantling of 6 inches (16.3 cm) square.

The first step in installing the deck was to determine the run of the deck clamps. Estimating the height of the clamps from the deck heights on several early 18th century drafts,[39] it appears that on a vessel with one continuous deck from bow to stern, the upper face of the clamp is typically flush with the upper edge of the lower wale at midships. This point was established for the wale during the reconstruction of the midship section. Running parallel with the top of the lower wale through the waist of the vessel, the clamp begins to diverge towards the stern as it rises on the inside faces of the futtocks to butt against the forward face of the wing transom. However, if *La Belle* was a sloop of war or light frigate, her main deck would not have run all the

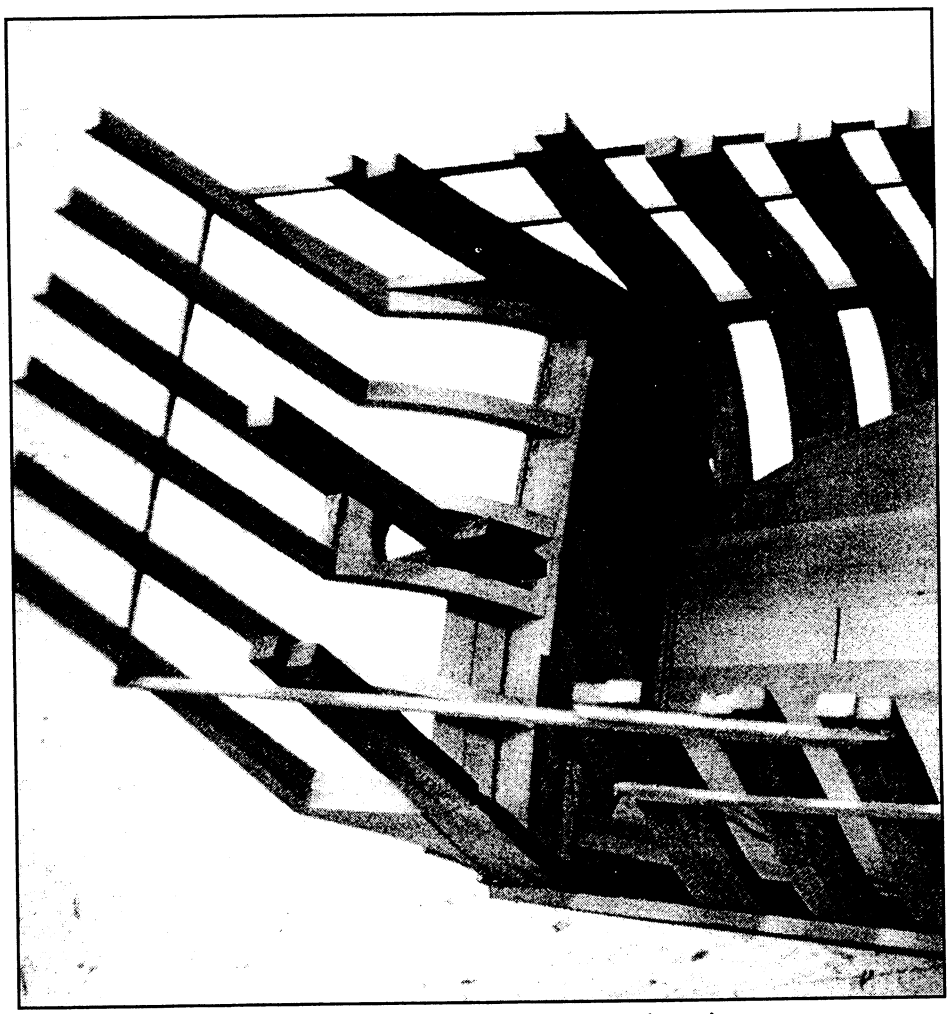


Figure 50. The six transom timbers in place on the wing transom. Notice the deck for the stern cabin to the right. The false post runs too high in this photo and still needs to be cut to its proper length. Photo by G. Grieco.

way to the stern. Olivier made the following observations concerning sloops of war of twelve guns: "Such vessels should have but a single deck, with the guns only as far as the mizzen mast, where the upperworks should be raised 2 feet, with a quarterdeck 3 ½ feet above the upper deck. In the event that we should build sloops of war of ten, eight, six or four guns, they should be fitted out like those of twelve guns."[40] A break in the deck just aft of the mizzen mast, with a deck 2 feet (65.0 cm) below it and a quarterdeck 3 ½ feet (1.138 m) above, suggests the presence of a stern cabin. For this reason, the main deck clamp would supported deck beams back to frame XIID. From XIID aft, the deck beams of this small stern cabin would have been supported by the ceiling plank 2 feet (65 cm) below the clamps.

Having less sheer than the wales, the clamp typically dips below the level of the lower wale in the bow. This configuration varies from ship to ship. Ships often had a small bulkhead just aft of the hawse holes to catch water draining from the anchor hawser. Forward of this bulkhead was a scupper with its outboard end centered between the two wales. If the clamp dipped too low, this area would not drain properly. To avoid this problem, the deck clamp was positioned at a height that allowed a drainage angle of about 30 degrees from the top of the deck

Next, the locations of the deck beams were determined. Figure 51A indicates the deck beams whose presence is indicated by the surviving internal structures. The lower image, 51B, shows the beams that supported the stanchions of the three bulkheads and the pump well, as well as the beam that supported the upper end on the notched stanchion amidships. The upper image in figure 52A illustrates the addition of beams to support the fore, main, and mizzen masts. Forward of the first bulkhead and

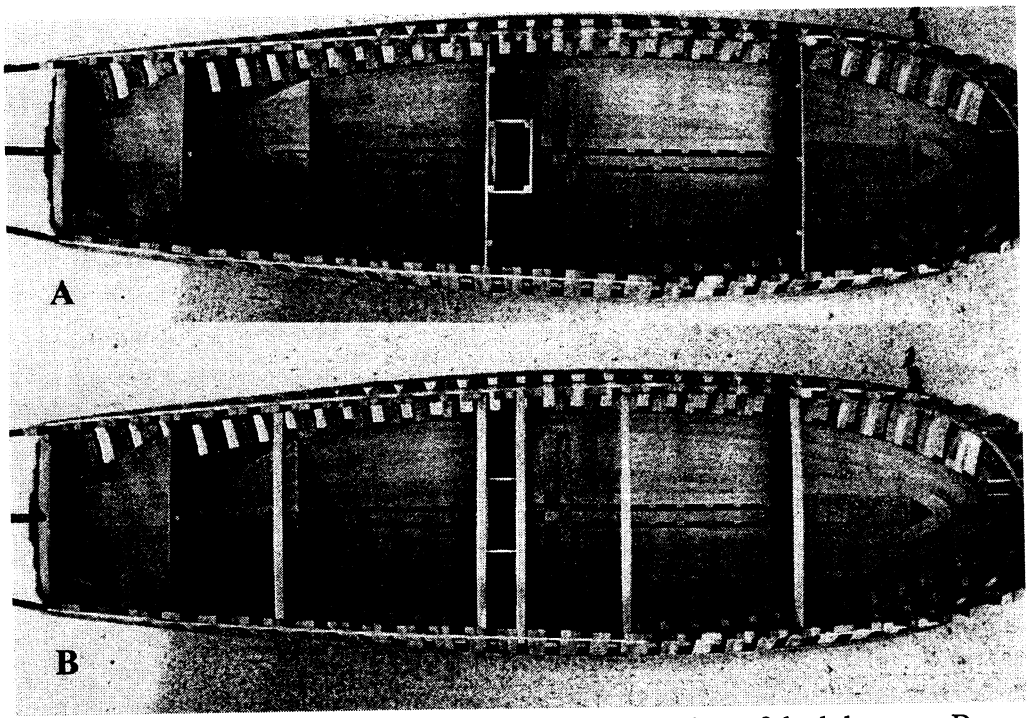


Figure 51. A. Internal structures before the installation of deck beams. B. Installation of deck beams required by internal structure. Photos by G. Grieco.

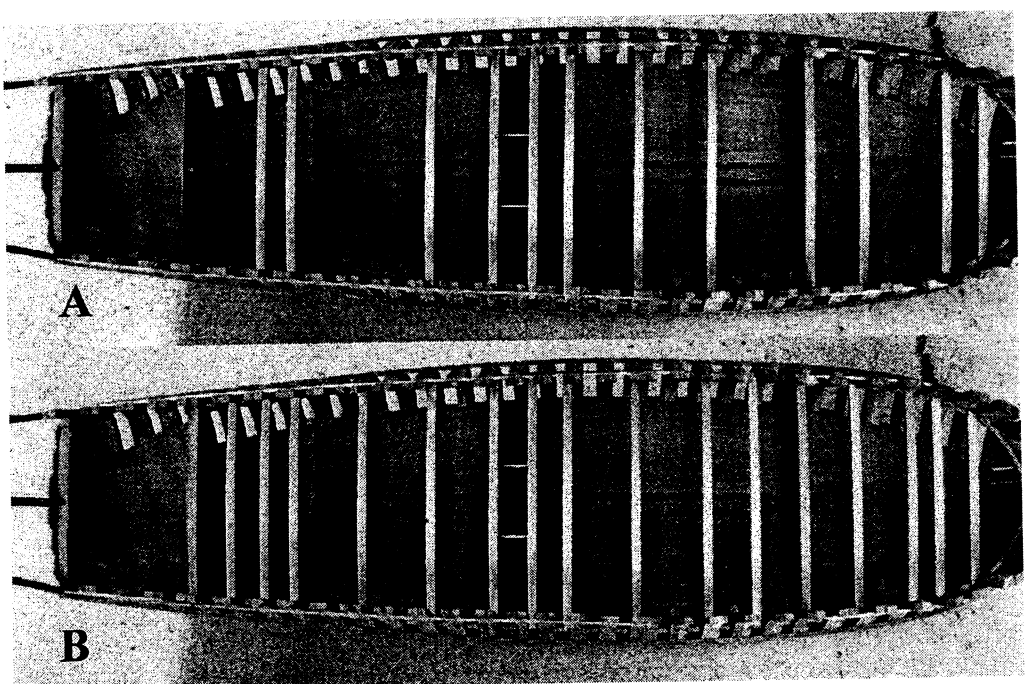


Figure 52. A. Installation of deck beams necessitated by hatches, mast partners and windlass. B. Installation of three remaining deck beams to bridge the remaining spans of deck. Photos by G. Grieco.

the notched post, beams were added to frame the forward and main hatches. The hatch aft of the pump closet required another beam. The lower image shows the addition of a beam aft of the foremast to support the bitts of the windlass. Three additional beams were positioned to break up spans of more than 3 feet (97.6 cm). In order to tie the clamps together at the bow and to add lateral strength, a breasthook was notched down into the clamps and bolted through the futtocks. With molded dimensions equivalent to those of the deck beams, the breasthook also served as a fastening surface for the forward ends of the waterways and planking.

Figure 53A illustrates the difference between English and French deck framing techniques. The English system was comprised of fore and aft carlings set into notches in the sides of the deck beams. In a similar manner, lighter ledges were set down into notches in the sides of the carlings. The upper faces of all three timbers were flush with the underside of the deck planking.

In contrast, the French system (B) used a number of interlocking and overlapping timbers to create a more rigid structure. The carlings typically measured a third of the molded dimension of the beam and were set down a third of the depth of the beam into its forward and aft faces. A ledge plank of the same width as the deck beam and one third of its depth was then bent down over the carlings and its ends were placed into shallow notches in the inner faces of the waterways. Using this method, only the upper faces of the deck beams and ledges were in contact with the underside of the deck planking. Another typical feature of French deck construction is the use of a two-piece waterway, notched to fit over the ends of the deck beams. These heavy timbers secure the beams longitudinally and eliminate the need for lodging knees. This

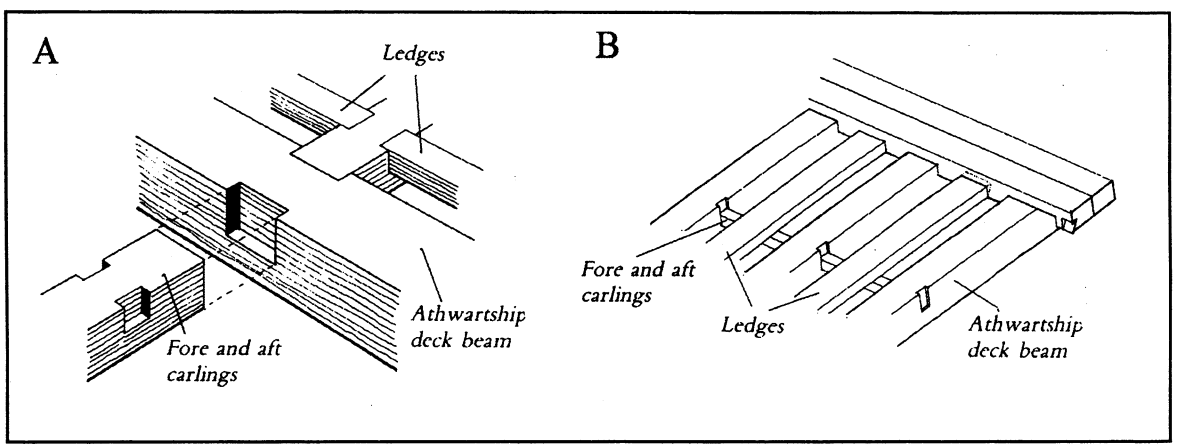


Figure 53. A. English method of deck framing (after Franklin, 1989, 20). B. French method of deck framing (after Boudriot, 1986, 110).

method of construction is illustrated in the Monceau's *Élémens de l'Architecture Navale*.[41]

Hanging knees were commonly used on French ships, to fasten the ends of the deck beams down into the hold, preventing them from lifting away from the clamp or separating from the sides of the ship. One arm was bolted to either the forward or after face of the beam and the other extended down over the clamp and into the hold. Because knees were securely bolted to the inside of the frames and uppermost stringer, it is surprising that no fragments of knees or empty bolt holes were found in the upper futtocks of *La Belle.* If knees did exist, the lower arm would have been unusually short. The small size of the vessel and the robustness of her clamps and waterways may have eliminated the need for hanging knees.

Construction of the deck framing began by dovetailing the deck beams 2 inches (5.4 cm) into the clamps (fig. 54). The dovetail joints increased the lateral strength of the hull and tied the sides of the vessel together. With all the beams placed in their proper positions, the locations of the hatch carlings and mast partners were marked. These timbers had the same dimensions as the deck beams and were set into beveled notches in the fore and aft faces of the beams. Next, the locations of the carlings, windlass bitts, main bitts, and bowsprit step were determined. Large ships typically had five or more rows of carlings running the length of the hull. A vessel the size of *La Belle* only required one central carling and two side carlings that divided the space on either side of the centerline. Mortises were then cut in the forward and after faces of the beams for the ends of the carlings. *La Belle*'s 6-inch (16.3 cm) square beams required 2-inch (5.4 cm) square carlings and 2-inch-by-6-inch (5.4 cm by 16.3 cm)

Figure 54. Dovetailing of beams into the beam clamps. Photo by G. Grieco.

ledge planks. On one beam face, the width and the height of the mortise was equal to that of the carling. On the other, the height was extended to the upper face of the beam to create an opening to accommodate the free end (fig. 55). The locations of the carlings were marked with the beams temporarily in place. Once their positions were determined, the beams were removed and the mortises were cut.

Next, the beams were reinserted into the clamps. Filler pieces measuring 2 inches by 4 inches (5.4 cm by 10.8 cm) were inserted between the dovetails in the beams to fill the space between the top of the clamps and the bottom of the waterways. The two waterway timbers were then placed over the ends of the beams (fig. 56). The waterway timbers measured 8 inches by 4 inches (21.7 cm by 10.8 cm) and were notched over the deck beams to a depth of 2 inches (5.4 cm). With the waterways in place, the carlings and ledges were inserted. In places where the ledge terminated at a hatch carling or mast partner, it was dovetailed into the top face of the timber (fig. 57). The ledge plank is longer than the space between the inside faces of the two waterways. The plank had to be bent slightly to be inserted into the shallow notches on the inside faces of these timbers. Once in place, the spring in the timber holds it firmly in place over the carlings. The absence of fasteners securing the individual timbers of the deck structure is significant. The lack of rigid joints between the component timbers allows the deck to flex without damage to the structure. Figure 58 shows the framed deck structure.

The forecastle and quarterdeck were lightly framed (fig. 59). The beams of these decks used smaller scantlings because these decks did not support any guns, although they would have supported the weight of the crew. Beams measuring 5

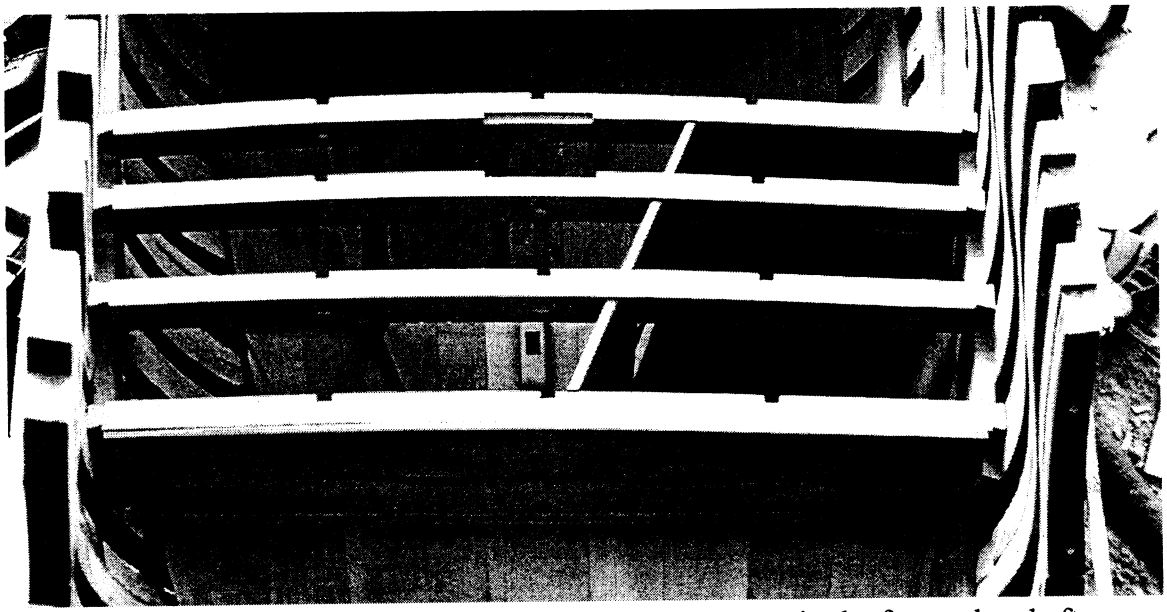


Figure 55. After deck beams installed. Note the notches cut in the forward and after faces of the beams for the longitudinal carlings. Photo by G. Grieco.

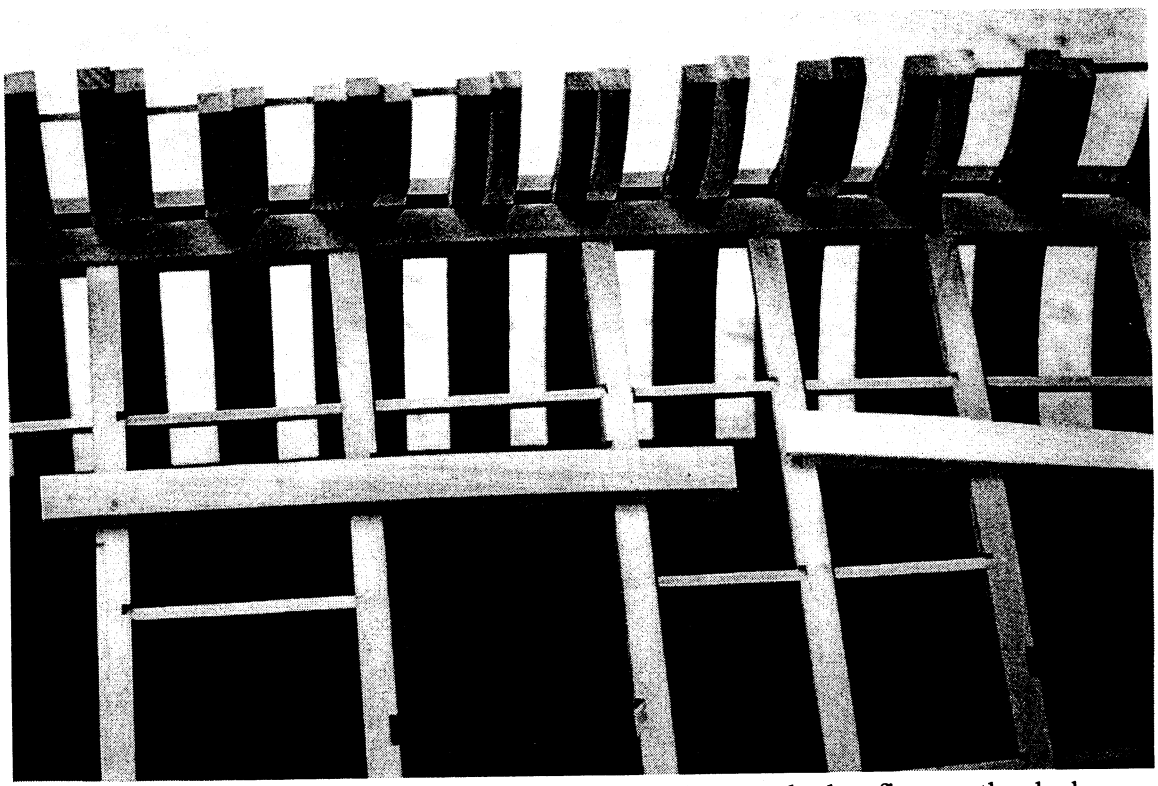


Figure 56. Short sections of the inner waterway timber notched to fit over the deck beams. Photo by G. Grieco.

