USS Constitution Museum

USS *Constitution*: Construction and Repairs

Matthew Brenckle, 2013

Revised by Carl Herzog, 2024

A publication of the USS Constitution Museum, Boston

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Designing the Frigates

At the beginning of 1793, Philadelphia naval architect and shipwright Joshua Humphreys wrote a letter to Robert Morris, a United States senator and former Agent of Marine during the American Revolution, outlining his ideas about the sort of ships the young nation should build if it wanted to have an effective navy.

> *From the present appearance of affairs, I believe it is time this country was possessed of a Navy; but as that is yet to be raised, I have ventured a few ideas on that subject.*
>
> *Ships that compose the European navys are generally distinguished by their rates; but as the situations & depth of Water of our coasts & Harbours are different in some degree from those in Europe, & as our Navy must for a considerable time be inferior in number we are to consider what size Ships will be most formidable and be an over match for those of an enemy, such Frigates as in blowing weather as would be an over match for double deck Ships, & in light winds, to evade coming to action, or double deck Ships as would be an overmatch for common double deck Ships, and in blowing weather superior to Ships of three Decks, or in calm weather or light winds to outsail them. Ships built on these principles will render those of an Enemy in a degree useless, or require a greater number before they dare attack our Ships.*
>
> *Frigates I suppose will be the first object and none ought to be built less than 150 feet keel to carry 28, 32 pounders or 30, 24 pounders on the main gun deck &12 pounders on the quarter deck. Those ships should have scantling equal to 74s and I believe may be built of Red cedar & Live Oak for about twenty four pounds per Ton Carpenters tonage including Carpenters bill, smith, including Anchors, Joyners, Boatbuilders, Painters, Plumbers, Carvers, Coopers, Block makers, Mast makers, Riggers & Rigging, sail makers & sail cloth, two suits [of sails], & chandlers bill.*
>
> *As such Ships will cost a large sum of money they should be built of the best materials that could possibly be procured, the beams for their decks should be of the best Carolina pine & the lower Futtocks & Knees if possible of Live Oak. The greatest care should be taken in the construction of such Ships, and particularly all the timbers should be Framed and bolted together before they are raised.*
>
> *Frigates built to carry 12 or 18 pounders in my opinion will not answer the expectations contemplated from them, for if we should be obliged to take a*

> *part in the present European War, or at a future day we should be dragged into a War with any powers of the old continent, especially great Britain, they having such a number of Ships of that Size, that it would be an equal chance by equal combat that we loose our Ships and more particularly from the Algeriens, who have Ships & some of much greater force. Several questions will arise, whether will one large or two small Frigates contribute most to the protection of our trade or which will cost the least sum of money, or whether two small ones are as able to engage a double deck ship as one large one. For my part I am decidedly of opinion, the large ones will answer best.*[1]

This remarkable letter laid out the philosophy that would govern U.S. naval construction for the next half century. Because it would be many years before the United States could hope to build a navy as large or as powerful as those of the major European powers (if indeed the depth of water on our coast would allow for large ships) the country should focus its limited resources on building a small fleet of high-quality frigates. These should be heavily armed and as fast as possible so that they could outrun any vessel they could not out fight. They should be built carefully of the best materials. Luckily, American policy makers agreed with Humphreys, that the large frigates "will answer best."

American shipwrights were not making choices or designing in a vacuum. They had the opportunity to observe the best of European shipbuilding. Even if they could not examine the ships themselves in foreign ports, many publications described the best practices of shipbuilders in Britain, France, the Netherlands, and elsewhere in northern Europe.

After initial philosophical discussions outlined the general strategic uses for the new frigates, Humphreys spent a considerable amount of time reading and talking about the newest trends in shipbuilding. He himself later said,

> *After the most extensive researches and mature deliberation, their dimensions were fixed, and I was directed to prepare the drafts which was accordingly done, and approved. Those plans appear to be similar with those adopted by France, in their great experience in Naval Architecture*

[1] Joshua Humphreys to Robert Morris, January 6, 1793, Joshua Humphreys Letterbooks, Vol 1, 1-2. Joshua Humphreys papers (Collection 0306), The Historical Society of Pennsylvania.

they having cut down several of their seventy fours to make heavy Frigates, making them nearly of the dimentions of those for the United States.[2]

One French ship, in particular, likely inspired the design for the new American frigates. In 1777, shipwrights in Amsterdam launched a powerful new ship built to a French design. It was 154 feet long on the gun deck and mounted 24 36-pound guns and 12 12-pound guns. Christened *L'Indien*, it was turned over to the French soon after, who then sold it to the Duke of Luxembourg. The Duke ultimately loaned it to the state of South Carolina, and bearing that state's name, the ship sailed for America. *South Carolina* was captured by a British squadron off the Chesapeake in 1782, but not before leading three frigates on an 18-hour chase.

Despite its unsuccessful career, the ship's great length and heavy armament impressed American shipwrights. The long keel also favored speed, especially when pitted against the short ships of the British Royal Navy. American designers also learned from it that long, heavily armed ships tended to hog, or arch upwards in the center, considerably, and that they required special longitudinal stiffening.[3] A draft of the ship from volume 5 of the *Souvenirs de Marine* depicts a hull form remarkably similar to Humphreys' frigate plans.

With a broad sheet of paper and a set of drafting curves, Humphreys began to draw his concept. The hull followed "closely that curious feature called the 'tumble home,' an inward curving of the sides above the water line, which secured the much desired load line beam without corresponding bulk above board. Below their water line, their lines were sharp, clean and clear, cutting the water like a rapier, which in the hands of a skillful fencer glides without effort into the body of the opponent."[4]

Before creating the final draughts, or paper plans of the ship's form, Humphreys built a model of his proposed design. He worked on the model from April to May 1794 and about the middle of the latter month submitted it to the War Department for approval. The Department called in the "best shipwrights" to give

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[2] "Report on the Progress made in building the Frigates," Humphreys Letterbooks, Vol. 1, 6-7. Joshua Humphreys papers (Collection 0306), The Historical Society of Pennsylvania. This is an interesting revelation, considering the constant British accusation that the American frigates were "74s in disguise."

