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The INA Quarterly

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On the cover: The raised Confederate submarine *H. L. Hunley* at Mt. Pleasant, South Carolina, after killing its builder and captain of the same name on the bottom of Charleston Harbor in October, 1863. A few months later, *Hunley* became the first submarine to sink an enemy warship in battle. Painting by Conrad Wise Chapman, circa 1863. The recent excavation has shown that some details are incorrect. Courtesy of the Museum of the Confederacy.

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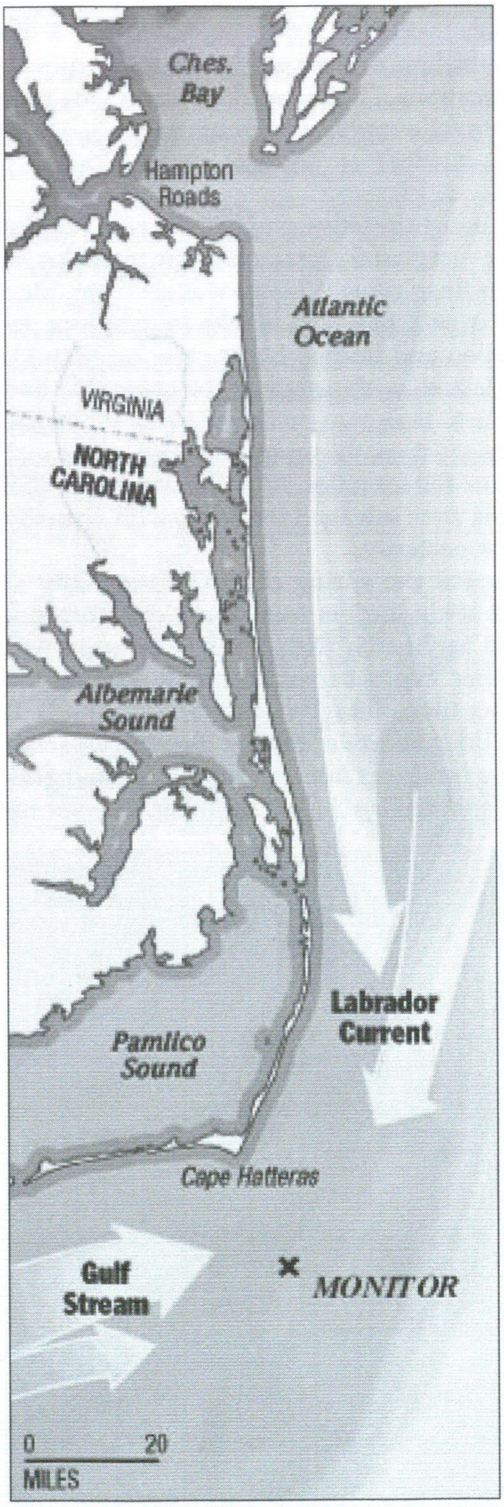
Editor: Christine A. Powell

Management, Archaeology, and Engineering: Preserving the USS *Monitor*

John Broadwater



Arms versus Armor: Dawning of the New Iron Age at Sea

It was on March 9, 1862, early in the American Civil War, when the ironclad warships USS *Monitor* and CSS *Virginia* engaged in an epic battle at Hampton Roads, Virginia (fig.1). When the confrontation ended, both ships were essentially undamaged, even though they had bombarded each other at point-blank range for nearly four hours. Although equally matched, the two vessels were quite different in appearance. Nevertheless, they shared several innovative traits: both were clad in wrought iron armor, both employed partially-submerged hulls to limit their exposure to enemy fire, both were powered exclusively by low-profile steam engines driving screw propellers, and both were designed to fight effectively with relatively few cannon. The "Battle of the Ironclads" at Hampton Roads marked the first encounter between vessels of this new type. Although the battle was brief, had no clear victor, and was fought in America, the impact was felt by all the standing navies of the world. The result was the rapid abandonment of conventional wooden, sail-powered ships-of-the-line and an escalation of naval weaponry and armor.

Monitor was designed and built by the brilliant but controversial Swedish-American inventor John Ericsson. The U. S. Navy awarded Ericsson a contract primarily because he guaranteed the remarkably rapid delivery of an ironclad capable of countering the threat of the Southern ironclad *Virginia* (ex-USS *Merrimack*), already under construction at the Gosport Navy Yard, Portsmouth, Virginia. Employing a radical design and innovative construction methods, Ericsson delivered *Monitor* from draft to functioning vessel in less than four months. *Monitor* was commissioned at the Brooklyn (New York) Navy Yard on February 25, 1862, barely a week after the commissioning of *Virginia*.

Monitor was strikingly different from any other vessel afloat (fig. 2). A radical departure from conventional high-sided wooden warships, *Monitor's* hull was almost completely submerged, presenting enemy ships a target with only a thirty-three-centimeter freeboard. *Monitor* had no superstructure except for her armored gun turret amidships and a small raised pilothouse forward. Instead of a conventional battery of cannon lined along a gun deck, *Monitor's* armament consisted only of two eleven-inch (twenty-eight centimeter) Dahlgren smooth-bore cannon, mounted side-by-side in the revolving turret (fig. 3).

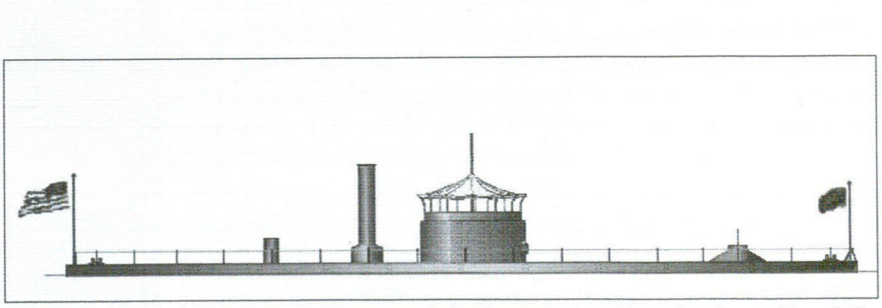


Fig. 2. *Profile view of* Monitor *as it might have appeared at the time of its sinking.* Images courtesy *Monitor* Collection, NOAA

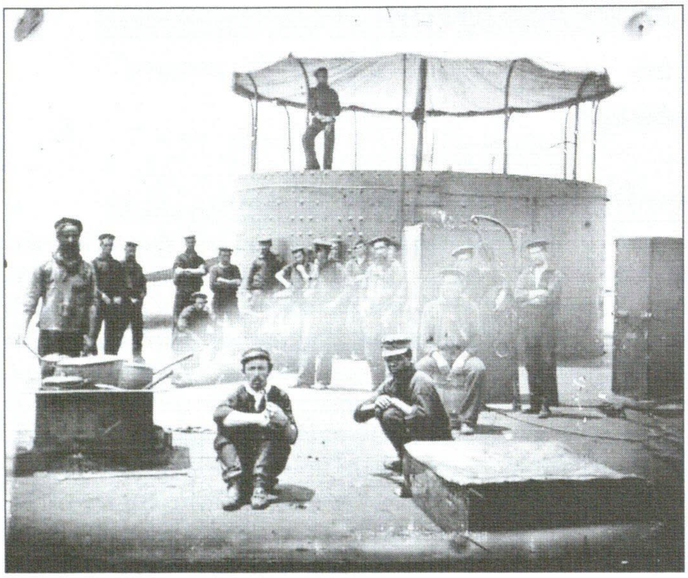


Fig. 3. *Part of USS* Monitor's *crew on July 9, 1862, near Harrison's Landing in the James River. Photo by James Gibson, courtesy of The Mariners' Museum.*

Monitor's keel was laid on October 25, 1861, and the completed vessel was launched on January 30, 1862. After very hurried and abbreviated sea trials, it arrived in Hampton Roads on the evening of March 8, 1862. Incredibly, earlier that very day CSS *Virginia* had also made its maiden voyage into Hampton Roads. *Virginia* immediately attacked and wreaked havoc on the Union fleet, sinking two warships and running a third aground. The battle was halted—and the remaining Union ships saved—by a receding tide that confined the deep-draft *Virginia* to a narrow channel.

Arrival of *Monitor* brought new Union hope to a battle that was certain to resume the next day. That hope, however, was not universally shared. Skeptics—both from North and South—doubted the prowess of this strange little "cheesebox on a raft." Early on March 9, *Virginia* steamed back into Hampton Roads, prepared to finish off the wooden warships. *Monitor* advanced to engage her iron counterpart, thus commencing one of the most celebrated naval battles in history. *Monitor's* design demonstrated several advantages: Her low profile was an almost impossible target for Confederate fire. The revolving turret allowed *Monitor* to fire from almost any angle without having to maneuver the ship into position. Her armor was clearly a match for *Virginia's* guns. The four-hour fight ended in a draw with neither ship being able to significantly damage the other.

The repercussions of this battle were felt worldwide. Although there were other ironclad warships in existence, they were untried in battle against similar foes. The Battle of Hampton Roads dramatically demonstrated the power and significance of ironclad vessels, and this drama was played up by the world press. Of course, the United States government was pleased to promote this enthusiasm, as was the U.S. Navy. The "clash of armor" at Hampton Roads helped bring about the rapid abandonment of conventional wooden broadside warships. In the United States, *Monitor* gave her name to an entirely new classification of low-freeboard, turreted vessels. By the end of the American Civil War, sixty monitors of various classes had been completed or were under construction. Even though these monitors had all the characteristics of the first, each successive class incorporated design modifications. Therefore USS *Monitor*, the prototype for those to follow, was wholly unique.

Legacies Lost

Although both ironclads seemed impervious to shot and shell, neither survived the year. As Union troops overran the Hampton Roads area, *Virginia* was soon stranded without a friendly port in which to take refuge. As a result, it was scuttled and burned by its crew on May 11, 1862, at Craney Island, within sight of the arena that had made it famous less than two months earlier. When the fire reached the magazines, the vessel exploded with a roar that was heard and felt for miles. After the war's end, CSS *Virginia's* remains were salvaged for scrap, with virtually nothing saved for posterity.

Monitor spent the spring of 1862 sitting idly at Hampton Roads under orders from President Abraham Lincoln to avoid a rematch with *Virginia* (Lincoln was afraid that *Monitor* might be sunk, thus thwarting the planned attack on the Southern capitol at Richmond). It participated in a brief, abortive attack in the upper reaches of the James River and was later sent to the Washington Navy Yard for repairs. Finally, in December, *Monitor* re-

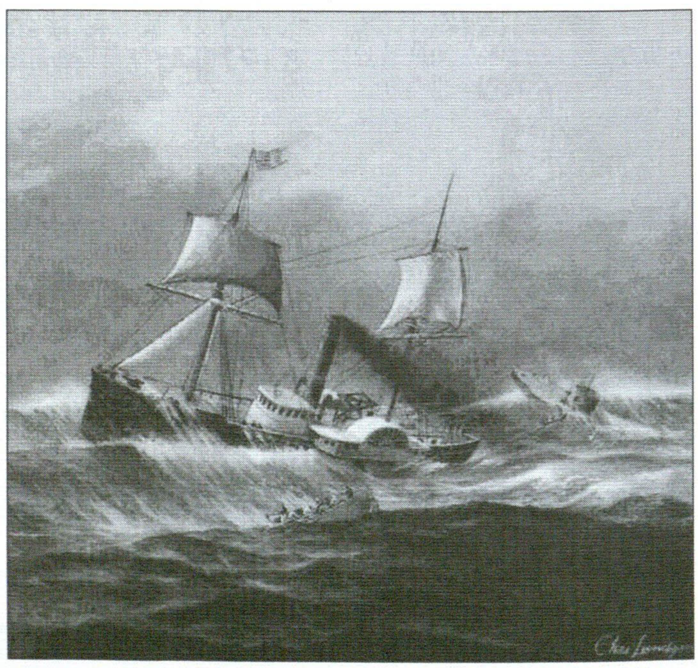


Fig. 4. *USS* Rhode Island *and USS* Monitor *on New Years Eve 1862. Courtesy the United States Postal Service.*

ceived orders to join the Union blockade of Charleston, South Carolina. However, while being towed south on New Year's Eve, *Monitor* sank in a severe storm off Cape Hatteras, North Carolina (fig. 4 and 5).

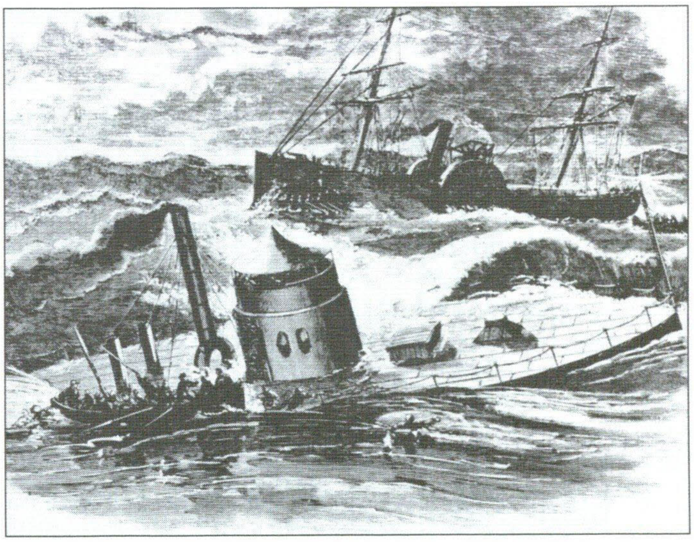


Fig. 5. *The sinking of* Monitor, *originally published in* Harpers Weekly *January 1863. Courtesy* Monitor *Collection, NOAA.*

Location, Protection, Research, and Management

USS *Monitor* lay relatively undisturbed, its exact location unknown, until 1973 when it was discovered approximately sixteen nautical miles (25.8 km) SSE of Cape Hatteras Lighthouse by a scientific team aboard Duke University's R/V *Eastward* (fig. 1). The discovery created tremendous excitement, since *Monitor* had long been hailed as one of the most famous and significant warships in the history of the United States Navy—indeed, in terms of naval technology, one of the most important ships in the world. While *Monitor*'s discovery generated widespread interest and excitement, there was also serious concern.

The first problem faced by researchers and historic preservation managers was how to protect this important historic vessel. Since its location was outside the territorial waters of the United States, and since the U.S. Navy had officially abandoned *Monitor* in 1953, no simple means of protection was apparent. However, it was soon recognized that recent federal legislation—the Marine Protection, Research, and Sanctuary Act of 1972—could be applied to a significant shipwreck such as this. Therefore, on January 30, 1975, the Secretary of Commerce designated *Monitor* America's first National Marine Sanctuary. Since then, it has been protected and managed by the National Marine Sanctuary Program, National Ocean Service, National Oceanic and Atmospheric Administration (NOAA), an agency of the U.S. Department of Commerce. *Monitor* is now listed on the National Register of Historic Places and has been designated a National Historic Landmark.

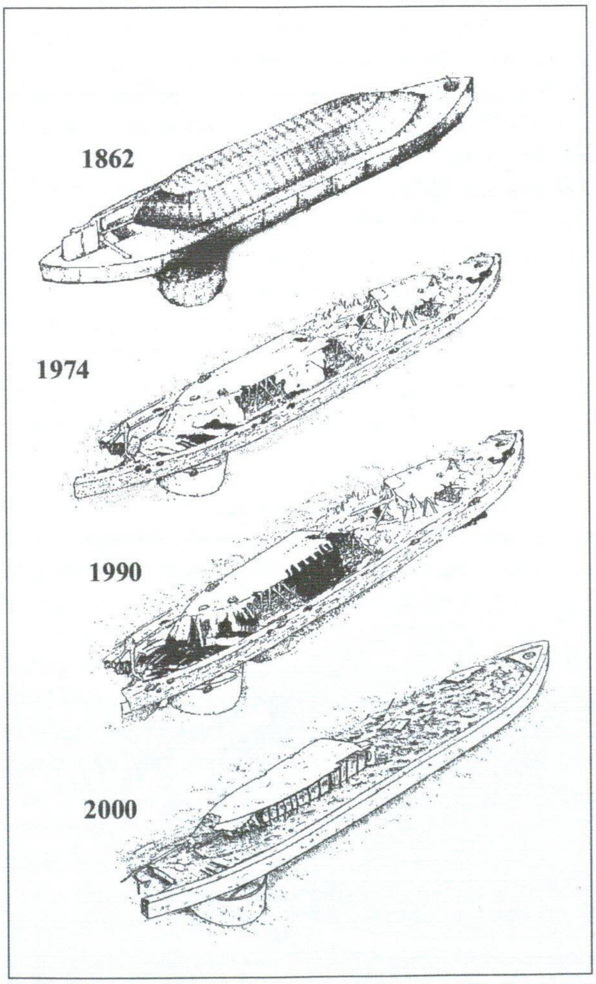
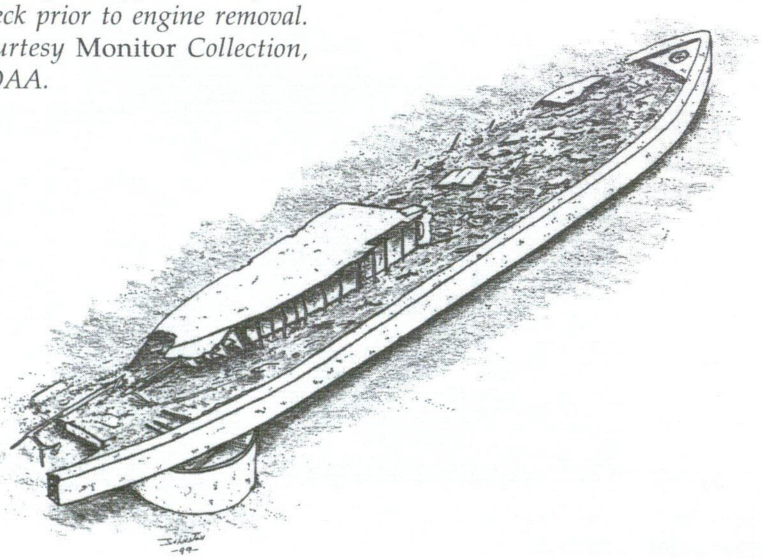


Fig. 6. *The progressive deterioration of USS* Monitor. *Courtesy of* Monitor *Collection, NOAA.*

Monitor's inaccessibility is a major factor influencing both management and research. The remains lie on a flat, featureless, sandy seabed at a depth of nearly seventy-three meters. The wreck reached its current state of deterioration as a result of three factors: damage that occurred at the time of sinking, deterioration caused by more than a century of exposure within a dynamic seawater environment, and damage resulting from human activities (fig. 6). *Monitor* sank near the confluence of two major ocean currents, the cold southerly-flowing Labrador Current and the warm Gulf Stream, which follows the coast northward but begins to turn to the east when it reaches the coastal projection known as Cape Hatteras. These currents compete for dominance in the vicinity of *Monitor*, creating confusing and often violent currents that place tremendous stresses on the wreck and have carried away parts of the hull and its contents.

The water depth at the *Monitor* Sanctuary places the site out of reach of most scuba divers, and deep divers have been very cooperative in helping NOAA protect *Monitor*. However, trawlers sometimes drag their nets through the site and at least one anchoring incident damaged the wreck. Also, some researchers have postulated that *Monitor* was inadvertently depth-charged during World

Fig. 7. *Archaeological drawing showing the appearance of the wreck prior to engine removal. Courtesy* Monitor *Collection, NOAA.*



port quarter held above the bottom by the displaced turret (fig. 7). The lower hull, which is now the highest part of the wreck, has collapsed forward of the midships bulkhead, and the stern armor belt and its associated structure has deteriorated severely. In addition, the elevated port quarter creates a list to starboard that produces severe stresses within the hull.

