H.M.S. *Warrior*

Recently restored after suffering more than a century of neglect, the vessel was the first iron-hulled, armored warship. It deterred the enemy as it sealed its fate by engendering a naval arms race

by Walter Brownlee

Vice Admiral Lord Nelson ensured lasting fame for his flagship *Victory* by commanding from its deck the British Royal Navy in its triumph over the combined French and Spanish fleets at the Battle of Trafalgar in 1805. The warship is now preserved in Portsmouth, England, as a monument to Britain's naval prowess and to the memory of Nelson himself, who died in the battle. Recently another British warship has been restored in the largest and most expensive such project to date to take a permanent berth in Portsmouth near H.M.S. *Victory*. The ship has no battle scars and its decks were not stained with the blood of war heroes. Indeed, it never fired a single shot in anger. Yet it deserves a figurative as well as a literal place of honor beside *Victory*.

The ship is named *Warrior,* and it is the only surviving large Victorian warship. But this is not what makes the ship particularly noteworthy in naval history. *Warrior*'s historical impact resulted from its creation: merely by being built it caused the entire pattern of warship design to change throughout the world. For H.M.S. *Warrior* was the first iron-hulled, armored battleship.

Warrior was so superior to any other warship at the time of its construction that its supremacy never had to be challenged in battle. Hence the ship never had the opportunity to distinguish itself in any military confrontation, and no valiant deeds were ever demanded of its crew. As a consequence it was quickly forgotten by the general public a decade after it was launched, forced into a premature retirement as other naval powers adapted and perfected many of the features *Warrior* had introduced.

Ironically, the full implications of *Warrior*'s role can be appreciated better today, in a world that has had 40 years' experience with nuclear weapons, than it was during Victorian times. For *Warrior* was a deterrent. The warship emerged in 1860 as an awesome machine of war that rendered obsolete all previous warships and thereby successfully deterred a threatening enemy. Yet like all technology-based deterrents, it could not be uninvented and its emulation by the enemy could not be prevented. It thereby also presented the Victorian world with another concept unfamiliar to their time but familiar in ours: an arms race.

Although various countries fought during the 18th and 19th centuries to establish and protect trade routes across the oceans, before 1840 all essentially played by the same rules: warships were constructed of timber and propelled by wind. Wood was a common, natural and self-replenishing building material. Thousands of years of experience with it had resulted in an industry capable of producing reliable vessels that could sail anywhere in all but the most adverse weather conditions. Provided a landing party could buy, beg, borrow or steal a suitable piece of timber, the repair or alteration of any part of a warship's structure could be accomplished by teams of skilled carpenters, who always formed part of a ship's crew. Wind, of course, was also available worldwide and completely free. Tall masts (typically three) carried a highly complex system of sails, yards and tackles that could be expertly manipulated to propel a warship wherever its captain chose. Only in the case of extreme weather conditions, such as a total absence of wind or a raging hurricane, did this form of propulsion fail old-time sailors.

The basic function of such warships was to deliver enough firepower against an enemy target to destroy it, while ensuring a reasonable degree of safety for the ship's crew. The ships were in essence floating wood castles that protected the crew from enemy gunfire and at the same time provided a firm and steady platform from which cannons could be discharged. The need for massive and stable structures on a fighting ship meant that the shape of its hull had to be rather bulky, which in turn made it ponderous and slow.

A warship's cannons, named for the weight of the shot they fired, came in a variety of sizes. The largest common cannon was a 32-pounder and weighed about 5,000 pounds; smaller sizes were 24-pounders, 18-pounders and 12-pounders. Because the timbers of a wood warship could not withstand the increased weight and the wrenching recoil of guns larger than a 32-pounder, an increase in firepower could be achieved only by distributing as many 32-pounders and smaller cannons as possible on as many decks as possible throughout the ship—the heavier guns on the lower decks and the lighter ones on the upper decks.

To maximize the total destructive firepower of a large number of guns, they were all aimed at the same target and discharged at about the same time—a technique called a broadside. By the 1850's a ship of the line (a large warship capable of holding a forward position in a major battle) carried a total of 130 guns on three decks and could hurl a broadside weight of as much as 1,800 pounds of shot every minute.

Britons in the first half of the 19th century relaxed with pride and satisfaction behind their armed "wood walls." Potential enemies could build similar ships, but Britain was way ahead in numbers and types of warships and had a large pool of trained

seamen to man them. Britannia ruled the waves not because she possessed a more advanced technology but by virtue of the quantity of her warships and the quality of her "Jack-tars."

Because the balance of sea power was so clearly in Britain's favor, any innovation that threatened the status quo worried the British Admiralty. As a result the Admiralty kept a close watch on naval developments of potential enemies and then made the minimum response to counteract the move. Yet the admirals could not control the advances of British commercial shipbuilders.