Figure 57. Deck framing installed. Note the method of dovetailing the ledges into the hatch carling. Photo by G. Grieco.

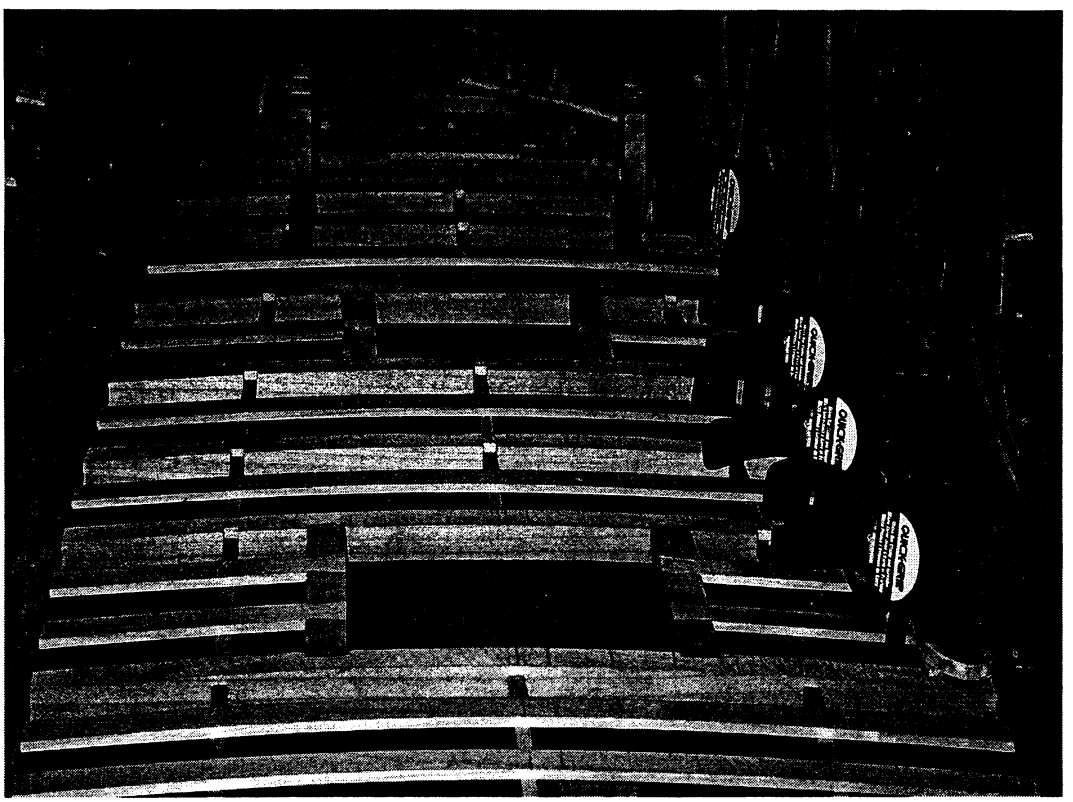


Figure 58. View of the completed deck framing looking forward. Photo by G. Grieco.

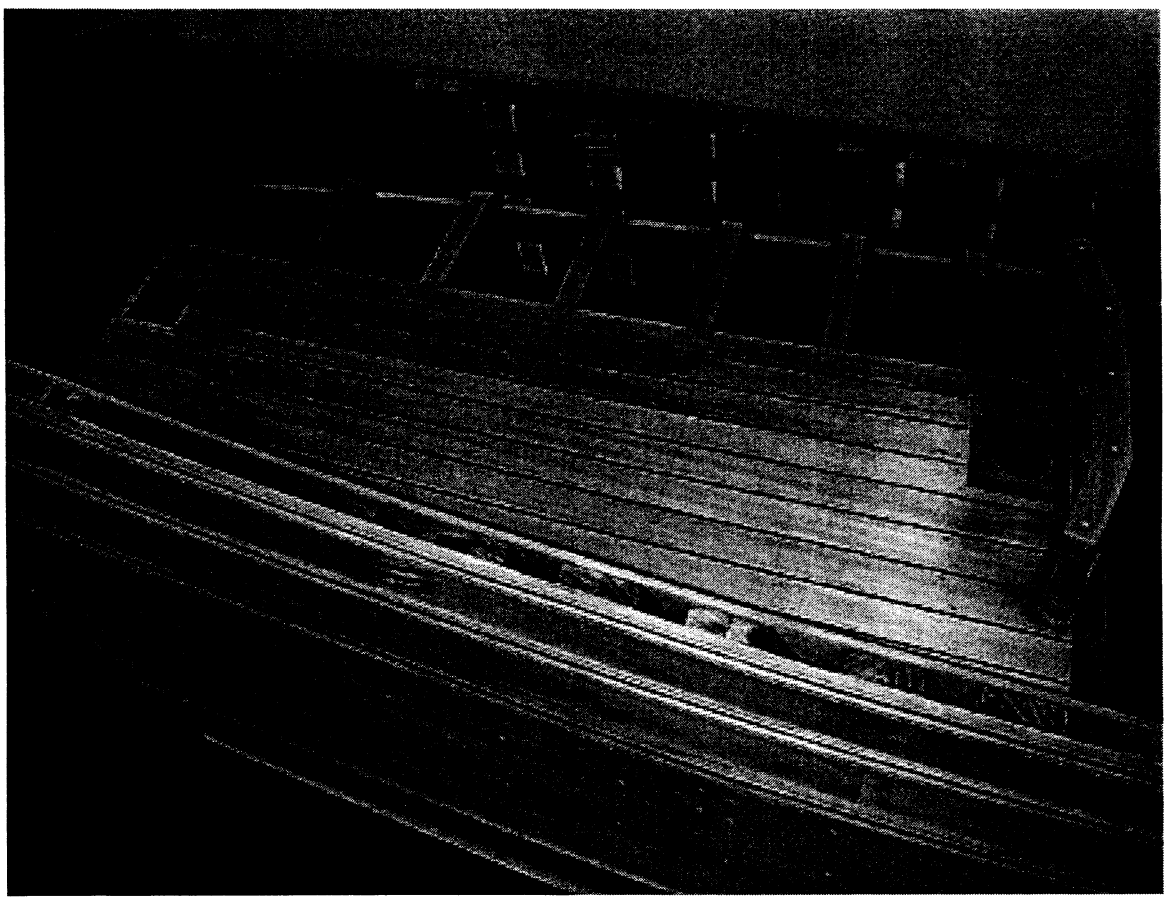


Figure 59. View of quarterdeck framing and planking. Photo by G. Grieco.

inches (13.6 cm) sided and 4 inches (10.8 cm) molded dimension were used in the model. Based on contemporary drawings, these smaller decks do not appear to have required carlings or ledges.[42]

Deck Planking

On both models, only the starboard side of the deck was planked. This not only permits the inspection of the internal construction features, but also allows the details of the deck framing to be seen.

It was common for large ships of the French navy to have gun deck planking 4 inches (10.8 cm) thick or more. These planks are needed to distribute the load of the heavy guns, each weighing 4 tons or more. Boudriot lists planking thicknesses of 2 ½ inches (6.8 cm) for the quarterdeck and 1 ¾ inches (4.7 cm) for the poop deck of a seventy-four gun ship.[43] In the case of *La Belle*, the quarterdeck and the forecastle deck carried no guns at all. Although picking dimensions off old drafts and drawings is not necessarily accurate, 2- to 2 ½-inch (5.4 to 6.8 cm) thick planks seem appropriate for decks carrying 6- to 8-pounder guns. The decks in *La Belle*'s hold were 1 ¼ to 1 ½ inches (3.4 to 4.1 cm) thick and her hull planking was up to 2 inches (5.4 cm) thick. The main deck planking was thicker than the lower deck planking, but probably did not exceed the thickness of the hull planks. Therefore, a thickness of 2 inches (5.4 cm) was selected for the deck planking.

Due to the absence of archaeological evidence, the deck planking pattern on *La Belle* will never be determined for certain. The deck planking of the model approximates the appearance and planking patterns of models from the seventeenth and

early eighteenth centuries. The examination of several early models and drawings, revealed that the typical deck had a single centerline plank, or "king plank," with an equal number of planks on either side. The deck plan of the frigate *La Renommée* provides a good example of this layout. [44] Strakes ranged from about 6 inches (16.3 cm) wide at midships on small vessels, up to 1 foot (32.5 cm) wide on larger ships. With an odd number of equal width planks at midships, all the planks would be tapered evenly fore and aft to compensate for the narrowing of the hull. This would allow all the strakes to run nearly the entire length of the vessel without tapering to a point at the waterways.

Assuming that a king plank was used amidships, the space between the inner edges of the two waterways was divided by odd numbers until a reasonable width for the individual planks was calculated. The space between the waterways measured exactly 136 inches (3.686 m). If this distance was divided into fifteen strakes, each plank would be more than 9 inches (24.4 cm) wide. With seventeen strakes, each plank would be only 8 inches (21.7 cm) wide. Using a ¼ inch (0.7 cm) caulking seam between each plank, resulted in a final plank width of 7 ¾ inches (21.0 cm). At every second deck beam, the distance between the waterways was measured and divided to obtain seventeen divisions.

Thin strips were cut from black plastic binder cover sheets to insert between the planks to represent the tarred seams. Each plank was fastened to each deck beam using two 1-inch (2.7 cm)diameter treenails. To prevent the width of the planking from tapering to a point, the outer three strakes at the bow were joggled (fig 60). Figure 61 shows the completed deck planking.

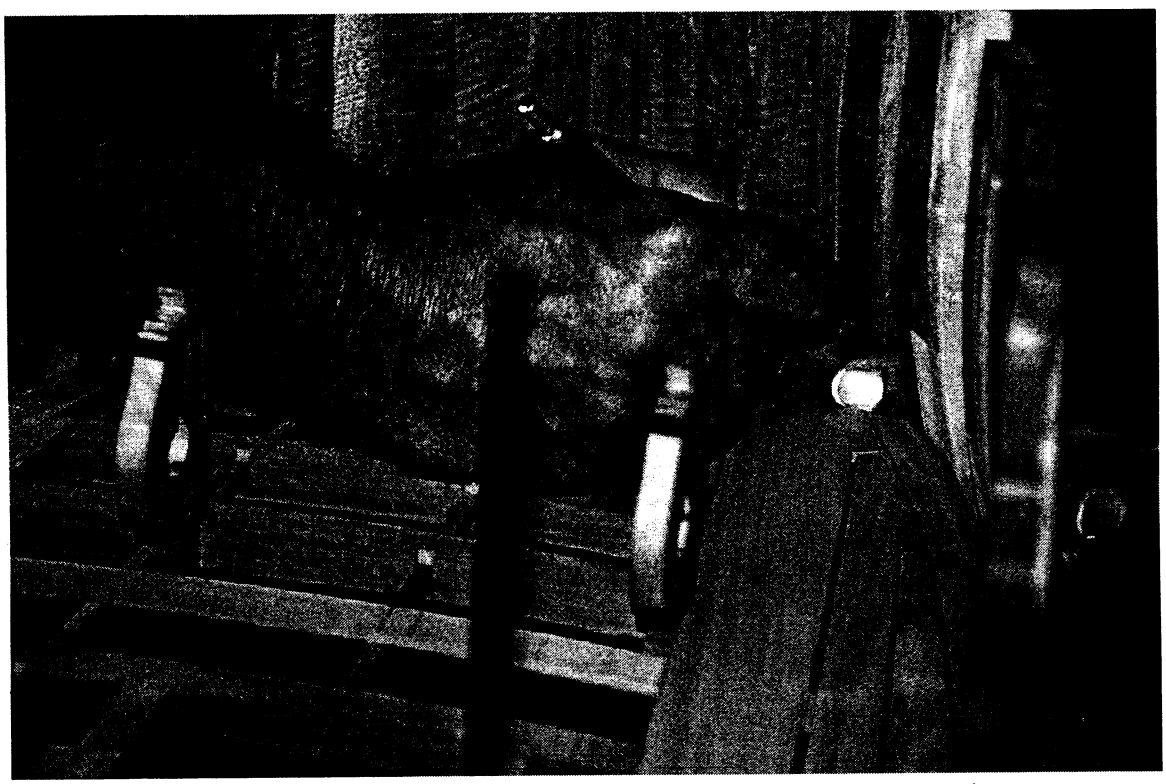


Figure 60. Fitting the first three strakes of deck planking. Photo by G. Grieco.

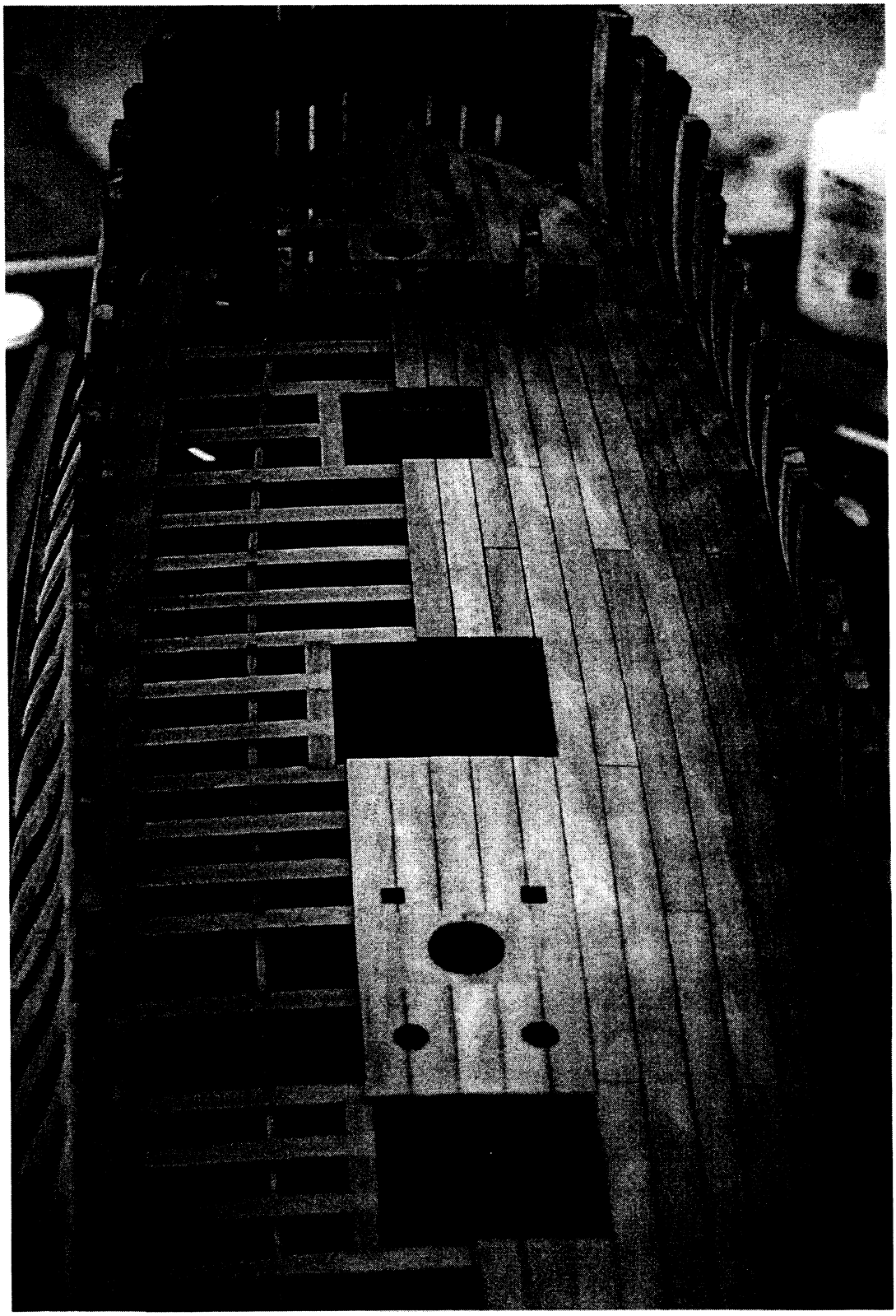


Figure 61. Deck planking on the starboard side of the model. Photo by G. Grieco.

Gunports

Before the gunports were cut and framed, their locations were determined. Many factors were considered in determining the placement of cannon on a narrow-decked vessel like *La Belle*. Structures such as hatch coamings, masts, pumps, and bitts, can prevent them from being withdrawn from their ports. Outside of the hull, the location of the fore and main mast channels can dictate the placement of gunports. The breadth of the vessel is also a limiting factor. The barrel of a four-pounder cannon is 6 feet (1.951 m) long. With a deck less than 14 feet (4.553 m) wide and a foot of tumblehome in the waist, two cannon barely fit abreast with the port lids closed. Forward and aft of midships, the narrowing of the deck would prevent this arrangement entirely unless the guns were drawn in at an angle. Consideration must also given to the gun crews who fired the guns. Seventeenth-century French naval regulations required a minimum spacing of 6 feet, 6 inches (2.114 m) between the guns on larger warships to provide room for the crews to service them.[45]

The reconstructed breadth of the gunports was calculated to be 18 inches (48.8 cm) square. This calculation was later confirmed by research by Boudriot, and also by a single gunport lid found during the excavation of *La Belle* (fig 62). The frames were erected on18-inch (48.8 cm) centers, conveniently allowing the top timbers of two adjacent frames to be used to frame the sides of the ports.

Two possible configurations were formulated. The first configuration relied on Enriquez Barroto's description of the hull and assumed the use of eight gunports. Employed on the first model (fig 63), this arrangement allowed the forward two pairs of guns to be secured inboard with the gunports closed, but the space available on deck

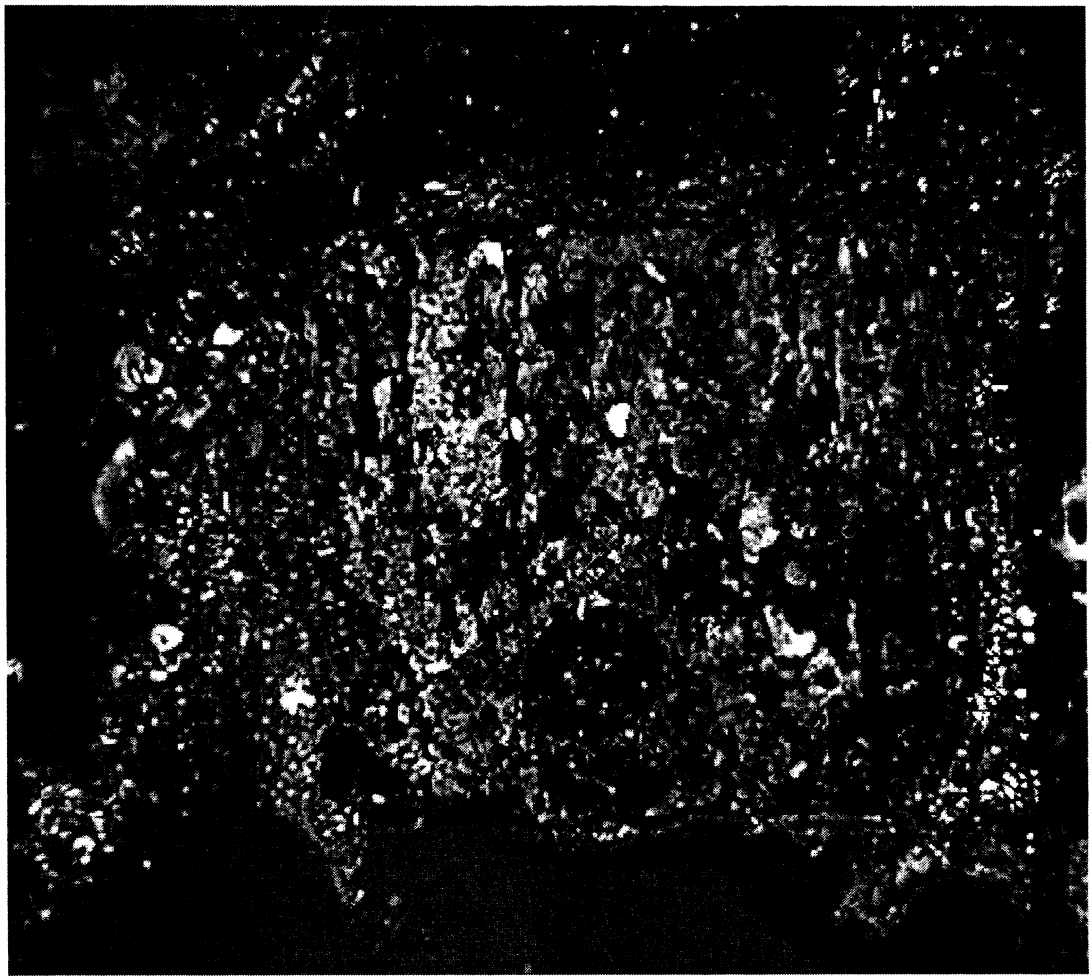


Figure 62. Photograph of the inside face of one of *La Belle*'s gunport lids. Notice concreted ring bolt on the lower side of the lid. Photo by J. Cozzi.