[3] Howard Chapelle, *The History of the American Sailing Navy*, (New York, 1949), 96,99.

[4] Henry H. Humphreys, "Who Built the First United States Navy," *The Pennsylvania Magazine of History and Biography*, Vol XL, no. 4, 1916, 397-398. Two highly capable draughtsmen worked with Humphreys: William Doughty, who later became Navy Constructor, and Josiah Fox, an English Quaker who had worked in British naval shipyards.

their opinion on the model, "which they did candidly," and the Secretary directed Humphreys to "make such alterations in the formation of the Frigates body as was formable to the General Ideas."[5]

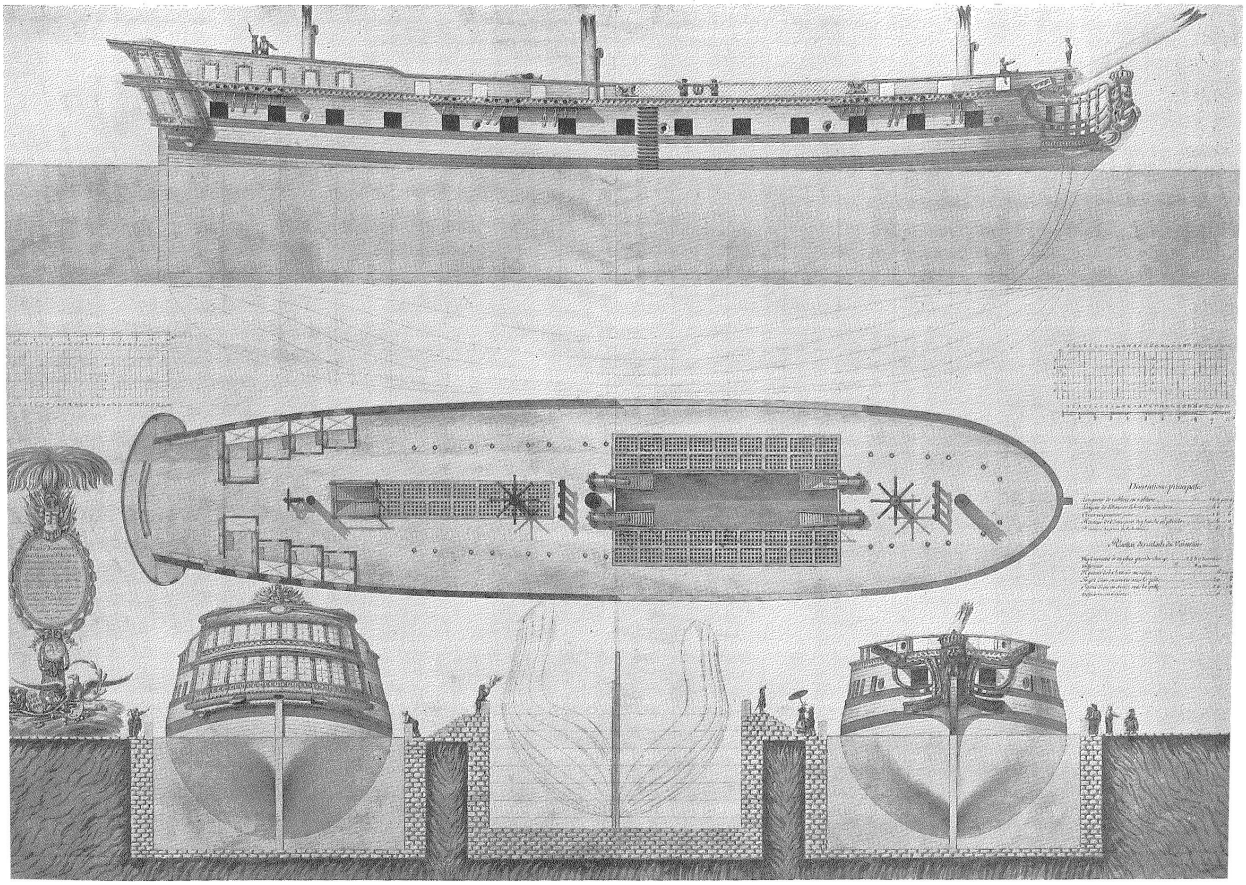


Figure 1: *South Carolina* ex *L'Indien,* from Admiral Paris' *Souvenirs de Marine.*

Lofting Moulds

In order to accurately cut and shape the hundreds of individual parts going into each ship, a set of full-scale patterns, or moulds, had to be created. This was done on a large loft floor the size of an entire ship. The moulds were made of thin boards that the builders could use to mark out the proper shape and width of each piece on the timbers to be cut. The required angles, or bevels, of the edges on each piece had to be marked as well on bevelling boards designed to duplicate the angles on the timbers. Each mould for every piece was marked and shipped to the different ports where the frigates are to be built.

[5] Joshua Humphreys to Sec. of War, n.d.[1795], Humphreys Letterbooks, Vol. 1, 165. Joshua Humphreys papers (Collection 0306), The Historical Society of Pennsylvania.

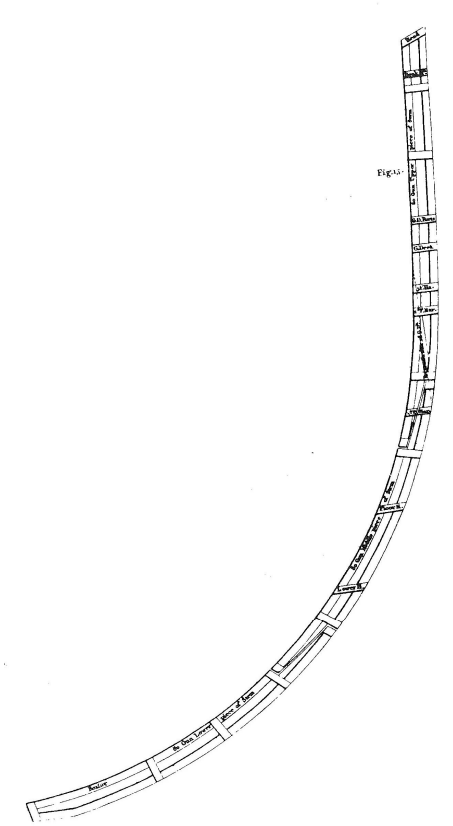


Figure 2: A stempost mould, from Steel's *Naval Architecture,* 1805.