The iron-smelting and steam-engine technologies developed during the Industrial Revolution in Britain made it possible to improve on steamship designs such as the ones originally realized by Robert Fulton and Henry Bell. In 1837 Isambard Kingdom Brunel introduced the first reliable transatlantic paddle steamer, *Great Western,* and eight years later he astounded the world with *Great Britain,* which had an iron hull and a screw propeller.

To the British merchant navy the advantages of iron-hulled, propeller-driven ships were clear: they offered increased speed, reliability and durability. In fact, by the mid-19th century such commercial ships were a common sight. Nonetheless, the Admiralty refused to follow the trend set by the merchant navy beyond commissioning a few small experimental vessels of this type.

At the same time France under Napoleon III had already begun to challenge the Royal Navy's control of the seas, and it was more receptive to the military application of the new naval technology. In 1850 France built *Napoléon,* a large three-decked wood warship fitted with an engine and a propeller. The British Admiralty, which had long regarded France as its "natural enemy," was compelled to react. It responded by converting *Sans Pareil* to propeller power. By 1858 each of the two nations had amassed a total of 32 propeller-driven wood ships of the line.

These developments underscored the limitations of traditional wood hulls. The massive three-deckers sagged under the additional weight of an engine and boilers. Indeed, because the hulls were nearly at the breaking point, a "rippling" broadside technique had to be introduced in which the fusillade typically began at the bow and worked its way down the length of the ship to the stern. A captain who thoughtlessly ordered a

RESTORED *WARRIOR* was towed in June of this year to its permanent berth in Portsmouth, England, where it is open to the public. Its restoration required more than seven years and £6 million. The vessel is the only surviving large Victorian warship. Its construction was a major technological leap in the history of warships: the transition from wood hulls to armored, iron hulls.

traditional broadside from an engine-powered wood warship was likely to see his vessel in drydock for six months while cracked and torn beams and frames were replaced. Nonetheless, since Britain still had the lead in total number of warships, the Admiralty saw no need to rethink the situation.

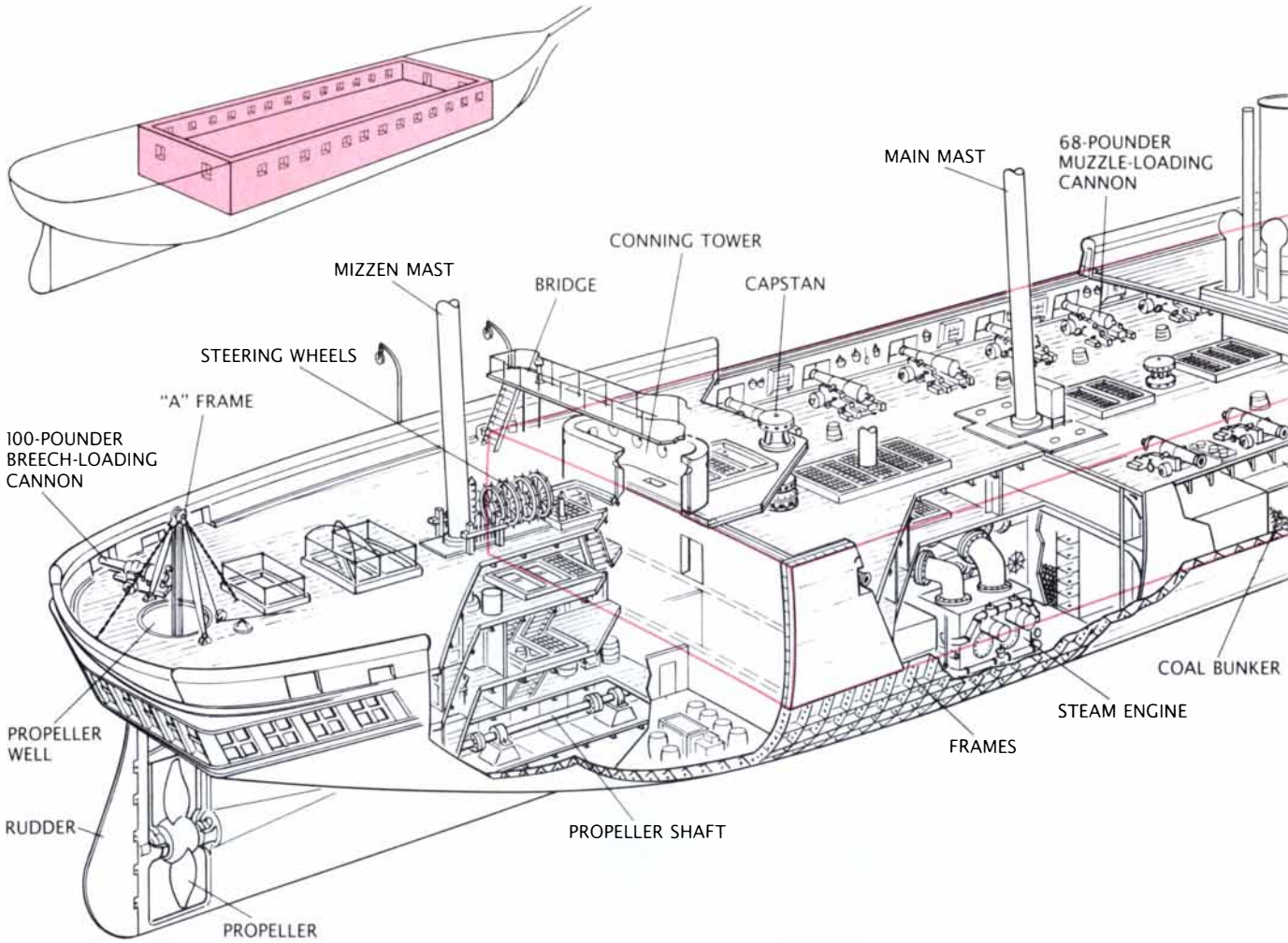
In France, however, the tireless and brilliant ship designer Stanislas Dupey de Lôme had been appointed director of matériel, and he immediately called a halt to the building of wood warships. Dupey de Lôme was aware of the fact that in the Crimean War floating batteries had been armored with iron plates and that the batteries had been able to withstand heavy pounding by shore guns. He recognized that over the years the quality of wrought iron had been greatly improved, a point overlooked by the British Admiralty. His aim was to establish a fleet of iron-hulled, iron-armored and engine-powered warships for the French navy. Yet France's economy was still basically agricultural, and its foundries could not supply enough iron to realize his ambitious plans.