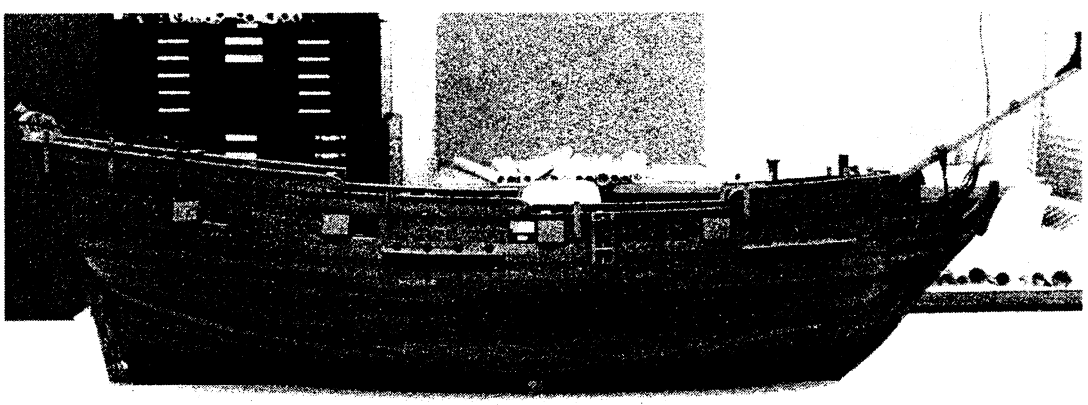


Figure 63. Starboard side of completed hull of first *La Belle* model. Notice arrangement of four gunports with lids that open fore and aft. Photo by G. Grieco.

between the aftermost pairs of ports was not sufficient for two guns to be positioned abreast. This suggests an eight port configuration using only six guns. With four guns in the forward four ports, the two aftermost guns could be used one per pair of ports and moved from side to side as necessary. The second configuration assumed that only six ports were present (fig. 64). In this arrangement, space would have been tight between the aftermost pair of guns. However, with a slight angling of the carriages, both guns could have been run in when the ports were closed.

Once the locations of the ports were estimated, the top timbers at the port openings were cut to a height of 11 inches (29.8 cm) above the deck. A 3-inch (8.1 cm) thick lintel raised the sill to the required height of 1 foot, 2 inch (37.9 cm). A second timber of the same dimensions formed the upper edge of the gunport.

The planking around the gunports was cut around the opening on the top and sides of the port, leaving a 1-inch (2.7 cm) lip around these three sides. The planking of the gunport lid was cut to fit an opening of this size. The dimensions of the port lid were 20 inches (54.2 cm) wide by 19 inches (51.5 cm) high. The planking of the port lid continues the run of the planking seams across the face of the lid. Nailed to the inner surface of the port lid was a lining of 1-inch (2.7 cm) thick planking that, when closed, fit tightly into the 18-inch (48.8 cm) square opening in the framing. The gunport lid uncovered on the shipwreck confirmed the accuracy of these dimensions. The remains of three gunport hinges indicate that the hinge straps were almost 19 inches (51.5 cm) long and 2 ½ to 3 inches (6.8 cm to 8.1 cm) wide. The orientation of the surviving wood grain still concreted to the hinges confirmed that the lids were hung from the top and did not open fore and aft, as constructed on the first model. On both

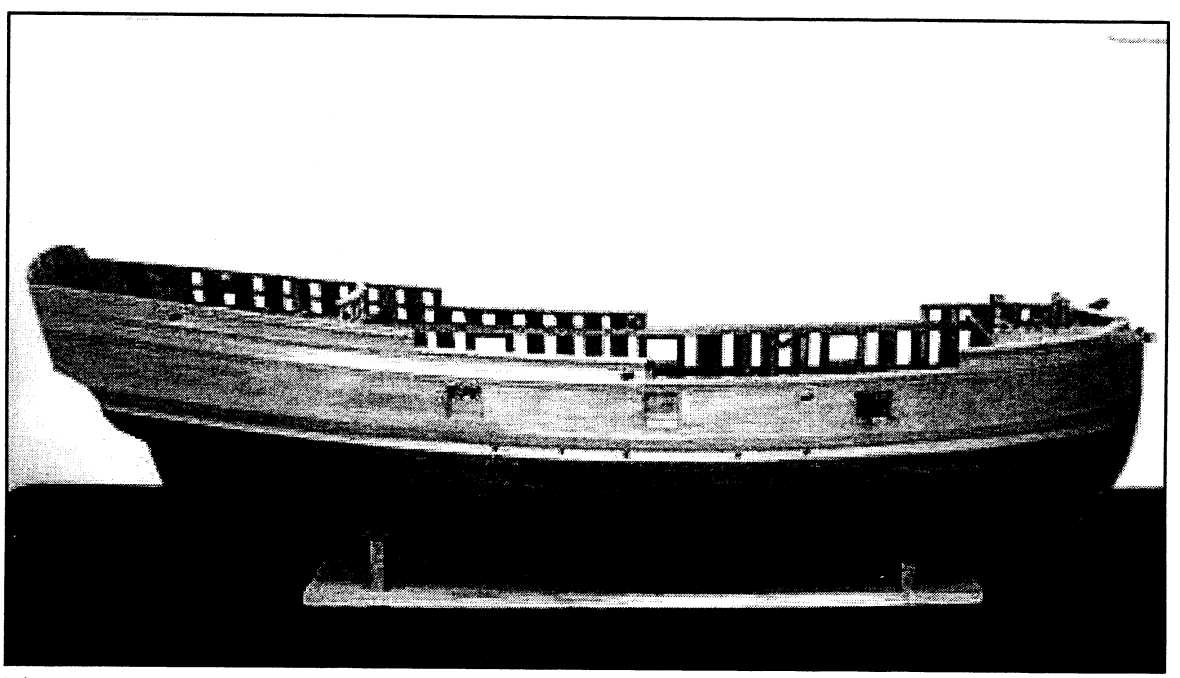


Figure 64. Partially complete hull of second *La Belle* model showing placement of three gunports on each side. Photo by G. Grieco.

models, the lining is attached with a diagonal pattern of evenly spaced nails. However, this appears to be inaccurate. The lining on the recovered lid was fastened using a more random pattern of nails around the circumference and at the seams of each of the individual planks. A small ring is centered about 4 inches (10.8 cm) above the lower edge of the lining inside the lid. It was apparently used to secure the lid when closed.

Bulwarks

Before the bulwarks were planked, several fittings were installed in the framing above the wales. Scuppers were needed on *La Belle* to allow water to drain from the deck. Typically, ships were equipped with several scuppers in the waist of the vessel and in the manger at the bow. By the early eighteenth-century, lead scupper pipes were already in use aboard ships in the French and English navies. In the case of *La Belle*, however, no lead artifacts that resembled scuppers were found among the archaeological remains. It is possible that the lead linings were scavenged from the hull after her grounding, although it is equally possible that her scuppers were not lead lined. Bored elm blocks with leather linings were commonly used as scuppers during the fifteenth and sixteenth centuries. The practice was still in use aboard English vessels during the late seventeenth and early eighteenth centuries and may have been used on vessels of other nationalities as well.[46] Considering the absence of evidence for metal linings, wooden scuppers appear to be the best solution. Contemporary drawing of small vessels depict five to seven scuppers in the waist and one at the bow for the manger. Because cutting a hole for the scuppers in one of the wales would have compromised the strength of the timber, contemporary drawings show the outlet of the

scuppers in the strake between the two wales. Placing the deck clamp at the height of the lower wale, the angle from the top of the deck to the outlet of the scupper is close to 45 degrees (fig. 65). For the reconstruction of *La Belle*, five 2-inch (5.4 cm) scuppers were provided in the waist and one in the bow.

While sailing, several lines of rigging must run through the sides of the hull. To assure the proper lead of the sheets and braces, three sets of fairlead blocks were set into the hull (fig. 66). Positioned between the second and third frames forward of midships, a single sheave block on each side of the hull trimmed the fore sheets. Between the second and third frames aft of midships, a double sheave block is provided for the fore yard braces. Finally, a double sheave block for the main sheet and braces is set between the sixteenth and seventeenth frames aft.

After these elements were installed, the planking of the bulwarks was completed. The reconstructed midship section was used to define the dimensions of the planking. Externally, the planking was composed of parallel-sided planks that continued the curve of the wales up the side of the vessel. Contemporary drawings of small vessels and frigates indicate that the space between the upper wale and the molding below the waist rail typically consists of three strakes, with a single strake between the waist rail and the sheer rail, and another between the sheer rail and the drift rail. By dividing the space between the wale and the molding, it was determined that three 9-inch (24.4 cm) wide planks were required. Continuing up the sides of the stern, two additional 9-inch (24.4 cm) planks alternating with two 3-inch (8.1 cm) moldings provided the height necessary for the quarterdeck. One additional plank in the bow provided the height needed for the forecastle deck. The reconstructed thickness of the

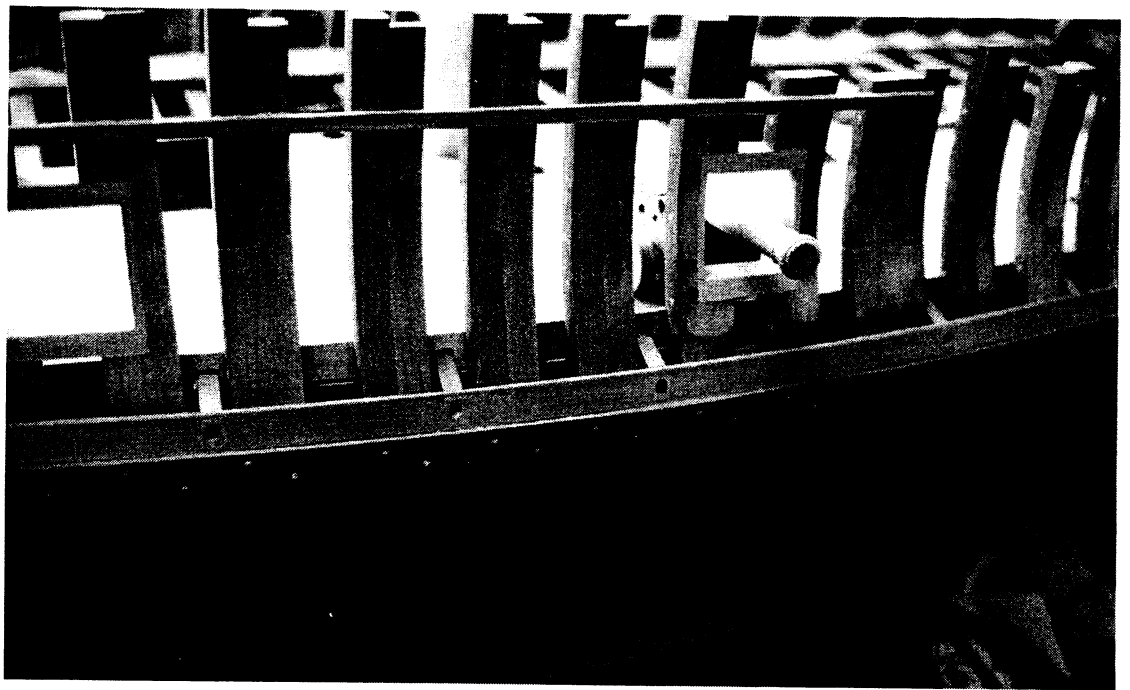


Figure 65. Scuppers composed of bored wood blocks installed on the starboard side of the model. Photo by G. Grieco.

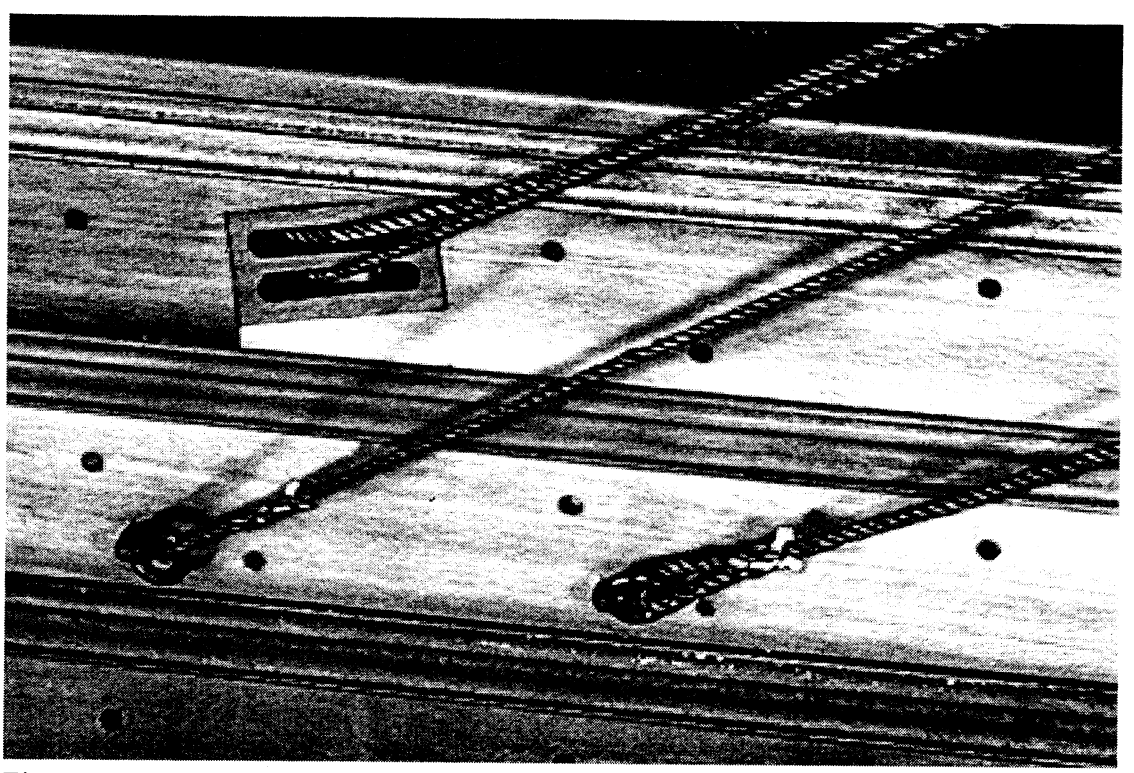


Figure 66. Close-up photo of fairlead block for the main sheets and braces. Standing ends of the sheet and brace are spliced to the ring bolts below. Photo by G. Grieco.

planking in the upperworks was 1½ inches (4.1 cm).

On the inside of the bulwarks, two spirketting timbers, each measuring 7 inches (19.0 cm) wide and 2 inches (5.4 cm) thick, were planked to the height of the gunport sills. A simple half-round molding was cut into the top inner face of the upper timber. Because the run of the deck diverges from the run of the wales, and the sheer of the vessel is determined by the run of the external planking, the area above the spirketting has an irregular shape. The clamps for the quarter deck and forecastle deck were installed parallel to the deck with their upper face at a height of 3 feet, 8 inches (1.192 m). Notched 2 inches (5.4 cm) into the clamps, the beams of the fore and after decks are set 3 ½ feet (113.8 cm) high, as mentioned by Olivier.[47] The clamps are 3 inches (8.1 cm) wide and 4 inches (10.8 cm) deep. The area between the spirketting and clamps was planked with four strakes, each 6 ½ inches (17.6 cm) wide and 1 ½ inches (4.1 cm) thick. Following the installation of the forecastle and quarter decks, the planking of the bulwarks was completed up to the sheer using 1 ½-inch (4.1 cm) planking.

Deck Furniture and Fittings

With the hull framed and planked, it was next necessary to fit out the hull. In the absence of a definite order of construction, this discussion will begin at the bow and work towards the stern on the inside of the vessel and then on the outside. Little of the upperworks of the vessel have survived and most of the material from this area that has been recovered consists of metal artifacts or, in rare instances, a few bits of wood preserved by the corrosion products of associated iron fasteners. In order to

reconstruct the original appearance of *La Belle*, it was necessary to include structures that, although not represented archaeologically, were typical features onboard contemporary vessels. Except where it is specifically indicated that dimensions were taken from surviving artifacts, dimensions provided in this section are reconstructions or "best guess" estimates.

In the bow of the ship, support was needed for the heel of the bowsprit. The reconstructed bowsprit step was composed of two vertical posts of 4-inch (10.8 cm) square section that bolted to beams in the main and forecastle decks. A heavy timber was bolted laterally between these two timbers and morticed for the 3-inch (8.1 cm) square heel tenon of the bowsprit. The posts continued through the forecastle deck to form the fore bitts.

On the main deck, just aft of the bowsprit step, a low plank was tightly fit to run laterally across the deck planking. The space forward of the plank captured water draining from the anchor cable and prevented it from washing down the deck. Two scuppers in the corners of this enclosure allowed the water to drain. This enclosed area, known as a manger, was often used to house any livestock kept onboard the vessel.

On the forecastle deck, two heavy catheads to either side of the fore bitts were used to raise the anchors (fig. 67). These 6-inch (16.3 cm) square timbers extended outboard 2 feet (65.0 cm) at about 45 degrees to the centerline of the vessel and had two 5-inch (13.6 cm) diameter sheaves set into their outboard ends. Inboard, the arms angled aft approximately 15 degrees to ensure contact with two deck beams.

Just aft of the bowsprit step are the partners for the foremast. A hole was cut in

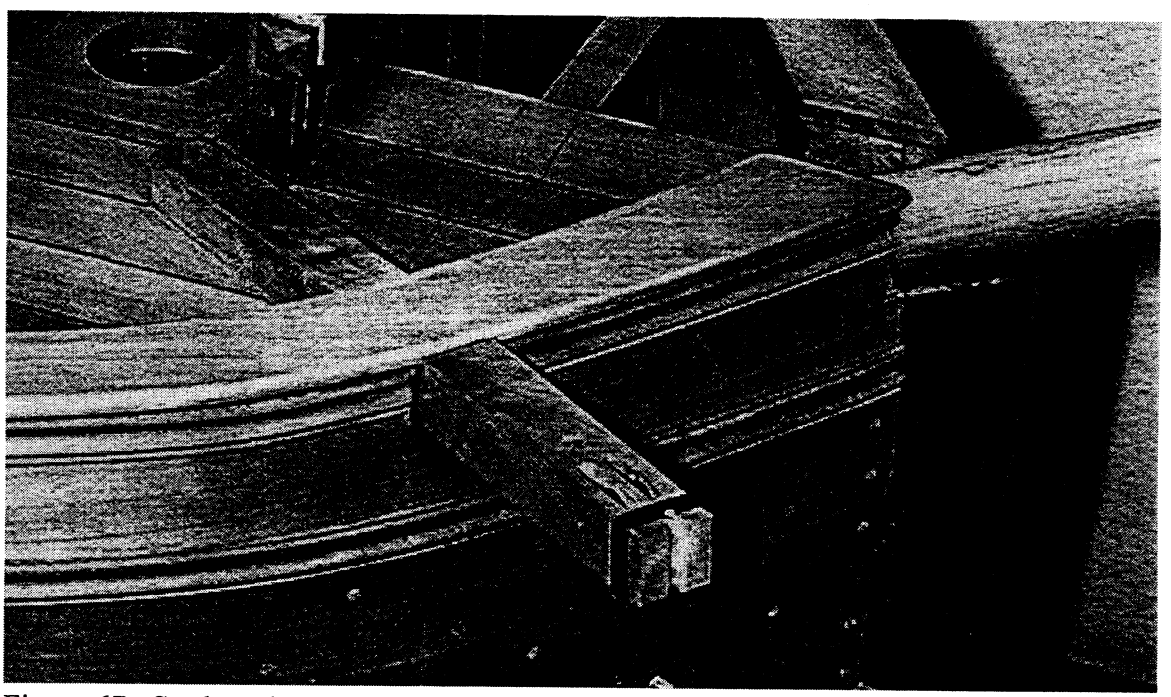


Figure 67. Starboard cathead on the model. Photo by G. Grieco.

the center of this timber with a diameter 4 inches (10.9 cm) greater than that of the mast, and twelve wedges were driven around the mast to secure it.

La Belle most likely carried a bell to strike the watches. A small belfry was installed on the model aft of the forecastle deck (fig. 68). The bitts supporting the belfry also hold the pawl of the windlass. The windlass uses a simple design that was common for centuries before and after the construction of *La Belle*. The six-sided windlass is 6 ½ feet (2.11.4 m) long and 12 inches (32.5 cm) between its faces at the center. When laying out the deck, special consideration was taken to assure a clear run for the anchor hawser from the hawseholes to the cable tier hatch.