The War Department decided to spread the construction between six different locations, and because each builder had varying amounts of experience building large warships, Humphreys and his team in Philadelphia had to produce multiple sets of moulds for both the 44-gun ships and the 36-gun ships. After it was done, Humphreys remarked, "It has been a Herculean piece of business to make the moulds for the whole six Frigates."[6]

Choosing Timber

The longevity of the ships largely depended on the choice of wood for the various components. Humphreys adamantly believed that live oak was the best timber available for the ship's major structural members. "This timber is greatly superior to any in Europe & the best that ever came to this place," he wrote. Though expensive, "as the duration of Live Oak and red cedar may be computed from 40 to 50 years, the difference of cost was of no consequence compared with the durability of the materials."[7]

While those in decision-making positions readily conceded the point about live oak, he had a rather more difficult time convincing Secretary of War James McHenry and several advising captains that pitch pine made superior deck beams. After conducting a number of experiments on the relative strength of pine versus white oak (the standard beam wood) and gathering testimonies about pitch pine's resistance to rot, he at last succeeded in getting clearance to make the berth deck, gun deck, and spar deck beams of the wood.

As naval constructors and master builders at the different ports began to review the drafts and moulds, they naturally wished to make alterations to the plans to suit their own ideas about what made a good ship. Humphreys strenuously

[6] Joshua Humphreys to John Morgan, November 18, 1794, Humphreys Letterbooks, Vol. 1, 30. Joshua Humphreys papers (Collection 0306), The Historical Society of Pennsylvania.

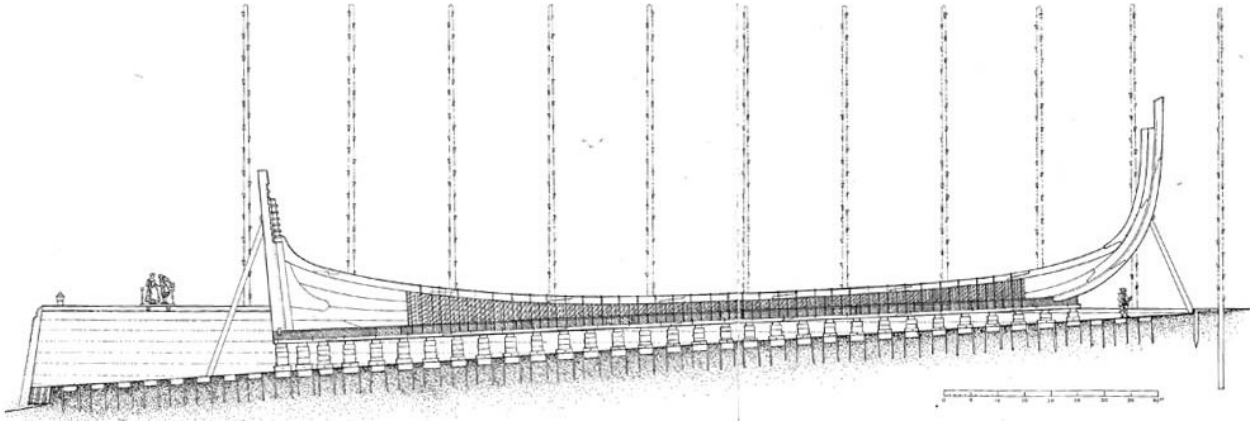
[7] "Report on the Progress made in building the Frigates," Humphreys Letterbooks, Vol. 1, 7. Joshua Humphreys papers (Collection 0306), The Historical Society of Pennsylvania.

defended his design decisions, and in the end could simply say, "In the formation of the plan of those ships no pains was spared to have them the most perfect…."[8]

Building "Frigate D"

Between September and December 1794, Joshua Humphreys and his team shipped to Boston the hundreds of timber molds and gauges that would be used to shape the hull of "Frigate D."[9] Most of those delivered in 1794 were used to construct the ship's frames (consisting of three pieces: floors, futtocks, and top timbers), as well as the intricately shaped stem, deadwood, and transom.

Construction on the Boston frigate began in the spring of 1795 at Edmund Hartt's shipyard in Boston's North End. The keel, made of four massive lengths of New Jersey white oak scarfed and bolted together, was the first piece cut and assembled. The editors of Boston's *Columbian Centinel* regarded the newly laid keel with awe. "It is 156 feet in length, and from the elegance of the workmanship, and the goodness of the timber of which it is composed, as well as that in the dockyard, we anticipate that she will be one of the finest vessels that ever floated."[10]



[8] Joshua Humphreys to James McHenry, June 5, 1795, Humphreys Letterbooks, Vol. 1, 163. Joshua Humphreys papers (Collection 0306), The Historical Society of Pennsylvania.
[9] The names for the new frigates were not authorized by President George Washington until March 14, 1795. Before that, the six ships were referred to by letter. The frigate building at Norfolk was called A, the one at Philadelphia B, the one at New York C, the one at Baltimore E, and the one at Portsmouth F. The timber mould invoices come from Joshua Humphrey's Letterbooks, Vol.1, 86-91. Joshua Humphreys papers (Collection 0306), The Historical Society of Pennsylvania.
[10] *Columbian Centinel* (Boston), May 20, 1795.

Figure 3: A ship on the blocks. Keel, deadwood, and stem and stern posts scarfed and assembled. From Dodds and Moore, *Building the Wooden Fighting Ship*, 60-61.