NOAA conducted the first diving expedition to *Monitor* in 1977, when commercial divers from the Harbor Branch Oceanographic Institution explored the site from the *Johnson-Sea-Link I* submersible, recovering a signal lantern and a sample of hull plate for analysis. In 1979, NOAA conducted a major archaeological expedition, headed by Gordon Watts, North Carolina State Underwater Archaeologist and co-discoverer of the wreck (Dr. Watts is also an INA Adjunct Professor). This month-long expedition permitted three archaeologists to conduct mapping and recovery activities at the site, watched

War II, resulting in further injury to the lower hull.

Since 1975, NOAA has gathered a considerable amount of data at the Sanctuary. The unique characteristics and location of the site have made it the object of studies by a wide range of specialists, including archaeologists, geologists, oceanographers, biologists, corrosion and structural engineers, and marine salvors. From archaeological and engineering studies, we know that *Monitor* rolled over as it sank, causing the turret to pull free and sink to the bottom, upside down. The hull then settled to the seabed, still inverted, where it landed on the turret. The inverted hull now rests partially buried in sediment with the stern

over by professional divers from Harbor Branch (fig. 8). Even today, this remains one of the deepest excavations conducted in person by trained archaeologists. Additional expeditions were conducted in 1983, 1985, and 1987, the latter being the most extensive. NOAA contracted with J. Barto Arnold (now with INA) for the 1987 expedition, which examined corrosion rates and the state of preservation of the wreck. In his report, Arnold warned that if no action was taken to preserve *Monitor*, it could be rendered unrecognizable in as little as five to ten years. With this information in hand, NOAA realized that additional site data was needed in order to make effective long-range management decisions.

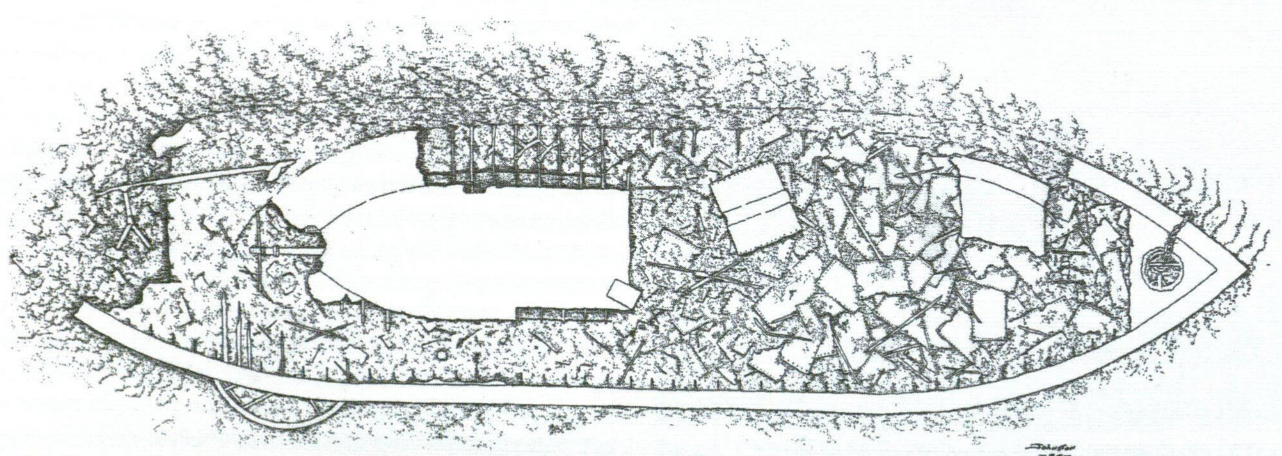


Fig. 8. *The* Monitor *wrecksite as it existed in 1998, incorporating data from over twenty years of surveys. Courtesy* Monitor *Collection, NOAA.*

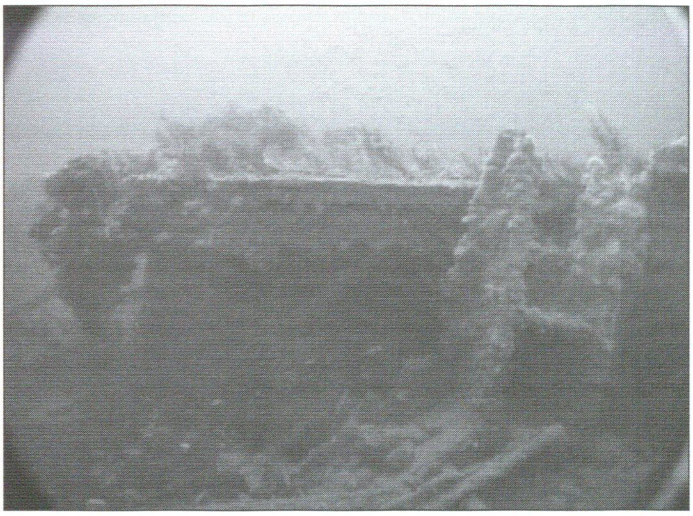


Fig. 9. *The midships bulkhead, looking aft. The turret support truss can be seen at the right of the image. Courtesy* Monitor *Collection, NOAA.*

NOAA began revising the sanctuary management plan and preparing for additional site investigations.

NOAA conducted brief site surveys in 1990, 1991, and 1992. In 1993, it conducted the *Monitor* Archaeological Research and Structural Survey (MARSS) Expedition. The goals of this major project were to map and videotape *Monitor*'s hull, deploy a permanent mooring, recover exposed, threatened artifacts, and conduct test excavations and mapping of *Monitor*'s turret in order to assess the feasibility of recovery. Despite adverse weather conditions, the permanent mooring was installed and limited test excavations were carried out both inside and outside the turret.

Two years later, NOAA developed the 1995 *Monitor* Archaeological Research, Recovery, and Stabilization Mission (MARRS'95). This time the primary goal was to help stabilize *Monitor*'s deteriorating hull by moving its displaced skeg and recovering its propeller and shaft. For this major undertaking, the agency enlisted the assistance of several other organizations, including the U.S. Navy, The Mariners' Museum, the National Undersea Research Center at the University of North Carolina at Wilmington (NURC/UNCW), and Key West Diver, Inc. Although Hurricane Felix and two lesser storms interrupted the expedition, both NOAA and the Navy conducted successful dives on *Monitor* (fig. 9). The civilian team conducted a series of self-contained, mixed-gas dives—the first such dives ever approved by NOAA. The NOAA and NURC divers were trained and supervised by Key West Diver personnel, who were pioneers in deep, mixed-gas "technical" diving (see page 13).

Navy dives were staged from USS *Edenton* (ATS-1) in an effort to recover *Monitor*'s propeller. Navy divers employed their standard "hard hat" dive gear, the Mk 21 mixed-gas, surface-supplied system. Adverse weather conditions prevented recovery of the propeller despite several attempts, but the experience was very useful in planning future expeditions. This project also resulted in intensive discussions between NOAA and the other participants concerning the need to develop a detailed, long-range management plan for the site before conducting additional fieldwork.

During 1996 and 1997, NOAA conducted two mapping surveys utilizing laser line scanning devices. Although adverse sea conditions hampered both surveys, additional site "baseline" images were obtained. In 1997, Oceaneering International offered to assist the agency by conducting a no-cost "trade study" to determine the best method for stabilizing and/or recovering portions of *Monitor*'s hull and contents. In order to support the study, NOAA compiled the scientific, engineering and archaeological reports that had been generated over the years, and made them available to Oceaneering. They prepared an archaeological plan and The Mariners' Museum in Newport News, Virginia, NOAA's principal museum for *Monitor*, prepared a conservation plan.

In April 1998, the agency submitted to Congress the resulting report, "Charting a New Course for *Monitor*: A Long-Range, Comprehensive Plan for the Management, Stabilization, Preservation, and Recovery of Artifacts and Materials from *Monitor*." The plan reviewed a matrix of stabilization and recovery options and concluded that complete recovery of the wreck was not feasible, due to the advanced state of deterioration of the hull. The plan therefore recommended that the government pursue a plan of hull stabilization along with selective recovery of the most significant components, including the propeller, engine and, especially, the famous revolving gun turret and guns. The plan included sections on archaeological recovery, major component recovery, conservation, curation and exhibition.

By 1998, NOAA also had received substantial commitments of support for implementing the plan. The U.S. Navy's Naval Sea Systems Command approved a request to allow Mobile Diving and Salvage Unit Two (MDSU TWO), stationed in Little Creek, Virginia, to recover the propeller as part of their training program. The Mariners' Museum offered to assume responsibility for conservation and eventual exhibit of all recovered material. NOAA also obtained Navy permission to conduct its own diving operations from *Kelly Chouest*, the Navy-leased vessel to be used by MDSU TWO as their dive platform. The civilian team comprised personnel from the National Marine Sanctuary Program, NURC/UNCW, and a private, non-profit research organization, the Cambrian Foundation. The 1998 expedition was very successful, resulting in the recovery of *Monitor*'s cast iron propeller and a segment of the driveshaft.

During 1999 and 2000, NOAA and the Navy conducted additional dives on *Monitor*. In 2000 the Navy, operating from a large derrick barge, succeeded in placing a ninety-ton engine recovery structure (ERS) across *Monitor*'s

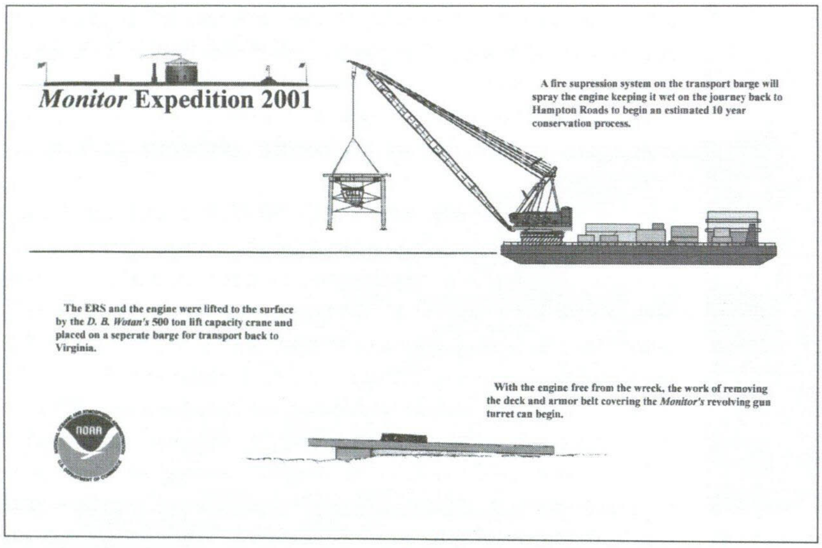


Fig. 10. *The procedure used to lift* Monitor's *engine during the 2001 excavation season. Courtesy of NOAA.*

hull (fig. 10). This device was designed to serve as an overhead support to which *Monitor*'s engine could be rigged for recovery. The ERS was similar in concept to the lifting frame designed for raising the Civil War submarine *H.L. Hunley*. In fact, both systems were designed and built by Oceaneering International, the Navy's salvage contractor.

The year 2001 was a busy one for the recovery team, with five separate expeditions conducted at the *Monitor* Sanctuary. In late March 2001, NOAA conducted a preliminary survey of the site, recording data requested by the engineering team. In April and May, divers aboard the Navy salvage ship USS *Grapple* (ARS-53) installed hydraulic lifting equipment on the ERS. Then, during a six-week expedition in June and July, the Navy successfully raised *Monitor*'s engine and an attached segment of the lower hull (fig. 11.). The engine, while secured in the ERS, was placed on a smaller barge and transported to Newport News Shipbuilding, where it was secured in a steel cradle before being transported up the James River to The Mariners' Museum where it is undergoing conservation treatment.

NOAA conducted a second diving expedition that overlapped the Navy's effort. The NOAA team arrived shortly after the engine had been removed, so they were able to map the removal area and recover artifacts that were exposed after the lift. In October, NOAA conducted an additional video survey utilizing the *Johnson-Sea-Link I* submersible.

During 2002, NOAA and the Navy plan to recover *Monitor*'s famous gun turret and guns, along with the other contents of the turret that are now obscured by silt. The engine weighed approximately thirty-five tons, while the turret is estimated to weigh at least 130 tons, empty. Since the condition of the turret is unknown, the plan must be flexible enough to permit the recovery team to make adjustments on site, if necessary.

The Future

Following recovery of *Monitor*'s turret and guns, onsite activity at the Sanctuary will be significantly reduced. NOAA divers will conduct much of the work, but the Navy may continue to assist if the proposed expeditions are seen to offer sufficient training value. The *Monitor* Sanctuary once again will be opened to private researchers and explorers, who have been unable to access the site in recent years due to the increased level of NOAA and Navy activity. Most of NOAA's effort will be redirected to the ongoing conservation and analysis being conducted at The Mariners' Museum. In addition, NOAA and the Museum are working together on a new and exciting project: the design and construction by the Museum of a "USS *Monitor* Center" that will house and interpret the objects raised from the site. NOAA hopes that the *Monitor* recovery project can serve as a model for future deepwater archaeology projects involving Navy vessels or aircraft.

Acknowledgments: The *Monitor* National Marine Sanctuary is managed and funded through the National Marine Sanctuaries Program, National Ocean Service, National Oceanic and Atmospheric Administration (NOAA), an agency of the United States Department of Commerce. The Navy's partnership in the *Monitor* program was developed with the enthusiastic cooperation of Captain Christopher Murray, Supervisor of Diving, Naval Sea Systems Command, U.S. Navy. The Navy's 2000 and 2001 expeditions were made possible by grants from the Department of Defense Legacy Resource Management Program. The Mariners' Museum, Newport News, Virginia, has become an essential partner, assuming responsibility for conservation, curation, and exhibition of the material being recovered from *Monitor*. There are many other military units, government agencies, academic programs, and private organizations and individuals who have contributed to the success of the *Monitor* recovery efforts. Although space does not permit mentioning them all, they will be included in the final report on the *Monitor* recovery program.

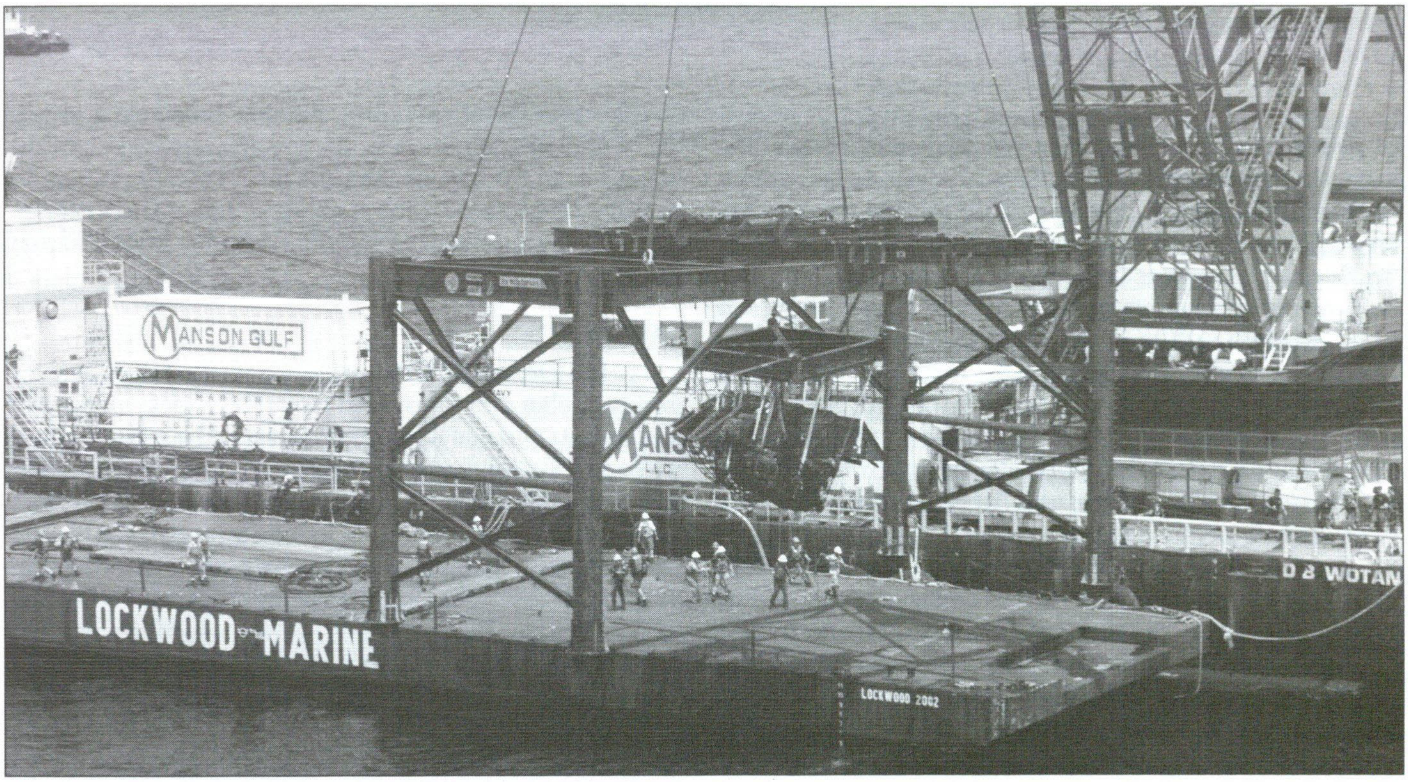


Fig. 11. *Navy divers working with NOAA archaeologists, on the Manson Gulf Derrick Barge WOTAN, recovered the steam engine of USS* Monitor *from the waters of the* Monitor *National Marine Sanctuary, sixteen miles off the coast of Cape Hatteras, NC. The engine's recovery marks a major milestone for the* Monitor *2001 Expeditions and NOAA's long-range plan to recover and preserve the historic Civil War vessel. Official U.S. Navy photo by Photographer's Mate Petty Officer First Class David C. Lloyd, CLF Det. Combat Camera Atlantic (Released) CDR Phil McGuinn, U.S. Navy* Monitor *Project Public Affairs.*

Suggested Readings

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Preserving *Monitor*'s Most Significant Components

Jeff Johnston

USS *Monitor* was a product of the inventive genius of Swedish engineer John Ericsson. From the laying of the keel to launching ninety-eight days later, nearly everything concerning *Monitor* was unique. The ship was constructed primarily of flat iron plate made to Ericsson's rigid specifications. These plates (and other components of the vessel) were fabricated at various facilities within a hundred-mile radius of the Continental Iron Works at Greenpoint, New York, where the ship was being constructed. As the various components arrived, they fit together with little or no alteration. During construction, the inventor and his design suffered considerable ridicule from skeptics and the Northern press. It was not until *Monitor's* perceived victory at Hampton Roads that the true value of the monitor design was finally accepted. The impact that John Ericsson and USS *Monitor* had on the maritime world is certainly worth attention and continuing study.

The hurried construction of John Ericsson's *Monitor* left little time for complete documentation of components and design. Approximately two hundred plan drawings associated with the construction of USS *Monitor* survive. NOAA research at the *Monitor* sanctuary has revealed many differences between the plans and the wreck, and encountered many interesting components for which there are little or no detailed historical information (fig. 1). Such discrepancies may be due to a combination of factors. As-designed and as-built drawings do not always match, due to last-minute changes or alterations that are not documented. In addition, Ericsson's name can be found on plans that depict components of later class monitors (or other vessels), that have been inadvertently attributed to the original *Monitor*. Few researchers are aware that over sixty monitor-type vessels were designed and built by the engineer and his partners. Another reason for the lack of information is that many of the components used in *Monitor's* construction (such as valves, gauges, linkages, and piping) were fairly common to nineteenth-century shipbuilders and were readily available for use. They did not require detailed discussion at the time. It is, therefore, fortunate that we can document the as-built *Monitor* from its actual remains.