Hatch coamings were constructed of 5-inch (13.6 cm) square timbers, ship-lapped at the corners. The coamings on the forward and aft sides of the hatches are shaped to follow the camber of the deck. The upper inside face of the entire circumference of the coaming has a rabbet 2 inches (5.4 cm) square to accept the hatches. The hatches of the first model were of solid construction with four to six planks nailed to two lateral braces. Ring bolts were provided at two opposing corners for lifting the hatch. However, this arrangement would have restricted ventilation to the hold. With up to forty-four passengers and crew on board, it would have been necessary to berth below deck in shifts. At any time, day or night, there were probably people below deck. For this reason, gratings seem more appropriate for the hatches of *La Belle*. For the second model, gratings were constructed from 2-inch (5.4 cm) square ledges notched at 2-inch (5.4 cm) intervals to take 2-inch (5.4 cm) wide by ½ inch (1.4 cm) thick battens (fig. 69).

Just forward of the main mast are the main bitts. Measuring five inches

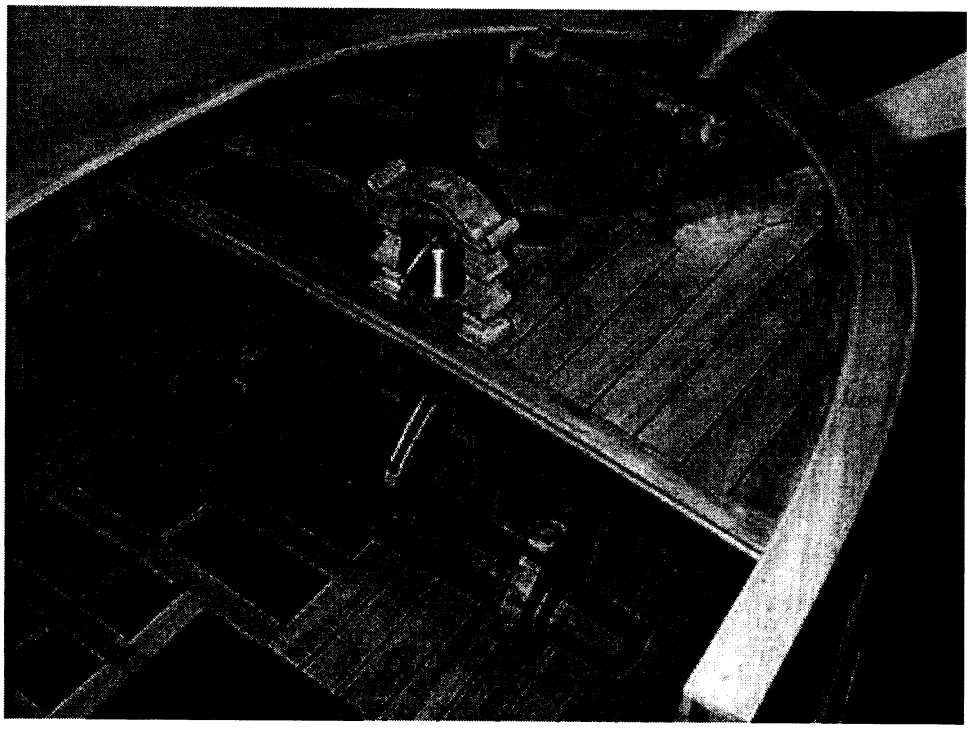


Figure 68. Close-up photo of the forecastle deck on the model of *La Belle*. Notice how the supports for the belfrey also support the pawl of the windlass. Photo by G. Grieco.

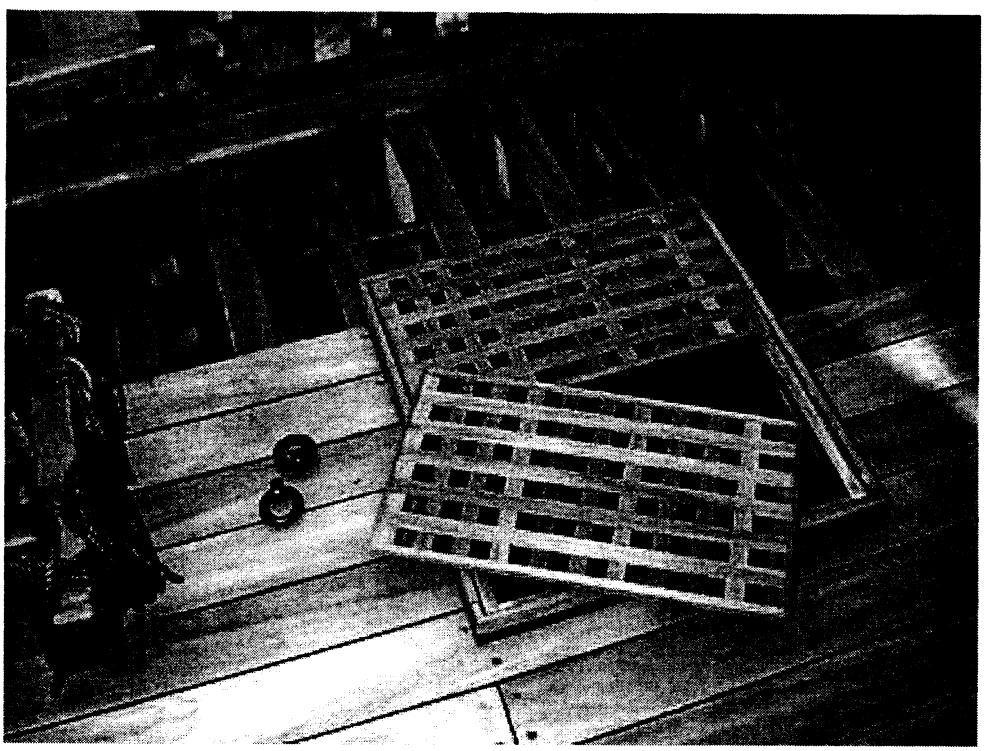


Figure 69. Close-up view of *La Belle*'s main hatch. Photo by G. Grieco.

(13.6 cm) square in section, they are connected by a cross piece 1 ½ feet (48.8 cm) above the deck. The cross piece is 4 inches (10.8 cm) wide and 3 inches (8.1 cm) deep. On English vessels, belaying pins don't begin to appear until the end of the eighteenth century.[48] The very detailed eighteenth-century models in the Musée de la Marine show an absence of belaying pins on the cross pieces until late in the century; instead, the lines were simply hitched to it. Just above deck level, two sheaves were set into the bases of the bitts to lead the lines such as the topsail sheets that require additional mechanical purchase.

Aft of the main mast are the two bilge pumps (fig. 70). Only a small section of the heel at the base of one of the tubes has survived. Measuring 9 ½ inches (25.7 cm) in diameter, it tapered only slightly and probably had a diameter of about 10 inches (27.1 cm) at deck level. Contemporary drawings show pump tubes with square or octagonal sections. The rounded heel of the pump from *La Belle* suggests an octagonal tube. Drawings from the *Album del Marquez de la Victoria* were used to reconstruct the pumps on *La Belle*.[49]

Access to the quarterdeck was provided by two ladders on the inside of the bulwarks (fig. 71). The omission of deck planking on one side of the model precluded the installation of the port side ladder. Between the ladders at the forward end of the quarterdeck, a short rail not only prevented the officers and crew from falling from the deck, but also provided a hitching point for the rigging of the mizzen mast.

As mentioned earlier, belaying pins were not common on French vessels during the late seventeenth century. Instead, cleats and kevels were used to belay most of the rigging. Several cleats of different sizes were recovered from the wreck, indicating that

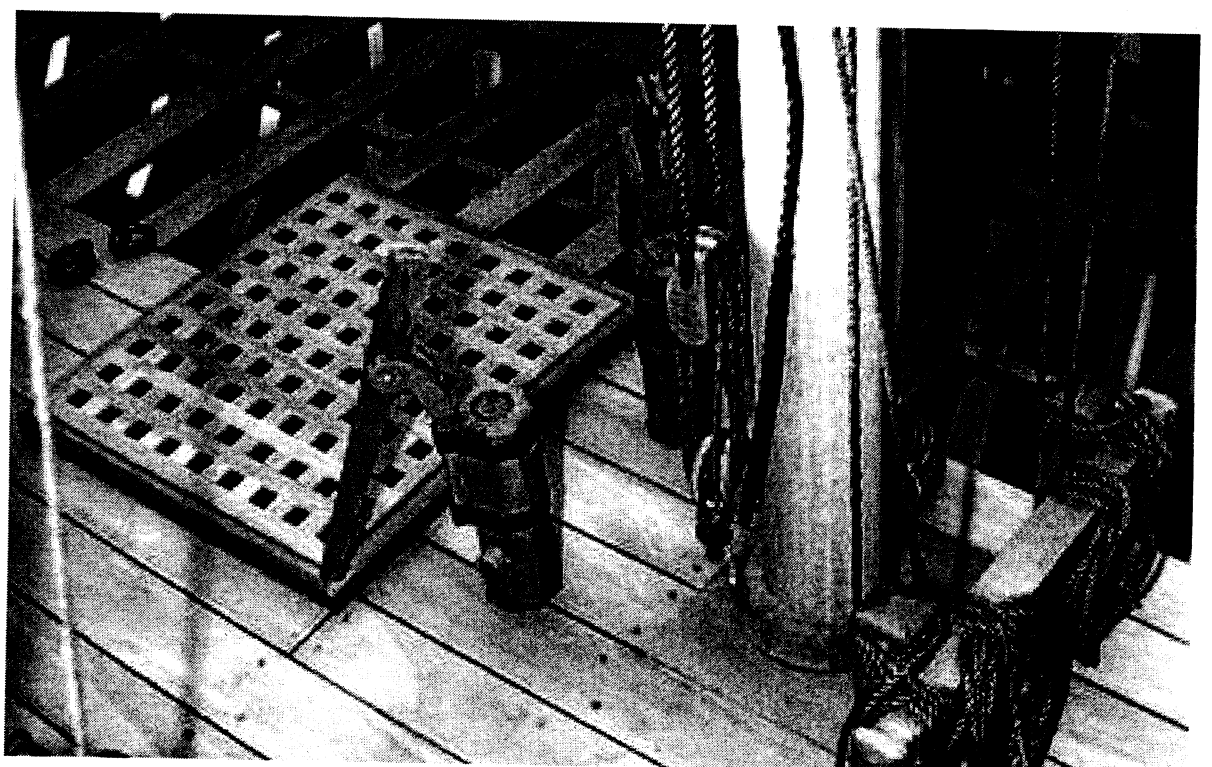


Figure 70. Photograph of the waist of the model showing arrangement of the main mast, main bitts and bilge pumps. Photo by G. Grieco.

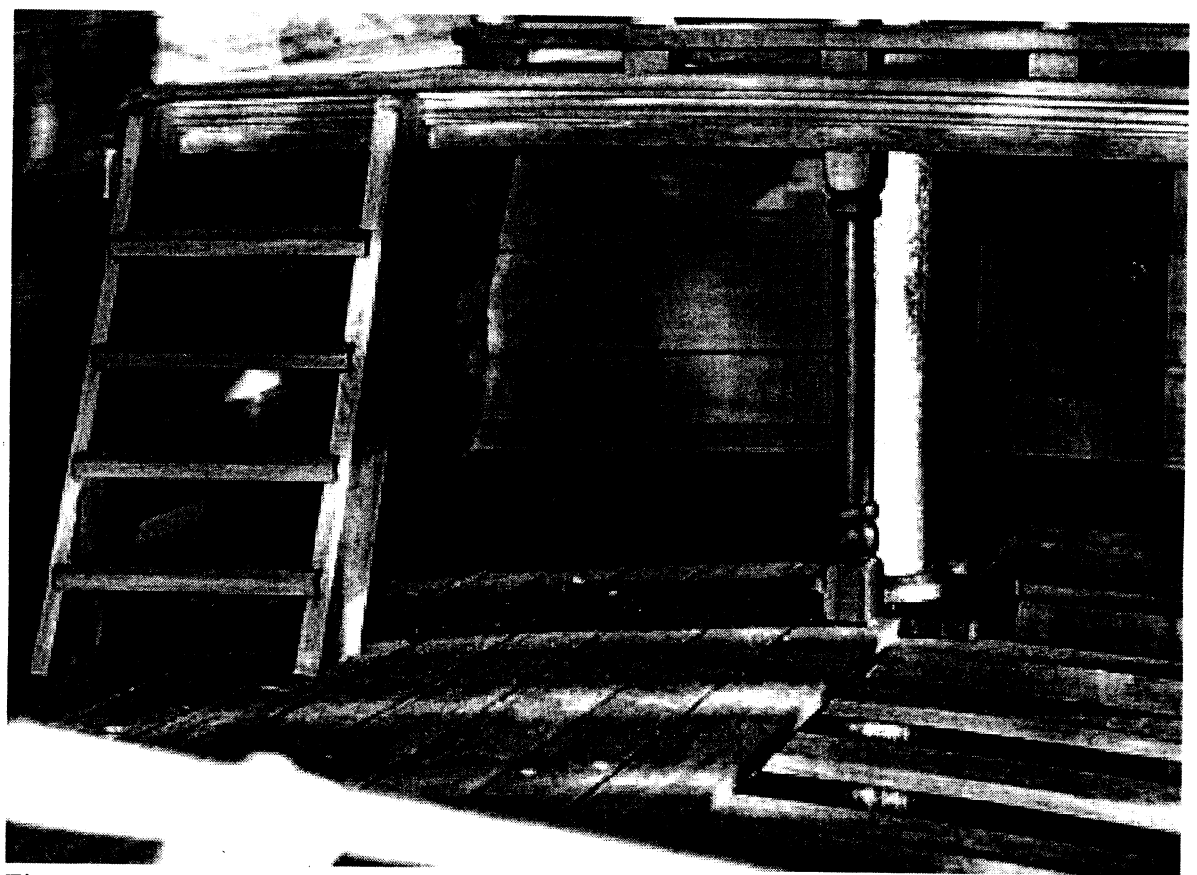


Figure 71. Close-up view of ladder to the quarterdeck. The door to the small stern cabin is visible to the right. Photo by G. Grieco.

they were common onboard (fig. 72). Examples of kevels from early eighteenth century models were used to construct those for *La Belle.*[50] The kevels were heavily constructed, and designed redistributed the load applied to them over a large area of the bulwarks, allowing them to absorb, much like a spring, the sharp or sudden force applied to them by a sail or yard. These forces would eventually work a more rigid cleat loose. For the model, kevels were used for lines bearing the heaviest loads, such as the lower sheets and braces (fig. 73). Lines carrying moderate loads, such as the tacks, were belayed to large cleats, while light loads were belayed to small cleats. It was not unusual at this time to simply belay many of the lighter lines of running rigging to heavier lines of standing rigging, such as stays and shrouds.[51]

Ring bolts were used throughout the hull to anchor various elements of the rigging. Blocks secured at deck level were stropped through ring bolts and various lines of running rigging such as the lower braces, sheets and tacks were secured at their standing end through ring bolts. More than eleven ring bolts were recovered among the archaeological remains. The most common size has a ring that measures approximately 4 inches (10.8 cm) in diameter and is constructed from iron bar with a 1-inch (2.7 cm) diameter. Some smaller rings with a diameter of 3 inches (8.1 cm) were also found. For the model, the larger ring bolts were used in the bulwarks and along the center of the deck for the gun tackles, and the smaller size was used in the rigging.

Moving along the exterior of the hull, starting at the bow, the remains of one hawse hole lining were found (fig. 74). Based on its semicircular shape, it appears that only the lower half of the hole was lined. Although slightly distorted, several dimensions were measured from the lining. Constructed of 1/8th inch lead sheet, it was

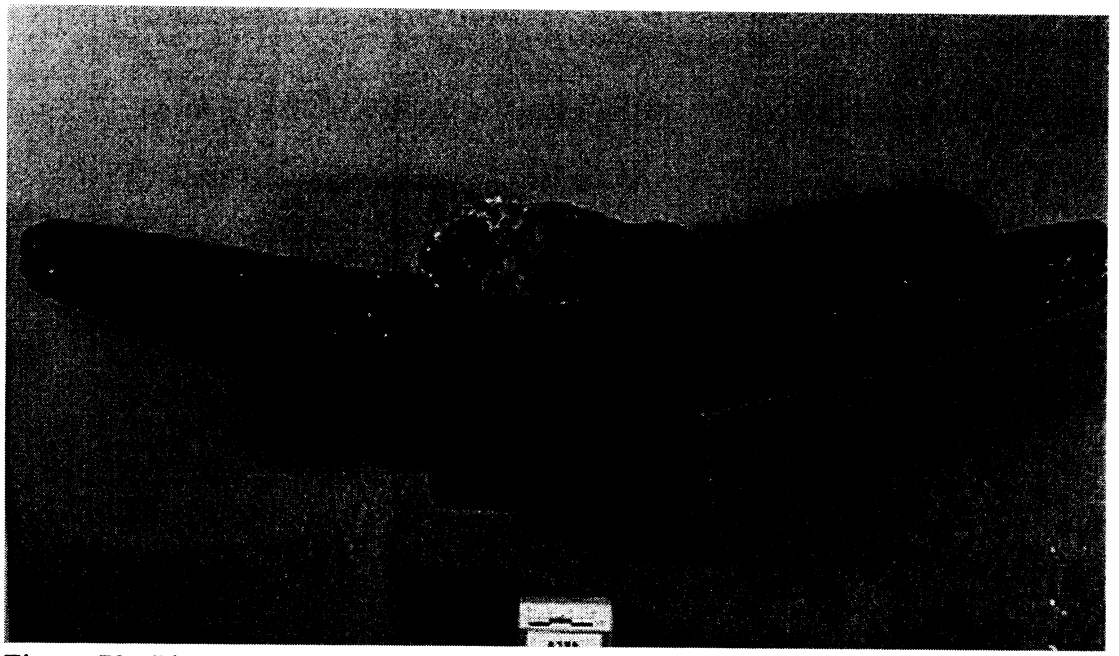


Figure 72. Photograph of one of the large cleats recovered from *La Belle*. Courtesy of the Conservation Research Laboratory.

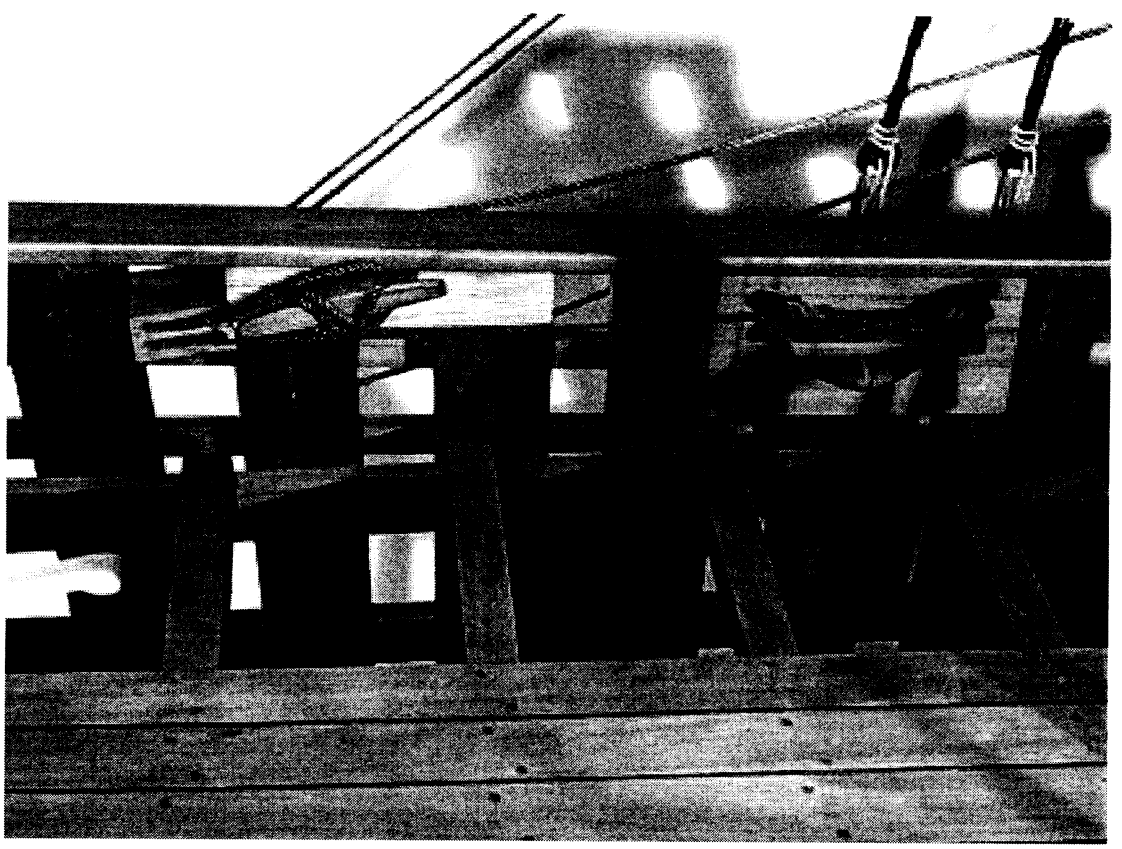


Figure 73. Kevels in place on the bulwarks of the quarterdeck. Photo by G. Grieco.

