In summer 1865 the navy gathered a large fleet of decommissioned ironclads south of Philadelphia at League Island. Some of these worn-out ships had bombarded southern forts for months to open the Confederacy for a final assault. In 1864 Admiral David Farragut had led ironclads into one of the most dramatic naval battles of the Civil War at Mobile Bay. Now, after the final shot had been fired and the last rebel fort had surrendered, dozens of the ironclads lay anchored in the Delaware River to rust on League Island’s “Monitor Row” for years to come.

Civil War ironclads had a resounding impact on naval warfare. The impressive sight of cannonballs bouncing off the USS Monitor and CSS Virginia at Hampton Roads precipitated the introduction of iron armor in European navies. Unlike American ironclads, these vessels were oceangoing ships and redefined the parameters of naval warfare. Henceforth, it became virtual suicide for wooden men-of-war to seek battle with a metal-armored vessel.

The effects of ironclad construction on iron shipbuilding are less clear. Maritime historians have concluded that “monitor building,” as it was popularly known, had little impact on the development of iron shipbuilding. According to some studies, a strict division of ironclad building into armor plate production performed by subcontracting boiler works and hull construction at shipyards blocked a transition from wooden to iron shipbuilding: “Neither did the boilermakers learn to bend iron to ships’ curves nor did the shipwrights learn to work with metal. An excellent opportunity to master already
crucial skills was thus lost to the American shipbuilding industry.” However, closer examination of the industry reveals that monitor building changed over time. Eventually, it did facilitate the transition from wooden to iron construction. When the navy ordered its first experimental vessels in 1861, shipbuilders learned little about iron as a shipbuilding material because ironclad armor was produced and processed by subcontracting ironworks. But in 1863 some builders retooled their yards, hired metalworkers, and acquired iron shipbuilding capacity to construct second-generation monitors for the Union Navy. This opened a new chapter in the history of Philadelphia shipbuilding as Cramp joined the ranks of Delaware Valley iron shipyards.

The Development of Armored Vessel Technology

Ironclad construction was intertwined with major changes in ordnance. Until the 1820s the armies and navies of the Western world were equipped with guns firing solid shot and shrapnel; cannonballs gained their destructive power from their impact velocity when hitting a target. During the 1820s, however, the French inventor Henri Paixhans developed a shell that contained gunpowder and detonated upon impact. This invention rendered traditional defense systems more vulnerable to artillery hits. The wooden side armor protecting warships, for example, splintered and burned when hit by the new explosive shells. British experiments during the 1840s illustrated that simple iron plating failed to protect warships against modern artillery because shells shattered thin plates and turned them into shrapnel that injured crews. The first real progress was made during the Crimean War, when the Anglo-French allies built floating batteries protected by 4-inch-thick armor plates that resisted explosive shells.3

During the late 1850s and early 1860s Britain and France entered into an ironclad arms race. Operating a second-class navy at best, the French built the prototype ironclad La Gloire, which featured a wooden hull sheathed with heavy armor plates. In Britain, La Gloire inspired fears that a few French ironclads could challenge the entire Royal Navy with its eighty wooden ships-of-the-line. In 1859 the Royal Navy responded to the French project with the first true ironclad, HMS Warrior. This vessel epitomized British leadership in naval architecture and marine engineering. The Warrior was designed in cooperation between the Royal Navy and John Scott-Russell and Isaac Watts, arguably two of the best engineers of their time. Plans and specifications called for an iron hull throughout, including frames and armor backing—a marked contrast to La Gloire’s wooden hull. Moreover, while the French hammered together thinner iron plates, British ironclad builders devised a one-piece
Ironclads and the Transition from Wood to Iron

Armor plate made of rolled iron 4½ inches thick. Only British mills were equipped to make iron this thick. In following years the Royal Navy improved this prototype and thereby helped maintain Britain’s undisputed control of the seas for the rest of the century. The French-British ironclad rivalry held an important lesson for the American Civil War: that no matter how bold the ironclad initiatives of a growing naval power might be, what counted in the end was the ability to build the better ship.4