By December, Naval Constructor Joshua Humphreys was able to report to Secretary of War Timothy Pickering (presumably based on correspondence with Naval Constructor George Claghorn or Navy Agent Henry Jackson) the state of the Boston frigate. Pickering in turn reported to Congress:

> *The keel is completed and laid on the blocks. The pieces are scarfed and bolted to each other in the best manner. The stern frame is now completing, and will be soon ready to raise. The stem is also putting together, every part being worked to the moulds. About two-thirds of the live oak timbers have been received, and are all worked agreeable to the moulds; great part of those timbers are bolted together in frames, and are ready to put into the ship, but some of the principal pieces for the frames have not yet arrived. All the gun deck and lower deck beams are procured and ready for delivery, and the plank for those decks are received into the yard. The plank for the outside and ceiling are also received and are now seasoning. The copper is all in the public stores. The masts, bowsprit, yards, and other spars, all are ready for working. The bits for the cables, coamings for the*

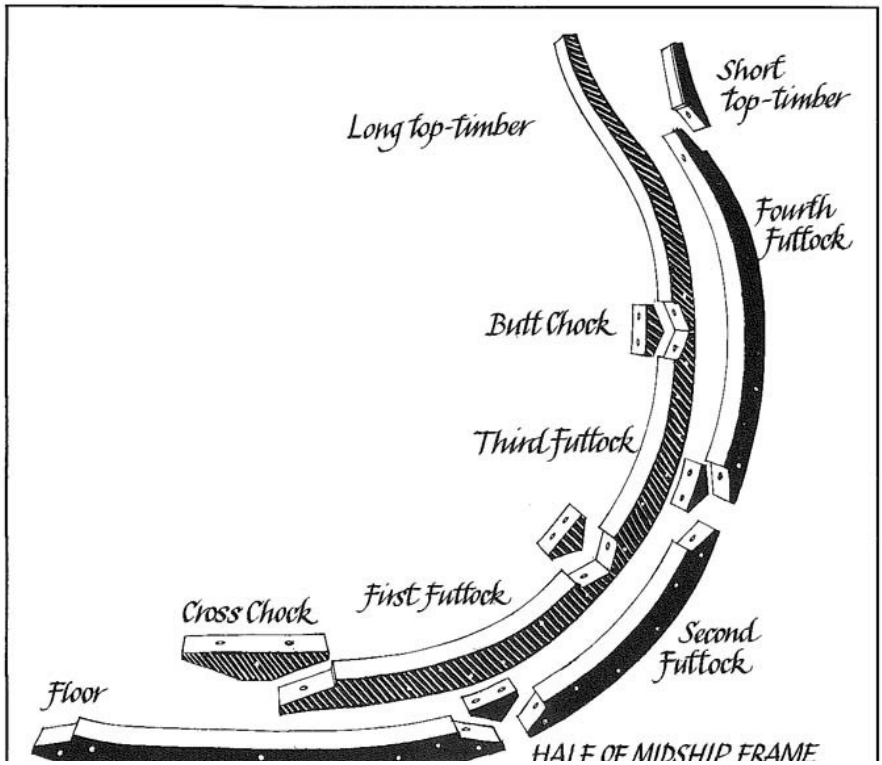
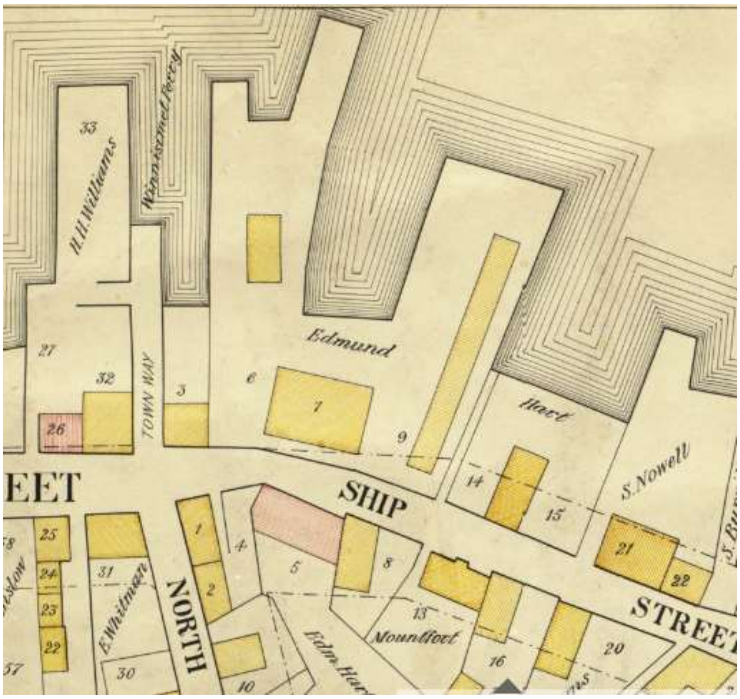


Figure 4: Drawing of the constituent parts of a ship's frame, from Dodds and Moore, *Building the Wooden Fighting Ship*, 71.

hatchways, partners for the masts, are all ready. The caboose, with a forge, hearth, armorer's tools, spare coppers, boilers, etc. are all complete. Most of the ironwork is in great forwardness. All the necessary contracts are entered into by agent, and the articles contracted for are arriving daily.[11]

Three months later, in early March 1796, news of a peace treaty with Algiers reached Philadelphia. Because Article 9 of the 1794 Act to Provide a Naval Armament called for the cessation of the shipbuilding program in the event of a peace treaty, work on the frigates stopped. Nevertheless, President George Washington was concerned that putting an immediate stop to the work would be a waste of resources. He asked Congress to approve funds to finish three of the ships, and the body passed a bill on April 19, 1796 that called for two 44-and one 36-gun ships. The next day Washington directed work to continue on the frigates at Philadelphia, Boston, and Baltimore.



EDMUND HART, occupant and owner.
A Ship yard on which are 1 Store, 40 by 56 ; 1 Smiths Shop, 20 by 40 ; 1 Shed for workmen, 15 by 130 feet.
S. W. on Ship Street ; N. W. on Tho. Stoddard ; S. E. on J^n Floyd ; N. E. on the Sea.
9,240 square feet, valued at 10,000 Dollars.

Figure 5: Edmund Hartt's shipyard at the junction of Lynn St. and Ship St., Boston, from Samuel Chester Clough's manuscript map of Boston, based on 1798 tax records, c. 1900. Courtesy of the Massachusetts Historical Society.