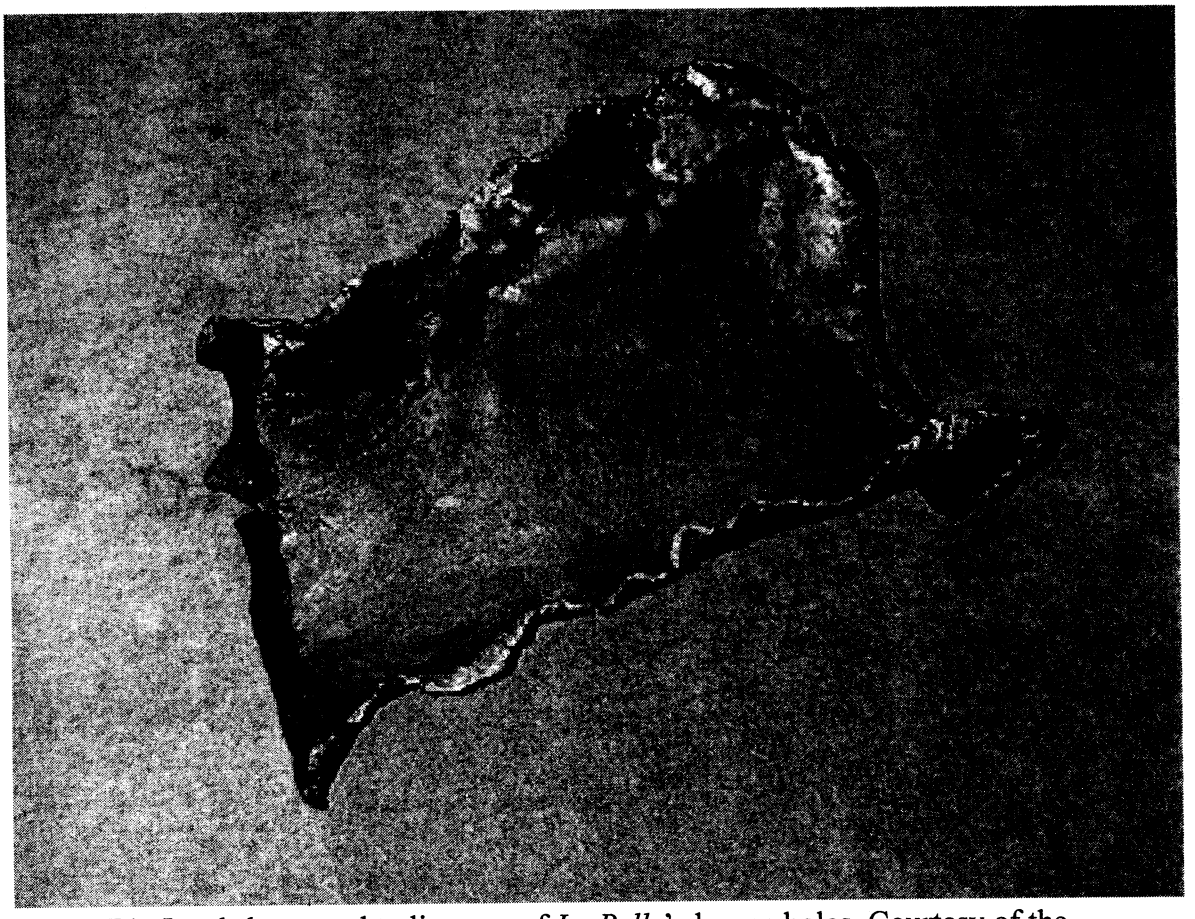


Figure 74. Lead sheet used to line one of *La Belle*'s hawse holes. Courtesy of the Conservation Research Laboratory.

probably cut a few inches longer than the depth of the hole, then bent into a semicircular shape and inserted into the hole. The lead that protruded from either side of the hole was beaten flat against the bulwarks to form a flange around the outside of the hole. The angle at which the flanges were formed indicates that the hawse hole sloped downward at about 30 degrees. The length of the inner face of the lining was about 11 inches (29.8 cm) and the diameter was just under 6 inches (16.3 cm). Anchor cable recovered from the wreck site had a diameter of 2 ½ inches (6.8 cm).[52] Dividing by 3.14 gives a diameter of 2 ½ inches. Although discussing English ships, Goodwin gives an equation for the calculation of the size of the hawse port as being nine-fourths of the size of the hawser, which in the case of *La Belle* would be 6 5/8 inches (17.9 cm).[53] This closely approximates of the relationship between the lead lining and the hawser excavated from the wreck.

Continuing aft along the outside of the hull, the next feature is the channels. These timbers have the dual purpose of extending the shrouds away from the side of the hull to prevent abrasion, while also transferring the load of the masts laterally through the hull. The first consideration was the height of the channels. Contemporary drawings of sloops and light frigates place the channels for the fore and main masts either on the upper wale or, more commonly, immediately above it. The second option was considered more appropriate as it makes use of the support of the upper face of the wale. Determining the proper length and location of the channels along the hull was more problematic. The only available sources that discuss the length of channels refer to larger vessels with up to twelve or more shrouds per channel.[54] Contemporary drawings of sloops and light frigates (Figs. 19, 20, 22) commonly show three shrouds

on the forward channel, four on the main channel and two on the mizzen channel. Anderson mentions that the length of the channel should be two-fifths of the vertical distance between the top of the channel and the bottom face of the corresponding crosstrees.[55] This distance would be more than 9 ½ feet (3.089 m) for the main channel of *La Belle*, which appears inappropriate with only four shrouds. Contemporary drawings suggest that the forwardmost shroud is typically located immediately abreast of its mast. The remaining shrouds are spaced at intervals of about 18 inches (48.8 cm) on the channel. This value seemed appropriate for *La Belle* as it corresponds with the frame spacing, which permitted the bolts that fastened the chainplates to the hull to pass not only through a wale but also through a frame. With the location of the deadeyes determined, the forward and aft edges of the channels were extended an additional 18 inches (48.8 cm) to assure that the ends also terminated on a frame.

The distance by which the channels protrude from the sides of the hull was next determined. A temporary mast with the intended height of the final mast was set into the mast step. A line was run down from the estimated height of the crosstrees to the height of the channel. By moving the line along the hull at this level, the minimum projection needed for the channel in order for the shrouds to clear the caprail was determined to be 14 inches (38.0 cm). The channel was cut from 2 ½-inch (6.8 cm) thick planking. The thickness of the channel tapers slightly at its outboard end. On the model, the channel tapers to 2 inches (5.4 cm).

Fortunately, a number of deadeyes, deadeye straps and part of one chain plate from *La Belle* have survived. Others may be present, but have not yet been identified or processed by the conservation laboratory. The deadeyes range from 4 to 6 inches

(10.8 to 16.3 cm) in diameter, and the surviving straps all appear to be for the larger size of deadeye (fig. 75). A sharp bend in the chain plate approximately 2 inches below the deadeye indicates that the eye of the plate extended above the channel. It is difficult to determine the profile of the strap below the channel. While early English ships used curved chainplates, the *Album de Colbert* and the *Album del Marquez de la Victoria* illustrate straight chainplates. Figure 76 illustrates the reconstruction of the main channel for the model. Fastened to the channels aft of the last shroud, a small deadeye was used to tighten the backstay. It is possible that this is an error. Recently, a chainplate from *La Belle* with a small eye in the upper end has been conserved. This eye may have accepted the hook from a tackle used to tighten a backstay.

The existence of a mizzen channel is less certain. Depending on the size of the mizzen mast, the mizzen may have been braced by a pair of tackles set inboard on the quarterdeck. The first model used this arrangement. The second model assumed a more advanced mizzen mast requiring a pair of 4-inch (10.8 cm) diameter deadeyes per side (fig. 77).

Traditionally, boarding ladders were used on ships. The ladder would have taken the form of a series of cleats fastened to the side of the hull above the wales. The bulwarks on *La Belle* were low enough at midships that only three cleats were required. Each cleat was shaped with a simple molding and pierced at its center for a boarding rope (fig. 78).[56]

Numerous ringbolts were provided on the hull to secure the standing ends of rigging such as the braces. Ringbolts may also have been attached along the length of the lower wales,[57] perhaps to assist in setting up the shrouds.

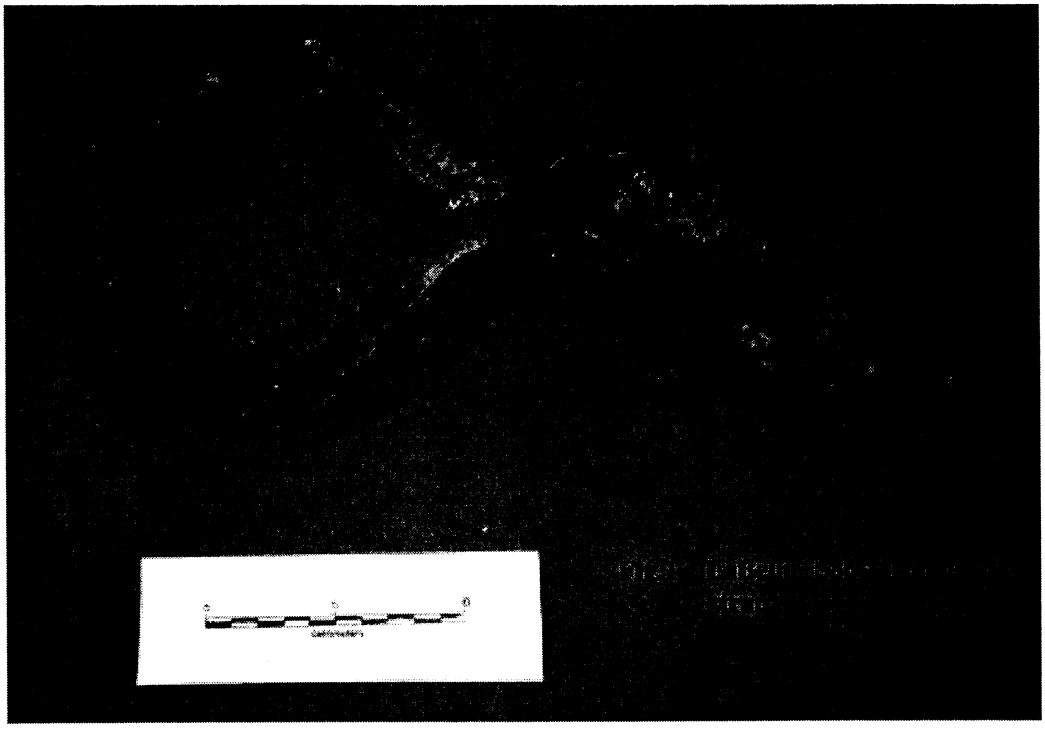


Figure 75. Deadeye strap and segment of a chainplate from *La Belle* after conservation. Courtesy of the Conservation Research Laboratory.

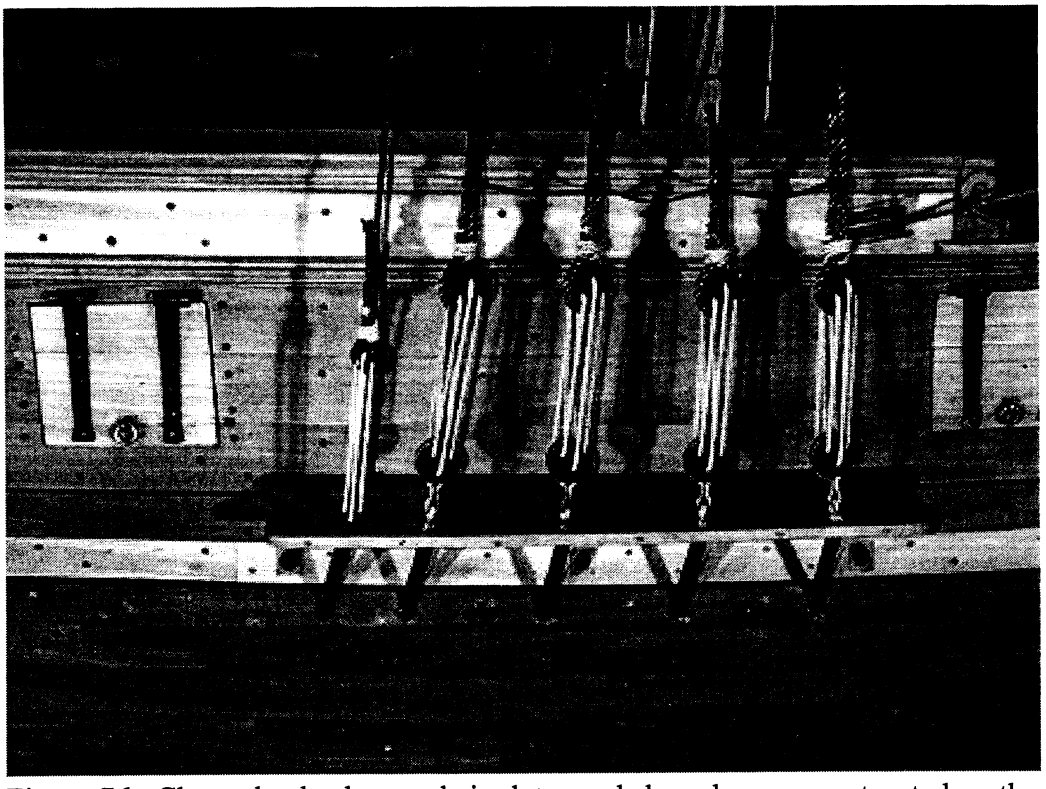


Figure 76. Channels, deadeyes, chainplates and shrouds as reconstructed on the model. Photo by G. Grieco.

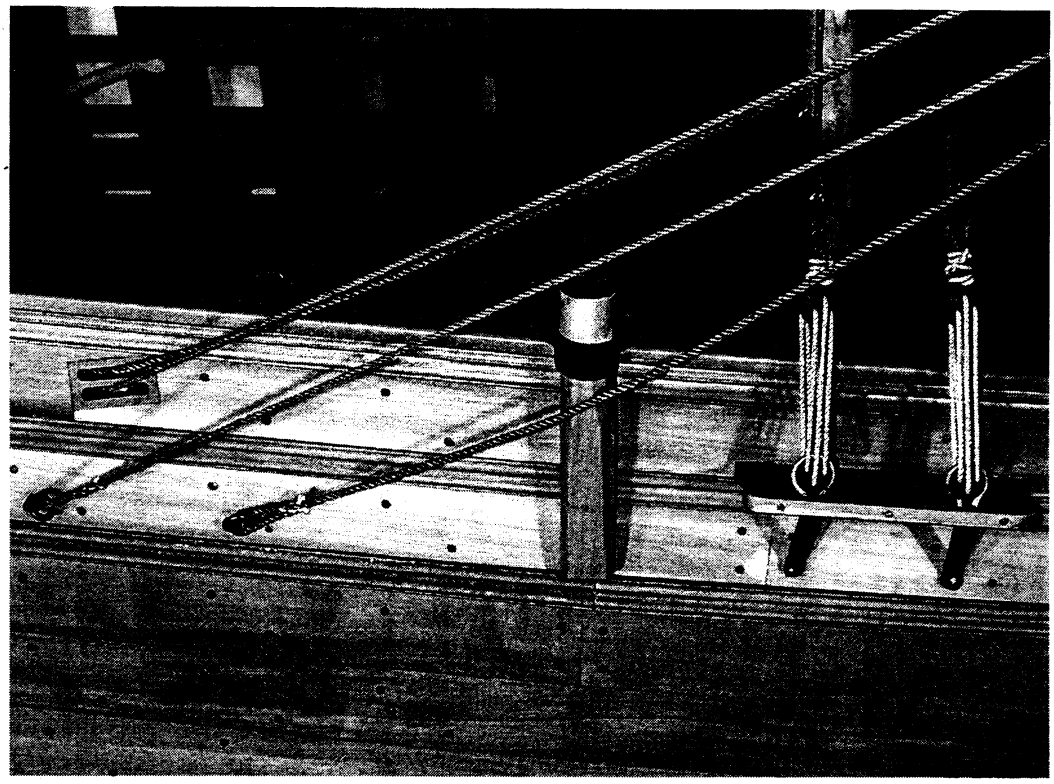


Figure 77. Post for swivel gun with associated iron hardware as reconstructed on the second model. Photo by G. Grieco.

Figure 78. Close-up photograph of *La Belle*'s boarding ladder as reconstructed for the model. Photo by G. Grieco.

Determining the size of the rudder was problematic. Contemporary sources regarding the dimensions of rudders could not be located. As with many other aspects of ship design, most of the available information does not apply to a vessel the size of *La Belle*. It was difficult to find examples of models of comparable size or contemporary drawings of similar vessels that showed the shape of the rudder below the waterline. Because *La Belle* was so small, she would probably have carried a simple tiller without the mechanical advantage of tackles, wheels or whipstaffs. A rudder with a large surface area would have required more force to handle, while a small rudder would have been less responsive. Without the benefit of mechanical purchase to increase the strength of the tillerman, a smaller rudder would be expected. Most of the models that were examined were too large to be controlled with a simple tiller. Drawings of early eighteenth century vessels that use a simple tiller configuration were used to estimate the size of *La Belle*'s rudder.[58] Comparing the length of the heel of the rudder to the overall lengths of the vessels, a ration of about one thirtieth the length of the vessel seemed appropriate. This gives a value of about 1 ½ to 2 feet (48.8 cm to 65.0 cm) for *La Belle*.

For the model, the rudder was constructed from two timbers (fig. 79). The forward timber was a continuous piece from the heel to the top of the rudder head. This piece was nearly square in section, with its forward edges beveled to about 30 degrees to allow the timber to pivot against the sternpost; near the top a fore and aft mortise was cut for the tenon at the end of the tiller. Fayed to the aft side of the main rudder timber is a second piece that extends from the heel to just below the point where the rudder enters the counter of the transom. This timber tapers from about 1 foot

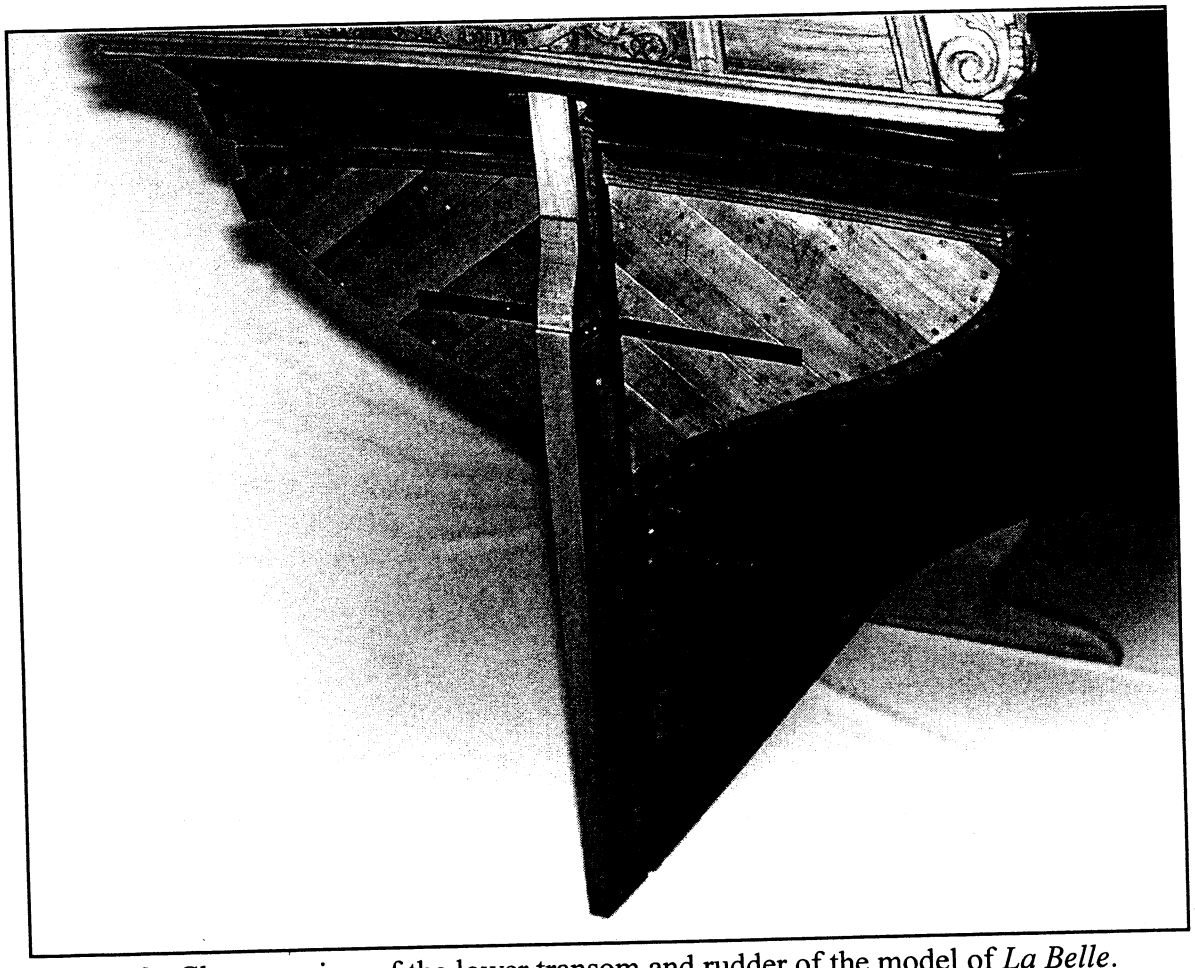


Figure 79. Close-up view of the lower transom and rudder of the model of *La Belle*. Photo by G. Grieco.

(32.5 cm) molded at the heel to about 5 inches (13.6 cm) near its top, where it tapers to an ornate profile. The sided dimension of the rudder tapered from its forward face aft as well as tapering longitudinally towards the heel.