Across the Atlantic, the Confederacy—a naval power of virtually no significance—first seized upon the new technology to gain a strategic advantage over the Union. When the U.S. Navy abandoned the Norfolk Navy Yard in April 1861, retreating Union officers and sailors burned several warships, including the wooden steam frigate USS Merrimack. After seizing the site, the Confederates discovered that the Merrimack’s hull and machinery had remained intact below the water line. In July 1861 the Confederate secretary of the navy, Stephen Mallory, approved a plan to raise and rebuild the USS Merrimack as the ironclad CSS Virginia. The Tredegar Iron Works at Richmond, the leading southern foundry, supplied the hammered iron armor.5

In July 1861 the U.S. secretary of the navy, Gideon Welles, called attention to the ironclad problem and asked for funds to build a series of experimental vessels. In early August Congress appropriated $1.5 million for this project. The Navy Department soon asked shipbuilders for proposals, received sixteen bids, and appointed a committee to examine them.6

The committee consisted of three naval officers who were familiar with wooden ships but admitted that they had “no experience and but scanty knowledge” of iron vessels.7 Reflecting the typical suspicions of naval traditionalists, their report suggested that armored vessels were useful as floating batteries for harbor operations but that “as cruising vessels . . . we are skeptical as to their advantage and ultimate adoption.”8 Considering the navy’s task of entering shallow southern harbors, the officers argued, the Union’s ironclad program should emphasize “vessels invulnerable to shot, of light draught of water, to penetrate our shoal harbors, rivers and bayous.”9 In their discussion of armor problems, the officers called attention to the Union’s limited industrial capacity to produce thick iron plate. The most desirable armor would consist of rolled plates, tougher than hammered ones, but “we are informed there are no mills and machinery in this country capable of rolling iron 4½ inches thick.”10 They weighed the advantages of buying a complete ironclad in Britain but in the end favored American-made hammered plates.11

The officers also evaluated the sixteen construction bids and concluded that only three proposals warranted close attention. They rejected most bids, citing insufficient specifications, exaggerated claims and prices (a naval architect
proposed a 6,520-ton ship developing “at least” 18 knots for $1.5 million), as well as freak inventions (one bid suggested a “rubber-clad vessel, which we cannot recommend”). The more serious proposals included Merrick & Son’s plan for a 3,296-displacement-ton, three-masted frigate costing $780,000. “This proposition we consider the most practical one for heavy armor,” the officers commented. Next to the Philadelphia monster ship, John Ericsson’s proposal looked moderate: The Swedish inventor suggested a floating battery displacing 1,255 tons without a sailing rig at $275,000; its most innovative feature was a revolving turret equipped with two guns. Despite some apprehensions about the vessel’s seaworthiness, the board advised that the plan be adopted—USS Monitor’s first step on the way to the Battle of Hampton Roads. The third experimental ironclad approved by the board was based on another Ericsson design, improved by Bushnell & Co. of New Haven, Connecticut. The Navy Department followed the board’s recommendations and signed contracts with the three builders.

**Building the USS New Ironsides**

When Merrick & Son booked its contract for an ironclad, the firm mobilized the mid-Atlantic manufacturing elite as subcontractors. Merrick’s own Southwark works built engines and boilers, and Cramp constructed the wooden hull. Armor plates were forged and hammered at Bailey, Brown & Co.’s Pittsburgh foundry and by the Bristol Forge Co. in Bristol, Pennsylvania. Merrick also enlisted dozens of small Philadelphia machine shops to have armor plates grooved and finished. The contract for the long propeller shaft went to Trego, Baird & Co. in Baltimore; the Phoenix Iron Works in Trenton, New Jersey, furnished heavy gun carriages. The Philadelphia Navy Yard had the only dry dock of sufficient size to take on the enormous hull for coppering. The result of these combined efforts was the frigate USS New Ironsides.

The hull contract gave Cramp an opportunity to recover from recent financial troubles. The financial panic of 1857 had forced William Cramp to default on several loans and transfer the firm’s management to his sons William M. and Charles H. Cramp (William Cramp, Sr., henceforth served as a shop foreman). By 1861 the yard had built a few steamships, but it still needed a large order to settle old debts.