Dupey de Lôme had to settle for a fleet of wood-hulled ships that were merely plated with iron. The first such ship was *Gloire*. The new ship had a wood hull 26 inches thick to which 4½-inch wrought-iron plates were bolted; it was primarily a sailing vessel, but it had been equipped with an engine as well. Such a ship would be capable of pounding an entire unarmored wood fleet to pieces, at the same time remaining impervious to returned gunfire.

Work on *Gloire* was begun in March, 1858, and within a few weeks reports of its construction had reached Britain. The news caused an uproar in Parliament. Public reaction was also swift and alarmist, and war rumors spread quickly. The Surveyor to the Admiralty stated on June 28:

"It is not in the interest of Great Britain...to adopt any important change in the construction of a new class of very costly vessels, until such a course is forced upon her by the adoption of a foreign power of formidable ships of a novel character requiring similar ships to cope with them.... This time has now arrived. France has commenced to build frigates of great speed with their sides protected by thick metal plates and this renders it imperative for this country to do the same without a moment's delay."

It was generally assumed that Brit-



CUTAWAY VIEW of *Warrior* reveals holdovers from the preceding century as well as features that were ahead of their time. The ship was outfitted with a figurehead and an elegant stern gallery for its officers. It was also designed to fire traditional broadsides: the simultaneous discharge of cannons lining a warship's sides. Although it was equipped with a steam engine, it relied on its square-rigged sails (not shown) as the main source of propulsion and on the muscles of its crew to weigh anchor, lift equipment and load provisions. On the other hand, the keel, frames, beams and cladding of the hull were all made of wrought iron and its shape was more like a speedy "clipper" than a standard, ponderous ship of the line (a front-line warship). *Warrior* also

ain would simply respond by building a series of similar ships, but First Sea Lord Sir John Packington argued for a different plan. Backed by Chief Constructor Isaac Watts and by many merchant-ship designers and builders, Packington convinced a reluctant Admiralty and Parliament that Britain should take an unprecedented step: the creation of a completely new warship so advanced and powerful that France would have no option other than to retire from the developing naval contest.

The basic design objective was clear and simple, although daunting to realize. The new ship was to be the largest, fastest, most powerfully armed and most heavily armored warship that had ever been built. In spite of the misgivings of many, preliminary plans were quickly drawn up and tenders were called for on April 29, 1859. Because the Royal Navy had little experience in building ships of iron, the construction would have to be in the hands of a merchant shipyard. (The armament, however, was to remain under Admiralty control.) The building contract was won by the Thames Iron Works of Blackwall and the keel of the ship that would be known as *Warrior* was laid on May 25 of the same year.