Although only one gudgeon has survived, the rudder probably pivoted on three pairs of iron gudgeons and pintles. Figure 80 illustrates the construction of the gudgeons for the first model. The original gudgeons were composed of an iron strap forged around an iron bearing and shaped to fit the contours of the hull. For the first model, the gudgeons were shaped to fit perpendicularly to the back face of the sternpost. It was later discovered that the gudgeons actually ran parallel to the bottom of the keel. This arrangement is also seen in early eighteenth- century French models and in the *Album del Marquez de la Victoria.*[59] This orientation was used on the second model. Since the strap was no longer perpendicular to the direction of the pintle, the new configuration require a bit more effort to calculate the required angles. What was the reason for this complication to the fabrication of these fittings? Was it practical or merely aesthetic? The lowest of the three gudgeons was fastened to the hull 18 inches (48.8 cm) above the bottom edge of the keel. The uppermost was bolted to the transom at the height of the middle filling transom and the third was positioned halfway between the other two.

Armament

As mentioned in chapter IV, the armament carried on *La Belle* included two types of ordnance: six iron carriage guns firing four-pound balls, and breech-loading iron swivel guns. Several artifacts relating to these guns have survived. Although no

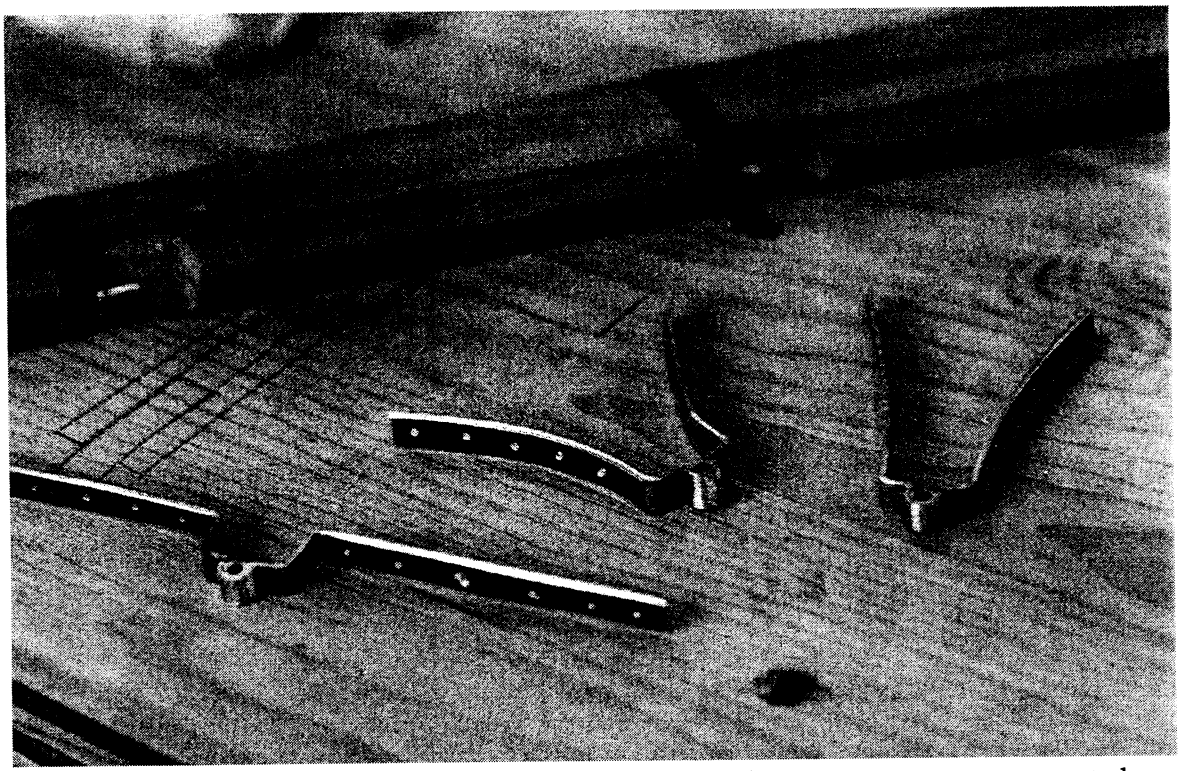


Figure 80. Completed gudgeons for the first model. Gudgeon straps were constructed from brass and blackened to resemble iron. Photo by G. Grieco.

four-pounder long guns were recovered from the wreck, two four-pounders were among the guns excavated from the remains of Fort St. Louis on the Gulf Coast of Texas.[60] Using scale drawings (fig. 81), models of the barrels were turned in brass at the scale of 1:12, and then blackened to imitate the appearance of the original iron guns. Measurements from a single gun carriage recovered from the wreck were used to reconstruct the carriages for the model (fig. 82). Interesting features of the recovered carriage include the deep mounting holes for the trunnions and the flat capsquare locking the trunnion in place. It is more typical to have the trunnion resting in a semicircular notch half the depth of the trunnion, with the upper surface held in place by a capsquare forged with a corresponding semicircular contour. The reason for the position of the trunnions on the sides of the gun carriage on *La Belle* is unknown. Setting the trunnions low certainly eliminated the need for the extra work required for forging semi-circular capsquares. Fine craftsmanship may not have been considered important for such small caliber guns.

A related artifact recovered from the hull consists of concretions containing a ring bolt and an associated hook bolt (fig. 83). Clearly intended for securing the gun tackle to the bulwarks, the conserved artifacts furnish several important pieces of data. Preserved by the corrosion products of the iron, a large section of the wood through which the bolts were fastened has survived. Although the original thickness of the wood has diminished, a rove for the forelock of the hook-bolt has corroded into the position where it rested against the outer surface of the hull planking. Neither the rove nor forelock has survived on the ring bolt; however, the remains of the shank indicate that the bolt ran through timber approximately 2 inches (5.4 cm) thicker than the hook.

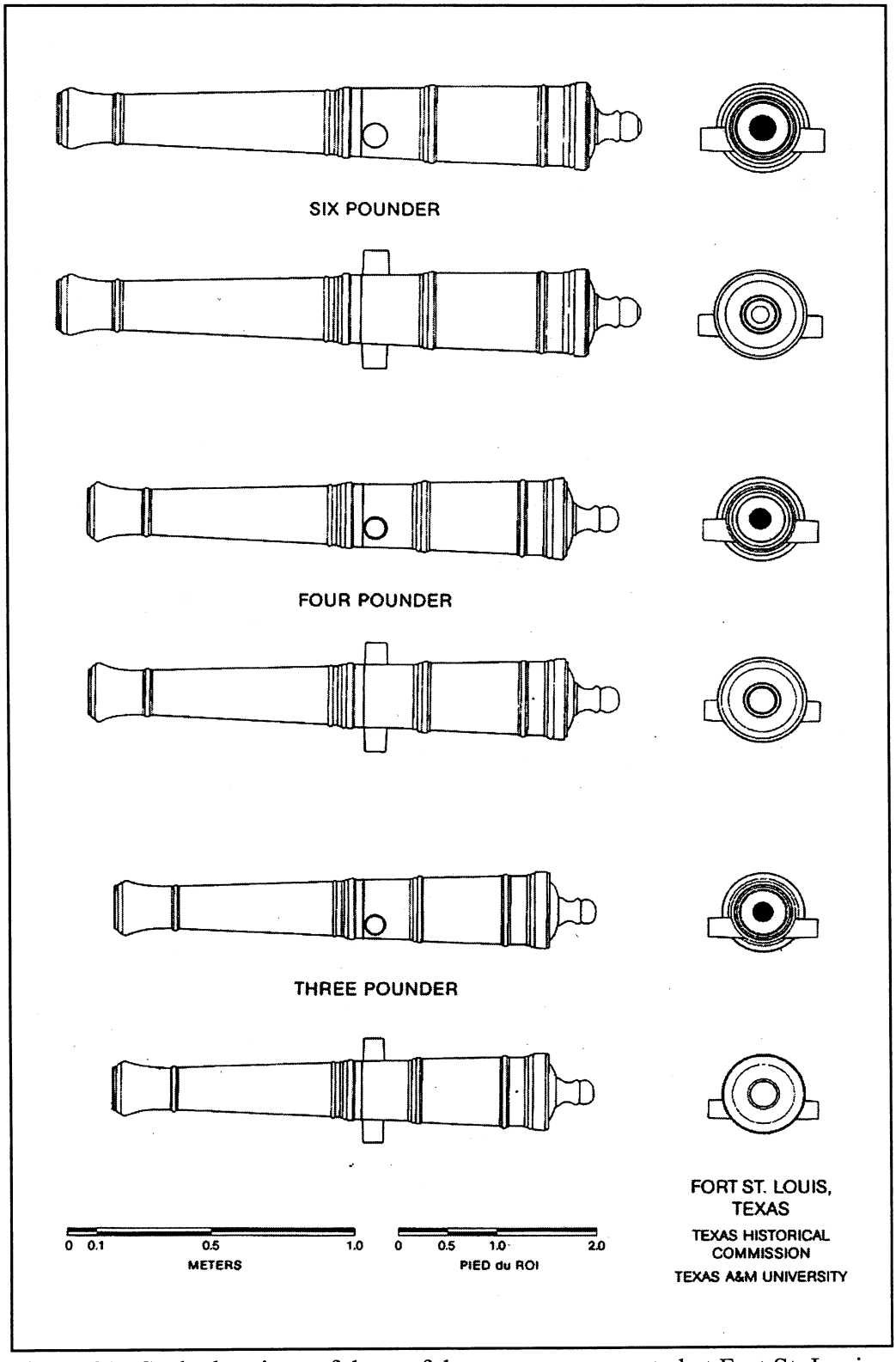


Figure 81. Scale drawings of three of the cannons excavated at Fort St. Louis by the Texas Historical Commission. (In Tunnell, 1998)

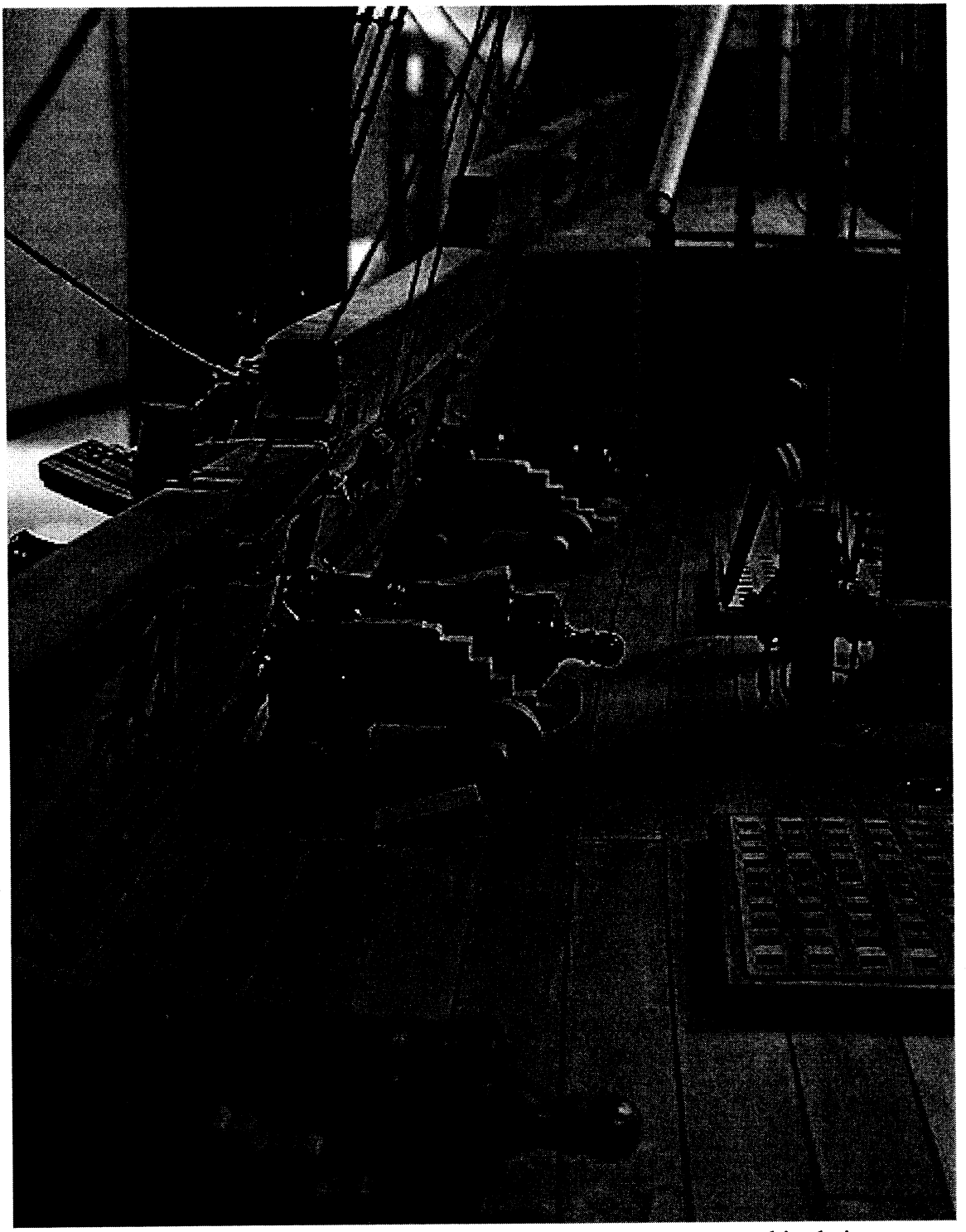


Figure 82. View down the deck of *La Belle* showing the guns mounted in their carriages. Photo by G. Grieco.

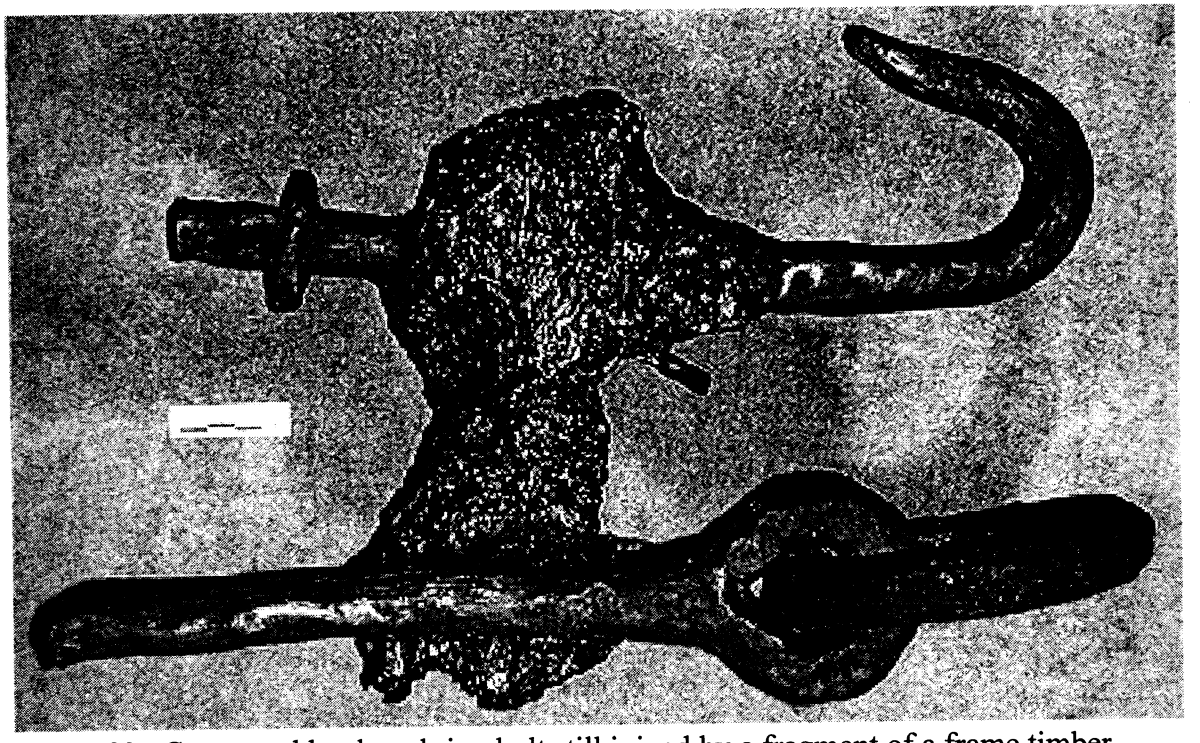


Figure 83. Conserved hook and ring bolt still joined by a fragment of a frame timber. Courtesy of the Conservation Research Laboratory.

This suggests that the hook pierced the outer hull planking while the ring bolt penetrated a wale. Superimposing a scale image of these artifacts over the bulwarks of the reconstructed midship section, the angle of the bolts and their lengths provides supporting evidence for the reconstruction (fig. 84).

Also found on the wreck was a loaded swivel gun attached to its post and mounting hardware (fig. 85). The conserved gun was 54.55 inches (1.478 m) long from the muzzle to the tip of the tiller (fig. 86). The muzzle had a bore of 3.42 inches (9.3 cm), close to the bore diameter of the four-pounder carriage guns. Although Baroto mentions that the swivel guns appeared to be capable of firing a four-pound ball,[61] the breach of the barrel contained a 2-inch ball and the chamber held a powder charge with a wooden plug. Primarily used as an anti-personnel weapon, the gun could also have fired a handful of small shot.

Iron swivel guns were used aboard vessels from the 16th through the 18th centuries. Examples of wrought iron, stave and hoop constructed weapons almost identical in design and dimensions to the one found on *La Belle* have been found on shipwrecks from as early as the16th century.[62] The post and mounting hardware still attached to the gun were more unusual finds. The swivel was set into a hole in the top of the 5 ½ -inch (14.9 cm) diameter post. A 2 ¼-inch (6.1 cm) wide iron band encircles the top of the post, and 4 inches (10.8 cm) down from the band a two-flanged iron strap that went around the front of the post and twisted 90° to fix the post to the top of the caprail. Each flange had three holes down the center for the nails that attached it to the top of the caprail. Examination of many contemporary drawings and treatises did not reveal any images of a swivel post with this configuration.

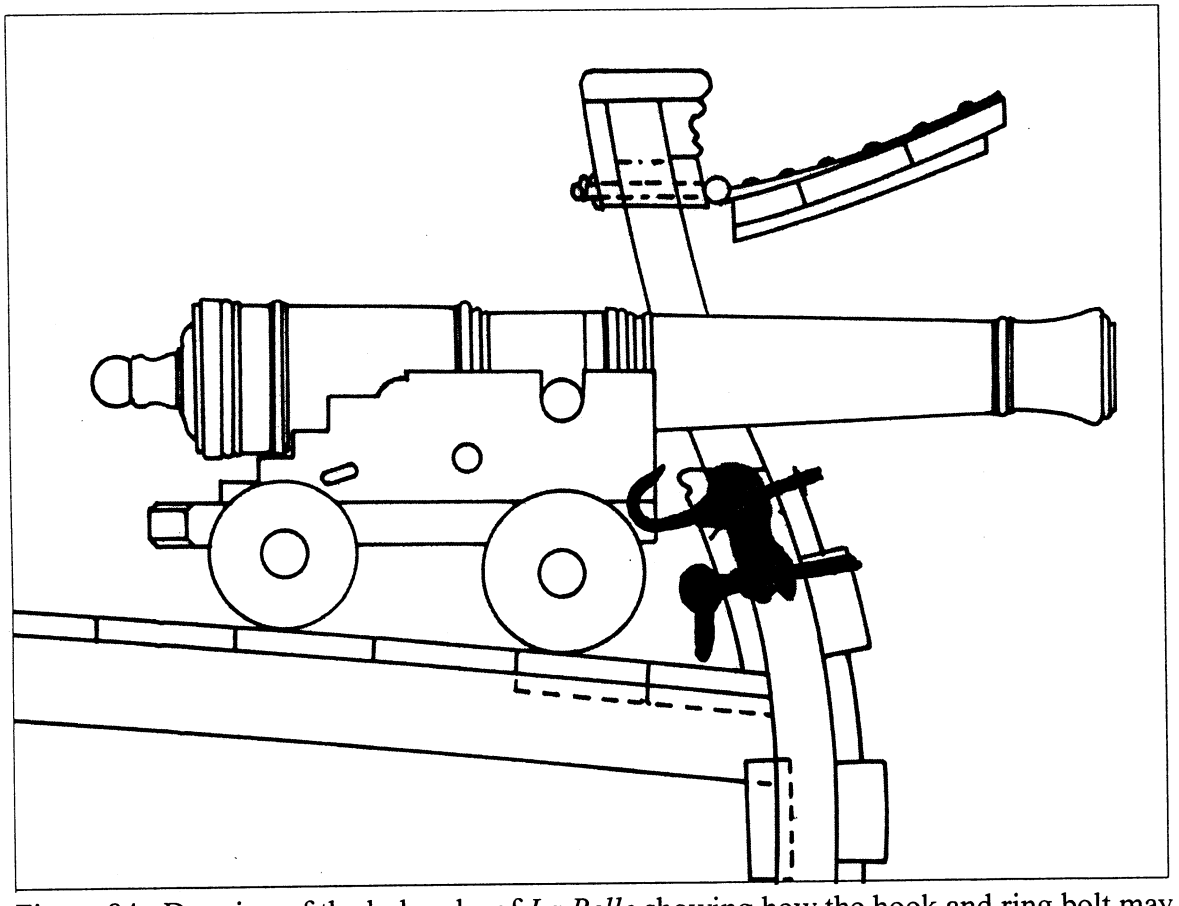


Figure 84. Drawing of the bulwarks of *La Belle* showing how the hook and ring bolt may have been oriented. Drawing by G. Grieco.