As the ship's carpenters began to raise the completed frames, the new structure towered over the surrounding town. Amidships, *Constitution* stood 38 ½ feet from the bottom of the keel to the top of the bulwarks. Added to the height of the

[11] 4th Cong, Senate, Sec War Reports, RG46, National Archives and Records Administration.

blocks under the keel (probably another 2 feet), the ship's frame was nearly double the height of the average two-story frame buildings that made up the bulk of Boston's waterfront architecture.[12]

Framing continued as more live oak timber became available. By January 1797, Secretary of War James McHenry could report more progress to Congress:

> *The whole of the frame is raised, and is ready for planking; the wales are prepared, and it is expected will be on and fastened this month; the keelsons are now in their places and bolted off; the masts are now in hand, and the boats are building; all the dead eyes for the lower and topmast shrouds are made and strapped; the knees for all the decks are procured, as well as the beams, carlings, ledges, etc; iron ballast sufficient is in store, and the necessary materials for completing the hull are procured and received.*
>
> *The hemp for the cables, rigging, etc, and blocks, are in the hands of the respective tradesmen, manufacturing, and if this winter should prove favorable, there is no doubt but this frigate may be launched July next.*

As it turned out, McHenry's hopes for a July launch proved premature, but now *Constitution* began to truly take shape. Unfortunately, estimates indicated that the ship required another $96,000 before it could be completed. Congress appropriated the money on March 3, 1797, scarcely an hour before George Washington left office.

Newly inaugurated President John Adams revitalized the frigate building program as diplomatic troubles with France increased. While French privateers began to prey on undefended American merchant vessels in the Caribbean, Adams encouraged Congress to speed defensive measures.

As Republicans and Federalists argued over how far toward open war the nation was willing to go, gangs of shipwrights busily planked *Constitution*'s hull inside and out, fitted beams, installed the diagonal riders, placed mast steps, and laid deck planking.

By June 16, Secretary McHenry reported on a ship nearing completion.

> *The bottom of the ship is squared off, and the caulkers are at work. The various decks are laying; the breast-hooks, diagonal riders, and counter*

[12] Nearly all of the structures adjacent to Hartt's Yard were made of wood and only two stories. Most late-18th century wooden houses in New England measure between 22 and 24 feet from sill to ridgeline.

timbers, are all in and secured, and the mast makers are employed on the masts and yards. All the boats excepting the pinnace are built.

The riggers are at work on the rigging, which will be soon ready; the water casks are in hand, sails are preparing, and the constructor reports the ship may be launched about the twentieth of August next- the Captain is of the opinion she may be completely equipped in one month after.

By July, workers began installing 4,000 sheets of British-made copper on the finished hull, and on September 15, 480 men carried *Constitution*'s hempen anchor cable into Hartt's Yard.[13] The ship stood ready for launching, but failed to do so in September because the ways on which it was built had settled during the ship's construction. After a delay to the next spring tide, on October 21, 1797, the ship finally launched into Boston Harbor.

Repair Periods

No wooden ship, no matter how well built, can exist for more than a few years without significant repairs. While *Constitution*'s sturdy live oak frames remained largely intact for the first half-century of its service, large portions of its other timbers, including planking, beams, and other more superficial parts required constant renewal. The first major repair and restoration occurred just four years after the ship's launch.

Today, after more than 225 years of repairs, refits, and restorations, the Navy estimates that between 8 and 10 percent of the ship's structure can be dated to 1795-1797. This wood can be found in the lowest sections of the ship's hull and includes the keel and keelson, the floor timbers (the lowest section of the frames), and the deadwood (the large timber structures at bow and stern, just above the keel).

Details of the historic shipyard work listed here is largely drawn from Edwin Bearss' *Historic Resource Study: Charlestown Navy Yard 1800-1840,* and former *Constitution* Commander Tyrone Martin's *A Most Fortunate Ship*.[14]

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[13] *Massachusetts Mercury,* September 19, 1797.

[14] Edwin C. Bearss, *Historic Resource Study: Charlestown Navy Yard 1800-1842*, 2 vols. (Washington, D.C: U.S. Dept. of Interior, 1984); Tyrone G. Martin, *A Most Fortunate Ship: A Narrative History of Old Ironsides, Revised Edition*, Revised edition (Annapolis, Md: Naval Institute Press, 2003).

All costs listed are historical amounts, not adjusted for inflation to reflect relative costs today.

1795-1797 Boston:

Constitution was constructed at Edmund Hartt's shipyard for a total construction cost of $302,718.84.

1801-1803 Boston:

On September 8, 1801, Lieutenant Isaac Hull ordered to "give every necessary attention to her repair." The work initially was to be done at Hartt's Yard, but the Navy ordered the ship into ordinary before work commenced. The ship hove down and copper was replaced at John May's Union Wharf. The work took 14 days, with copper supplied by Paul Revere's copper rolling mill. The total cost for repairs over two years was $117,911.80.

1807-1809 New York:

After returning home from its Mediterranean duty, the ship required repairs, including new masts, boats, water casks and other miscellaneous parts. The ship received a new billethead and trailboards to replace the repairs done in Malta after its collision with USS *President* in 1804. At the same time, the ship's armament was augmented with 30 new 24-pounder long guns and 24 new 32-pounder carronades. The total cost for the refit was $99,967.76.

1812-1813 Boston:

Constitution suffered considerable damage during its engagements with HMS *Guerriere* and HMS *Java*, and as a result spent much of 1813 under repair. According to Captain William Bainbridge, the ship required new beams, waterways, decks, ceilings, and knees, as well as new copper sheathing (now ten years old), a considerable quantity of spars and rigging, and another suit of sails. Nearly all the gundeck beams were found to be decayed along with the decks, but there was considerable delay in finding enough timber to make the repairs. The gundeck was raised amidships by 5 or 6 inches, but not raised forward or aft. Most of the carpenters' work was finished by June 23, 1813. The work cost $46,638.46. [Bearss, 1984]

1815-1819 Boston:

After the War of 1812, *Constitution* was paid off and laid up in ordinary, but still required a number of repairs, including new sails and copper. The ships guns and gunner's stores were transferred to *Independence* in 1815.