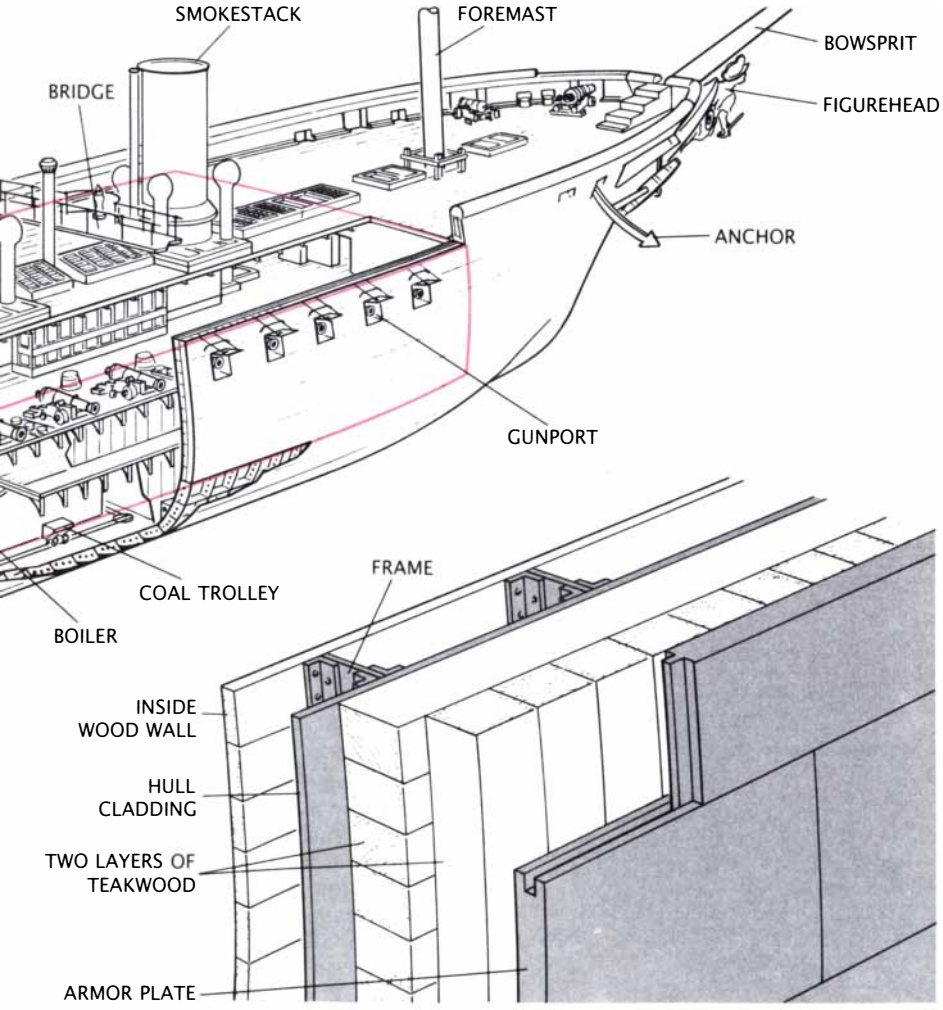
In spite of Packington's forward-looking vision, some aspects of the ship still reflected the practices of the preceding century. *Warrior,* for example, was quaintly outfitted with a huge figurehead and an intricately carved stern gallery. A more important 18th-century holdover was the fact that the ship was designed principally as a stable gun platform, its guns lining the ship's sides in keeping with the old broadside tradition. Moreover, although the ship had a steam engine that powered a propeller, its main form of propulsion was to be the wind. Indeed, its masts and sails were almost identical with the rigging of an 80-gun ship of the line.

The inclusion of two propulsion modes necessitated some special features. In order to provide enough room for the lower square-rigged sails to unfurl, the smokestacks were made collapsible. To lessen the drag caused by the motionless propeller while the ship was under sail alone, the propeller was fixed in a cradle so that it could be disengaged from the propeller shaft and hoisted into the hull [*see top illustration on page 135*]. The propeller had to be lifted by a team of more than 600 crewmen, just as more than 100 men were needed to weigh the ship's anchors (which were the heaviest of the time). The Royal Navy was so convinced of the benefit to be derived from putting its Jack-tars through hardship that it refused to include any steam-operated mechanical aids on the new ship.

On the other hand, many aspects of *Warrior* were clearly ahead of its time. The keel, frames, beams and cladding were all made of wrought iron. Iron bulkheads fitted with watertight doors divided the ship into sealable compartments and also provided additional structural strength. Above the keel a second watertight layer of wrought iron protected the ship against damage from grounding. (*Warrior* was the first Royal Navy warship to have a double bottom.)

The shape of *Warrior*'s hull followed the principles put forward by John Scott Russell in his wave-line theory, which was basically a set of mathematical relations among the length, breadth, depth and cross section of ships with slim, wave-cutting bows and streamlined sterns. The ship was about 425 feet from stern to figurehead and its beam (width) was 58 feet. Its draft (depth below the waterline) was 27 feet and it was designed to displace well over 9,000 tons of water. Today the ship would be regarded as having typical "clipper" lines. With a length-to-breadth ratio (at the waterline) of 6.5, *Warrior* was as speedy as it looked: it could do in excess of 13 knots when powered by sails alone, more than 14 knots when powered by steam alone and an amazing 17.5 knots when powered by both. *Warrior* was capable of overtaking any warship then afloat.