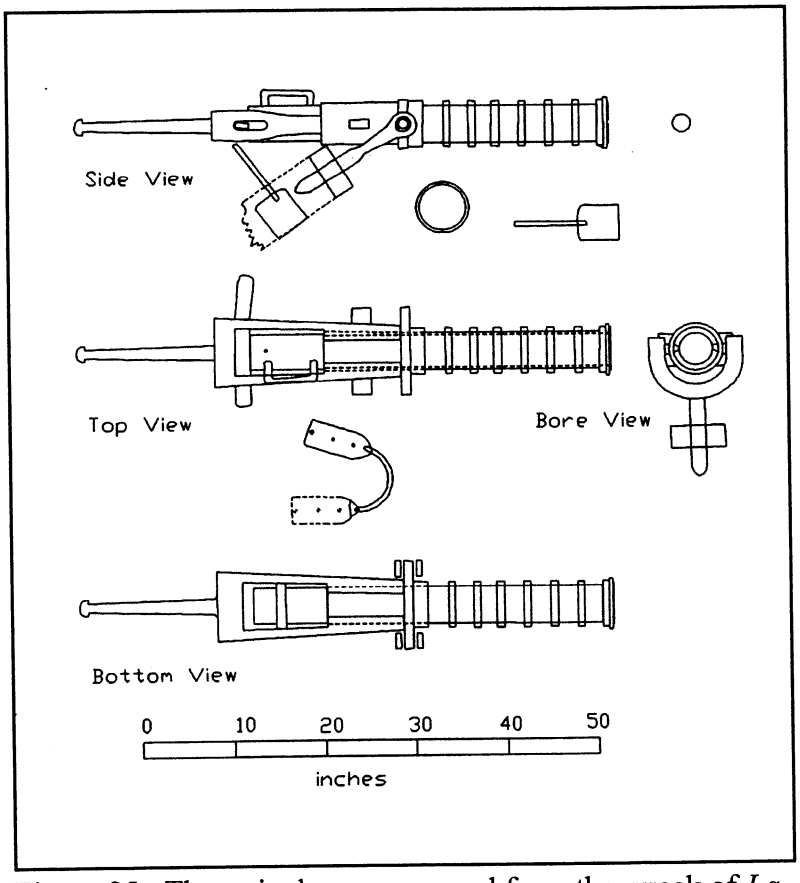


Figure 85. The swivel gun recovered from the wreck of *La Belle*. Drawing by D. L. Hamilton.

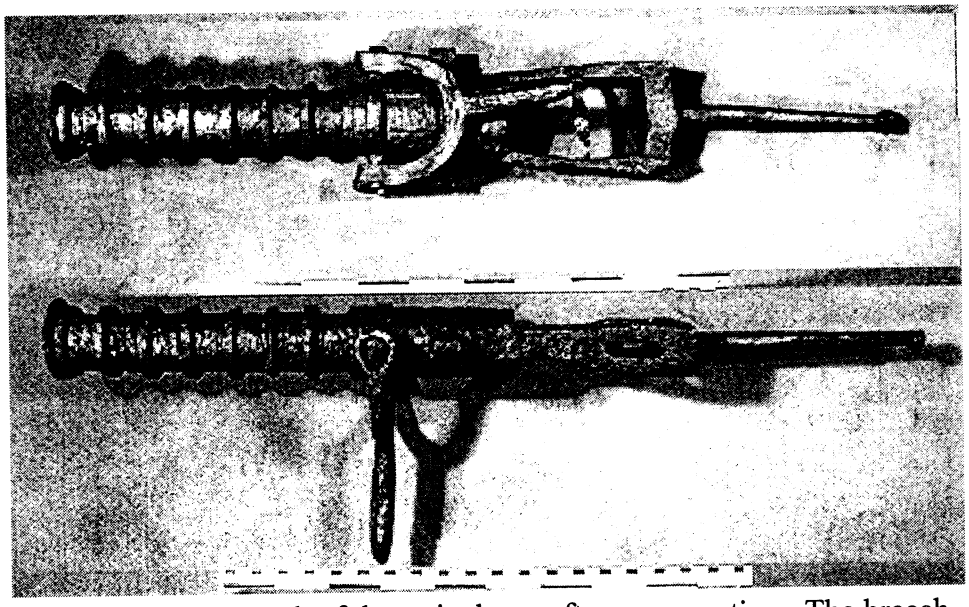


Figure 86. Photograph of the swivel gun after conservation. The breech chamber and wedge are not shown in this photo. Courtesy of the Conservation Research Laboratory.

The original gun was built up of forged iron staves and bands. For the model, the guns were constructed of lathe-turned and hand-filed brass components and blackened to resemble iron as described in the chapter on materials. Figure 87 shows two views of the swivel gun on the rail of the model. The first photo shows the orientation of the barrel in relation to the post, much as it was found along side of the wreck. The gun, as shown here, does not have the breech chamber or breech wedge in place.

Rigging

At the time the models were constructed, few artifacts from the rigging of *La Belle* had been identified and conserved. Therefore, the reconstruction has focused on the hull of the vessel as she would have looked as a bark or light frigate. The rig employed on the model is a generic rig representative of ships of this class during the late seventeenth century. Although the heel of the main mast was recovered, not enough of it has survived to determine its maximum diameter at the deck. Mast dimensions were estimated from the sizes of various deadeyes (fig. 88) recovered from the site. As a general rule, a deadeye should be half the diameter of the associated mast.[63] A single topmast fid (fig. 89) provided additional clues for the dimensions of one of the topmasts. Preliminary dimensions for the spars and rigging were taken from contemporary formulas and adapted according to the mechanical advantage necessary for the proper function of the component.[64] Where the dimensions of rigging elements such as deadeyes and certain types of blocks were known, scale copies were constructed and implemented in the rig (fig. 90). Figure 91 displays the entire

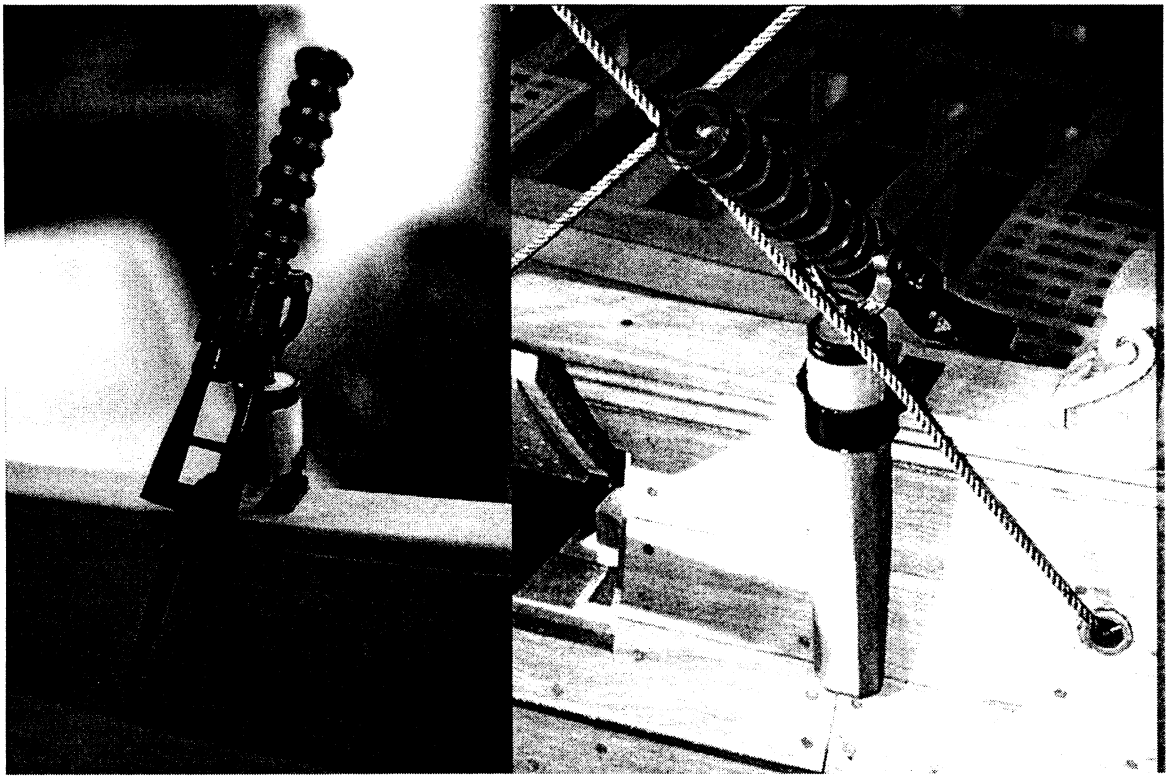


Figure 87. Two views of the model swivel gun. Photo by G. Grieco.

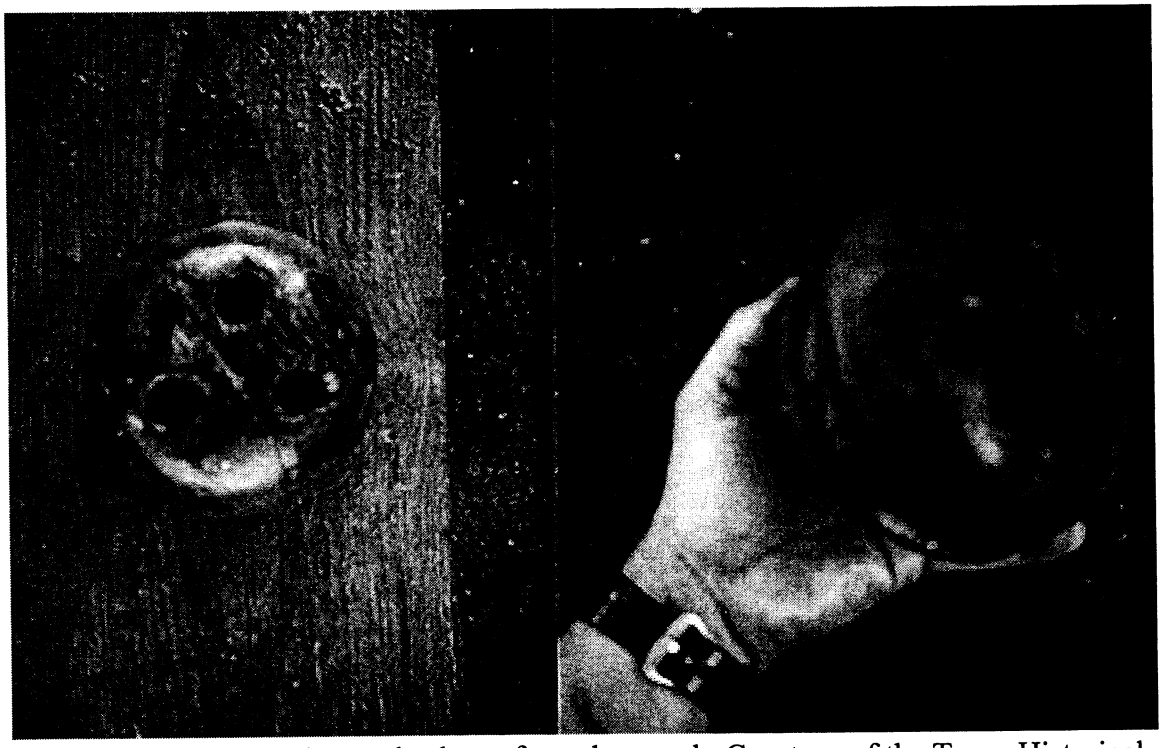


Figure 88. One of the larger deadeyes from the wreck. Courtesy of the Texas Historical Commission.

Figure 89. Topmast fid after conservation. Patterns of wear and discoloration provided clues to the dimensions of the topmast and trestletrees. Courtesy of the Conservation Research Laboratory.

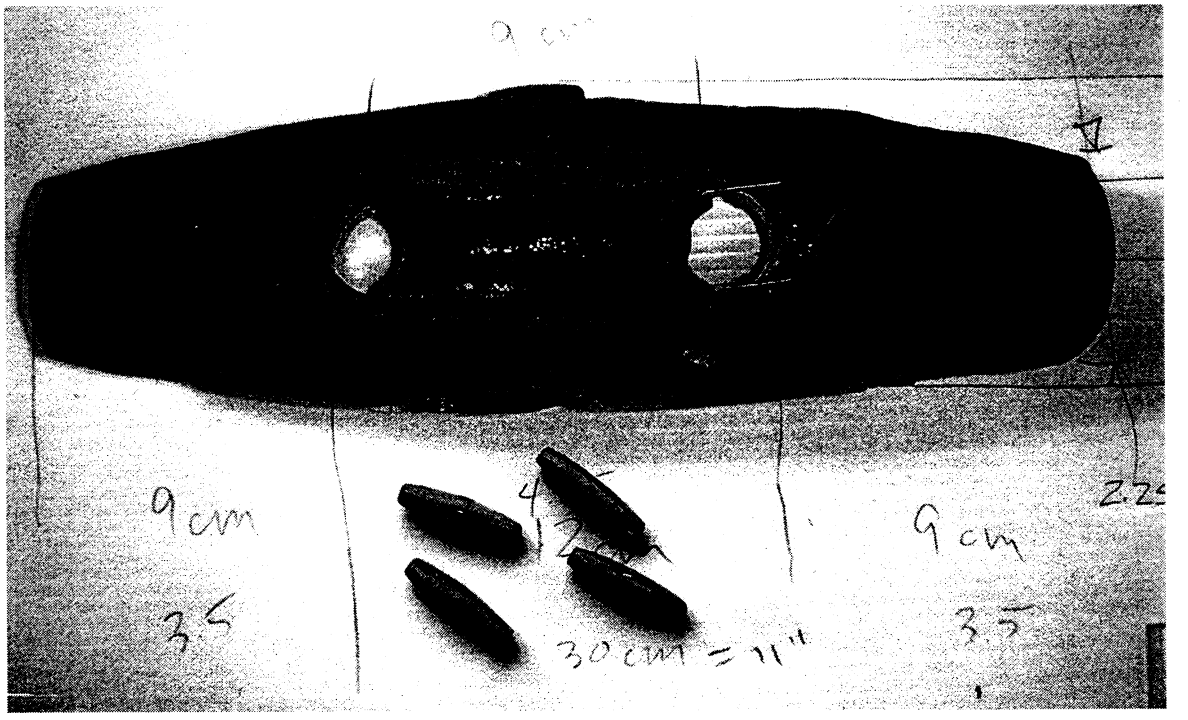


Figure 90. Scale models of *La Belle*'s lift blocks resting on a full size photo of the original artifact. Photo by G. Grieco.

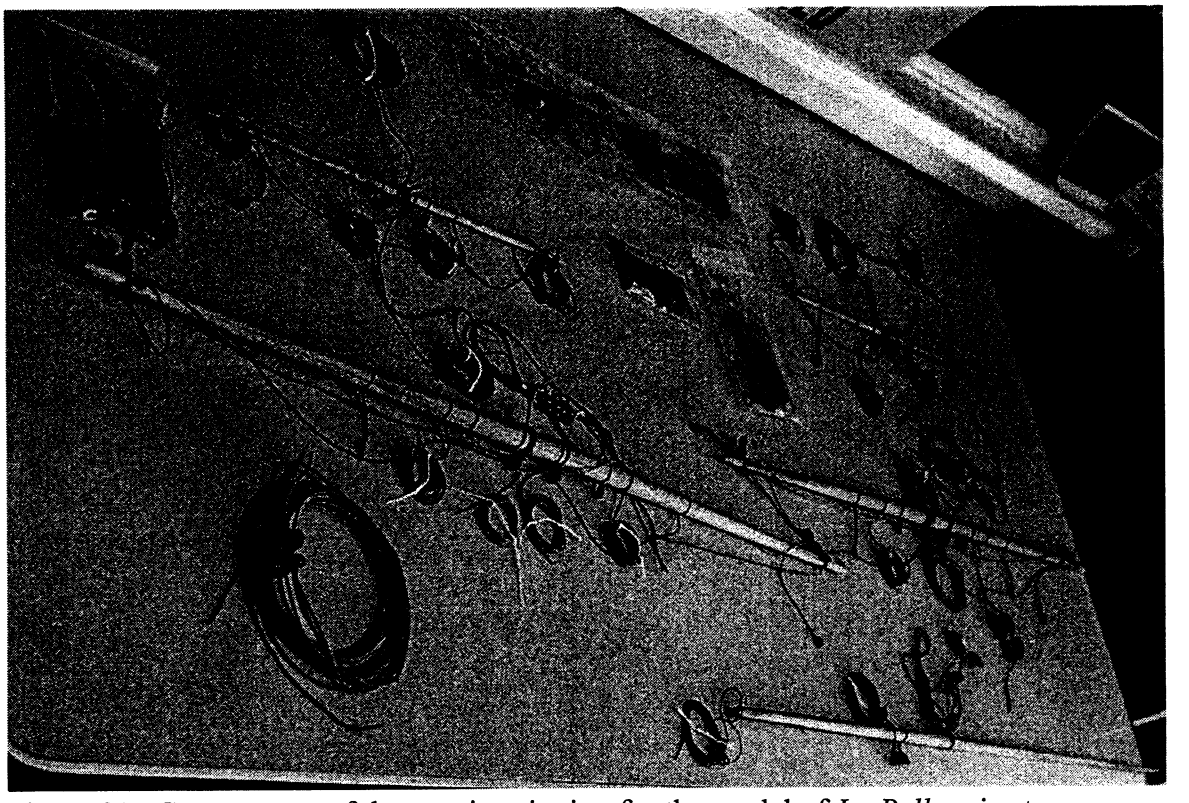


Figure 91. Components of the running rigging for the model of *La Belle* prior to installation. Photo by G. Grieco.

collection of running rigging used on the first model. Except for the spars, every element of rigging shown is represented by an artifact recovered from the site. Nevertheless, new discoveries about the rigging of *La Belle* will arise as the conservation process continues. As the best estimate of her rigging at the time the models were built, the entire rig is functional and adaptable, as the original would have been, allowing for alterations as new evidence comes to light.

Carved Work

Since only the lowest portion of the hull of *La Belle* has survived, nothing remains of any ornamental carving that was once present. On such a small hull, without stern and quarter galleries and with a simple head, it would be surprising if *La Belle* had very elaborate carvings. Baroto mentions that *La Belle* had "three *fleurs-de-lis* on her poop,"[65] but other than this, nothing is known of her carved decorations. For this reason, decorative carving has been left to a minimum on the models. A molded strake below each rail was common on French ships of all sizes, as were the sculpted terminals at the break of each rail. These are represented on the model, and the theme is carried to the head rails. A vessel of this size probably would not have carried stern lights, and if she did, they would have probably been small glazed ports, insufficient to break up the space of the transom. In addition to the sculpted *fleurs-de-lis* and a plaque with her name, simple moldings or false balusters would have been used to fill the field of the transom. Quarter decorations would have continued the theme around the sides of the transom.

If *La Belle* had head rails, they would have likely terminated with some type of

carved decoration. This may have been as simple as a small shield, monogram, or coat of arms, or a more elaborate sculpted bust, although this may never be known. Although simplified for *La Belle*, drawings of the carvings of the frigate *La Victor* were used as a model.[66] *La Victor* was built in Dunkirk in 1704, and its style was surely similar to that used in the late seventeenth century.

CHAPTER VIII

COMPARING THE HULLS

Figure 92 shows the completed first model, now on display at the Texas Maritime Museum in Rockport, Texas. Figure 93 shows the second model on permanent display in the Nautical Archaeology Program at Texas A&M University. Figures 94 provides the final longitudinal profile drawing of *La Belle*. Although the profile drawing was created from the second model and presents the most likely configuration for the overall hull, the drawing differs slightly from the first model. The corrections made are the result of information derived from artifacts that have been conserved since the first model was completed.

Considering the overall layout of the hull, the second model seems to more closely reflect the configuration of a sloop or light frigate. The extended quarterdeck provides additional support to the mizzen mast. However, the break of the deck for the stern cabin may have been forward of the location in which it is represented on the model. In its present location, the small cabin provides only a minimum amount of space but the long, low quarterdeck eliminates much of the useful deck space aft of the mizzen. By moving the forward bulkhead of this cabin and the break of the deck forward, valuable cabin space is created without any significant loss of deck space. Placing the bulkhead of this cabin forward of its present location, on the other hand, eliminates the deck area aft of the mizzen and makes the eight gunport configuration used in the first model impossible.