Merrick and Cramp followed standard procedures of wooden steamship design. Charles Cramp formulated technical specifications in collaboration with Barnabas Bartol, a boiler engineer, sugar manufacturer, and Merrick’s superintendent for naval affairs. Cramp, Bartol, and the Navy Department recorded construction details in a booklet that was submitted to the Navy
Department for approval. The USS *New Ironsides* was to measure 232 feet in length and 54 feet in the beam; 2,000 square feet of 4½-inch armor plates would protect her magazines and ordnance.\(^1\)

In October 1861 Cramp advertised in eastern Pennsylvania country newspapers for white oak timber, and farmers in Bucks, Berks, Delaware, and Chester Counties soon began cutting ship timber for the *New Ironsides*. According to Charles Cramp, “These counties were transversed by the North Pennsylvania Railroad, and the various stations from Quakertown down were soon gorged with logs.”\(^2\) By January the shipyard had stocked sufficient timber to construct keel and frames.\(^3\)

Hull construction was the domain of woodworkers. Axmen hewed timber into ship-shape, borers drilled holes for bolts and fastenings, ship carpenters assembled and raised frames, joiners built the inside of the hull, and caulkers filled the seams between the planks with oakum and pitch to seal the hull. The only metalworkers involved in wooden shipbuilding were a few smiths who made iron and copper bolts. In the mold loft, Cramp’s loftsmen copied the construction plans in full size on the floor to determine the lengthwise and crosswise shape of the frames. Ship carpenters then laid thin pine sticks on top of each frame drawing, tacked them together, and handed them to the axmen who hewed timber into the required shapes.\(^4\)

The main hull components included the “backbone” (keel, stem, and stern), the “rib cage” (frames and beams), and the “skin” (outside planks). The 220-foot keel for the *New Ironsides* consisted of long pieces of timber connected by scarfs (angled overlapping joints). Ship carpenters cut a 10-foot scarf into either end of a keel timber and then fastened it to the adjoining scarf of the next timber with four strong copper bolts. They also raised the stem and stern and installed frames, deck beams, and outside planks.\(^5\)

In early spring of 1862 the tall hull towered over the shipyard. The *New Ironsides* drew such crowds of spectators to the Kensington riverfront that Cramp fenced the property to keep visitors out. The shipyard swarmed with 400 workers who completed the hull. Ship carpenters assembled the rudder; joiners built the magazines; dozens of subcontractors worked on ropes, chains, and fittings. In early May the *New Ironsides* was ready for launching.\(^6\)

The christening on May 10, 1862, attracted 20,000 spectators, the largest launching party in memory. The ship was appropriately christened by a veteran navy officer who had served aboard the USS *Constitution* fifty years earlier; during the War of 1812, her crew had nicknamed this famous frigate “Old Ironsides” because no enemy cannonball had pierced her oak timber. At 9:45 A.M. a revenue cutter fired a warning shot to chase vessels cruising on the Delaware River out of the launching path. Ship carpenters sawed through the
last shores, and at 10:15 A.M. they were ordered to “clear the ways, haul in the
gangway planks.”23 The USS New Ironsides slid down the launching ways in 15
seconds. Steam tugs towed the hull downriver to Merrick’s Southwark works
for further construction.24

Armor contractors had already forged iron plates that were now attached to
the outside planks. Weighing up to 3 tons apiece, the plates were hammered to
the appropriate thickness by blacksmiths who brought long pieces of scrap
iron to red heat and forged them with a 2½-ton steamhammer over a large
anvil. Because the iron cooled during the process, the plate had to be reheated
several times before it reached the required thickness and strength. The mills
shipped the plates to Philadelphia, where small ironworks planed and grooved
them.25

At Merrick’s wharf, New Ironsides received her engines, boilers, masts, and
iron armor. Riggers lifted each plate from the wharf with a large derrick and
placed it onto armor bolts protruding from the hull. Blacksmiths attached the
lowest row of plates 4 feet below the load line and worked their way upward.
Before installing the last plates, Merrick had the ship towed to the Navy Yard
for coppering. After the hull was placed securely onto a floating dry dock,
heavy steam engines pumped the water out of the tanks that kept the dock
afloat, and coppersmiths commenced their work. The ship’s underwater body
had to be copper-sheathed to prevent the growth of marine zoophytes, which
sprouted on wood and iron so abundantly as to slow down the vessel after
several years of service; copper was the only cheap metal resistant to mussel
growth. Coppersmiths attached the first row of copper plates adjacent to the
lowest row of iron plates and worked their way downward to the keel. How-
ever, they failed to consider the electrolytic reaction that takes place between
copper and iron in saltwater, which oxidized the armor plates. After only two
years of service, the lower part of the New Ironsides’s armor plating showed
signs of erosion.26