Warrior's armored section, known



had a boxlike armored section (*color, upper left*), known as the citadel, in which most of the ship's heavy cannons were placed. The citadel was sealed off from the rest of the ship by watertight iron bulkheads, so that if the unarmored stern and bow were shattered by enemy gunfire, it could still remain afloat. A more detailed view of the citadel's sides (*lower right*) shows that they consisted of wrought-iron plates 4½ inches thick bolted through 18 inches of teakwood onto the one-inch iron cladding of the hull.

as the citadel, took up the middle 230 feet of the ship and was designed as an integral part of its structure. The citadel was essentially a box whose sides were made up of plates of wrought iron 4½ inches thick. These plates were bolted through 18 inches of teakwood onto the one-inch iron plates of the hull. No shot from any standard gun of 1860 could pierce the armor. Viewed from the side, it was impossible to distinguish the unarmored ends of the ship from the armored citadel section. The ship was designed so that if the unarmored bow and stern sections were shattered by enemy gunfire, the citadel would remain intact and afloat.

The fore and aft walls of the citadel, made of four-inch wrought-iron plates backed by 12 inches of teakwood, represented another first. The gun decks on warships built before *Warrior* did not have armored walls that spanned the entire width of the ship, leaving sailors manning the guns extremely vulnerable to a raking shot (a shot that enters the bow or stern and traverses the full length of the gun deck).

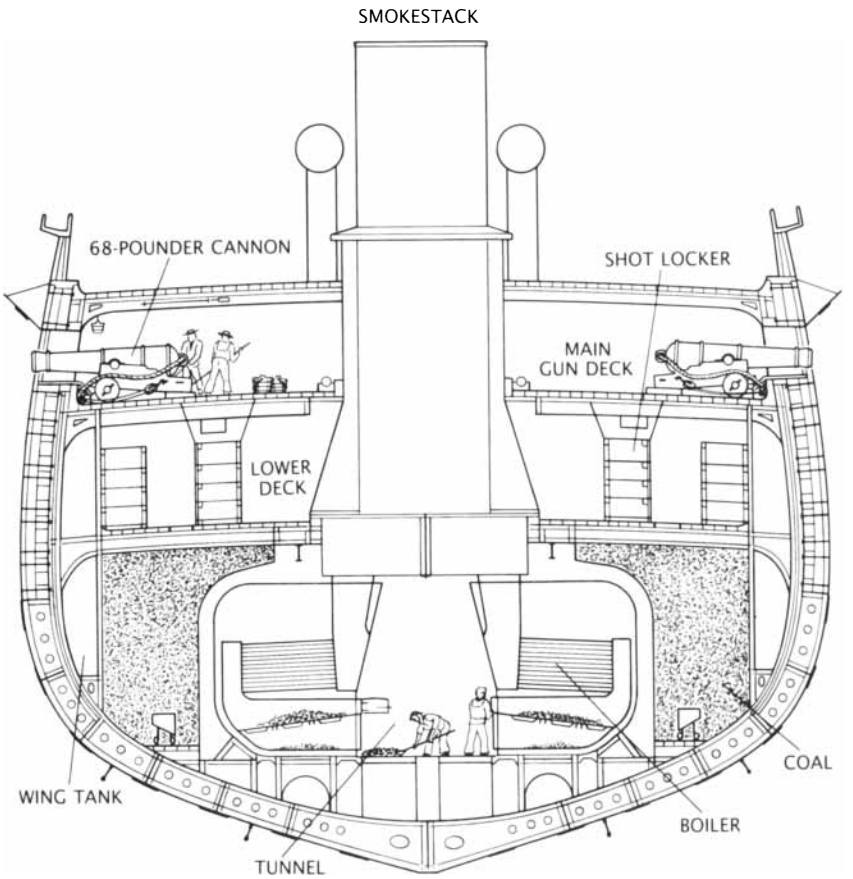
On the top deck a small enclosure made of iron-plated teak—a rudimentary conning tower—also gave officers some protection from small-arms fire (which had killed Nelson) while they oversaw the course of a naval engagement. Small openings in the enclosure allowed them to view the decks and sails, and a large hatch at their feet made it possible to communicate with the helmsmen on the deck below. Although such an arrangement represented a first step toward centralized bridge control, the old-time officers of the Royal Navy objected to it. Perhaps inspired by Nelson's example, they thought it was more appropriate to pace the top deck in full regalia while the battle raged about them.

The engine and the boilers were placed in the belly of the ship, under the armored citadel. The engine, manufactured by John Penn and Sons of Greenwich, had two horizontal cylinders, each with a bore of nine feet four inches, a stroke of four feet and a piston speed of about five miles per hour. Its drive shaft revolved a maximum of 55 times per minute and its nominal horsepower was 1,250. Steam at a maximum pressure of 22 pounds per square inch was fed into the engine from 10 coal-fired boilers, each of which held about 19 tons of water. Some 850 tons of the best Welsh coal filled the ship's bunkers. The iron hull of *Warrior* easily bore the weight of the engine, boilers, coal and drive shaft.

The great load-bearing strength of wrought iron also eliminated the need to spread a large number of small guns throughout the ship. Instead *Warrior* carried fewer but bigger guns, most of them on one deck in the citadel. Its main battery consisted of 26 smooth-bore, muzzle-loading cannons that fired solid balls or shells weighing 68 pounds. One of these 68-pounders, along with its wood undercarriage, weighed more than five tons. The cannon had a theoretical range of three miles, although normal firing range was about 1,000 yards. Ordinary wood warships could carry at most one 68-pounder, and it had to be fired with caution since its weight and recoil could easily strain the hull. *Warrior*'s hull soundly supported all 26 cannons, and they could even be discharged in a simultaneous broadside without undue strain.