Propeller

In 1998, the *Monitor*'s nine-foot (2.7 m) diameter cast iron propeller was recovered from the wreck, along with eleven feet (3.4 m) of wrought-iron shaft. The propeller itself is a one-of-a-kind design. Later class monitors used a similar screw, modified to meet changing hull designs. John Ericsson is often credited as father of the screw propeller. Although he did not invent the concept, he was one of the leading contributors to perfecting its effectiveness as a method of ship propulsion. There are several still-existing examples of screws built using the inventor's patents, but the propeller from USS *Monitor* is possibly the only surviving example whose construction was supervised by Ericsson himself.

Engine

Monitor's "semi-cylinder" engine was not one of the unique features of the vessel (fig. 2). Ericsson had been constructing this style of steam machinery since the 1840s. It was the perfect design for a warship of any kind and extremely vital to the success of *Monitor*.

Ericsson first introduced this style of machinery when he constructed USS *Princeton*, the first United States warship to have its machinery entirely below the water line. The design that became known as the "vibrating side lever engine" used a horizontal cylinder containing two pistons connected to the propeller shaft by a series of connecting shafts, links, and rods. The unique feature of this style of machinery was that it permitted the entire steam engine to be placed deep

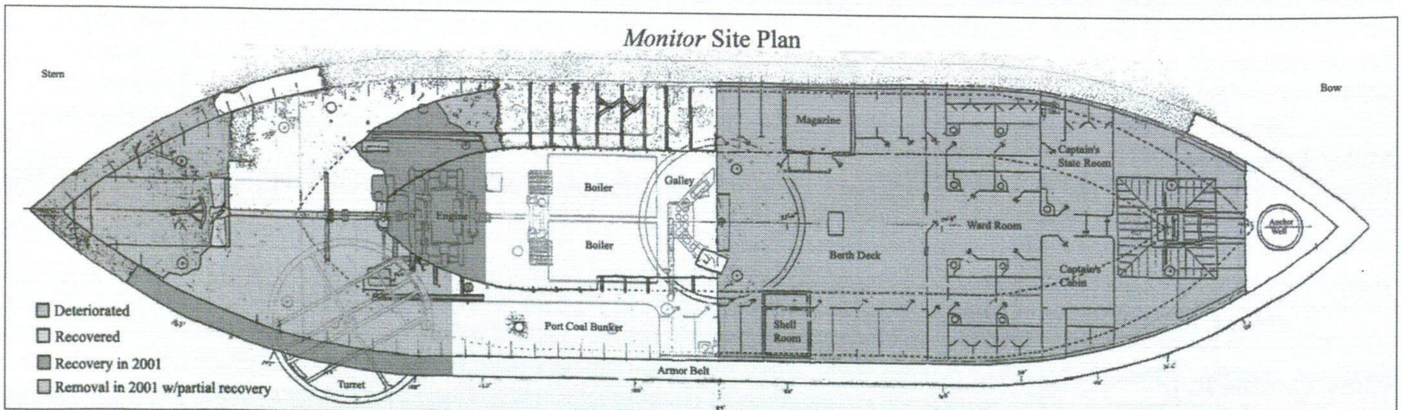


Fig. 1. Monitor *site plan. Courtesy* Monitor *Collection, NOAA*

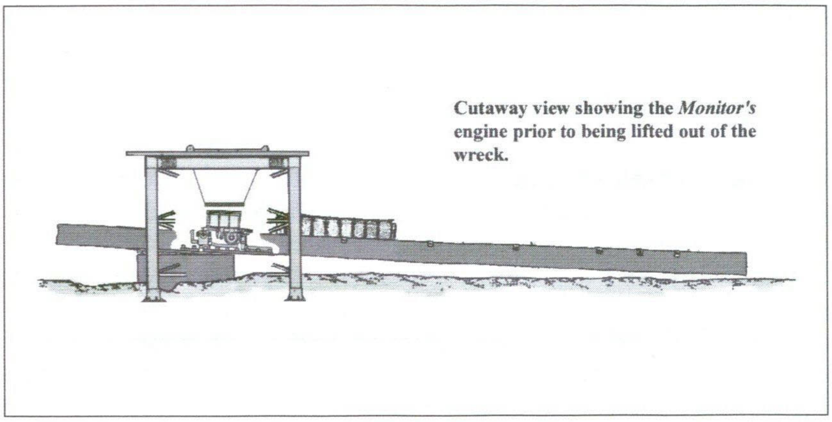


Fig. 2. *Cutaway view showing* Monitor's *engine prior to being lifted out of the wreck. Courtesy* Monitor *Collection, NOAA*

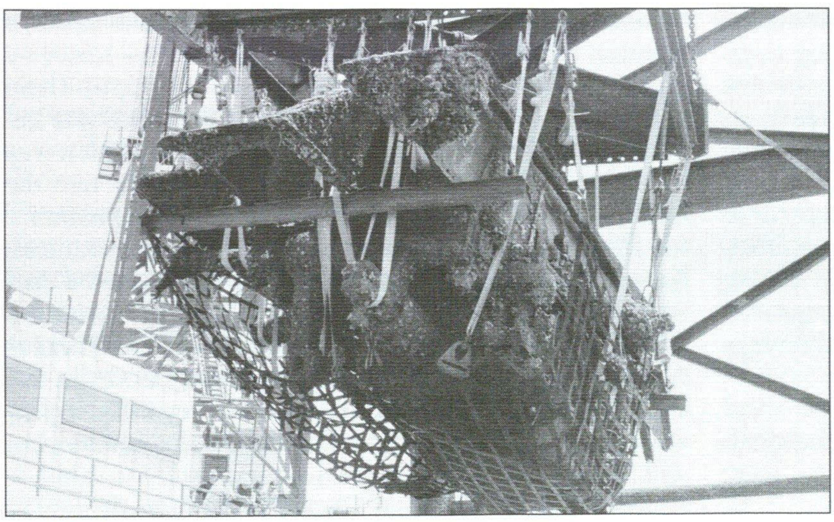


Fig. 3. Monitor's *steam engine just after the lift. Courtesy Tom Bailey, Phoenix International.*

Fig. 4. *Mosaic image compiled from digital video showing* Monitor's *revolving gun turret under the armor belt. Courtesy* Monitor *Collection, NOAA.*

inside the vessel, thus freeing up valuable space on deck for additional cannon or other equipment.The machinery also provided essential protection in battle, as it was located below the water line.

On July 16, 2001, after three years of planning and site preparation, *Monitor*'s engine was back on the surface for the first time in 139 years. The utmost care was employed to preserve all surviving aspects of *Monitor's* steam machinery. Collateral damage was kept to a minimum (fig. 3). The engine is currently undergoing a lengthy conservation process at The Mariners' Museum in Newport News, Virginia. As encrustations are removed and the engine's features become more discernable, every detail of its construction will be documented.

Turret

Following the successful recovery of *Monitor's* steam engine, attention shifted to recovery of the turret and cannons. These have tremendous historic and archaeological significance. Ericsson's revolving gun turret was *Monitor*'s most original feature, one that can be seen on virtually every modern warship. For the first time, a warship could train its guns in virtually any direction without having to alter the ship's heading. Also, the gun crews were protected against enemy shot and shell.

Monitor's gun turret was constructed entirely of iron. It stood nine feet (2.7 m) high and was almost twenty-two feet (6.7 m) in diameter. Today, the turret sits upside down on the bottom and is filled almost to the top with silt and sediment (fig. 4). Test excavations in the accessible areas verified that at least one cannon is still inside, resting in the diagonal bracings that comprised part of the turret's framework. The weight estimates for the turret, based on engineering studies that include the cannons, carriages, components, silt, and sediment, comes to approximately 238 metric tonnes. Although the preferred scenario would be to recover the turret with the contents intact, engineering studies indicate that this would likely result in the destruction of some of the key components of the turret and the loss of valuable cultural material that it contains.

Monitor was armed with two eleven-inch (27.9 cm) Dahlgren smooth-bore cannon. Ericsson wanted to shorten these guns for installation in the turret. However, the Navy Department was adamant that they remain unaltered. This presented a problem for the inventor. He had to design a carriage that could safely control the recoil of a 13.5 foot (4.1 m) long cannon barrel inside the twenty-foot (6.1 m) interior diameter of the turret. Ericsson successfully did this by designing a "friction carriage" that used a compression braking system to safely control the recoil of the cannon. Fairly complete plan information exists for these gun carriages, since Ericsson applied for patents based on their design. The problem for safe recovery is that they were made of a composite of iron, wood and brass and the condition of the carriages is mostly unknown. Although Ericsson continued to use this style of carriage with later classes of monitors in the same and in modified forms, in all likelihood *Monitor* holds the only surviving examples.

The eleven-inch Dahlgrens taken from USS *Dakota* were placed in *Monitor* at the Brooklyn Navy Yard shortly after it arrived in February 1862. They are cast iron guns weighing approximately 16,000 pounds (7273 kg) each. Eight months after the fight with CSS *Virginia, Monitor* was sent to the Washington Navy Yard for repairs. While there, the cannon were engraved in tribute to the man who commanded the ship during the battle (Lt. Commander John L. Worden) and to the man who invented the vessel. Since the exact wording of the engravings is unknown, it is important to ensure that the guns are not damaged during recovery. Examples of other Civil War cannon engraved at the Washington Navy Yard show that the engravings are not very deep.

A recent study of existing American siege guns and large naval ordnance show that only twenty-four eleven-inch Dahlgrens still exist. Half of these smooth-bores were converted to rifled guns in the late 1860's and early 1870s by inserting steel sleeves into the barrels. The *Monitor's* Dahlgrens are not included in this inventory, so they would make a significant addition to the list.

Another potential problem for turret recovery is the unknown condition of the turret roof. Although there is sufficient information from historic plans and documents to provide an accurate idea of how it was assembled, its current condition is unknown. The roof was never intended to be subject to cannon fire and therefore was lightly armored. Ericsson designed the turret roof so that a work party could remove it by without the vessel having to be in a repair yard. This would allow the cast-iron guns to be easily replaced in the event of excessive wear from firing or damage associated with stress. His accounts indicate that the turret roof was only lightly bolted in place.

Another unknown aspect of the turret is the hardware attached to the upper rim. Surviving historic accounts mention that the crew modified the top of the turret by installing a rifle shield made from boiler plate (fig. 5). There is enough information to confirm that the work was begun, but no surviving plans or drawings verify that it was present at the time of sinking. It is also known that the crew fitted the top of the turret with a temporary helm for the *Monitor's* ocean journey southward. These features, combined with the iron stanchions that supported a canvas awning, may have been crushed when the turret impacted with the bottom. The presence of these components would be an important factor for recovery. However, test excavations and a sub-bottom profiler survey failed to provide the desired information. Therefore, the recovery plan will have to be designed with these unknowns in mind.

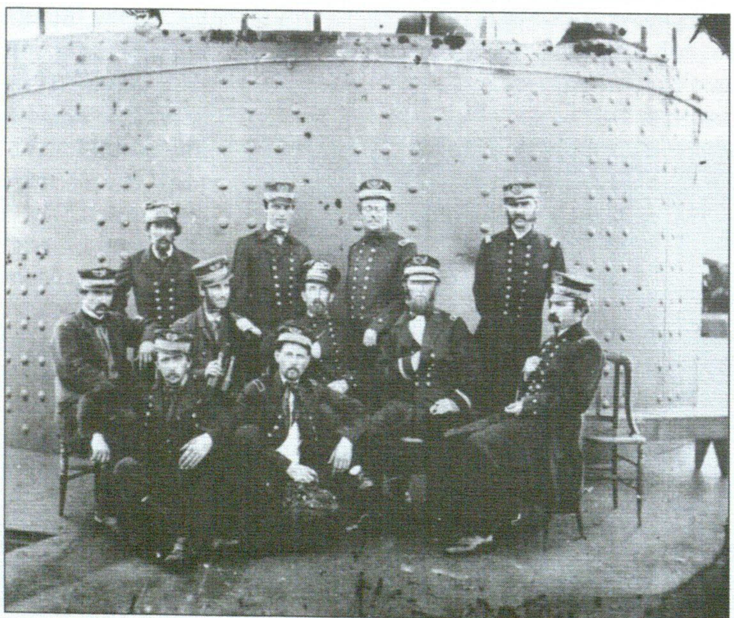


Fig. 5. Monitor's *ward room officers pose for James Gibson's camera on July 9, 1862. Courtesy Library of Congress.*

Technical Diving on the *Monitor*

Tane Casserley

Scientists have been studying *Monitor* in a myriad of ways since its discovery off Cape Hatteras in 1973. Initial research began with remote sensing and eventually progressed to a more hands-on approach. In 1977, the first scientific dives were conducted. On that expedition, commercial divers from the Harbor Branch Oceanographic Institution entered the water at the site from a lock chamber on the submersible *Johnson-Sea-Link I*. In 1979, a team of archaeologists conducted investigations at the site using the same craft. This method of diving was the best technology at the time but it had its limitations. The divers were restricted in their movement around the site because they were connected to the submersible by an umbilical that provided their gas supply and communications. They were also forced to undergo a lengthy chamber decompression for less than an hour's time underwater.

Today we use a method called "technical" scuba diving, using a mixture of helium, oxygen, and nitrogen. The team is made up of between six and twelve bottom divers and three additional divers acting in a support role. It includes professional archaeologists, scientific divers, and volunteers. Under the supervision of the National Undersea Research Center at the University of North Carolina at Wilmington, up to twelve researchers can be launched on a single dive.

The team enters the water as a group and usually descend a buoyed down-line anchored just off the site. However, when a strong current is running, the divers would find it almost impossible to descend the traditional down-line. The powerful Gulf Stream current so prevalent off the North Carolina coast can make it extremely difficult to hold onto a fixed line, so another system was developed to put less stress on the divers. The boat captain and dive safety officer check the current direction and velocity and agree on using the alternative diver deployment method. The boat captain motors directly upcurrent from *Monitor*, giving the command to dive when he is far enough up-current that the divers will drop to the seabed very close to the wreck. Since visibility at the Sanctuary is normally in excess of ten meters, and because the boat captain has worked with the *Monitor* dive team since 1995, this system is almost always successful.

The divers normally spend thirty minutes working at 240 feet. Then they collect in a group and choose between two options for their seventy-minute decompression ascent, depending on conditions. The preferred method is to use the anchored line when it is used for their descent. This line is connected to another buoyed to the surface and held by a quick-release clip. The lead diver detaches the line by disconnecting the clip and the team drifts with the current for the remainder of their decompression. The second option is used in case of high current. After moving away from the wreck and any overhead obstructions on the surface, the lead diver attaches a lift bag to a line reel and inflates the bag, sending it to the surface. This bag indicates to the waiting *Cape Fear* that the team has left the bottom. Under either ascent option, another lift bag is attached to the line and inflated. The second lift bag signals that the bottom team is together and everyone is accounted for. Since the divers have no voice communications with the surface vessel, the two lift bags are crucial to indicate that everything is going according to plan.

Regardless of the method chosen, the bottom team has a freely drifting ascent line. Not every diver can hold onto the line because it would be impossible to keep everyone at the same depth. Therefore, the divers monitor their own depth and decompression times, but also hover around the lead diver, whom they can use as a reference point.

On the surface, a safety diver is ready in case of an emergency. Once the two lift bags are seen on the surface, however, the safety diver stands down and two support divers are launched from the dive boat. The first acts as deep support and will descend approximately one hundred feet to the dive team undergoing decompression. Through hand signals the leader communicates the bottom team's decompression schedule to the deep support diver, who then ascends to twenty feet to the waiting shallow support diver and passes on the information. The deep support diver returns to the bottom team for the remainder of their decompression while the shallow support diver ascends to the surface to relay the decompression information to the boat. Using this system the bottom team can stay in constant communication with the surface without endangering any of the divers. As an extra precaution, the two support divers also carry extra nitrox (nitrogen/oxygen mixed gas) and oxygen tanks in case one of the bottom team has a decompression gas shortage or equipment malfunction.

Monitor is the deepest site in North America to be surveyed by professional archaeologists using scuba, and one of the most intensely studied shipwrecks in history. The method of diving described above has been used reliably on *Monitor* for the past six years without a single incident, proving that deepwater archaeology and scuba diving can be partnered successfully.

H. L. Hunley:

The World's First Successful Submarine Warship

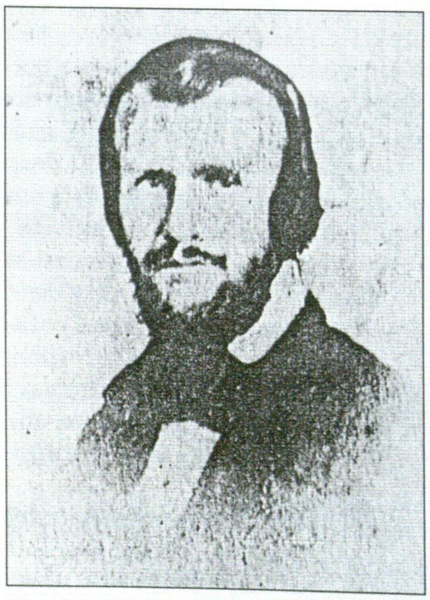
Christine Powell

Very early in the American Civil War, Confederate strategists knew that they could not beat the North at its own game. The overwhelming superiority of the Union in population, capital resources, and industrial capacity would inevitably win any contest based on quantity alone. The South would have to rely on quality if it was to have any chance of holding on until either a war-weary North agreed to an armistice or a cotton-starved Europe intervened. On land, better marksmen, better riders, and better generals partially compensated for constant inferiority in numbers and materiel. At sea, the last best hope of the Confederacy was technology. The Union responded to the challenge in a competition reminiscent of the "space race" a century later.

The INA-excavated blockade runner *Denbigh* illustrates the contest between runners and blockaders, while CSS *Virginia* (ex-*Merrimack*) and USS *Monitor* show how the intense competition provoked a revolution in the design of major surface warships. Perhaps even more significant in the long run were the developments that led to the Confederate submarine *H. L. Hunley*. There were several "collateral branches" in *Hunley's* family tree. The Confederate ram *Manassas* was an ironclad semi-submersible that took part in the unsuccessful defense of New Orleans in April 1862. *David* (as in Goliath's nemesis) was a cigar-shaped steam torpedoboat, the first of eight or nine similar craft that contributed to the defense of Charleston. The torpedo was an explosive charge carried on a spar at the bow. Ballast tanks allowed lowering the boat in the water until only the stack and pilot were visible. *David* seriously damaged the most powerful warship in the U.S. Navy, *New Ironsides*, in October of 1863.

A direct ancestor of *Hunley* was *Pioneer*, a submarine with a crew of three that successfully destroyed a barge in a test run in Lake Ponchartrain, before being scuttled to avoid capture. Two members of the *Pioneer* design team, Baxter Watson, Jr., and James McClintock, fled to Mobile, Alabama, where they were joined by Captain Horace L. Hunley, who provided financial backing. The three built a new, larger, and more streamlined submarine, which was lost while under tow to Fort Morgan to pick up its first crew. The team took the opportunity to design a slightly larger and improved craft. This third submarine, built in 1863 at the Parks & Lyons machine shops, eventually took the name of its principal backer, H. L. Hunley (fig. 1).