1820-1821 Boston:

To ready *Constitution* for Mediterranean service, workers at the Navy Yard performed a number of repairs. According to Commodore Isaac Hull, the ship needed "a thorough repair, but when that is done she will be a good ship." Repairs were authorized on April 17, 1820. Workers were ordered to rebuild the gun deck to restore the original sheer and make it the same on all decks. Nearly all the port timbers and most of the top timbers had to be replaced. In addition, the ship got new masts, yards, and rigging. Before this point, *Constitution* had been fastened with iron spikes; Paul Revere gave an estimate for copper ones, as well as new sheathing. In the end, the ship received extensive repairs. It had all new sails, bulwarks, planking between gunports, channels, plank below gunports, top timbers and stanchions, upper futtocks, counter timbers, gun deck and spar deck beams, knees, deck planking, waterways, quarter galleries, cutwater, carved work on stern plus many other odds and ends. In addition, the ship got new gun carriages, new pumps, and much new joiner's work in cabin, wardroom, steerage, and storerooms. According to Hull, when the repairs were complete, the ship would be "much handsomer…than she ever was." By March 1821, it was ready to receive officers and crew.

1828-1831 Boston:

After returning from a long Mediterranean deployment, *Constitution* needed repairs. The ship was turned over to the Navy Yard on July 19, 1828. A general survey found the frames sound, but that the ship required "new plank from lower edge of wales to the rail, new ceiling in the hold, new orlop & birth decks & beams – magazine platforms and spar deck planked; new quarter galleries & channels – knightshead; stem and head to be repaired, and to be coppered and caulked throughout." In addition, the ship needed new masts and lower yards and sails. The estimated cost for repair was $124,720.22. Repairs were deferred until the drydock became operational.

1833-1835 Boston:

Having laid in ordinary for many years, and in want of repair, *Constitution* was now considerably hogged, and its original lines "were all altered and injured." All these issues, however, could be ameliorated if the ship were repaired in the dock. *Constitution* entered drydock on June 24, 1833. The Navy Commissioners ordered Commander Jesse Duncan Elliott to see that the repairs maintained "her former internal arrangements, as respects the positions of her decks – accommodations for officers – store rooms and similar objects, taking great care to preserve the original form of her bottom." Placing the ship on blocks in the

drydock corrected its hog by straightening the keel, but this put the gundeck port sills at different heights. Much of the top timbers and other structural members were replaced or strengthened. All the outside hull planking was replaced and new copper put on. The infamous figurehead of Andrew Jackson was added in April 1834, along with busts of War of 1812 captains Isaac Hull, William Bainbridge, and Charles Stewart on the stern. The ship left the drydock on June 21, 1834, after 358 days, having been "repaired in a complete manner; and no difference in her sheer is perceptible to the eye of the closest observer."

1843-1844 Norfolk:

The Navy Department directed a survey of the ship in August 1843. After the naval constructor reported that it would cost $70,000 to repair the ship, the Navy ordered Captain John Percival to make an independent inspection to estimate what it would cost to prepare the ship for three years of "special service." Percival thought he could do it for $10,000 and was allowed to proceed. The ship was taken into drydock at Norfolk and recoppered and recaulked.

1847-1848 Boston:

Following the ship's two-and-a-half-year circumnavigation, *Constitution* needed another refit before returning to active duty. Again, much of the structure was renewed, but most of the changes were superficial. A new rendering of the Andrew Jackson figurehead replaced the one installed in 1834, along with new trailboards. Suction pumps replaced the chain pumps, and a new model of fife rail was installed behind the main mast. To accommodate the new 8-inch Paixhans guns that were now standard on the Navy's frigates, the gunports were enlarged. The spar deck carronades were replaced by 32-pound long guns. Captain John Gwinn put the ship back in commission on October 9, 1848.

1851-1853 New York:

After being designated the flagship for the African Squadron, workers at the Brooklyn Navy Yard erected a poop cabin as flag officer quarters. These included a reception room, sleeping cabins, clerk's office, a pantry, washroom, and head.

1857(July)-1860(Aug.) Portsmouth, NH:

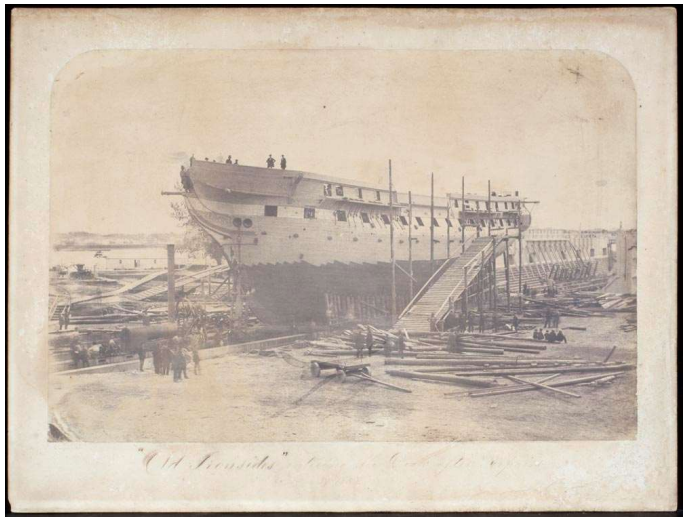

Figure 6: "Old Ironsides" entering the Dock after Repairs, May 27, 1858. Photograph by Albert Gregory. USS Constitution Museum Collection, 2072.1.

No longer required as a front-line warship, *Constitution* was outfitted as a school ship for the Naval Academy. Hauled from the water at the Portsmouth Navy Yard, the ship was stripped to the frames and rebuilt. Figure 6 above, an image of the oldest known photograph of the ship, shows this process. The poop cabin became recitation rooms, and a small house was erected over the main hatch. On the gun deck, long bulkheads divided the space into three study rooms lit by windows in the gunports. On the berth deck, lockers for midshipmen's gear were erected. Forward was a washroom. The ship's armament was reduced to 16 32-pounders. *Constitution* was recommissioned by Lieutenant David Dixon Porter on August 1, 1860.

1873-1877(Jan.) Philadelphia, PA:

Figure 7: "*Constitution* as docked, Jan. 13, 1874." This photograph shows the ship hauled from the water and stripped of its planking during the 1874 restoration in Philadelphia. USS Constitution Museum Collection, 1528.1.