Warrior was also outfitted with the latest in gun technology: a complement of breech-loading cannons with rifled bores. The cannon's rifling (a spiral groove cast into the bore) caused projectiles to leave the barrel spinning, thereby endowing them with a stable trajectory. Because the projectile and powder charge was inserted through the breech, or rear section, of the cannon, the cannon did not have to be withdrawn from its port for loading. The cannon was designed by Sir William Armstrong and fired conical shot or shells, each of which weighed 100 or more pounds, over a maximum range of five miles. Ten such weapons were placed on the ship soon after its launching. In addition *Warrior* had four smaller rifled-bore, breech-loading guns, giving it an official armament of 40 guns. Not included in the official rating were two 25-pounders, a 12-pounder and a six-pounder.

Any one of *Warrior*'s larger cannons would have pierced the 24 inch-



CROSS SECTION AMIDSHIPS reveals the layout of *Warrior*'s boilers, coal bunkers and main gun deck in the citadel as well as the structure of its double bottom. *Warrior* was the first Royal Navy vessel to have such protection against damage from grounding.

es of timber armor on a wood warship. From the day *Warrior* took to the seas on December 29, 1860, all other warships of the period were given the nickname "egg shells." It was believed *Warrior* could tackle entire fleets of traditional warships with impunity.

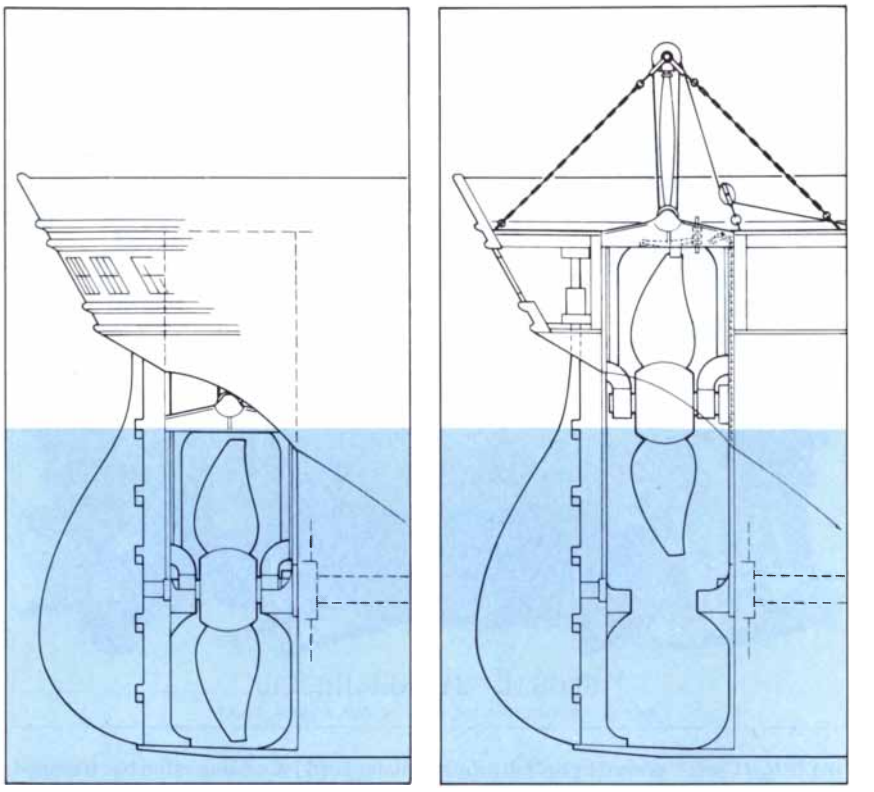
Yet *Warrior* was not immune to criticism at home. Some observers dismissed the ship even before its construction began, because they could not believe an iron warship of more than 9,000 tons' displacement could float. Others attacked the ship simply because they hated its appearance, so different from the colorful high-sided ships to which they were accustomed. *Warrior* was long and thin, was painted a monotonous black and floated low in the water; it soon was dubbed "Black Snake."

The ship's armament also caused some bewilderment. The more informed public was aware that a standard 130-gun ship of the line could hurl a broadside weight of well over 1,600 pounds. Although *Warrior* had the largest guns then available, it hurled a broadside weight of only 1,480 pounds. To satisfy the inquiries of the public, the British government had to explain that a single 68-pound shot had the destructive impact of five 32-pound shots; similarly, a 100-pound shot was equivalent to seven 32-pound shots. By this measure *Warrior* could deliver every minute the equivalent of 3,500 pounds of shot from ordinary guns.