From June to mid-August 1862 Navy Yard workers and Merrick’s men com-
pleted the armor while the vessel was docked at the Navy Yard’s Southwark
wharf. Fitted with engines, boilers, and ordnance, the USS New Ironsides
steamed down the Delaware River for her trial trip on August 21. To civilians,
she presented a breathtaking sight that gave rise to wild speculations about her
fighting capabilities. The Navy Department was slightly less impressed. Despite
claims to the contrary, the ship’s draft exceeded 20 feet, her rudder was too
small, and her 700-horsepower engine yielded a speed of only 6 knots. But
even so, there was nothing afloat in North American waters that the USS New
Ironsides had to run away from. The Philadelphia builders had constructed the
mightiest ship of the Civil War.27
For Cramp the ironclad was a much-needed success. First, the hull contract enabled the firm to restore its credit after netting a $60,000 profit. Brothers William and Charles Cramp soon worked out a plan with the firm’s creditors to settle the old debts. Second, the ironclad was a prestigious vessel that boosted Cramp’s reputation as a reliable contractor; during the next two years the Navy Department entrusted the yard with a side-wheeler, another ironclad, and the supercruiser USS Chattanooga. Third, Cramp made its reputation as an ironclad builder without forging or punching a single plate. Indeed, the contract was probably so profitable mainly because the builders could use the tools and techniques of wooden shipbuilding, instead of launching expensive yard improvements to obtain iron shipbuilding capacity.  

From a larger perspective, however, the USS New Ironsides illustrated structural problems facing inexperienced builders who ventured into iron con-
struction. Apart from a few designing skills, Cramp and other subcontractors learned little about iron as shipbuilding material, both because the contract was divided into minuscule tasks and because they had no part in the metal processing, which was performed by ironworks. When conventional shipbuilding techniques, such as copper sheathing, did intersect with those of metal shipbuilding, construction mistakes ensued. To master the transition from wooden to iron construction, shipbuilders could not simply enlarge the traditional subcontracting network by drawing forges and ironworks into the orbit of shipyards. Effective ironclad construction required greater familiarity with iron processing techniques among shipbuilders themselves.

The Transition to Iron Shipbuilding

The Union’s experimental ironclad program ended prematurely in spring 1862 during a series of dramatic events. On March 8, the CSS Virginia steamed out of Norfolk and attacked a Union blockade fleet at Hampton Roads. The Confederate ironclad played havoc with the Union’s wooden fleet, destroyed two large warships, and threatened to sink a third. That night, Ericsson’s USS Monitor arrived at Hampton Roads and positioned herself to protect the Union fleet from the Virginia, which returned the next morning. On March 9, 1862, the two vessels slug it out in the first battle between ironclads in naval history. Neither ship could pierce the other’s armor, and the battle ended in a draw. But the Monitor prevented the Virginia from breaking the Union blockade and steaming north to bombard the capital, as many panicked Unionists had feared. Impressed with Ericsson’s vessel, the Navy Department selected the Monitor as a prototype for Union ironclads even before the USS New Ironsides had been launched.29

Charles Cramp was outraged by what he perceived as favoritism and pleaded with naval officials to improve the New Ironsides’s design. “We recommended that the government build other vessels like her but with twin screws and various other improvements,” he wrote later. But “all [our plans] were thrown aside without examination by the navy department.”30 Even the editors of the influential Army and Navy Journal could not persuade the navy to build another New Ironsides.31

The Navy Department proposed several changes to build the next generation of ironclads. In March 1862 a memorandum authored by navy officials John Lenthall and Benjamin Isherwood—respectively, chief of the Bureau of Construction and Repair, and chief of the Bureau of Steam Engineering—asked the secretary of the navy to build a new navy yard for ironclads, so as to construct the entire Union monitor fleet under government auspices. Much to
Lenthall and Isherwood’s chagrin, however, Congress blocked the plan because it could not agree on a location (the proposed sites were League Island and New London, Connecticut). The press surmised that private contractors had concocted this deadlock to prevent the nationalization of monitor construction. For the duration of the Civil War, the ironclad navy yard scheme came to naught, and the navy established only a depot for decommissioned monitors at League Island.\textsuperscript{32}