The "fish boat" was built of riveted iron plates and measured forty feet long and 42.8 inches in height and 3.5 feet wide. The hull form was decades ahead of its time. Most submarines until after World War II were more accurately called "submersibles." They were designed to be operated on the surface most of the time, so they needed to be good sea boats. *Hunley* was built to attack submerged,



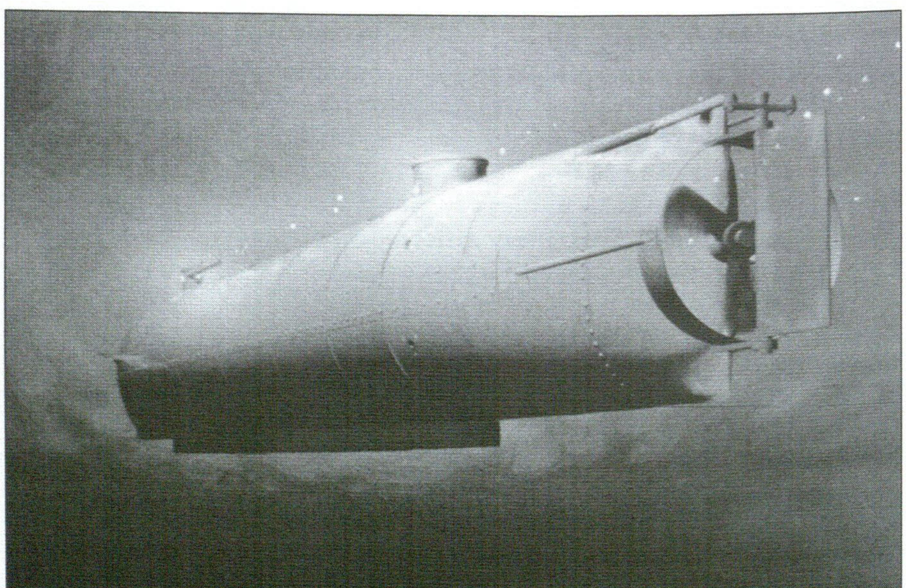


Fig. 1 (left). *H. L. Hunley, principal backer and commander of the submarine. He gave his fortune, name, and life to the world's first successful wartime submersible. Courtesy of the Naval Historical Center.*
Fig. 2 (right). *The submarine was untied from its moorings and let out into the moonlit waters. As it sliced through the water on February, 17, 1864, the haunting glow of phosphorus trailed behind. Computer generated graphic by Dan Dowdy.*

and it barely emerged from the water even when it was fully surfaced. Since it relied on human power for propulsion, there was no need for exhaust stacks or large air intakes. Consequently, *Hunley* could be designed with a smooth shape to minimize drag when submerged. The resemblance to the lines of a modern nuclear submarine is obvious. Legend claimed that *Hunley* was built from a converted boiler, but the truth is much more interesting. Rather than overlapping plates, the hull was formed from plates butted against one another and fastened to a backing with countersunk rivets. This provided a very smooth exterior.

Ballast tanks in the bow and stern could be filled with water by opening seacocks and emptied with hand pumps. In operation, the tanks were flooded until the submarine was just beneath the surface at almost neutral buoyancy (fig. 2). The depth was then controlled with horizontal diving planes. The commander had a mercury depth gauge and a compass at his station beneath the forward hatch. He could control the steering lever that was linked to the rudder located at the extreme stern behind the shrouded propeller. The commander could see through windows in the small conning tower beneath the hatch. The rear hatch had a similar tower, for use by the second-in-command who operated the rear valves and pump, as well as taking the back seat at the drive crank. Six other men sat on the portside rowing bench, with nothing to do except wind the crank and hope they could make it to the hatches in time if disaster occurred. The small conning tower windows, five pairs of glass deadlights, and a single candle, which often guttered out due to lack of oxygen, provided the only light.

Originally, the submarine was designed to attack with a towed torpedo. *Hunley* would dive under an enemy ship and pull the explosive beneath the hull. There was considerable potential for fouling the line, however, even though the submarine's prop was protected by a shroud. On one occasion when *David* was giving *Hunley* a tow, it got caught in the line and nearly blew up both boats. As a consequence, the armament was changed to a spar torpedo with a 135-pound charge.

Because the blockade squadron at Charleston was anchored closer inshore than the force at Mobile, General P. G. T. Beauregard had Hunley's submarine sent by flatcar to South Carolina. Two weeks after it arrived, on August 30, 1863, the boat killed its first crewmen. The wake from a passing steamer swamped it, and five men drowned. Understandably, the Confederate Navy decided to turn the operation of the quickly-raised submarine back to its builders. Hunley himself led a volunteer crew until October 15, when the boat failed to return from a dive. Apparently the captain had failed to close the forward seacock, so the submarine's bow went down and stuck in the bottom mud. Water pressure held the hatches shut, preventing escape. Long before the vessel was raised a week later, the second crew had suffocated. His submarine design was to make H. L. Hunley immortal, but his dream had killed him.

There was no shortage of volunteers for the third crew, even though the submarine was now widely known as the "Paripatetic Coffin." The new commander was Lieutenant George E. Dixon, a mechanical engineer who had helped build the boat (fig. 3). For several months, the crew practiced in the back inlet of Sullivan's Island, north of the main entrance to Charleston Harbor, several afternoons each week. They then departed through Breach Inlet after dark, trying to reach a Union ship before exhaustion or approaching dawn drove them back. The threat presented by the Confederate torpedoboats and submarines had led the U.S. Navy to take defensive measures; the night anchorages were generally about twelve miles out. *H. L. Hunley* (as the submarine was now known) could travel at no more than four knots under ideal conditions, so it rarely got close to a target. Rough winter seas and low temperatures took a great toll on the men at the cranks.

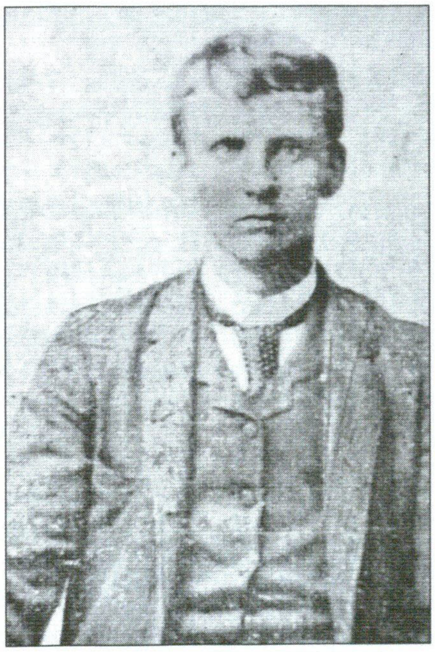


Fig. 3. *One-time company commander John Cothran described the final commander of the* H. L. Hunley: *"Dixon was very handsome, fair, nearly six feet tall and of most attractive presence. I never knew a better man; and there never was a braver man in any service of any army." Photo courtesy of Queenie Bennett's great-granddaughter, who wishes to remain anonymous.*

However, the defensive moves were not an unmixed gain for the Federal forces. *Hunley's* crew developed considerable proficiency, demonstrating this with dives of up to two hours and thirty-five minutes before surfacing. In addition, the loosening of the blockade could allow more runners to enter the port, which was critical for the survival of the Confederacy. The Union forces needed to take the chance of moving further in, particularly on the safer moonlit nights.

The moon was shining on February 17, 1864, when the U.S. Navy sloop-of-war *Housatonic* anchored only about three-and-a-half miles from the Charleston bar off the Isle of Palms (fig. 4). *Housatonic* had been one of the most effective of the Union blockaders, and there was a reward for its destruction. Around 8:45 that night, a Federal lookout spotted what at first appeared to be a floating log making for the starboard quarter. *Housatonic* slipped its anchor and backed its engines in an attempt to run down the unknown intruder. The sloop's guns could not be depressed sufficiently to fire on the object, which continued to approach the stern. An explosion just behind the mizzenmast threw water and debris high in the air and wrecked the after half of the warship, which quickly settled to the bottom thirty feet below the surface. Five sailors died, while the rest scrambled up the rigging.

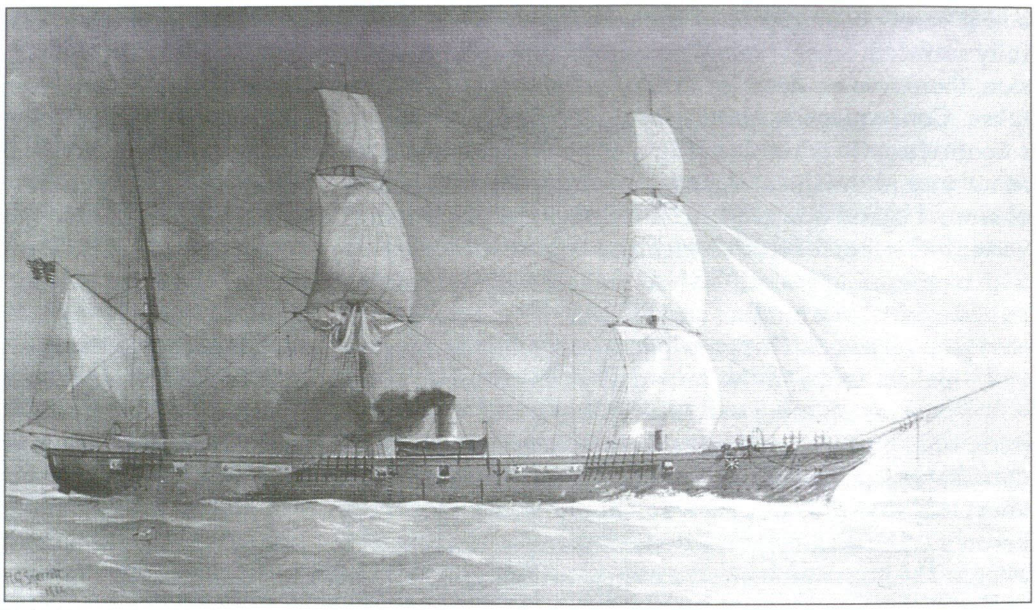


Fig. 4. *The sloop-of-war USS* Housatonic *was such an effective Union blockader that there was a reward for its destruction. Drawing by R. G. Skerrett, 1902. Photo provided by the Naval Historical Center.*

Observers on shore and aloft in *Housatonic* claimed to have seen a blue lantern after the attack, *Hunley's* agreed signal. This was disputed by others, who claimed that there were only the lights of Union boats looking for survivors. In any case, there was no further sign of the submarine. The Confederates at Battery Marshall on Sullivan's Island south of Breach Inlet left their beacon lights on until word came from Union prisoners of *Hunley's* successful attack on *Housatonic*. It was then presumed that the vessels had perished simultaneously, or nearly so.

After the war, government divers worked to clear the wrecks from Charleston Harbor and its approaches. One diver claimed to have found *Hunley* and looked inside to see the skeletons of the crew sitting at their positions, but this was never confirmed and widely dismissed. The wreck of *Housatonic* was lowered to the mudline as an obstruction to navigation in 1907. Many authorities thought it possible that *Hunley* had collided with *Housatonic* or been drawn inside by the rush of water, and had been mistaken for a boiler by the salvagers. Others thought the submarine could have been washed to sea before settling to the bottom. A few believed what now seems to be the case, that *Hunley* sank while waiting for favorable tides to return to Breach Islet and was buried in the shifting sand (fig. 5). After World War II highlighted the importance of submarine warfare, another search was made using magnetometers, but nothing was found. The consensus was expressed in 1987 by P. C. Coker III in *Charleston's Maritime Heritage 1670–1865*, "By now she is probably mere fragments of rust beyond possibility of salvage." Fortunately, this was not the case. The blue lantern has reappeared.

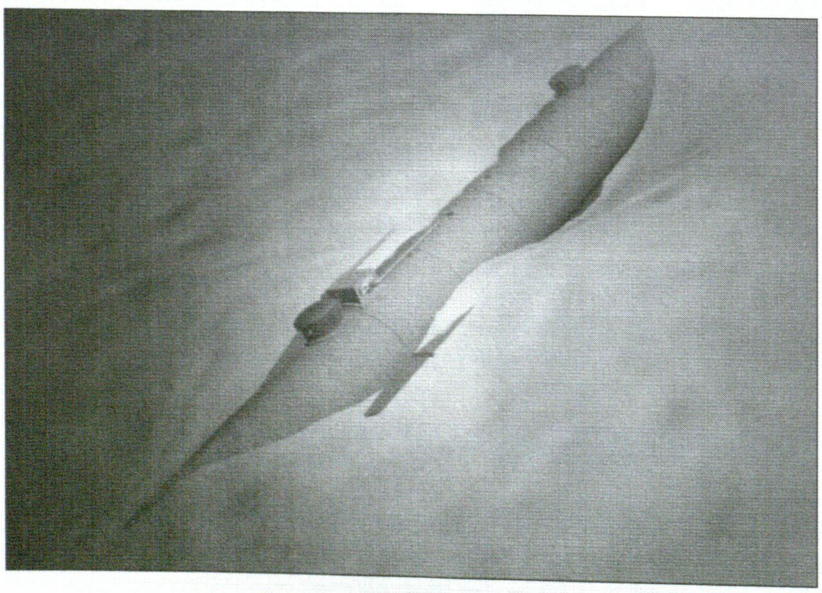


Fig. 5. Hunley *on the bottom near Charleston. Computer generated graphic by Dan Dowdy.*

An Interview with Dr. Robert Neyland

Dr. Robert Neyland (fig. 1) is a graduate of the Nautical Archaeology Program at Texas A&M University (M.A., 1990; Ph.D., 1994). For the past several years, he has been in the national spotlight as he conducted the excavation, recovery, preservation, and examination of the Confederate submersible H. L. Hunley. *In 1864,* Hunley *became the world's first submarine to sink an enemy warship when it attacked USS* Housatonic, *which was blockading Charleston (see pages 14–16). This feat was not equaled until World War I, a half-century later. The submarine signaled its success to the Confederate observers with a blue lantern, but that was the last that was heard of boat or crew for over 130 years. Dr. Neyland took time from his busy schedule to bring the readers of the* INA Quarterly *up to date on this historic project.*

Photo: B. Volgaris

Fig. 1. *Dr. Robert Neyland.*

Quarterly: **How did you become interested in the *Hunley* project?**

Neyland: I first became involved with *Hunley* in 1995 when Wes Hall contacted me at the U. S. Navy's Naval Historical Center (NHC). He, Ralph Wilbanks, and Harry Pecorelli had just discovered *Hunley* three-and-a-half to four miles offshore near Charleston (fig. 2). They were doing this under NUMA, working for Clive Cussler. Wes notified me because I was the Navy's Underwater Archaeologist at NHC and he assumed that the Navy would take the lead role in managing the submarine. I continued to be involved with negotiations over ownership between the federal government and the State of South Carolina.

An archaeological survey conducted in 1996 by the National Park Service-Submerged Cultural Resources Unit, South Carolina Institute of Archaeology and Anthropology, and NHC-Underwater Archaeology Branch confirmed that the wreck found by NUMA was indeed *Hunley*. The submarine appeared to be intact and in good shape. INA personnel involved in this survey included Rich Wills, who was with NHC at that time, Chris Amer with SCIAA, and Peter Hitchcock of the Nautical Program.

In the spring of 1998, while my wife and I were visiting Charleston, I had a lunch meeting with several concerned persons, including Admiral Bill Schachte USN (Ret) and Senator Glenn McConnell from the South Carolina *Hunley* Commission, Chairman Warren Lasch of the Friends of the *Hunley*, and representatives of the Charleston Museum. Admiral Schachte and Mr. Lasch pulled me aside and asked if I would be interested in running the project. I considered this offer for some time and finally agreed, provided the Navy would lend me to the State of South Carolina. I started work in the fall of 1998, developing plans for recovery and searching for a team of archaeologists and conservators.

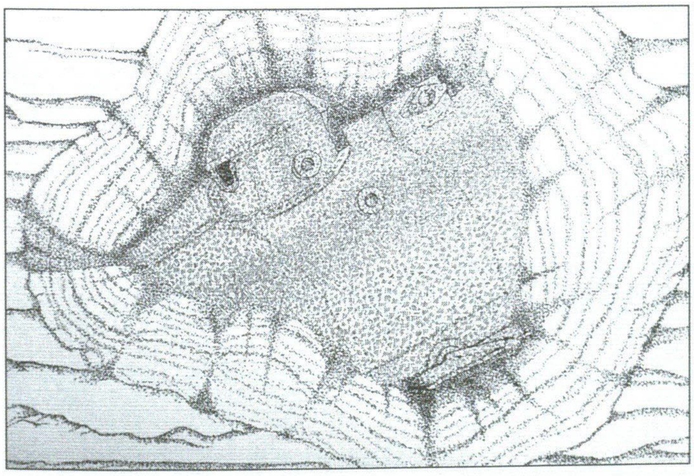


Fig. 2. Hunley *as first discovered in 1995, partially uncovered on the sea floor. Drawing by Wes Hall, property of Ralph Wilbanks.*

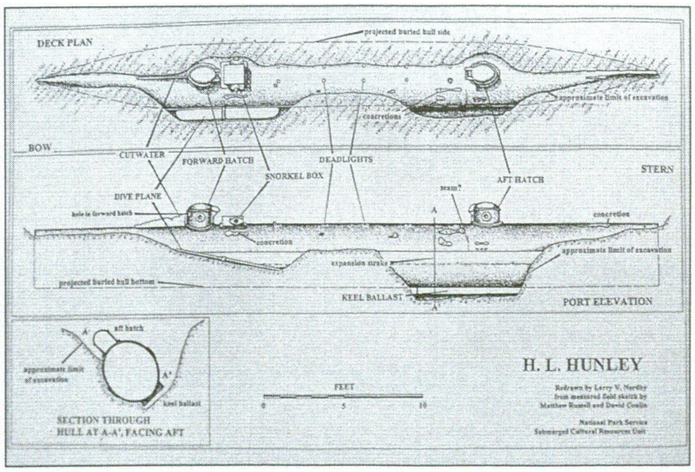


Fig. 3. *Redrawn by Larry V. Nordby from measured field sketches by Matthew Russell and David Conlin, National Park Service Submerged Cultural Resources Unit.*

Quarterly: **Why is *Hunley* significant?**
Neyland: Well, of course it is the first successful submersible to sink an enemy ship in combat. Nevertheless, the design was surprisingly sophisticated (fig. 3). Its overall shape is very sharp and graceful, a forerunner of the silhouette of submarines that only came some eighty to a hundred years later. It used water ballast tanks and may have had a means of shifting ballast from one end to the other.

Quarterly: **What special challenges set *Hunley* apart from other nautical archaeology projects?**
Neyland: Well... it is has *all* been challenging, and then some. Starting from scratch is always tough. When we began, I was always asked, "How much will it cost?" But until you have concrete plans for recovery and conservation you cannot begin to estimate costs. Trying to plan for recovery while at the same time planning and building a state-of-the-art conservation lab was extremely difficult. Also, getting contractors committed to a deadline for completion of the conservation lab ahead of recovery was not easy. Neither recovery nor conservation had a set formula. We came up with innovative solutions for both.

Quarterly: **Why was the decision made to raise *Hunley*, rather than conducting an in situ excavation?**
Neyland: We needed to excavate *Hunley* promptly because it could not be protected from looting once its position was known. It would have been tremendously expensive to conduct a full excavation offshore under the difficult local conditions (fig. 4). Also, because the submarine was truly a time capsule, it provided an ideal opportunity to recover it intact and bring it into the lab to do a controlled excavation. In retrospect, it would have been impossible to do a quality investigation and maintain proper scientific control without doing the work in the lab.

Quarterly: **What were the conditions at the site, and how did you handle them?**
Neyland: There was zero visibility and strong current at times. We were often working at night, and had overhead obstructions. There were two teams: one of archaeologists and another of professional commercial divers. All were helmeted and on surface supply because of safety and the overhead obstructions (fig. 5). Our platform was thirty feet above the water, so we had to use a stage to lower divers in and out of the water. The site was unprotected from storm or hurricane, so time was of the essence to reduce the exposure of the wreck and workers.