As for the rig of *La Belle*, only minor changes were made between the two models. Several of the rigging elements that were undergoing conservation and

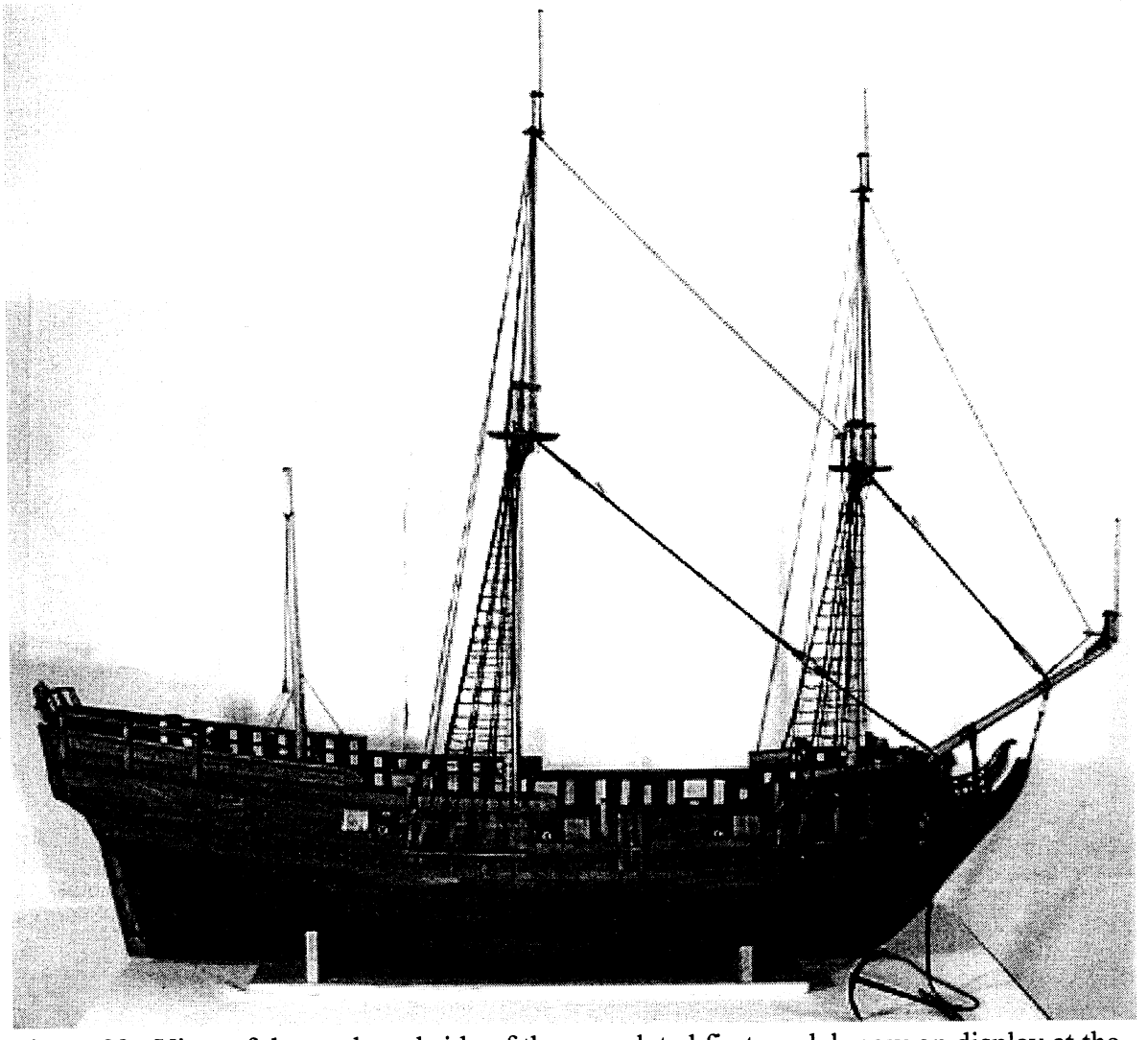


Figure 92. View of the starboard side of the completed first model, now on display at the Texas Maritime Museum in Rockport, Texas. Photo by D. L. Hamilton.

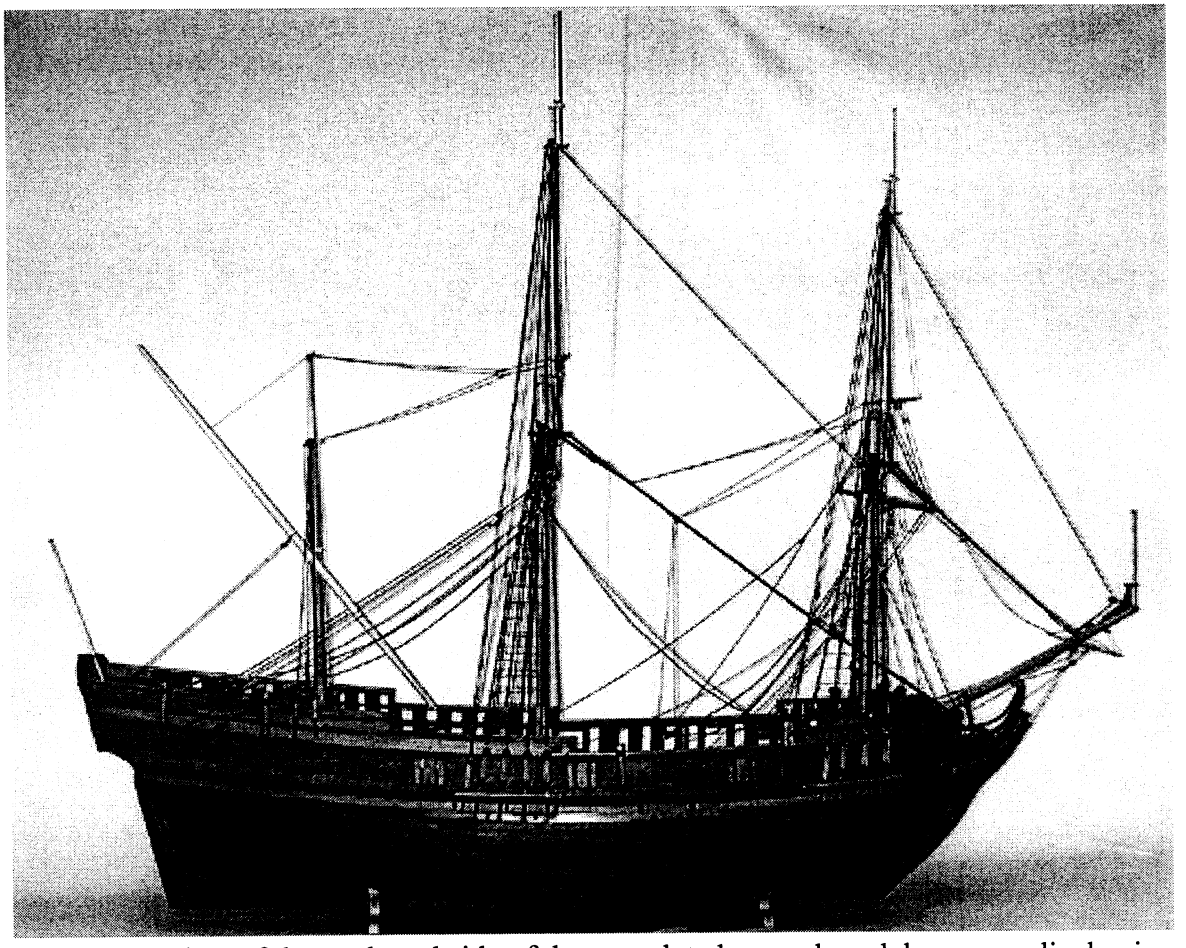


Figure 93. View of the starboard side of the completed second model, now on display in the Nautical Archaeology Program at Texas A&M University. Photo by D. L. Hamilton.

Longitudinal Profile of the French
Light Frigate

La Belle

Built in the French shipyard at Rochefort
1684

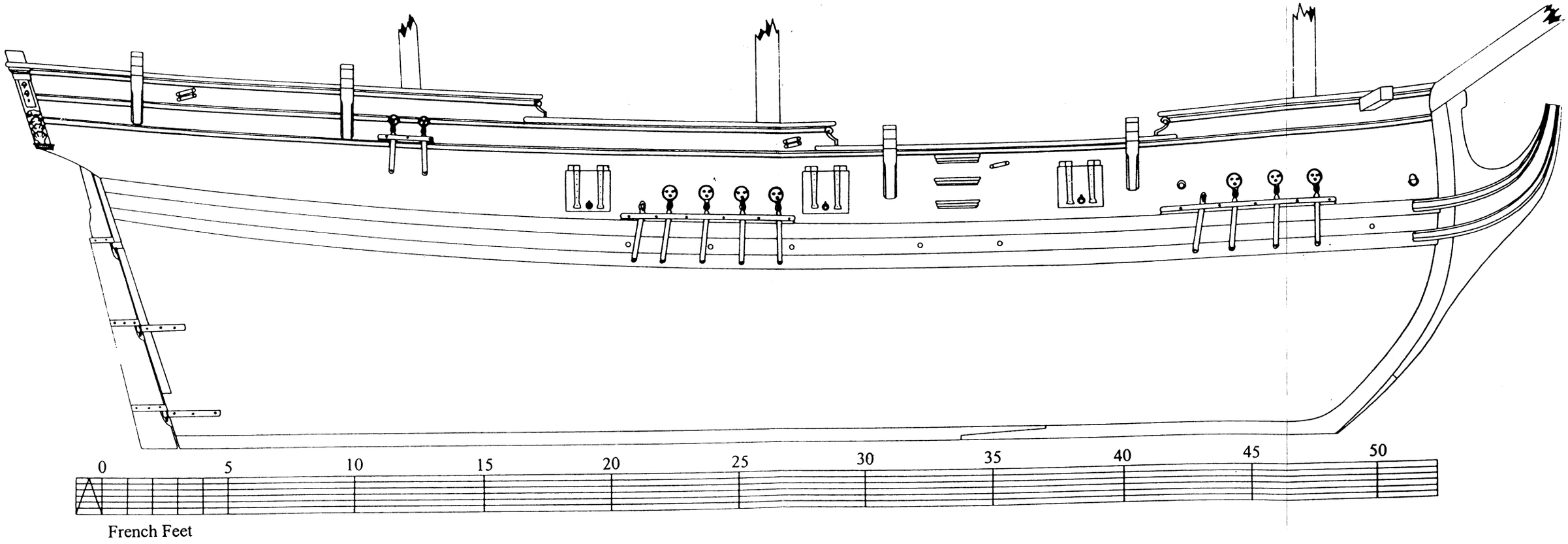


Figure 94. Longitudinal profile of the second model of *La Belle*. Drawing by G. Grieco.

unavailable when the first model was rigged were incorporated into the second model. The arrangement of parcels, deadeyes, chainplates, and lower yard lifts are three examples where new archaeological evidence has allowed a much more reliable rigging plan.

CHAPTER IX

CONCLUSIONS

The primary question of this study was "What is a barque longue and what can *La Belle* tell us about this type of vessel?" Existing descriptions of the barque longue were heavily influenced by its long history as a small, undecked vessel. Every contemporary source describing a barque longue depicts a ship with only two masts. The problem lies in the fact that *La Belle* is too developed to fit the accepted definition of a barque longue but too small to fit the definition of a frigate. With this in mind the problem becomes, "which type of vessel is more similar structurally?"

If *La Belle* was a barque longue, her remains indicate that the development of the vessel type has been underestimated. Eyewitness accounts of the vessel, as well as the archaeological remains, provide a great deal of evidence that this ship fit the description of a sloop or frigate in every aspect except size. Joutel's references to *La Belle* as a barque and a little frigate suggest that the term barque longue was already considered an inappropriate description. Even the dockyard manuscript recording her dimensions refers to her simply as a barque. The term barque longue may already have been archaic at the time *La Belle* was built and was therefore used only loosely in reference to her.

An unexpected outcome of the study was a glimpse into the efficiency of the techniques used to build the hull. For example, the material used for hull planking was used very economically. My experience with models of other vessels has often been that considerable waste of materials occurs due to the use of long planks with pronounced curves. The entire hull of *La Belle* was planked with straight planks,

resulting in minimal waste.

The uniformity of the dimensions of the timbers used also increased efficiency. Aside from the frames, almost every timber in the vessel had standard dimensions that would have allowed the builder to draw from existing, standardized supplies of timber in the shipyard, much as a modern home builder selects his timbers from a lumberyard. There is some indication that *La Belle*'s timbers were bundled together to be loaded aboard another vessel for reassembly in the Americas.[67] Components of standardized dimensions would have facilitated this task.

Construction of the models was remarkably straightforward, a good indication that many of the assumptions made during the reconstruction of the upperworks and rig were accurate. Enough evidence exists to establish a high degree of confidence that the final configuration of the hull is realistic. Although the rig is based on only a few surviving artifacts, the results are appropriate in both size and arrangement. This reconstruction supports the argument that the barque longue evolved into a much more substantial vessel than previously assumed and that there was little to distinguish this type from the sloops and light frigates of the French Navy.

Hopefully, this study has demonstrated the usefulness of research models for determining the appearance of a vessel for which we have very little historic information. Artistic ship modeling is sufficient for creating a impression of what the vessel may have looked like, but there is so much more that the individual artifacts can tell. The differences between the first and second model were almost

necessitated almost entirely by the artifacts that were recovered. Although only a portion of a ships hull may remain, proper analysis of what we have can contribute a wealth of information to our knowledge of ship construction.

NOTES

1. Anonymous manuscript. Port of Rochefort Archives, cote 1 L3. Registre 19. Fl 88.89.

2. Anonymous, *Album de Colbert* (1670; reprint, Nice: Editions Omega, 1988).

3. Juan José Navarro, *Album del Marquez de la Victoria* (Fac-simile, Madrid: Museo Naval y Lunwerg Editores, 1995).

4. Blaise Olivier, *18th Century Shipbuilding*, trans. David H. Roberts (Rotherfield: Jean Boudriot Publications, 1992).

5. Henri Joutel, *The Last Voyage Perform'd by de La Sale* (1714; reprint, New York: Readex Microprint Corporation, 1966). For a more recent analysis of Joutels Diary see Foster, William C., *The La Salle Expedition to Texas* (Austin: Texas State Historical Association, 1998).

6. Robert S. Weddle, *La Salle, the Mississippi, and the Gulf: Three Primary Documents* (College Station: Texas A&M University Press, 1987). Translation of the Journal of Juan Enriquez Barroto.

7. Jean Boudriot, "The Barques Longues," trans. H. Bartlett Wells, *Nautical Research Journal* 27 (1981): 94-98.

8. Jean Jouvé, *Deux Albums des Batiments de l'Atlantique et de la Mediterranee* (1679; reprint, Paris: Éditions Neptunia des Amis des Musées de la Marine, 1971), Plates 3,4.

9. Boudriot, "Barques Longues," 98.

10. Boudriot, "Barques Longues," 96.

11. Anonymous manuscript. Port of Rochefort Archives, cote 1 L3. Registre 19. Fl 88.89.

12. William Falconer, *Universal Dictionary of the Marine: or a Copious Explanation of the Technical Terms and Phrases Employed in the Consruction, Equipment, Furniture, Machinery, Movements, and Military Operations of a Ship* (1780; reprint, New York: Augustus M. Kelley, 1970), 337.

13. Joutel, *Last Voyage*, 3.

14. Falconer, *Universal Dictionary*, 30.

15. Joutel, *Last Voyage*, 15.

16. Weddle, *La Salle,* 172.

17. R. C. Anderson, *The Rigging of Ships in the Days of the Spritsail Topmast 1600-1720* (London: Conway Maritime Press, 1982), 8-10.

18. Dassié, *L'Architecture Navale* (1695; reprint, Paris: Editrice Pharos Sanremo, 1994), 202.

19. Weddle, *La Salle,*, 171.

20. Weddle, *La Salle,*, 171.

21. Weddle, *La Salle,*, 171.

22. Guéroult du Pas in Jean Boudriot, *The History of the French Frigate*, 58.

23. Jean Boudriot, *The History of the French Frigate*, 53.

24. Curtis Tunnell, "A Cache of Cannon: La Salle's Colony in Texas," *Southwestern Historical Quarterly* 102 (1998): 18-43.

25. Boudriot, *History of the French Frigate*, 315.

26. Boudriot, *History of the French Frigate*, 16-17.

27. John Franklin, *Navy Board Ship Models 1650-1750* (Annapolis: Naval Institute Press, 1989).

28. Personal correspondence with the staff of the Conservation Research Laboratory at Texas A&M University.

29. Personal correspondence with the staff of the Conservation Research Laboratory at Texas A&M University.

30. Charles G. Davis, *The Built-up Ship Model*, (New York: Dover Publications Inc., 1989).

31. Harold Underhill, *Plank-on-Frame Models and Scale Masting and Rigging*, (Glasgow: Brown Son & Ferguson Ltd., 1960).

32. Boudriot, *History of the French Frigate*, 16-17.

33. Personal correspondence with Taras Pevny concerning observations he made about

fasteners while reassembling the original timbers.

34. Boudriot, *History of the French Frigate*, 52-66.

35. *Album de Colbert*, Plate 12.

36. *Album de Colbert*, Plate 8.

37. Jean Boudriot, *Modèles Historiques au Musée de la Marine* (Paris: ANCRE, 1997), 59.

38. See the model of *Le Triomphant* in Boudriot, *Modeles Historiques*, 126.

39. Chapman, *Architectura Navalis Mercatoria 1768*. Reprint, New York: Edward W. Sweetman Company, 1967. Plate LV, LVI . Various drafts in Boudriot, *History of the French Frigate*, 52-91.

40. Boudriot, *History of the French Frigate*, 53.

41. Duhamel du Monceau, *Élémens de l'Architecture Navale, ou Traité Pratique de la Construction des Vaisseaux*, 1755, reprint Grenoble: Édiions des 4 Seigneurs, 1970. Chap. I, Plate II.

42. Duhamel du Monceau, *Élémens de l'Architecture Navale*, Chap. I, Plate III.

43. Jean Boudriot, *The Seventy-Four Gun Ship. Volume 1: Hull Construction*, trans. David H. Roberts (Annapolis: Naval Institute Press, 1986), 157-58.

44. Boudriot, *History of the French Frigate*, 53.

45. Boudriot, *History of the French Frigate*, 16.

46. Peter Goodwin, *The Construction and Fitting of an English Man of War 1650-1850* (Annapolis: Naval Institute Press, 1987), 209.

47. Olivier, *18th Century Shipbuilding*, 57.

48. Brian Lavery, *The Ship of the Line*, 106.

49. Navarro, *Album del Marquez*, Plate 55. For an overview of common ship pumps from the 16th to the 19th century see Oertling, Thomas, *The History and Development of Ships Bilge Pumps, 1500-1840*, thesis, Texas A&M University, 1984.

50. Boudriot, *Modèles Historiques*, 48, 71.

51. Anderson, *The Rigging of Ships*, 151.

52. Weddle, *La Salle,*, 172..Baroto mentions that *La Belle* had an anchor cable with a circumference of 8 inches (21.7 cm).

53. Goodwin, *Construction and Fitting*, 179.

54. Anderson, *Rigging of Ships*, 64-69.

55. Anderson, *Rigging of Ships*, 66.

56. Boudriot, *Modèles Historiques*, see models of Vaisseau de 74 canons and *Le Sans Pareil.*

57. Boudriot, *Modèles Historiques*, see models of *Le Sans Pareil* and *L'Artésien*

58. Chapman, *Architectura Navalis Mercatoria.* Selecting several of the smaller vessels with only tillers, an average was obtained comparing keel length to width of the heel of the rudder.

59. Navarro, *Album del Marquez*, plate 125 see also models of *Le Sans Pareil* and *L'Artésien* from Musée de la Marine.

60. Tunnell, "A Cache of Cannon," 40-41.

61. Weddle, *La Salle,*, 171.

62. Rudi Roth, "A proposed standard in the reporting of historic artillery," *The International Journal of Nautical Archaeology* 18 (1989): 191-202.

63. Anderson, *Rigging of Ships*, 71.

64. Boudriot, *History of the French Frigate*, 340-343.

65. Weddle, *La Salle,*, 171.

66. Boudriot, *History of the French Frigate*, 327.

67. Robert S. Weddle, *The Wreck of the Belle, the Ruin of La Salle*, (College Station: Texas A&M University Press, 2001), 5.

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APPENDIX A
LETTER OF PERMISSION

TEXAS HISTORICAL COMMISSION
The State Agency for Historic Preservation

RICK PERRY, GOVERNOR
JOHN L. NAU, III, CHAIRMAN
F. LAWERENCE OAKS, EXECUTIVE DIRECTOR

December 18, 2002

Mr. Glenn Grieco
106 Anthropology Bldg.
4352 TAMU
College Station, TX 77843-4352

Dear Glenn:

I have received and reviewed your letter of December 9, 2002. In return for the use of these images, I would like to get in return from you the following: high resolution digital photographs of your model, showing various cut aways, for use in our publications on *La Belle*. I have been trying to get access to the model to photograph it myself, but have had no luck getting access. We also would want a copy of your thesis.

With this agreement, we will be happy for you to use the photographs.

Sincerely,

James E. Bruseth, Ph.D.
Director, Archeology Division

JB/lft

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1998-2002	Research Assistant, Nautical Archaeology Program, Texas A&M University.
1999-2000	Wave Tank Technician, Offshore Technologies Research Center, Texas A&M University.
1996-1997	Graduate Assistant, Nautical Archaeology Program, Texas A&M University.
1996-1997	Divemaster, Bozburun Shipwreck Excavation, Selimiye Turkey.
1995-1996	Marion Cook Fellowship, Nautical Archaeology Program, Texas A&M University.
1995	Research Assistant, Yassi Ada Shipwreck Reconstruction, Bodrum, Turkey.