With its most ambitious scheme stalled, the Navy Department encouraged private contractors to centralize production. Lenthall informed the secretary of the navy that “selling out or subletting . . . contracts . . . is always to the injury both of the Government, and of the individual interests of the country, by fostering middlemen.”\textsuperscript{33} The USS New Ironsides illustrated that an extreme subdivision of the construction process also caused technical problems. As a result of these and other developments, Congress in July 1862 outlawed unauthorized subcontracting of government orders. Moreover, the Navy Department established a “monitor office” in New York to centralize and supervise ironclad design. This navy “subdepartment,” nominally headed by veteran rear admiral Francis H. Gregory and managed by chief engineer Alban Stimers, was located across the hall from Ericsson’s design bureau, which supplied general plans and specifications. Navy inspectors at the shipyards supervised contractors and reported every other week to the New York office. Chief Engineer Stimers administered the office and corresponded with contractors, local inspectors, and the Navy Department bureaus for construction, engineering, and ordnance.\textsuperscript{34}

The centralization of ironclad design at the New York monitor office had several flaws, internal and external flaws. First, the office was understaffed. Stimers not only supervised its day-to-day operations but also called on workshops and shipyards in New York, Boston, Philadelphia, Chester, and Wilmington during troubleshooting assignments. Moreover, he was an ambitious man bent on reaping credit for designing ironclads and often visited the drawing rooms of the New York office to change plans and specifications. Second, the external coordination between the New York office and the bureaus for construction and steam engineering was insufficient, partly because Navy Department officials viewed it as an unwelcome competitor. Established bureaus rarely answered Stimer’s pleas for technical advice. He later recalled, “I always felt that it was a regular fight—that we had to conquer them before we could get anything. On the one side it was a fight with the bureaus, and on the other side it was a fight with the contractors, to make them do anything right. It was a very unpleasant position which I held.”\textsuperscript{35}

In spring 1863 the secretary of the navy charged the New York office with
planning the largest ironclad program of the Civil War, twenty Casco-class “Light-Draft Monitors.” The Navy planned to use Cascos in the Mississippi River war theater. To operate in shallow waters, the vessels needed a light draft, not exceeding 6 feet, as well as a low freeboard of only 15 inches to present a small target to Confederate guns. Ericsson’s initial plans showed a 225-foot hull, an armored upper deck, a revolving turret, and twin screw propellers to give the vessel a speed of 8 knots. This simple but effective design answered the navy’s needs for Mississippi River warfare, Ericsson argued.36

In planning the new series of ironclads, Ericsson paid special attention to the industrial geography of shipbuilding and iron production. He stressed that the river monitors should be built in the Midwest and not on the Atlantic Coast because light-draft vessels were not equipped to venture on the long voyage from the northeastern shipbuilding centers to the Mississippi River via the dangerous North Carolina coast. (The navy had already lost the Monitor in a storm off Cape Hatteras during the attempt to transfer her from Hampton Roads to Beaufort, North Carolina.) At the same time, Ericsson knew that midwestern shipbuilders and iron masters were not nearly so well equipped as their northeastern counterparts. The design, therefore, stressed technical simplicity. He explained, “I conceived the idea of building a plain, oval tank with a flat bottom and upright sides, that could be done in an ordinary establishment in forty days. Around this I attached a raft made of timber, the idea being to give stability and impregnability to this wooden raft.”37

Before construction began, this design underwent changes that infuriated Ericsson. Chief Engineer Stimers showed the drawings to Admiral Joseph Smith, chief of the Bureau of Yards and Docks in Washington, D.C., who was less hostile toward the New York office than other bureau chiefs. Smith suggested the first alterations to Ericsson’s design, recommending that the oval hull be surrounded with large iron tanks that could be filled with water. The additional weight would submerge the vessel further to create a smaller target; if necessary, the water could be pumped out to give the ship a lighter draft. This peculiar design required several auxiliary engines to drive water pumps. Stimers approved of Smith’s suggestion and ordered the required changes. The hypersensitive and arrogant Ericsson was so angry about these modifications that he informed the secretary of the navy of his decision to withdraw from the project.38