Photo: C. Amer

Fig. 4. *The diving conditions were difficult. It would have been tremendously expensive to conduct a full excavation at the site and impossible to conduct a quality investigation and maintain proper scientific control. Courtesy of SCIAA.*

Fig. 5. *All divers were helmeted and on a surface supply system for safety and because of the overhead obstructions.*

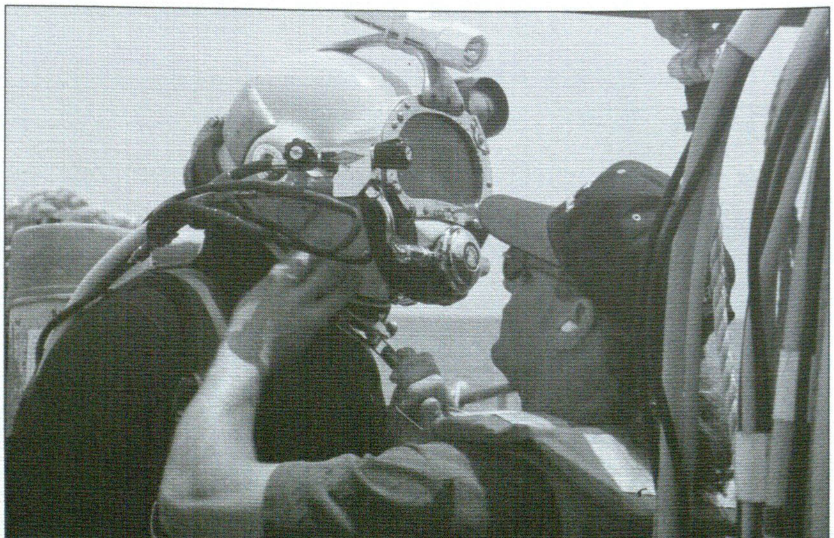


Photo: Friends of the Hunley

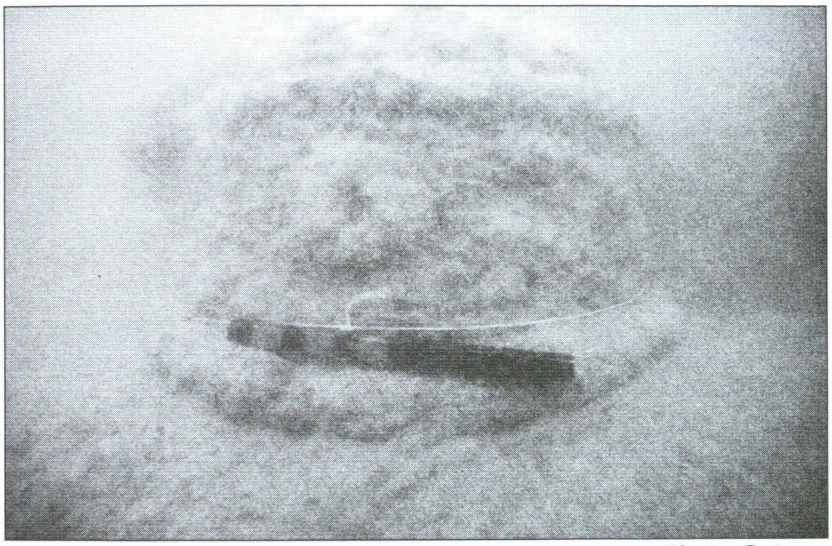


Photo: C. Amer

Fig. 6. *Underwater exploration of the* Hunley *site provided information that was to prove invaluable for preserving the vessel during the later recovery operations. Courtesy of SCIAA.*

***Quarterly:* What other technical challenges had to be overcome to raise the submarine from the sediment?**

Neyland: The recovery method prescribed a means of capturing *Hunley* in the same position as it lay in the seabed (with a forty-five degree list to starboard and the bow down about sixteen inches lower than the stern). This would require a continuous support system that provided a counter-pressure to the pressure of the sediment inside the boat, and a very controlled lift. We wanted to be able to excavate the submarine's interior in the same manner that it had filled with sediment, for we knew that the interior geology would be important in telling what happened to the submarine. The last thing we wanted was for the boat to break apart or the hull to rupture on the seabed or during the lift. We revisited the site in the fall of 1999 and took ultrasonic measurements of the hull and recovered a rivet (fig. 6). This information was used in a Finite Element Analysis (FEA) to determine if the sub's hull would withstand the lift and where the weakest parts were. This study determined that the greatest danger would be rivet failure along the longitudinal strakes, with *Hunley* in effect unzipping. Hence we came up with a system of slings with bags. These could be injected with a hard-setting foam that would take the shape of the hull and provide a counter-pressure to the sediment inside the submarine.

We used Oceaneering Advanced Technologies to develop a recovery system that fit the archaeologists' needs. They had to design a framework to support the weight of *Hunley* and the sediment inside (fig. 7). The recovery frame or truss had to have a foundation. We ruled out driving piles because of damage the vibration might do to the submarine. Instead we built and used large cans, eighteen feet wide by twelve feet high, called suction piles. Divers dug footings for these six feet deep. Hydraulic suction was then used to lower the piles into the sea bottom. After recovery, the massive forty-two-ton piles were removed by reversing the flow of water and pumping them out. Thirty-three slings with bags for the foam were slung under the submarine. We started in the bow and excavated sediment beneath *Hunley* for two slings at a time until the boat was suspended by all thirty-three slings. Each sling terminated in a load cell that was wired to a computer on the deck of the recovery platform. Engineers monitoring the computer instructed divers on how much to tighten each sling. A steady sea state was also essential for lifting and safely setting the submarine down on the deck of the recovery barge (fig. 8). Oceaneering also designed the tank into which *Hunley* was placed, so there would be no question that the vessel and recovery frame would fit in the tank.

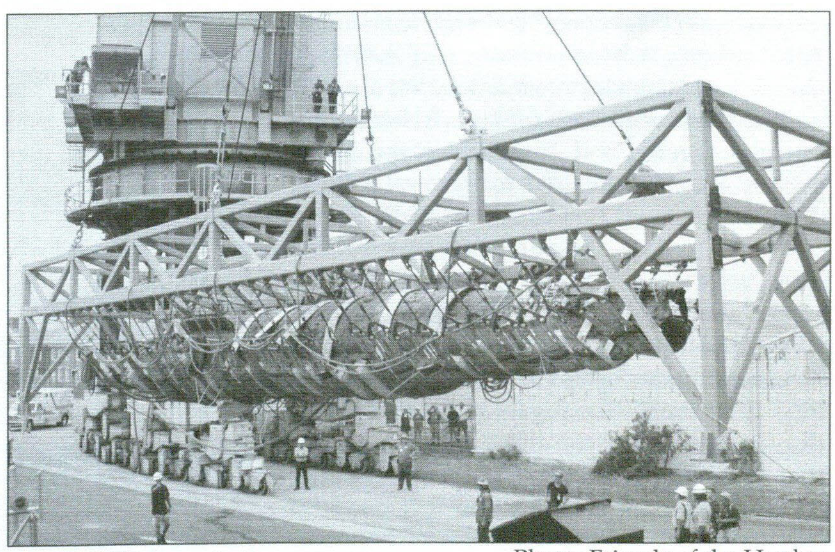
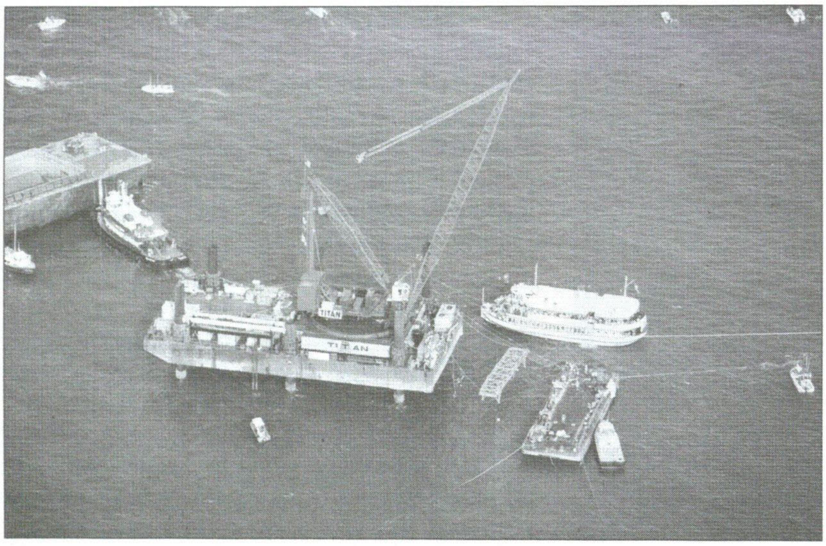


Photo: Friends of the Hunley

Fig. 7. *The framework used to transport* Hunley *from the bottom to the Lasch Conservation Laboratory without disturbing the stratigraphy of the submarine's contents.*



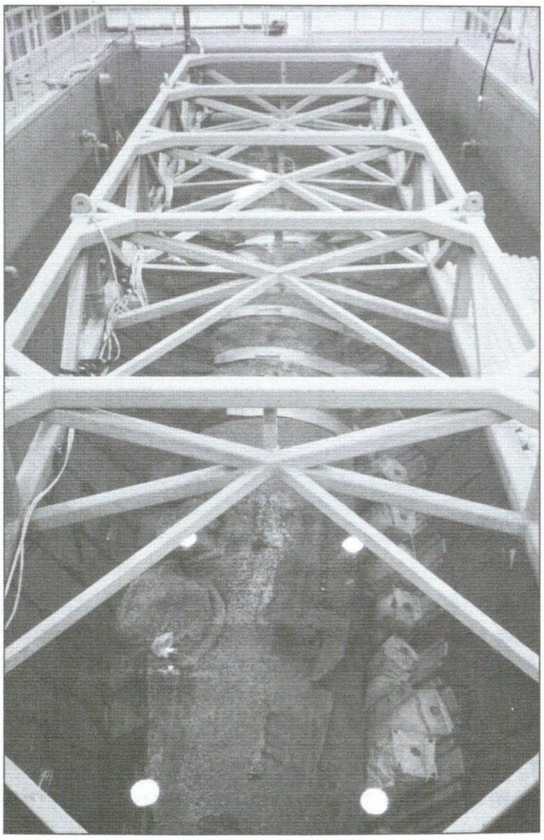


Fig. 8. *The equipment assembled to lift* Hunley *onto the waiting barge provides only a hint about the scale of the entire recovery operation. Courtesy of the Friends of the Hunley.*

Fig. 9. Hunley's *conservation tank at the Warren Lasch Conservation Center is only the centerpiece of a state-of-the-art facility that has also worked with material from CSS* Alabama *and other archaeological sites. Courtesy of the Friends of the Hunley.*

***Quarterly:* What steps were taken to ensure that the means chosen for the *Hunley* recovery were safe and effective?**
Neyland: The recovery plans were reviewed by a federal oversight committee made up of representatives from the Navy, Department of Defense, Army Corps of Engineers, General Services Administration, National Park Service, Smithsonian Institution, National Oceanic and Atmospheric Administration, and Advisory Council on Historic Preservation. We also did independent engineering checks to verify that our plans were good. Just in case, the whole project was also insured for several million dollars.

***Quarterly:* How is the submarine being preserved and protected during the excavation of its contents?**
Neyland: Hunley is kept in water chilled below 50° F. to preserve the organic materials inside (fig. 9). The water in the tank is filtered through a series of large pool sand filters. A system of impressed electric current was installed to help keep the hull from degrading. The submarine and the water in the tank are monitored for pH, conductivity, temperature, and dissolved oxygen. To excavate, the tank level is lowered and the hull is sprayed with water. When excavation is not going on, the water level is again raised.

***Quarterly:* Have you found any clues to why *Hunley* sank?**
Neyland: We have not found a "smoking gun" yet (fig. 10). I think that discovering the answer will be a true piece of detective work. We will use the archaeological evidence,

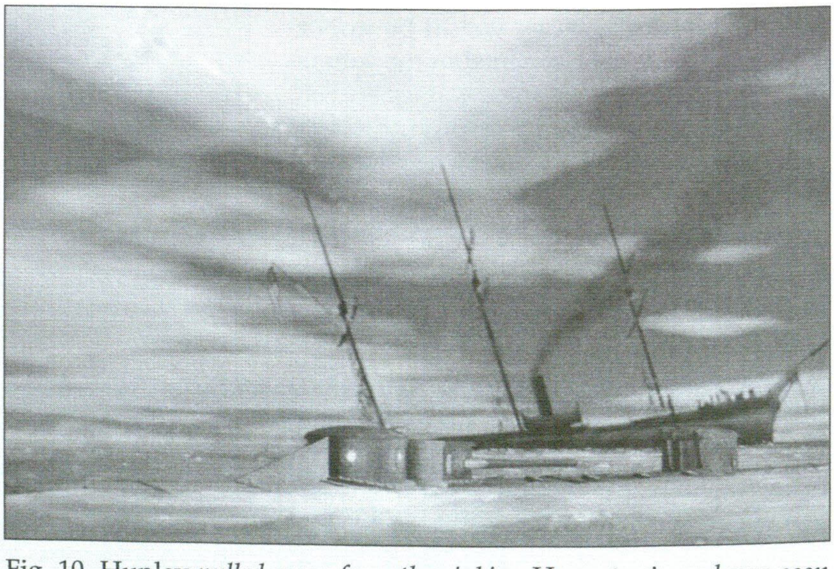
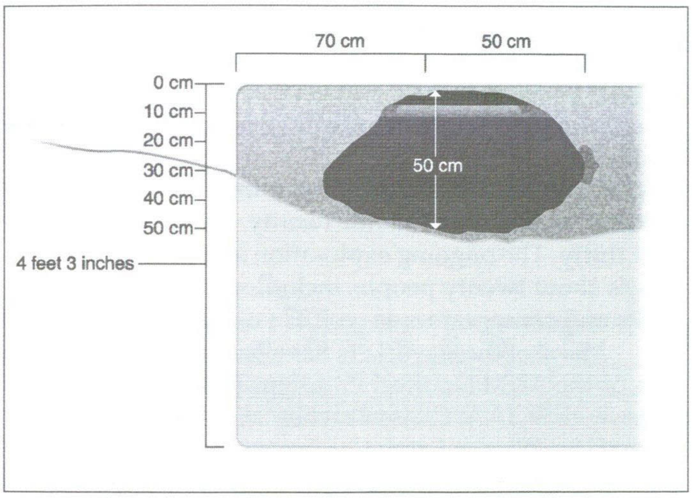


Fig. 10. Hunley *pulled away from the sinking* Housatonic *and was soon lost for reasons still unknown. Computer generated graphic by Dan Dowdy.*



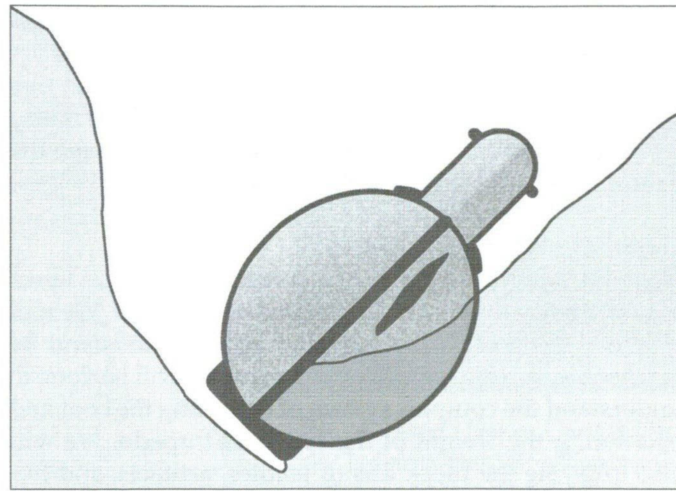


Fig. 11a (left). *Location of a hole found in the very aft section of the sub's hull on the starboard side.* Fig. 11b (right). *Size and shape of the hole. Images by Warner McGee, from a drawing by National Parks Service Archaeologist Matt Russell.*

the geology of the sub's interior, the forensics of the crew's remains, and engineering studies of the metal and structural condition of the submarine.

There are some indications *Hunley* did not drown its crew and filled slowly with sediment. There are stalactites of mineralization on the overhead of the cabin, which will be studied to determine if they formed in air or water. There is a very fine sediment in the lower levels of the boat, consistent with the hull remaining essentially intact for years and only later opening up to an intrusive marine environment that deposited coarser sediments and marine shells. These probably entered through holes both forward and aft on the starboard side, as well as through a broken glass viewing port in the forward conning tower.

***Quarterly:* What about the hole in *Hunley's* stern?**
Neyland: We think this occurred after it sank and was on the bottom for awhile (figs. 11a and 11b). This is suggested by the geological sediments inside this hole. The upper levels of the hull are filled with a very course sediment including shells, slag, and coal, which means that something happened to change the deposition pattern and allow the entry of larger debris. However this is preliminary analysis. An anchor could have dragged into it. This was also in an area of high scour activity.

***Quarterly:* How did you enter *Hunley* once it was recovered?**
Neyland: That was another major challenge for the project. Both hatches were completely closed and even if opened would be too small for us to enter. We wanted to do minimal damage to the submarine as well. It was finally decided to remove three (later four) upper hull plates by drilling out the rivets. At first, we did not know if this would work. Even if we could free a plate, there might be controls inside that would prevent full removal. However, it turned out that this was the best solution. It allowed maximum access into the submarine while doing minimal damage. Even so, it has been tight work to excavate *Hunley's* interior and recover artifacts and the remains of the crew.

***Quarterly:* What is it like working in the cramped quarters of the submarine?**
Neyland: Well, at around three feet wide and four feet high it is *exceedingly* cramped. In addition, the hand crank runs through the boat. Working is awkward and one gets used to stiff legs and cramps. Getting sufficient light in the dark interior is very difficult. I suppose most people would find it claustrophobic. However, I have always found it very peaceful to work inside the submarine, although it is tough because of the tight quarters.

***Quarterly:* Besides the boat itself and the remains of its crew, what has the excavation found?**
Neyland: The significant artifacts recovered include: a gold coin, a blue lantern, a compass, bellows, personal effects such as knives and canteens, a medicine bottle, several tobacco pipes with tobacco still in them, two pencils and a scrap of paper, a leather belt, buckles and buttons for garments, a wallet, binoculars, and a folding rule.

***Quarterly:* What do you think remains to be discovered in the current round of excavation?**
Neyland: The current round is almost over. We have uncovered and defined more machinery in the stern—the after pump and the hand crank gear and propeller gear connected by a chain drive. In the bow we have recovered

the rest of Lt. Dixon's remains, near the ship's compass and a shelf on which the compass sat. We have not as yet found the depth gauge. Under the bench, we found five canteens, textile material, buttons, and a file. There is also a pipe under the bench that may carry water between the ballast tanks, and the controls for the rudder.

Quarterly: **What comes next?**
Neyland: After this round of excavation, the ballast tanks in both ends will have to be emptied of sediment. We will record the interior of *Hunley* and try to understand its machinery. A series of engineering studies will be done to understand the complex system of ballasting the boat and countering the weight of the spar and torpedo. We will also excavate the block lifts of textiles, artifacts, and human remains. These block lifts were done to help recover the textiles intact.

Quarterly: **What will be needed to properly conserve *Hunley* and its associated artifacts?**
Neyland: Money, time, and patience. Doing the job properly and expeditiously may require some cutting-edge techniques. With current methods, it will probably take seven to ten years to complete the task.

Quarterly: **How many people have been involved in the project?**
Neyland: In the initial discovery, four to five people. The 1996 survey involved about twenty. Recovery required over thirty. The ongoing exploration and conservation involves about twenty people, including our core archaeologists and conservators as well as volunteers (fig. 12).

Many of these workers have had a connection with INA or the A&M Nautical Program. These include: Chris Amer with SCIAA, Claire Peachey with NHC, Mike Scafuri with the Warren Lasch Conservation Center, and Maria Jacobsen, Senior Archaeologist at the Lasch Center. Rich Wills and Peter Hitchcock were also involved. Donny Hamilton did the initial conservation study and report for us, and Wayne Smith and Jim Jobling have also provided input on conservation. I hope I have not left anyone out!