During the summer of 1871, the Navy decided to end the ship's service as a school ship, but no new role had yet been determined. Work continued off and on until 1873, when the ship was to be repaired "for yard duty only" and put on display for the centennial in 1876. The ship was hauled from the water and completely stripped of all planking, exposing the bare frames. Not until January 1876 was the ship ready to return to the water. The Jackson figurehead was removed, and a new billet head installed. The trailboards were replaced, and the new ones featured the shield the ship still carries today. The stern was also rebuilt, and carried the eagle and six stars it has today.

1880-1881 Philadelphia, PA:

The ship's age forced frequent repairs. In December 1880, the yard performed test borings and learned that while still sound, the hull had distorted. The rudder was repaired, the hull caulked, and the bilge pumps and boilers renovated.

1882 Portsmouth, NH:

Destined to serve as a receiving ship at the Portsmouth Navy Yard, dockyard workers constructed a "barn" over the ship's spar deck, providing

accommodations for sailors awaiting assignment to other units of the fleet. Although the alterations appear unfortunate, this was perhaps the best thing that could have happened to the ship at the time. The roof kept rain and snow from the hull, and probably prevented some of the rot that might have otherwise led to the ship's demise.

1906-1907 Boston:

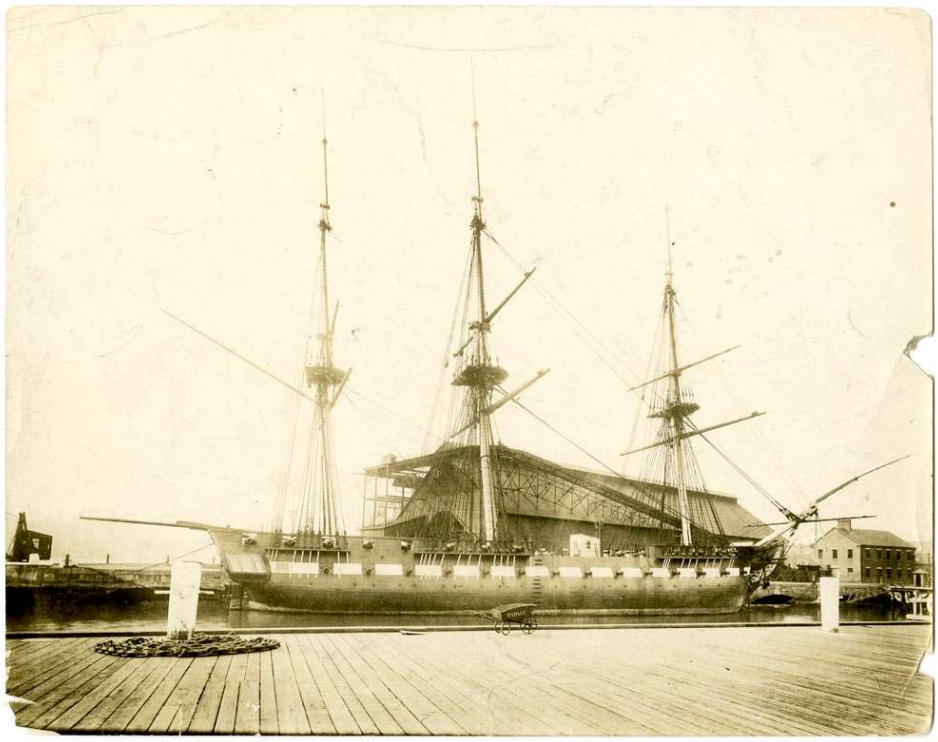

Figure 8: A photograph of *Constitution* in Boston soon after the 1907 restoration. USS Constitution Museum Collection, 1978.2.

The 1906 Naval Appropriations Act included $100,000 to "repair the *Constitution* but not for active service." For the first time, there was an attempt to "restore" the ship to its 1812 appearance. Because of a tight budget, little was done beyond superficial work. The barn that had covered the ship since 1881 was removed, and the open waist and spar deck bulwarks replaced. New non-firing guns were cast, and the ship had at least the "aura of a man-of-war." The repair cost $97,800.01.

1927-1931 Boston:

By the 1920s, the hull had seriously deteriorated, and a near-total rebuild was required to ensure the ship's survival. Congress authorized restoration on March 3, 1925, but because the Secretary of the Navy Curtis D. Wilbur thought the

restoration should be paid for with private contributions, a national executive committee was formed to oversee the fundraising efforts. The public contributed about $942,500 in cash and materials to the restoration. Lieutenant John A. Lord oversaw the restoration. Enough supplies and money had been collected by 1927 to commence the work. When the ship left drydock in March 1930, a large portion of its structural timbers had been replaced. *Constitution* was recommissioned on July 1, 1931. In total, the restoration cost $987,000. [*Interpreting Old Ironsides,* 83-84]

1957 Boston:

In March, the ship entered drydock to have 390 sheets of copper replaced and its hull inspected. No further work was deemed necessary at that time.

1963-1964 Boston:

Constitution drydocked for another inspection and repair work. This time the cutwater was replaced. The Navy could no longer locate hemp rope in the proper diameters for the ship's rigging, and the decision was made to replace it with polypropylene. During the same period, the Navy decided to substitute laminated timbers when natural timbers of the proper dimensions or shape could not be located.

1973-1976 Boston:

A 1970 inspection discovered that the ship was again in need of significant repair as a result of inadequate and ineffective maintenance over the decades since the 1930s. *Constitution* entered drydock in April 1973. While in dock, workers replaced 1/6 of the hull planking and recoppered the hull below the waterline. Work was also done to rejuvenate and strengthen the bow. Masts, rigging, and gun carriages were replaced. The ship left drydock on April 25 1974, but work continued on the rigging and upper hull planking. On July 1, a full-time group of artisans was established to repair and maintain the ship. The total cost for the restoration was $4.6 million.

1992-1996 Boston:

In 1992, *Constitution* began a major restoration addressing fundamental structural issues with the hull. Research discovered that a set of diagonal riders, interior framing originally designed by Joshua Humphreys, had been removed in the 1870s, likely contributing to the ship's decommissioning in 1881. A new set of diagonal riders along with associated knees, stanchions, and planking were installed. Extensive model testing and computer simulations had shown that the framing would significantly strengthen the hull and nearly eliminate the hogging

of the keel. The restoration opened the possibility of the ship sailing under its own power again on the bicentennial of its launch in 1997. The restoration cost about $12 million.