In February 1863 the monitor office asked for bids on the twenty light-draft monitors. It soon signed contracts with shipyards and engine builders across the Union, from St. Louis to Boston. Most of the river monitor contractors were northeastern concerns, because western builders had submitted an insuf-
ficient number of bids, thereby stifling Ericsson’s plan to have the vessels built close to their operational theater. Aggregate costs amounted to almost $8 million, or $395,000 per vessel. Contractors included Reaney & Archbold in Chester, Wilcox & Whitney at Camden, and Harlan & Hollingsworth in Wilmington. Merrick & Sons booked a contract to build engines and boilers for the USS Yazoo; Cramp built her hull and the turret.  

This subcontract triggered what may have been the single most important development in Civil War shipbuilding: Cramp erected new facilities that included iron-processing equipment. A new facility at the foot of Palmer Street featured a “frame building, 250 feet long and 40 feet wide, and supplied with a powerful engine, driving machines for punching, cutting and planing iron and bending inch plates while in a cold state, to be used in making the turrets etc.” Cramp received from iron mills prebent iron plates for hull components, tanks, and the turret. Cramp’s workers shaved irregularities off the surface of the plates using the planer, cut the plates into exact shape with a steam-driven shear, and operated a punching machine to pierce them at the rim where they eventually received rivets. To operate these new devices, Cramp hired ironworkers, including blacksmiths, platers, riveters, and machinists. By the summer of 1863, these men had joined Cramp’s woodworkers to construct the USS Yazoo.

Hull construction began in May 1863. Like the USS New Ironsides and other wooden ships, the river ironclad was first laid down full size in the mold loft by ship carpenters. The carpenters copied plans onto the floor and cut wooden patterns for hull components as well as for iron tanks. The patterns were
forwarded to blacksmiths, who copied them onto long iron rods by hammering each piece into the required contours. At the point of production, the iron age had begun.  

On the berth, the riveters and ship carpenters constructed the hull. Ship carpenters and laborers prepared the building slip by lining up a row of logs, laid the keel, and erected frames that were bolted and riveted by riveting gangs. Plates were precision-bent at Cramp’s small foundry; this procedure did not require elaborate shop equipment because the Yazoo’s hull was almost box-shaped and did not have intricately contoured lines like those of a seagoing ship. Riveters attached plates to the frames and painted them with a zinc layer to prevent oxidation. Ironworkers also assembled and installed Admiral Smith’s water tanks and connected them to pipes, valves, and steam-driven water pumps. Cramp cast propeller stuffing boxes at its small foundry and erected them aboard the ship.

Meanwhile, the ship carpenters constructed the wooden raft that encased the iron hull and the water tanks. Made of oak and pine timber, it gave the ironclad additional buoyancy. Like other contractors for the light-draft monitors, however, Cramp used unseasoned timber; one of the contractors recalled that “there was not a ton of seasoned oak in the market suitable for these boats.” Unseasoned timber was heavy because it absorbed water. As a result, the Yazoo’s wooden raft gave the ship less buoyancy than the designers had planned.

The organization of work and the division of labor between ironworkers and woodworkers involved surprisingly few problems. More than half of the 300 men who built the USS Yazoo were ironworkers, but there was very little rivalry between them and the ship carpenters. Many woodworkers took the opportunity to learn iron-processing techniques. According to Charles Cramp, “our yard became a sort of kindergarten, as most of the workmen had to be trained to the work and working appliances had to be designed. Most of the members of the old firm could take any part of the building of a ship, from mold loft to launching; and they soon were able to take any iron work, from bending frames to bending plates and designing furnaces and other appliances.” Cramp’s ship carpenters were more willing to become builders of iron ships than their New England counterparts, who avoided metalwork at any cost. Cramp’s experience also contrasted with the situation in Britain and Germany, where journeymen ship carpenters, fearing job losses, launched strikes during the transition from wooden to iron construction. Charles Cramp noted one exception from the relative quiet at the point of production: “Many young ship carpenters and joiners and some fishermen . . . took up all the varieties of the work except riveting, which they did not consider a mechanical occupa-
tion. This was probably because riveting represented one of the few mass-production-style jobs in iron shipbuilding and was usually paid by the piece; most skilled workers, by contrast, produced custom-made items and received hourly wages.