Quarterly: **Modern ship archaeology is sometimes controversial, because we often have less expensive sources**

Fig. 12. The Hunley *team.* Photo: Friends of the Hunley

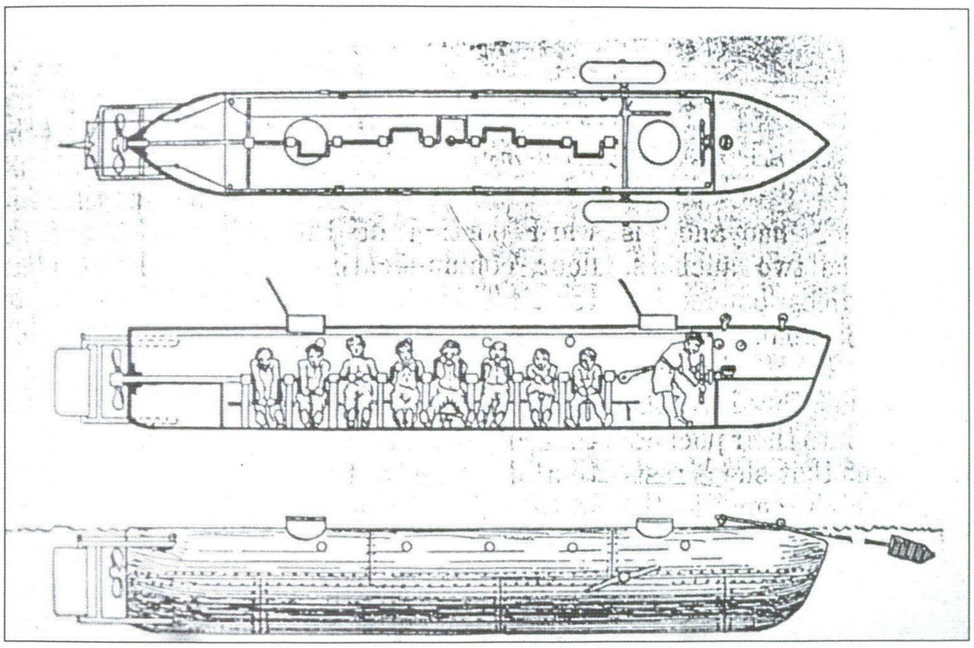


Fig. 13. *Sketch by submarine pioneer Simon Lake from a description of the vessel by Charles Hasker, one of the crew that survived the first sinking. Published in* McLures Magazine *in January 1899 and available at the National Archives.*

Fig. 14. *Dixon's fiancee, Queenie Bennett, had given him a $20 gold piece early in the war. A Union bullet at Shiloh had penetrated his trouser pocket and struck the coin. The impact left the coin shaped like a bell, with the bullet still embedded in it. It probably saved Dixon's life and became his "good luck" piece. Courtesy of the Friends of the Hunley.*

of information about recent vessels. What is to be learned from excavating *Hunley* that could not be discovered from historical research?
Neyland: Surprisingly, there is a great deal to be learned from excavation. The historical record on *Hunley* is not particularly accurate (fig. 13). From recovery, we saw that the shape of *Hunley* was far more hydrodynamic and graceful than anyone had imagined or portrayed in sketches and the one painting (see cover). We determined that the spar for the torpedo was on the bottom of the bow, not on the top as had been believed. From excavation we learned that seven men, not eight, propelled the sub's crank. That meant that the crew was in fact only eight men, not nine. The propeller shaft had a flywheel and brake mechanism. We discovered a system for circulating air inside with a large bellows. The submarine is well built with ninety-four to ninety-seven rivets holding a plate on, and a series of iron frames inside the hull. The men all sat on the port side and the crank was somewhat off-center to starboard. Ultimately we will answer the questions of who were the men on *Hunley* and why the submarine never returned. None of this was in the historic record or could be found from surviving documents or pictures.

In addition, we have confirmed two stories about *Hunley's* last mission that some had dismissed as folklore. We found the blue signal lantern mentioned as seen by both Confederate and Union sentries, which further suggests that the submarine initially survived *Housatonic's* sinking. We have also confirmed that Lt. George E. Dixon did indeed carry a good luck piece, a gold coin given him by his fiancée (fig. 14).

This was certainly one myth that turned out to be true. Queenie Bennett, Dixon's fiancée, gave him the twenty-dollar gold piece when he went off to war. The coin saved his life by stopping a bullet at the battle of Shiloh. This story was known from a letter from Dixon to

Photo: Friends of the Hunley

Fig. 15. *Maria Jacobson holding Lt. Dixon's $20 "lucky" gold piece.*

Queenie and a letter that a friend of Dixon wrote home to his wife. Everyone asked us about the gold coin, but its presence was unconfirmed until Maria Jacobson found it on the last day of the excavation as we were doing a block lift of Dixon's remains and clothing (fig. 15). It was apparently in a left pocket. No one knew, however, that it was inscribed on the reverse side with (fig. 16):

Shiloh
April 6, 1862
My Life Preserver
G.E.D.

Seeing the coin is very different from reading about it, just as the archaeological investigation of *Hunley* has provided a much richer picture of this historic vessel than contemporary documents and pictures could ever have done. I am glad to have played a role in this.

Fig. 16. *Reverse side of the coin, showing the inscription. Courtesy of the Friends of the Hunley.*

Bringing Texas Steamboats Alive for Texans

Michael Quennoz and Barto Arnold

Historical displays on nautical affairs are invaluable to the archaeologist. They provide a wonderful opportunity to give the community insight into what we do—the process by which we help bring their own history back to life. With this end, the Institute of Nautical Archaeology (INA) and the MSC Forsyth Center Galleries brought *Natchez on the Mississippi 1870-1910: A Photographic Exhibit* to Texas A&M University during the fall of 2001. The exhibit displayed a small part of the work of Henry C. Norman, who in the late nineteenth and early twentieth century photographed the life of Natchez, Mississippi, his home town. In 1960, Natchez physician Dr. Thomas Gandy purchased over seventy thousand glass negatives of Norman's work. Eventually Dr. Gandy and his wife published several books on Henry Norman and the steamboats he photographed, including *Norman's Natchez: An Early Photographer and His Town* and *The Mississippi Steamboat Era in Historic Photographs*. Beginning in 1993, a traveling exhibit visited the Barbican Centre in London, the Getty Museum in Los Angeles, and the Center for American History (CAR) at the University of Texas at Austin.

In the fall of 2001, Barto Arnold, Director of Texas Operations for INA, in cooperation with Cory Arcak of the Forsyth galleries, and Lynn Bell of CAR, arranged to display a portion of the exhibit, focusing on Mississippi river steamboats. The large format photos provided beautiful detail of these often-lavish vessels. Andy Hall, an INA research associate, provided additional panels on the history of steamboats in Texas as well as highlighting the underwater archaeology of steamboats. He also provided expanded captions for the photographs, enhancing historical and archaeological aspects. Forsyth curator Cory Arcak then organized the exhibit.

A series of free, public lectures were also scheduled to help bring the history and tradition of the steamboats to life. For example, Barto Arnold discussed the Red River Wreck currently being excavated on the Oklahoma and Texas border. Inspiration for the photo exhibit derived from the work on this wreck, the earliest western river steamboat yet excavated by archaeologists. Capt. Alan Bates, one of the foremost steamboat historians, discussed the evolution of steamboat technology and Andy Hall highlighted the long history of steamboats in Texas.

The timing of the exhibit could not have been better, as it coincided with the Texas A&M football season. Before and after every home game, hundreds of people visited the Forsyth Gallery, located directly across the street from Kyle Field. To take full advantage of this opportunity, students from the Nautical Archaeology Program acted as docents, explaining the exhibit to visitors and answering questions.

The steamboat photo exhibit, comprising some two dozen images, is available to tour museums. The same is true of the full (120-image) exhibit of *Natchez on the Mississippi*. Interested parties should contact Lynn Bell, Center for American History, University of Texas at Austin at (512) 495-4452 or by email at l.bell@mail.utexas.edu.

The *Denbigh* Project 2001: Excavation of a Civil War Blockade-Runner

Barto Arnold, Tom Oertling, and Andy Hall

To those who took the active part, it was—although attended with some privation, danger, and anxiety—on the whole a rather enjoyable occupation, with something of the zest of yacht-racing…

—William Watson, *The Civil War Adventures of a Blockade Runner*

American Civil War blockade-runners have become a hot topic in recent years and INA's current *Denbigh* excavation at Galveston, Texas has stimulated this interest (fig. 1). Although historians have carried out extensive research on the subject, archaeologists have not excavated many blockade-running ships. Likewise, iron-hulled merchant steamers of the nineteenth century are a largely unexplored field. The *Denbigh* Project is helping to fill these gaps in our knowledge.

This year's Society for Historical Archaeology meeting in Mobile, Alabama included an all-day session on blockade running in the Gulf of Mexico and Civil War wrecks in Mobile Bay. There were fifteen presentations and several discussions on the topic, and this does not include relevant papers at other sessions. The four presentations specifically devoted to *Denbigh* included two by the authors of this article, the first entitled "The *Denbigh* Project: Second Season of Excavation of a Civil War Blockade Runner," and the second, "Too Successful a Boat: New Historical Research on the Blockade Runner *Denbigh*." There were also papers by E. Gene Shimko ("The Blockade Runner *Denbigh* as an Example of Mid-Nineteenth Century Marine Engineering") and John de Bry ("*Denbigh*: The Cuban Connection"). Members of the *Denbigh* team presented several other papers on topics suggested by the Project research, and Katie Custer had a poster presentation, "A Rose from the Past: Conserving a Rose Stem from the Civil War Blockade Runner *Denbigh*." The Society presentations were only a part of our efforts to keep the academic community and general public informed about the Project.

I may safely say that one of the most successful, and certainly one of the most profitable, steamers that sailed out of Havana to the Confederate States was a somewhat old, and by no means a fast, steamer named the Denbigh. … *She was light on coal, made but little smoke, and depended more upon strategy than speed. She carried large cargoes of cotton, and it was generally allowed that the little* Denbigh *was a more profitable boat than any of the larger and swifter cracks.*

—William Watson.

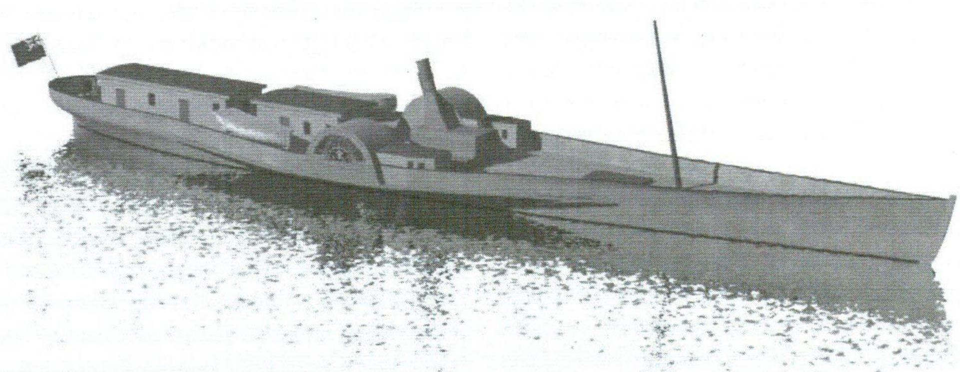


Fig. 1. A computer graphic compiled by Andy Hall from all the information to hand so far.

Denbigh's Machinery

The *Denbigh* investigation has continued since winter 1997. In the test excavation season, 1999, we completed two trenches of five by fourteen feet, one each in the forward and aft sections of the hull. We then opened the area along the centerline of the vessel and over the port engine. This revealed the engine frame, piston, and connecting rod. We removed the 550-pound rod from the wreck for conservation, study, and public display. The following year, we exposed the port cylinder on its aft and inboard side and opened a third trench in the middle section of the after hold. Most of the work in 2001 continued to focus on the engine room.

Most of the Institute of Nautical Archaeology's excavations over the past thirty years have involved vessels built before the Age of Steam. *INA Quarterly* readers may be unfamiliar with the operation of marine engines, so perhaps a brief explanation is in order. High-temperature, high-pressure steam can perform work as it expands (losing both temperature and pressure in the process). In each cylinder of a reciprocating engine, the steam pushes a piston while it is expanding. Steam can be introduced through valves from a steam chest into both ends of the cylinder alternately. This drives the piston equally on both the forward and back strokes, unlike the familiar four-cycle internal combustion engine (gasoline or diesel), which generates power on only one stroke out of four and consumes energy during its compression stroke.

As noted in the quote by William Watson at the head of this section, *Denbigh* was highly regarded as "light on coal." Efficiency is particularly important for marine engines, because fuel stations are so much farther apart at sea than on a highway or railroad line. Inefficient engines require extra fuel storage, so nonpaying coal bunkers will replace cargo space. More efficient engines need fewer stokers, hence less room for crew quarters and provisions and still more room for paying cargo (or, on a warship, extra guns). As an added benefit, a more efficient steamship need not rely on sails for auxiliary propulsion, which again saves on weight, space, and crew requirements. A blockade runner, in particular, would want to reduce the size of its masts and top-hamper to the absolute minimum, since this would significantly reduce its visibility and enable it to stay below the horizon.

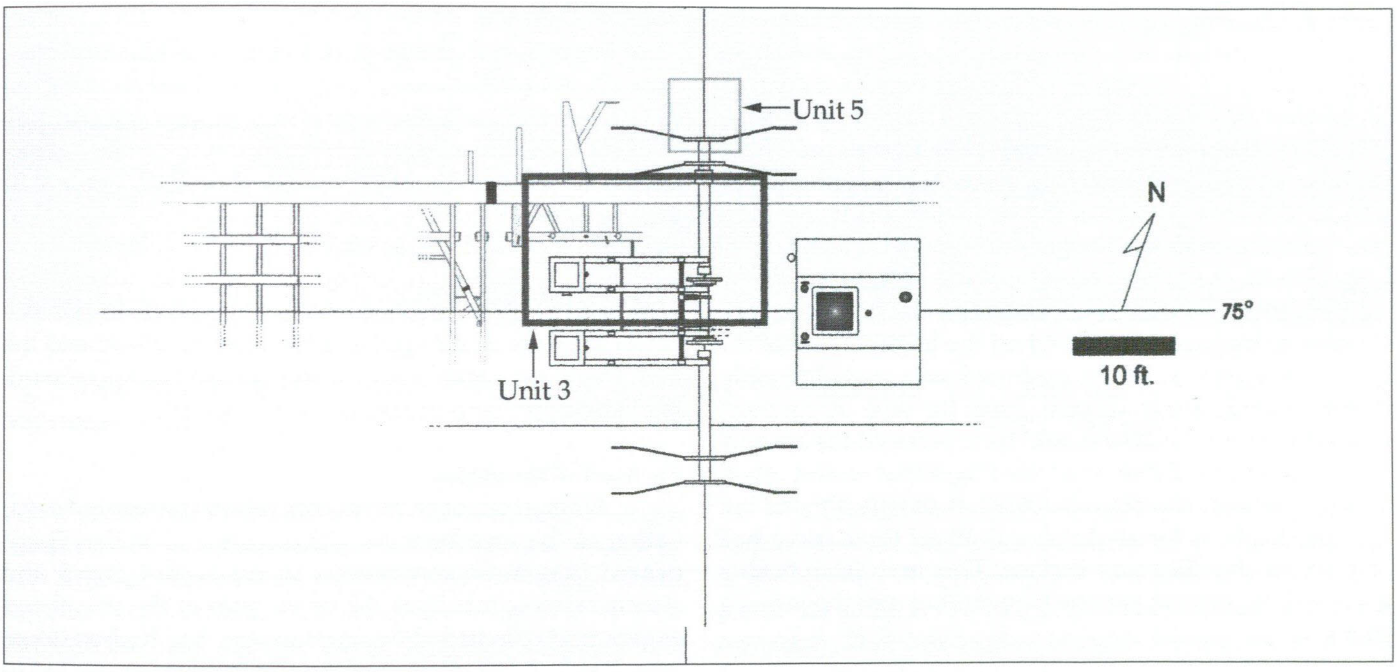
In steam locomotives, the exhaust is typically vented into the air, but ships (like fixed power plants near a lake or stream) use cooling water to condense the exhaust. This creates a partial vacuum that allows steam to push harder on the piston from the other side. In the low pressure engines used through much of the 1860s, this extra force provided a particularly significant percentage advantage in efficiency. To maximize the pressure differential between the two sides of the piston, it was essential to avoid condensation on the walls of the high-pressure end of the cylinder as the expanding steam cooled. Due to the increased steam pressure, the boiling point (and hence the condensation temperature) was significantly higher than 100° Celsius, the boiling point at normal atmospheric pressure.

Unwanted condensation was generally avoided in several ways: the steam leaving the boiler was often run through a superheater to increase its temperature, and the cylinder walls were also heated by surrounding them with a steam jacket. The condensate from the jackets also provided a source of fresh water. *Denbigh* appears to have employed both these strategies. In addition, engine designers limited the stroke length of the cylinder, so that unnecessary expansion would not cool the walls below the boiling point of incoming steam. This approach eventually led to compound engines, in which the steam was expanded in as many as four consecutive cylinders to reduce the cooling at any single stage. In the 1860s, however, ships relied on simple engines with a single expansion of the steam in large cylinders like *Denbigh's*.

To create the vacuum on the exhaust side, most ships in the 1860s used a condenser that sprayed a jet of cool seawater over the steam. An air pump then removed the water and gases from the condenser. They were pumped into the hot well, a vertical box with a domed top, where the water settled to the bottom. The engine's feed pump then transferred this preheated water back to the boiler as needed (again, a more efficient approach than using cold feed water). *Denbigh* had all these typical features, although the feed pump may have been removed during salvage operations after the Civil War.

Obviously, a piston moves back and forth in straight lines, while paddles and screw propellers move in circles. Every ship with reciprocating engines must therefore have some mechanism for converting one form of motion into the other. Typically, a pivot (often on an assembly called the crosshead) attaches the piston rod to a connecting rod that then drives a crank on the driveshaft—an arrangement that requires considerable room for a large single expansion cylinder. This was a particular problem for early steam screw warships, since the propeller shaft must run in a fore-and-aft direction fairly low in the hull. The cylinders needed a low profile to protect them from enemy fire, but also needed to fit crosswise within a narrow beam.

Paddle steamers like *Denbigh* had transverse axles well above the waterline, which presented a different set of problems. In order to keep the engine room as small as possible (to avoid cutting into payload size), many designs used vertical cylinders driving the paddles through a rocker assembly located either next to the engine (a side lever) or above it (a walking beam). *Denbigh* took the simpler and more mechanically efficient approach of placing almost horizontal cylinders behind the paddlewheels. Each piston rod drove a crosshead back and forth along diagonal I-beam guides. The crosshead then turned the paddle crank



by a connecting rod nearly eight feet long, as well as driving other rods to control the valves in the steam chest and transmit power to the auxiliary machinery like the air and feed pumps. The space this design consumed was considered an acceptable price to pay for speed and efficiency in *Denbigh's* original mission as a short-haul passenger packet, but it also worked well for the oceanic blockade runner that the ship eventually became.

In 2001, the *Denbigh* team focused almost exclusively on the engine room (fig. 2). We opened most of the remainder of the compartment from the central alleyway between the engines to the portside of the ship. We recovered the remains of the superheater cap, which had fallen from the upper section of the boiler to its port side. At the end of the season additional excavations were made on the sponson of the port paddlewheel. We hoped to better understand the operation of the paddle feathering mechanism, and particularly the bearing for the eccentric wheel hub.

The engine room work was conducted in several functional areas: the portside of the engine room; the central alleyway between the engines; and the forward area between the boiler and the engine. This excavation allowed the collection of more information about the port engine and its various components.

> *I said that on blockade-running steamers it was necessary to have everything cleaned in the morning watch, so as always to have a good head of steam, and be ready for a spurt at daybreak, in case daylight might show a cruiser close by, when we would want all the speed [the engineer] could put on to get beyond reach of her guns.*
>
> —William Watson

Unit 3—Engine Room

In 2000, we designated the port half of the engine room as excavation Unit 3 and recorded the basic engine structure while digging about halfway to the ship's bilge (fig. 3). The following year's work began with removing the sediment that had filled the hole over the winter. Most of the season was spent excavating to the interior hull surface. During this process, we examined the ancillary steam equipment and the surrounding structures. We observed a box-like series of rectangles outlining the engine and paddle shaft space. This was constructed of iron members that were massively oversized when compared to the normal hull frames and deck beams.