2007-2010 Boston

The 2007-2010 restoration brought the War of 1812 "look" back to *Constitution*'s hull. The bulwarks that had been raised about 20 inches in the 1927-1931 restoration were lowered to the 1812 cap rail height just above the spar deck gun ports. In addition and, most significantly, the waist bulwarks alongside the main hatch were cut open and replaced with custom-made, recreated hammock "cranes" (U-shaped irons), as seen in the earliest known model of *Constitution*, built in 1812 by sailors for Captain Isaac Hull (now in the collection of the Peabody Essex Museum). Lowering the upper bulwarks and opening the waist bulwarks removed approximately 20 tons of white oak and live oak from the ship, thus eliminating excess weight from the 215-year-old keel.

2015-2017 Boston

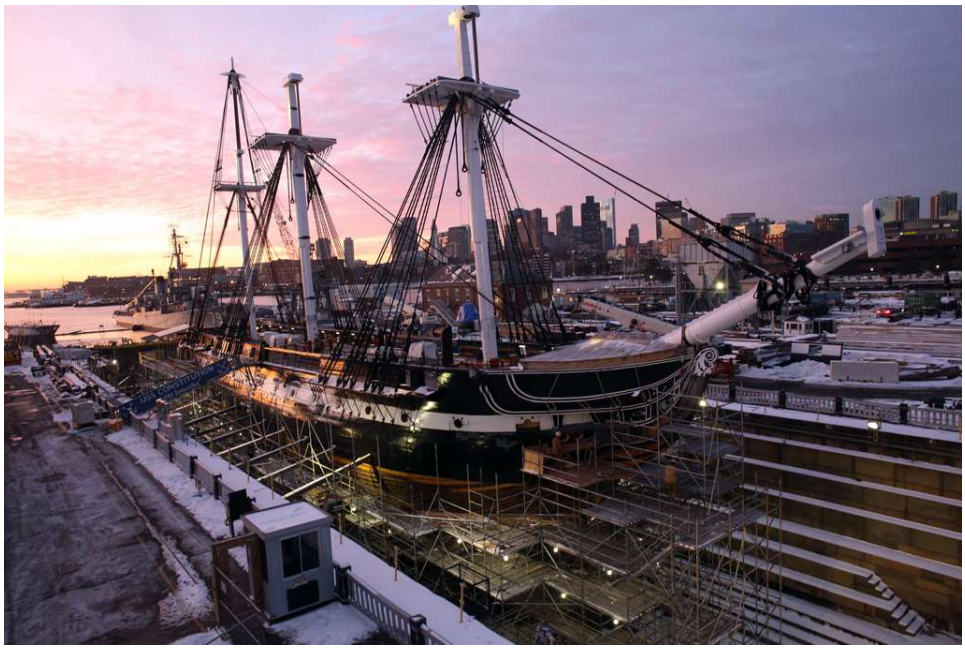

Figure 9: *Constitution* in dry dock at sunrise on January 10, 2017.
Photo by Greg M. Cooper Photography. Courtesy USS Constitution Museum.

In 2015, *Constitution* entered drydock for the first time since the 1990s. Much of the hull's copper sheathing was replaced – about 2,200 of the ship's 3,200 copper sheets. More than 100 new planks were installed, mostly above the waterline. The stern galleries and much of the stern were rebuilt. Substantial parts of the

cutwater were replaced, and new trailboards were carved and installed based on the old ones. The wire bobstays that support the bowsprit were replaced with Kevlar line, reducing the weight hanging off the bow by about 430 pounds.

Annotated Bibliography

Bearss, Edwin C. *Historic Resource Study, Charlestown Navy Yard 1800-1842.* 2 vols. Washington, DC: US. Dept. of the Interior. 1984.

A thorough and detailed history of the Charlestown Navy Yard, written entirely from primary sources. Bearss details the ship's major restorations from 1801 to 1834 and includes much of the correspondence between the men overseeing the repairs and the Board of Navy Commissioners.

Chapelle, Howard I. *The History of the American Sailing Navy, The Ships and Their Development.* New York: W.W. Norton & Co., 1949.

The quintessential classic work on the early American Navy. Chapelle pioneered research into ship design and construction using previously un-consulted original sources. Replete with sheer and breath plans of the various vessels, including *Constitution.*

Dodds, James and James Moore. *Building the Wooden Fighting Ship.* New York: Facts on File, Inc., 1984.

A highly detailed account of the shipbuilding process, complete with original line drawings depicting the various components of a wooden ship and the steps in shipbuilding.

Gilmer, Thomas C. *Old Ironsides: The Rise, Decline, and Resurrection of the USS* Constitution. Camden, ME: International Marine, 1993.

Gilmer, a naval architect, ship designer, and instructor at the Naval Academy was hired to conduct a structural survey of *Constitution* in the early 1990s. This book includes many of his findings, as well as a good recounting of the ship's repair history. His retelling of the ship's operational history is weak, however.

Lavery, Brian. *Building the Wooden Walls: The Design and Construction of the 74-Gun Ship* Valiant. Annapolis, MD: Naval Institute Press, 1991.

Lavery, the preeminent expert of the British Royal Navy, details the steps followed to build a ship of the line in the middle of the eighteenth century. Profusely illustrated with period images, the text provides a succinct summary of the process and labor involved-processes little changed by the 1790s.

Martin, Tyrone G. *Creating a Legend.* Chapel Hill, NC: Tryon Publishing Company, Inc. 1997.

Martin, a former commander of *Constitution*, explores the construction of the ship, paying special attention to the physical structure and outfit. The book includes useful appendices that reproduce Joshua Humphrey's "Dimensions for a 44 gun frigate," material estimates, specs for the original guns, and rigging dimensions.

_____. *A Most Fortunate Ship.* Annapolis, MD: Naval Institute Press, 1997.

Martin's best-known book follows *Constitution*'s career from the beginning to the 1990s restoration, and features information about all the ship's repairs and refits.