At the end of 1863 Cramp and other contractors for the light-draft monitors experienced growing problems due to constant design changes. Stimers and his team of thirty young draftsmen at the New York monitor office added new features to the engines and the turret while the vessels were already being built. A specifications booklet, dubbed the “monitor prayer book” by some builders, contained ninety-two pages of small print. One Boston yard received 83 drawings and 120 explanatory letters from Stimers detailing numerous changes. In the end, each light-draft monitor featured thirteen auxiliary engines and pumps, fancy brasswork where simple cast iron would have been sufficient, and a confusing system of pipes to drain the water tanks. These changes not only cost the government considerable amounts for extra work but also added weight to the light-draft monitors, whose hulls were designed for a freeboard of only 15 inches. The hulls and rafts, which had to carry the additional weight, were the only components that remained unchanged. Together with the heavy water tanks and the unseasoned timber, alterations raised the possibility that the light-draft monitors would not float.

A Boston builder was the first among the twenty contractors who worked his way through the perplexing design changes and finished his vessel, the USS Chimo, in spring 1864. At this point, shipyards were already brimming with rumors that something was wrong with the light-draft monitors. Stimers rushed to Boston in May and worked frantically to put the vessel into service. When the Chimo embarked on her trial trip, the disaster was complete: Waves washed across the upper deck, and the stern was submerged 3–4 inches. A naval constructor remarked drily that this was a “rather small margin for a man to go to sea with.”

In June and July 1864 the “light-draft monitor scandal” rocked the industry and the Navy Department. The press pointed out to the taxpaying public that the USS Chimo and her nineteen sister ships had cost close to $500,000 apiece and were entirely useless. The contractors, including Cramp, met at New York and disavowed any responsibility for the mistakes. The mortified secretary of the navy searched for a scapegoat, which he found in Stimers. Welles removed Stimers from his position and placed a team of experienced administrators in charge of the monitor office, including the chiefs of the Bureaus of Construction and Steam Engineering, Lenthall and Isherwood. In cooperation with Ericsson and the contractors, the bureau chiefs tried to rescue the ill-fated ironclad program.
The team redesigned the wooden raft by raising the sides 22 inches to give the vessel greater freeboard. Many pipes and other iron parts had to be lengthened to fit the larger raft. For a cost estimate for the proposed changes, the officials contacted Merrick & Son whose engineers, together with Charles Cramp, also proposed a method of raising the sides at a price of $68,000. Even at this stage, Cramp profited from the doomed monitor program. At Chester, Reaney & Archbold had launched its ironclad, the USS *Tunix*, and reported problems similar to those discovered in the *Chimo*. On her trial trip up the Delaware River, the vessel barely reached a speed of 3½ knots instead of 8, even small waves drenched the upper deck, and her draft was anything but light. The navy, apparently concerned that the *Tunix* might sink on her way back to Chester, kept the vessel in Philadelphia to have the raft rebuilt by Cramp. Lacking a dry dock, Cramp’s men, together with dozens of beasts of burden, pulled the *Tunix* out of the river and commenced the alterations in October 1864.52

Like many Union ironclads, the light-draft monitors were completed after the Confederate surrender. Without the usual fanfare, Cramp and the other contractors launched their Cascos in spring 1865. They were commissioned as serviceable vessels but never saw any combat; most of them joined the fleet of mothballed ironclads at League Island. On “Monitor Row,” the USS *Yazoo* anchored only a short distance from the USS *New Ironsides*.53

A few years after the war had ended, the short but momentous story of Philadelphia-built ironclads also came to an end. On a warm summer night in 1870, a watchman discovered a small fire aboard the decommissioned *New Ironsides*. Despite valiant efforts by Philadelphia fire companies, the blaze burned out of control and gutted the big wooden hull. The same year, Cramp completed its last sailing vessel and abandoned wooden shipbuilding to concentrate on iron steamship construction.54