The team also located a storage area between the engine and the portside of the ship. Ceiling planking over the floor timbers provided a walkway to access the outboard side of the engine and this stowage. The storage area contained two wooden bins, a few tools and supplies, a spoon, bricks, broken pottery and glass, and the engineering department's private supply of alcohol. The forward bin was excavated completely, but the other one awaits future work.

Central Alleyway

The flat plate of the keelson sitting on top of the floor frames served as a walkway for the engineers and oilers to access the inboard side of the engines. A hard compact layer of sandy material located between the frames may have been a marine concrete. It was a common practice of the period to fill the bottom of the ship with this material. A pipe running from the bottom of the vessel through a triangular hole in the keelson plate to the engine may represent the bilge pump intake. The bilge water ran into the condenser through a manifold on the inboard side of the engine (a manifold on the outboard side provided additional cooling water directly from the sea). A coaming around the pump intake would have reduced the amount of coal and other debris from the bilges that would otherwise be sucked into the condenser. A one-inch metal bar ran the length of the engine frame about three and a half feet above the alleyway surface. This may have been a guardrail to prevent anyone from falling into the moving parts.

Port engine

The engine was completely exposed from the cylinder forward. In prior seasons, we identified the cylinder, steam chest, piston rod, connecting rod, cross head, crank, and axle assembly. In 2001 we identified nearly all the remaining key components. These included the condenser, air pump, hot well, and linkage (power takeoff) from the crosshead to the air pump. We also identified some of the steam and water lines with their connections and through-hull exits, as well as recording the engine frame structure.

Portside of the engine room

This area included two oversized frames (partial bulkheads) extending into the hull, most likely to provide additional support to the center of the ship. The forward frame measures 3.7 feet and the after frame, measuring three feet, is paired with a stanchion and tied into a large longitudinal angle iron that was part of the deck support structure. We also noted four pipes running through the area.

Two storage tanks were placed against the port side of the hull. The forward tank was placed low in the hull between the partial bulkheads. It measured 2.2 x 2.7 x 6 feet. At the aft end was a drain opening with a rounded dowel still in place as a stopper. This tank is believed to have held fresh water condensate from the steam jacket of the cylinder. The aft tank was smaller, 1.65 x 1.8 x 2.2 feet. This was based about two feet below the deck in the corner of the after bulkhead and the hull. There was a small square inspection port facing inboard. We believe this tank contained lubrication oil.

Forward of the engine

Numerous large metal concretions prevented excavation of the area between the engine and boiler. It appeared that these concretions incorporated plates and structural elements from the upper part of the vessel and engine parts discarded during salvage. The firebox doors were blocked, but enough of the aft face was uncovered to show that the portside door to the boiler tubes was open and hanging on one hinge. Nineteen inches forward of the after boiler face was another bulkhead with only the upper portion of a round-topped opening exposed. This was probably the port coal bunker hatch.

Unit 5

Excavation Unit 5 was a five-foot square with one side centered on the paddle shaft outboard of the port paddlewheel hub. We hoped to identify the feathering mechanism and the structure of the sponson. We specifically hoped to determine the nature of the offset hub that anchored the rods for the adjustable floats (paddles). There were two types, one with a solid hub and the other with a central rim-like structure. Brief initial observations at the end of the season indicated the solid hub variety of feathering mechanism. Further work will be necessary in this area.

On my asking the engineer what they meant, he said that some of the firemen and trimmers had been picked up about the grog-shops in Havana, and a more worthless and despicable set he had never seen. ... they now wanted to get ashore to get drunk.

—William Watson

Artifacts

The Denbigh team found a variety of artifacts during the 2001 season. Our most intriguing finds were five intact wine bottles discovered in the wooden bin. Three of these still had corks in place when they were first seen, although one lost its cork during excavation (fig. 3). The contents of the remaining two bottles had a vinegar-like smell, and were saved for analysis. Other glass and ceramic items were found in fragments. One of these was the neck and numerous shards of a glass demijohn bottle (fig. 4), which still had shreds of the wicker basket on its neck. Ceramics include the bottom of a bowl with a naval crown transfer print, the handle of a cup, and numerous sherds of earthenware and whiteware.

We found several bricks in the bin and around the port side. Two were large and flat, like pavers. Although one appeared to be a standard English brick, the others were stamped, "Th. Boucher/Brevete." These bricks possibly pro-

Photo: J. Bowden

Fig. 3. *Liquor bottle, sealed and with contents intact. Scale 6 in.*

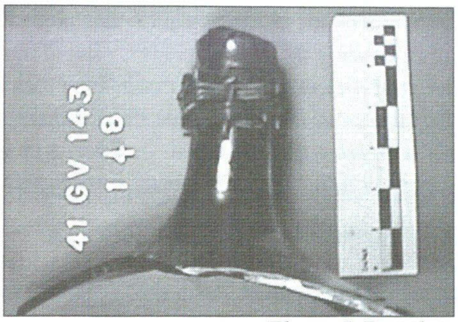


Photo: J. Bowden

Fig. 4. *Part of glass demijohn bottle with wicker at neck. Scale 6 in.*

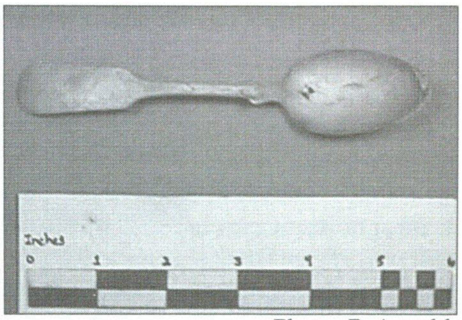


Photo: B. Arnold

Fig. 5. *Spoon marked "Rogers & Bro. Nickel Silver." Scale 6 in.*

vided installation around the boiler or hot tanks, or might have been for the galley. In the bin with the bricks were four iron rings or thimbles and three wooden wedges. Other items in the bin included a conch shell and coconut, opened but with the husk still on. A large bronze oval frame, with wood fragments adhering, is believed to be a scuttle cover, possibly for a deck opening to the coal bunker.

A spoon, possibly silver plated, was also uncovered. It is marked "Rogers & Bro. Nickel Silver" (fig. 5). This exact mark had not been identified in a standard reference, but several Rogers family companies operated in Connecticut.

A wooden mallet was found in the bottom of the ship next to the bin. It is thought to be part of the engineers' tool kit. A bronze spigot was also in this area. Of particular interest is a length of what is believed to be a rose stem. This was located beneath the keelson and can therefore be tied directly to the active life of the ship.

As with most excavations, debris from the years after the sinking was mixed with the many interesting original *Denbigh* artifacts. These anachronistic items, such as obviously recent fishing weights, were discarded from the archaeological record.

> *Havana now having become the principal centre for blockade running, a crowd of speculators soon found their way to the place, who bought up the goods in the limited market, and run them up to a high figure to sell to blockade runners, representing them, of course, as consignments recently got out from Europe specially selected for the Confederate market.*
>
> —William Watson

Historical Research

Jerry Powell, a student of Civil War history and a professor at the Baylor Law School, volunteered for archival research. Since he is familiar with admiralty court records, his assistance is most welcome. Powell visited the National Archives Regional Repository in Fort Worth, Texas. This is where the records of the New Orleans federal district court are kept. He also conducted research in the main National Archives collections in Washington, DC. Among other things, he found the vessel file on *Denbigh* and a salvage claim for cotton jettisoned by the ship after temporarily grounding while leaving Galveston in April 1865.

One of the documents retrieved by Powell concerned the European Trading Company, the firm the owners put together to handle their blockade-running operations. We learned that the managing director had his office in Paris, France, probably because this was the home of Emile Erlanger, one of the three owners. After the war, Erlanger married the daughter of the chief Confederate agent in France, John Slidell. This personal relationship may have been a factor leading the Erlanger concern to float a cotton bond issue. The funding was a key factor in enabling the South to continue the war, so Erlanger and his partners might have controlled the essential raw material for the textile mills at the center of Europe's economy... if the Confederacy had won.

Co-Principal investigator Andy Hall conducted historical research in Liverpool and Wales, where *Denbigh* worked before becoming a blockade runner. Long time colleague John de Bry pursued information in the archives of Havana, Cuba and Paris, France. The work in Cuba was a scouting trip for future research. As William Watson noted in the quote above, Havana was the home base for most runners in the final years of the war. The potential for finding *Denbigh* records there looks good, since John made good contacts for future work. The Project is still on the track of *Denbigh's* ship's papers. These are mentioned in the skimpy after-action report contained in dispatches from the fleet at Galveston. Much archival research remains to be done.

We soon got into the [Galverston] channel, which was perfectly smooth, but with barely eight feet of water, it being nearly low water. I knew that this was the deepest end of the channel, and that near the inner end there was a short space where there was nearly a foot less, and very likely we should there take the ground. … The vessel stuck and the engines were stopped. … There was little danger from the enemy, as we were now in past the fleet, and within three hundred yards of the Confederate guard-boat.

—William Watson

Sailing instructions

Near the end of the war the United States Consul-General in Havana scored an intelligence coup by obtaining the sailing instructions for the Galveston run. These are contained in a dispatch from the consul to General Banks in New Orleans. Since this communication is dated almost simultaneously with *Denbigh's* last voyage, it must describe the same set of signals and lights its officers were expecting to see.

U. S. CONSULATE-GENERAL,
Havana, May 20, 1865.

SIR: The blockade runner *Owl*, Captain Maffitt, under the rebel flag, will leave here for Galveston to-day or to-morrow. On her return from Galveston the *Owl* will come out by the main channel. By following the accompanying directions the *Owl* may be caught: Station a light-draft gunboat on the Northeast Channel (there are 7 feet of water at low tide); run in far enough to keep the Knoll buoy always in sight. If the night is very dark, cross the bar and anchor just inside. Let the *Owl* pass the buoy and cripple her from the start; then come in behind her. Don't trust sailors to look out. To cross the Northeast Bar, bring the light to bear S. W. _ S. The bar is a long one. There is no danger of the enemy or shoal water. I regard this information as reliable. Will you communicate it at once to the officer in command of the naval forces at New Orleans? The rebel ironclad ram *Stonewall* was given up on yesterday by those having charge of her to the Spanish colonial authorities of the island of Cuba.

I am, very respectfully, your obedient servant,

WILLIAM T. MINOR,
U. S. Consul-General at Havana.

Major-General N. P. BANKS,
Commanding U. S. Forces at New Orleans.

Navy O.R.–series 1–Volume 22 [S#22]
West Gulf Blockading Squadron.
From January 1, 1865, to January 31, 1866, pp. 156–201.

What amazing operational details for *Denbigh*! The runner frequently used this approach through the Northeast Channel, also called the Swash Channel. The instructions suggest why the ship may have grounded on the night of May 23–24. Due to the disorder at the end of the war, the garrison guarding the harbor forts left town on May 22–23. It seems probable that the navigation signal lights were not set on the night *Denbigh* strayed out of the channel, became stuck, and was destroyed. However, we know from William Watson's account that going aground was a routine event. The fatal problem for *Denbigh* on this occasion was that the deserted forts could not protect it while it was grounded.

Note that Consul-General Minor advises General Banks to warn the blockaders not to rely on sailors as lookouts. Perhaps he believed that the enlisted seamen's diligence was not what it should be. Therefore, a responsible officer should stand lookout instead.

> *It now seemed to me that blockade running between Havana and Galveston had been largely taken up by companies or syndicates who owned several vessels, and whose policy seemed to be to play a high stake.*
>
> —William Watson

Schroder Sails to Galveston?

It appears that a member of the Schroder merchant banking family, one-third owners of *Denbigh*, may have sailed to Galveston from Havana on the ship. A document from the National Archives vessel file on *Denbigh* lists the passengers arriving in Galveston on August 30, 1864—the ship's first trip to Texas, soon after Mobile Bay had been closed to Confederate shipping. The document lists "Henry Schreoter" among the passengers.

This could easily be a misspelling for Schroder. At least two of the family's English branch had "Henry" as one of their multiple given names. One of these was the head of English operations and the other was one of his sons, in his early twenties at the time. Schroder's Bank was conducting a bond issue and railroad construction project in Cuba at this time. With the South's fortunes ebbing, this was probably a more important operation than Schroder's interest in the European Trading Company or their stake in the Erlanger cotton bond issue. It would not be surprising for a family member to be in Cuba inspecting or supervising the railroad project. Having a family member make the first trip to a new port as supercargo would have provided a sound foundation for *Denbigh's* future operations in Galveston. International credit and trade relationships often hinged on personal contacts.

> *It may therefore be well imagined that rumours from reliable sources, of great victories, crushing defeats, and important successes of one or the other side were constantly being manufactured and circulated by way of bulls or bears. The news of Lee's surrender, however, was so authentic that no room was left for doubt.*
>
> —William Watson

Public Outreach

The recent work of the *Denbigh* team lent itself particularly well to public outreach. The Project assisted with the publication of the *Civil War Adventures of a Blockade Runner* by William Watson, reissued after 109 years by Texas A&M University Press. This contains a new introduction by Barto Arnold, and is intended as the first of two to three book-length publications related to the Project. The book is part of our outreach to both the public and the profession.

Several other exhibits on *Denbigh* have recently appeared. We have already described the presentations at the 2002 annual meeting of the Society for Historical Archaeology. The authors presented a poster session at the Archaeological Institute of America annual meeting in Dallas. By adding to these graphics an already-on-hand replica of a doll suggested by the leg found in 2000 (see page 33), the Project was able to present an exhibit in the library of Texas A&M University at Galveston (TAMUG).

The Discovery Museum at Galveston's Moody Gardens requested the *Denbigh* Project's participation in a large traveling exhibit about ocean exploration called *Treasures of the Deep*. Fortunately, the connecting rod completed conservation just in time for the August through May exhibition. This impressively massive 550-pound and nearly eight-foot-long artifact attracted much attention to INA's work on the Texas coast. Large graphics and the doll replica accompanied the connecting rod, forming a local addition to the exhibit.

By arranging exhibits during the fieldwork, preliminary results can be shown at very little cost. This provides a much higher profile for the Project in the local community. The exhibits described above exposed thousands of people to a historic preservation view of shipwrecks.

Dive Weekend

Another opportunity for public outreach was provided by an outing on the weekend of September 7, 2001, co-sponsored by INA and the Southwest Underwater Archaeological Society. The volunteer sport divers and *Denbigh* staff visited the wreck site. They also conducted preliminary mapping of a hulk used as a bulkhead in the town of Bolivar facing the Intracoastal Waterway. Local legend claimed that Al Capone had once owned this early twentieth-century steel yacht. However, Andy Hall was able to identify the wreck as the *Olive K*, built for one of the most prominent executives and inventors at Ford Motor Company. The work during the dive weekend included taking GPS coordinates, photos, and measurements. This was primarily a training exercise for avocational archaeologists and students, as there are no plans to excavate.

Of course the rope was a fixture and no part of the running gear, but it kept the old gentleman out of harm's way, and he was quite happy in the imagination that he had been of some service.

—William Watson

Press Day

The Project used the recovery of *Denbigh's* superheater cap to stage a press outing. The cap was exposed to high heat levels during the ship's life and it had been in shallow, oxygenated water for 136 years. The superheater is highly degraded and the artifact is prevented from crumbling only by its encrustation. Conservation and curation, therefore, was not really practicable. This was confirmed when a fragment of one of the superheater's iron pipes was CT scanned, revealing total oxidation of the metal. Thus, the plan was to recover the cap and study it before returning it to the site.

There was a good turnout of both print and broadcast journalists for the outing. The crew floated the superheater cap with a lift bag and a line was passed to the recovery boat provided by TAMUG. Due to the high winds and choppy seas, additional assistance was needed to haul in the line. Those members of the press party who were not photographing the recovery became participant-reporters.

Denbigh received good coverage on the Houston television stations, with a feature piece in addition to news reports. There was also radio coverage, including an on-site telephone interview. A thirty-minute Public Radio show produced and syndicated by KAMU-FM on the main A&M campus in College Station provided in-depth coverage. Front-page newspaper articles ran in both Houston and Galveston, and the Associated Press also ran an article. The Houston Chronicle's article by its science writer was perhaps the best yet on *Denbigh*. Much of this coverage can now be seen on the INA web site.

The senior author considers it a half-done, semi-sterile exercise if archaeologists concentrate solely on their scientific publications. Journal articles trade popular appeal for depth of coverage. They do not reach a mass audience with the story of the scientific study of shipwrecks. In contrast, the press does. Finally, museum exhibits give archaeologists the best opportunity to reach the greatest numbers with in-depth information on results. All three—scientific technical publications, press coverage, and museum exhibits—should be considered the archaeologist's professional obligation.

It was a kind of exciting sport of the highest order, in which the participators regarded with more satisfaction some successful elusion of the enemy, a chase and escape, or other adventure, than any other emolument.

—William Watson

Conclusion

After the successful 2001 excavation season, we now almost completely understand the layout of *Denbigh's* engine room. We have recorded all the major components of the power plant, except for the (probably salvaged) feed pump and steam piping. Although the depth of overburden makes for slow going (even with four induction dredges at once), the excavation is certainly worth the effort. There is a lot more to learn from this important and exciting wreck.

Acknowledgements. The *Denbigh* Project is an undertaking of the Institute of Nautical Archaeology, Texas A&M University. The work is funded entirely by grants and donations. The principal donors include: The Albert & Ethel Herzstein Charitable Foundation of Houston; The Brown Foundation, Houston, Texas; Communities Foundation of Texas (Bill's Fund of the); The Ed Rachal Foundation; The Hillcrest Foundation, founded by Mrs. W. W. Caruth, Sr.; The Horlock Foundation, Houston, Texas; Houston Endowment, Inc.; The Strake Foundation of Houston, Texas; The Summerfield G. Roberts Foundation of Dallas; The Summerlee Foundation of Dallas; The Joseph Ballard Archeology Fund of Texas Historical Foundation; and The Trull Foundation of Palacios, Texas.

For Further Study visit the *Denbigh* web site: http://nautarch.tamu.edu/projects/*Denbigh*/

The *Denbigh* Doll

Barto Arnold

The *Denbigh* excavation team found a china doll's leg on the site during the 2000 season. This is a particularly unusual artifact for an area thought to be the crew quarters. What was a doll—and perhaps even a child—doing aboard a ship that was in routine danger from the US Navy? More than most archaeological artifacts, this item allows us vividly to imagine a human connection with the past. There are several possibilities for how the leg came to be on the ship. It is fun to speculate about this... although we will probably never have a definitive answer.

First, however, we should describe how contemporary "china head" dolls were made and used. In the nineteenth century, this popular style of doll had a porcelain head and shoulder piece, and porcelain lower arms and legs. These decorated ceramic body parts were attached to a stuffed body of cloth or glove leather. As a toy, the doll could be shipped as a kit. A mother and daughter could sit by the fireside sewing and making the body and fashioning elaborate doll clothing. Family entertainment was far more creative in the days before broadcasting and the Internet.