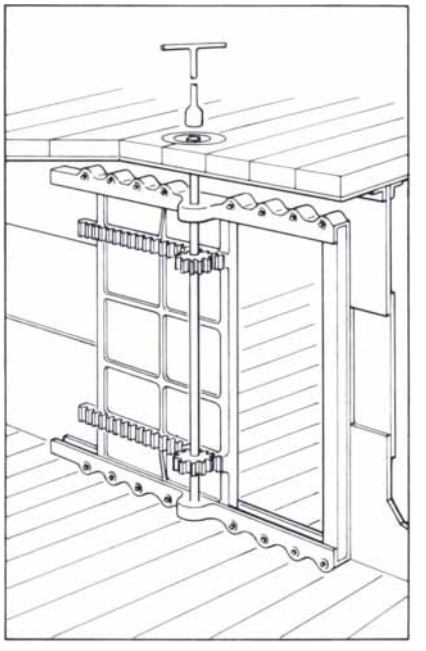
Warrior not only had (in effect) more firepower than two standard wood ships of the line but also cost more than the two ships combined. Whereas the grandest of the wood three-deckers were built for the then staggering sum of £176,000, *Warrior* cost £379,154. In Parliament and in the press there were heated debates over whether such an enormous sum of the taxpayers' money was in fact well spent.

In spite of the criticism, when *Warrior* took up its station in the English Channel, most Britons felt they could breathe a little easier. Napoleon III seemed to have given up ideas of challenging British sea power and turned his attention to conquests in continental Europe. *Warrior* had done the trick: it had deterred a potential enemy.

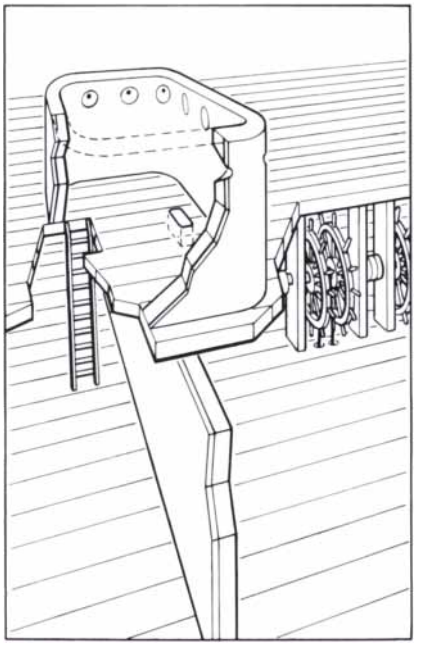
Nonetheless, many within the Admiralty viewed the developing situation with a sense of despair. They recognized that in one fell swoop the Royal Navy's massive wood fleet had



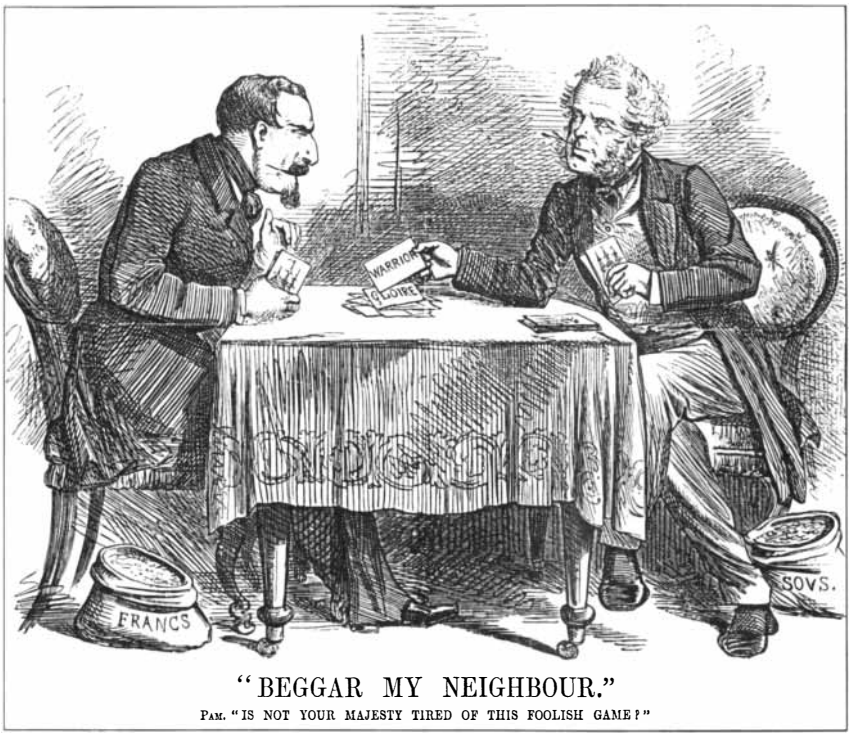
CRADLE (*left*) in which *Warrior*'s propeller spun made it possible to disengage the propeller from its drive shaft and retract it into the hull of the ship (*right*) in order to lessen drag when the ship was under sail. More than 600 crewmen had to haul on the lines of a block-and-tackle system on an A-frame to hoist the device, which weighed 35 tons.



WATERTIGHT DOORS were fitted into *Warrior*'s iron bulkheads. It is not clear whether the doors were part of the original design, but they certainly were added early in the ship's lifetime. Every door could be opened or closed from the overlying deck by means of a T-shaped bar.



ARMORED CONNING TOWER on the top deck afforded *Warrior*'s officers protection from small-arms fire as they oversaw the course of a naval battle through loopholes. A large hatch at their feet allowed them to shout orders to the helmsmen in the citadel on the underlying deck.



"BEGGAR MY NEIGHBOUR."

PAM. "IS NOT YOUR MAJESTY TIRED OF THIS FOOLISH GAME?"

"*WARRIOR* CARD" played by British Prime Minister Lord John Palmerston has trumped the *Gloire* card laid down by Napoleon III of France in a *Punch* cartoon that appeared in 1861. *Gloire* was a wood-hulled warship that had been plated with iron and equipped with steam power. It was regarded as the most capable warship until the launching of *Warrior,* which outdid *Gloire* by far in terms of speed, firepower and armoring. Faced with the prospect of having to engage ships such as *Warrior,* Napoleon chose to avoid entering a naval competition with Britain and turned his attention to the Continent.

been made obsolete. Bolstered by the knowledge that it could be done, other nations would soon build iron-hulled and -armored warships. Moreover, if a nation lacked the wherewithal to build such ships, it could always buy them from Britain, whose commercial shipyards were willing to build them for any nation (except France, of course). If Britain was to maintain control of the oceans, it would have to rebuild the entire Royal Navy in iron.

Warrior single-handedly threw the warship-building industry into turmoil and in so doing paved the way for its own demise. Nations throughout the world revised their military-construction programs to include iron-hulled warships, many of which incorporated improvements on the *Warrior* design. The most obvious improvement was the installation of more powerful guns whose ammunition could pierce *Warrior*'s armor. As a countermeasure the armor of subsequent warships was made thicker, but the countermeasure was implemented in vain: the next generation of warships were simply equipped with even larger guns. The placid and conservative Victorians were troubled by these seesawing advances in guns and armor, which today we would easily recognize as symptomatic of an arms race.

Once the pride of Britain, *Warrior* faded from the public eye after a few years. Within five years the ship that had been visited by most of the crowned heads of Europe was virtually forgotten. *Warrior* was so outdated by 1871 that it was no longer classed as a first-line battleship and was relegated to the reserve fleet.

Its subsequent fate was even more ignominious. The ship was offered for sale as scrap metal at the turn of the century, but there were no takers. In 1904 it became part of the Vernon Torpedo Training School at Portsmouth and was renamed *Vernon III.* After another unsuccessful bid to sell the ship as scrap, in 1924 it was turned into a floating jetty at the Pembroke Dock Oil Fuel Depot in South Wales and renamed *Oil Fuel Hulk C77.* Its masts, engine and most of its internal equipment had by then vanished, and a six-inch layer of concrete was spread over its top deck.

By 1979 *Warrior* was the only surviving British capital warship between Nelson's *Victory* and *Belfast,* which took part in the Korean war, yet only a few naval enthusiasts even knew of its existence. *Warrior*'s deteriorating condition, however, was noted by H.R.H. The Duke of Edinburgh, Prince Philip, and brought to the attention of the Maritime Trust. In September, 1979, the Royal Navy handed over *Oil Fuel Hulk C77* to the trust. The hulk was then towed to Hartlepool, England, where it was to be restored.

Surprisingly, its wrought-iron hull had enabled it to remain afloat for more than a century without letting a drop of seawater inside! Nevertheless, it soon became clear that the task of restoration would be larger than any previous such project. The *Warrior* Preservation Fund was set up to raise the necessary money, and a restoration team was organized among the local shipyard workers. By 1984 more than 150 people were working on the project.

On June 12 of this year the restored ship left Hartlepool and headed for a permanent home in Portsmouth, where it was opened to the public on July 27. The conservation of the hull and interior and the re-creation of the 19th-century equipment and fittings took more than seven years and an estimated £6 million.

With the masts and rigging once more towering 180 feet above its top deck the reincarnated *Warrior* is again a proud ship. Its lower decks are crowded with huge cannons and ancillary equipment. Mess tables and benches for the crew of 700 are in position along with all the wood cooperage used for eating and drinking. The officers' cabins are resplendent with gold leaf, and scores of brass items reflect the light from the replica candlesticks and lamps. Rifles, pistols, cutlasses and bayonets stand once again in rack after rack. Steering wheels operate the ropes connected to the rudder as they did 127 years ago. The upper-deck capstan, which was used to hoist the anchor, can still accommodate the 120 sailors needed for the job. Replicas of the engine and the boilers have also been installed deep in the bowels of the ship.

Although *Warrior* had revolutionized warship building, for nearly 100 years it survived by sheer good fortune. Now restored and protected, *Warrior* is as much a testament to the technological feats of Victorian Britain as it is a reminder of the vagaries of military technology in any age.

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