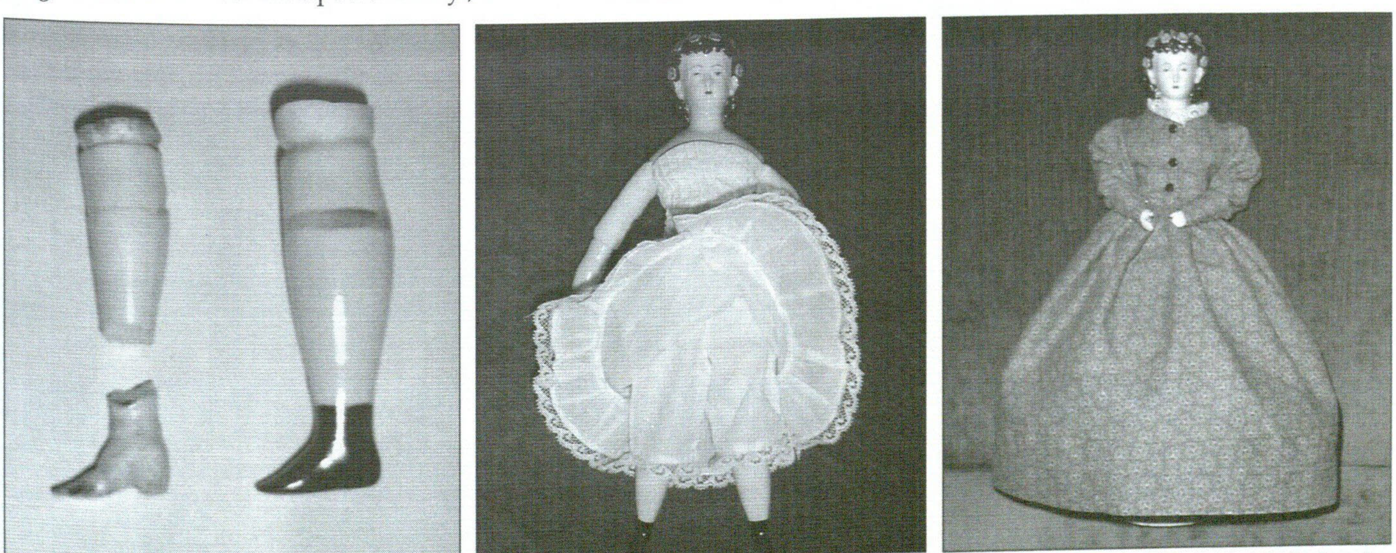
However, china head dolls were not only used as toys for children but also as fashion aids for adults. In the days before glossy magazines and televised style shows, couturiers publicized the latest fabrics, patterns, and fashions by sending dolls in miniature outfits from the fashion centers to the provinces. These allowed consumers to see the overall "look" of current styles, and order their wardrobe from a local dressmaker. The dolls also allowed the seamstress to see exactly how to assemble the clothes according to the designer's pattern.

This historical information suggests a number of ways in which the leg might have come aboard *Denbigh*. Before it began blockade running, the ship served for about two years as a passenger steamer between Liverpool and Rhyl, a resort about twenty-five miles away in Wales. During this time, a leg could have dropped off a passenger's doll and been swept accidentally into the bilge where it was found.

It is also possible that *Denbigh* had carried the doll's owner to Havana from Mobile or Galveston. Particularly near the end of the war, runners sometimes carried passengers. Some people felt they had good reason to evacuate the South with their families ahead of the victorious Federal armies. Since the Union Navy blockaders preferred capture rather than destruction of their targets, there was comparatively little risk from gunfire (besides, the Federal gunners were notoriously bad shots). Although the final voyage of *Denbigh* was inbound, a child could have lost the doll's leg on an earlier trip from the blockaded Confederacy.

Another possibility is that a doll was among someone's abandoned personal effects when the ship was hastily abandoned on the morning of May 25, 1865. Someone might have bought the doll in Havana as a toy for their daughter or a fashion template for their wife. In addition, many crewmembers carried merchandise for sale on their personal account. A doll, or the fashion news represented by the doll, might have been a valuable luxury item for the isolated well-to-do inhabitants of Galveston.

Barto Arnold asked Rebecca Bryant of Austin, Texas, to examine the *Denbigh* artifact. She teaches classes on doll making, including casting, firing, and decorating the china doll parts and making the bodies and garments. They decided to replicate an 1860s doll with the likely characteristics of the *Denbigh* example. Ms Bryant produced a completely handcrafted figure with a full set of handmade period clothing—a camisole, corset, pantaloons, slip, hoops, and dress. This replica was featured in the INA display at the Moody Gardens Discovery Museum, Galveston, described in the accompanying article.



On the left is the leg that was found on the wreck site and a newly produced leg. Rebecca Bryant has recreated replica dolls (center and right) as accurately as possible using all known facts. Courtesy of Rebecca Bryant.

2002 Institute of Nautical Archaeology Directors' Meeting

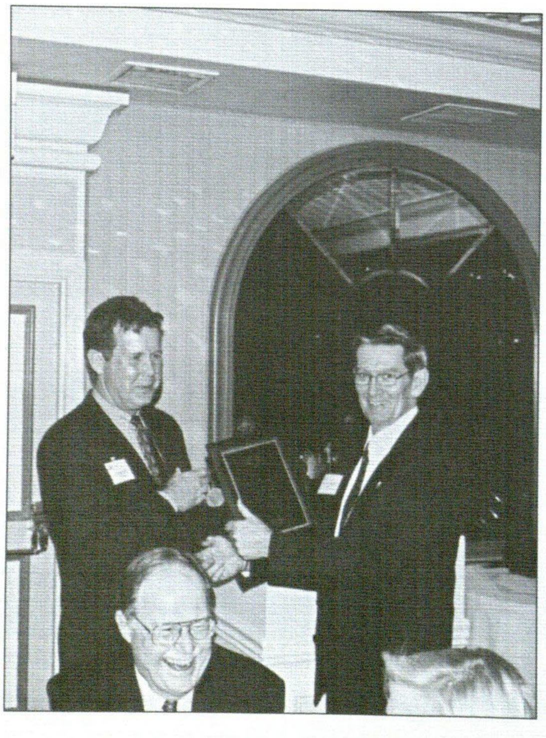
The Mansion on Turtle Creek in Dallas, Texas, provided an elegant setting for the annual meeting of the Board of Directors of the Institute of Nautical Archaeology, January 24–26, 2002. The gathering began with committee sessions on Thursday the 24th. The business meetings of the Audit and Executive Committees, and of the Board itself, followed on Friday. That evening, the Directors, INA researchers, and guests shared the annual banquet of the Institute. They were entertained by a presentation on the recent Turkish survey by George Bass.

On Saturday, the group was informed by a full day of illustrated presentations on recent INA projects. Board Chairman Ned Boshell and President Jerome Hall shared the honors as hosts. Dr. Bass returned to the podium to describe the final season of work at Tektaş Burnu. INA devoted three years to excavating its first Classical Greek shipwreck from the Golden Age. The small fifth-century BCE merchant ship might have shared the sea lanes between Samos and Chios with Pericles and Sophocles. Among the finds were the earliest known lead-core anchor stocks and ceramic eyes from the bow. Although there were no surviving hull remains, the clinched nails at the site suggest that this was a very early example of the standard Greek and Roman construction techniques. Dr. Bass also described the next major Turkish excavation, a wreck from the sixth century BCE, and a few high points of the recent survey. The submersible *Carolyn* found a new shipwreck nearly every day.

Shelley Wachsmann described two projects. His work at Tantura Lagoon on the coast of Israel, where seven wrecks were found within an area the size of a basketball court, is moving towards publication by TAMU Press. More recently, he has been working in some unexpected places. It seems that rice paddies in Portugal may be the most likely place to find well-preserved Phoenician ships. Due to the siltation of ancient harbors, the quayside sites where ships are likely to be found are now all well inland. Dr. Wachsmann has been working in several places where abundant Phoenician ceramic remains suggest the likelihood of finding contemporary ships abandoned near the harbors. There may also be Roman, Greek, native Iberian, and other wrecks from the ancient and early medieval periods. Since Phoenician seafaring was so important for Mediterranean history, and has left so few remains, this project has the potential to provide extremely valuable information.

Barto Arnold gave a presentation on the excavation, conservation, and public outreach efforts centered on the Confederate blockade-runner *Denbigh*. The site is so close to Galveston and Houston that this project has attracted enormous interest with a wide segment of the public. The recovered artifacts are Texas state property, and will ultimately be placed on museum display in the area.

Jerome Hall continues his excavation of the "Pipe Wreck" at Monte Cristi Bay in the Dominican Republic. The coins found at the site suggest that the wreck occurred around 1651–52. The ship was built of English oak felled in the winter of 1642–43 and was carrying a Dutch cargo (including enormous numbers of clay smoking pipes),



Left: *Dr. Donny Hamilton receives a plaque in recognition of his work for INA.*

Below: *Directors, guests, and INA staff enjoy an excellent lunch between presentations on Saturday.*

Photos: D. Frey

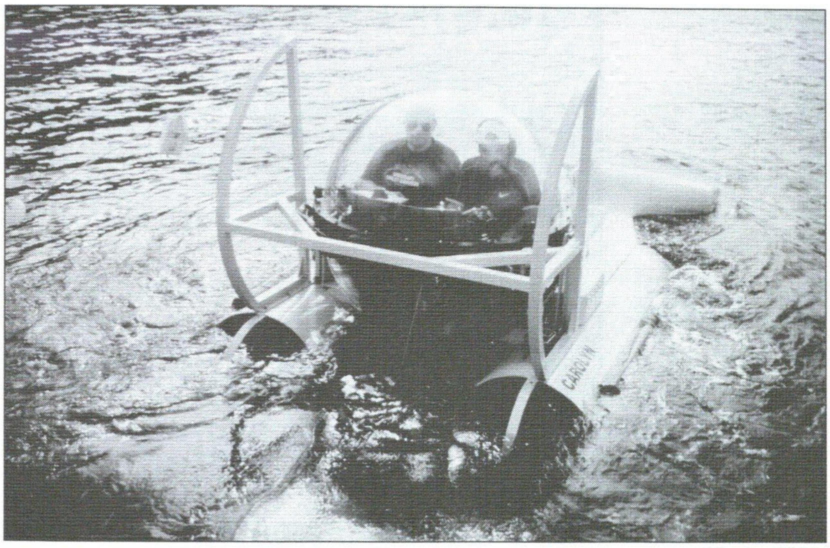


Photo: INA

Above: *The INA submersible* Carolyn *has already performed admirably.*

Photo: F. Alves, CNANS

Right: *Filipe Castro will be continuing his work in the Arade river.*

probably headed for upper New York. The chances are that the ship was at Monte Cristi to trade for meat, tobacco, hides, and salt. The site continues to provide valuable information from the age of most vigorous commercial competition between the English and Dutch.

Kevin Crisman has been working in the Azores since 1996. Although the islands have few decent harbors, their location made them an indispensable stop for ships returning to Europe from the Americas, Africa, and Asia. The combination of dangerous anchorages and high traffic led to over four hundred recorded shipwrecks. A quarter of these were in the vicinity of Angra, mostly between 1492 and 1660. Dr. Crisman's recent excavations and studies of two ships from Angra Bay therefore only represent a first step towards realizing the potential for Azorian nautical archaeology.

Filipe Castro has had three projects underway, all in his native Portugal. He has essentially completed the field work on the Pepper Wreck from the Tagus Estuary, but much remains to be done in the J. Richard Steffy Ship Construction Laboratory at Texas A&M University. The Cais do Sodre Ship from the Age of Discovery was found during construction of the Lisbon subway system. Finally, Dr. Castro is planning surveys and excavations at Arade, which was a major Phoenician, Carthaginian, and Roman port. It also was the site of a battle between Viking and Muslim fleets in 978 CE. Two ships have been found so far, one from the sixteenth to seventeenth century, and a clinkerbuilt hull from around the thirteenth.

Kroum Batchvarov continues his work on the Kiten Shipwreck, the first to be scientifically excavated in Bulgaria or the entire Black Sea. The hull (probably from around the turn of the eighteenth to the nineteenth century) reveals interesting details of construction, but it is hard to make comparisons, precisely because this is the first. The wreck is exceptionally well preserved, showing the potential for future projects in these waters.

Ayşe Atauz continues her survey and excavations in Malta. In addition to her continued work around the Quarantine Hospital and Xlendi, a Norwegian team using a remotely operated vehicle assisted her in carrying out a small survey below the depths accessible to looting by divers. They found an enormous deposit of what appear to be Roman amphoras, far too numerous and too widely scattered to be the remains of a single ship. Ms. Atauz is seeking a reasonable explanation for this phenomenon.

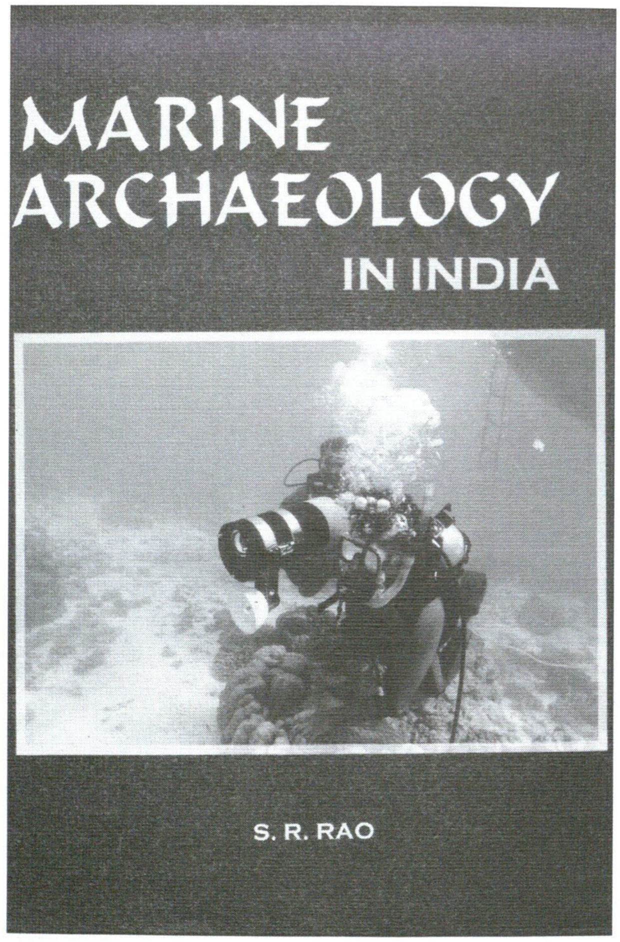
The business sessions ended with a time of remembrance. Directors Sylvia Baird, Frank Darden, Michael Katzev (a co-founder of INA) and Nautical Archaeology Program student, Erkut Arcak ended their earthly voyage this year. President Jerome Lynn Hall led a period of silence, punctuated with a reading from the Rubiat of Omar Khayan.

The Director's meeting ended with a final social gathering Saturday night at the Dallas Country Club. One exciting feature of the meeting was the addition of many new Directors and other contributors to the INA community. The Board forms the core group of supporters who make the work of the Institute possible.

Review

By Christine Powell

Marine Archaeology in India
by S. R. Rao



New Delhi: Government of India, 2001
ISBN 81-230-0785-X, 255 pp, 270 illustrations, notes, biblography, index. Cloth. Price: Rs. 600.00 per copy

Nautical archaeology has a Eurocentric bias. When someone talks about "Classical Archaeology," Greece and Rome are the subject. "Preclassical Archaeology" is about the Mediterranean Basin and the Fertile Crescent of the Near East. However, there are other—and equally classic and ancient—territories that have seen little archaeological attention. The Indian Subcontinent is one of those places.

Among the oldest texts describing sea travel, possibly in the early third millennium BCE, is the *Rig-Veda*. In that same millennium, the Harappan or Indus Valley Civilization was in contact across the Indian Ocean with Sumer and Egypt, when those cultures were still using reed riverboats. At the beginning of the Common Era, the most profitable trading voyages for Roman traders were not within the Empire, but to the Subcontinent. India anchored an active maritime trading network in the Middle Ages that stretched from Zanzibar to Indonesia. First the Portuguese and then the Dutch, French, and British inherited this trade and ran it from local ports. Despite India's rich nautical tradition, Western archaeologists and historians have largely ignored South Asia.

Indians are now stepping forward to fill the gap. Dr. S.R. Rao has been conducting excavations and surveys since 1948, and this lavishly illustrated book gives a broad overview of what he has learned. Among his first work was an excavation of Lothal, at the head of the Gulf of Cambay in Gujarat State, where a Harappan port flourished around 2300 BCE. This included a large tidal dock with locks to maintain the water level and a 240-meter-long wharf, a design similar to that used in the London Docklands some four thousand years later. The capacity of the Lothal dock has been estimated as thirty ships of sixty tons each. Archaeologists have found items in the town from as far away as Ugarit in western Syria. India in the third and second millennia was decidedly not a cultural backwater.

The warm water and energetic storm waves of the Subcontinent are hard on perishable materials such as shipwrecks. Therefore, *Marine Archaeology in India* features port excavations. Roughly half the book is devoted to Dr. Rao's work in the area of Dwarka and Bet Dwarka in northwestern India near the border with Pakistan. The divine avatar Krishna reputedly founded these ancient harbor cities, which prominently feature in ancient Hindu and Buddhist texts preserving traditions from the second millennium BCE. Fortunately for nautical archaeology, the ancient sites have largely subsided into the sea, where they have been preserved from subsequent development. Dr. Rao details his findings, correlating them with the *Mahâbhârata* and other ancient writings in a manner very reminiscent of Heinrich Schliemann's use of the *Iliad*.

Shipwrecks are not ignored, however, in *Marine Archaeology in India*. It includes a chapter that lists many promising sites for surveys and possible excavations. Most of these are from the well-documented eighteenth and nineteenth centuries. Another chapter lists many ancient port sites that might yield ship remains. Throughout the book, there are scattered mentions of rich local shipbuilding traditions that have spanned almost five thousand years. With its long maritime history, India could provide much valuable information in the future to students of hulls and cargoes alike.

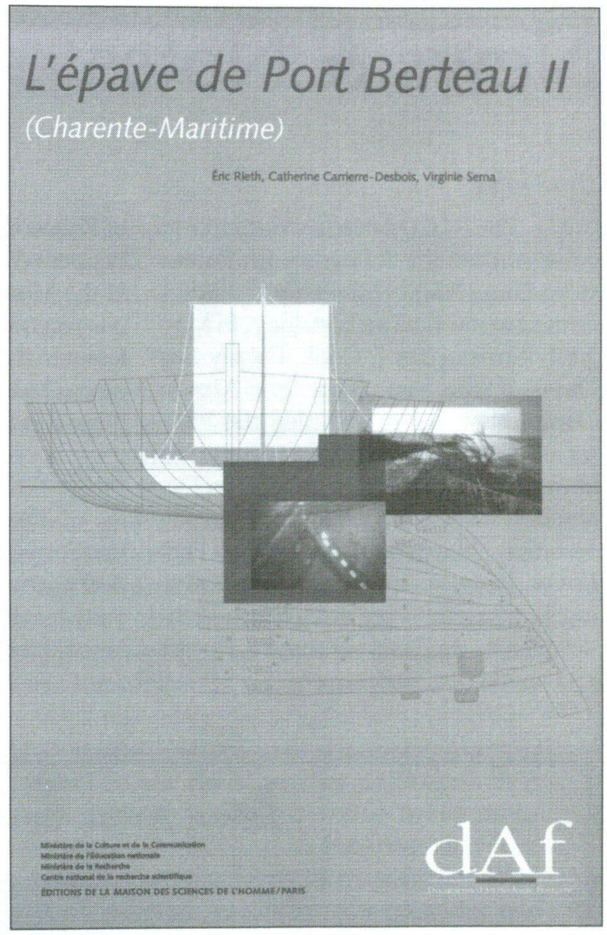
Although the book's organization is somewhat loose and the English is not always idiomatic, the account is informative and entertaining. Dr. Rao clearly targets an audience with a special interest in India who are unfamiliar with the techniques of underwater archaeology, so he repeats much information that would be familiar to readers of the *INA Quarterly*. The many color photographs and diagrams provide commentary to the text that will be particularly useful for those who have not personally participated in an excavation. More experienced readers are not ignored, however. The book provides abundant food for the thought of all those who were previously unfamiliar with India's nautical heritage.

Review

By Filipe Castro

L'épave de Port Berteau II
Éric Rieth, Catherine Carrierre-Desbois, and Virginie Serna

Éditions de la Maison des Sciences de l'Homme, Paris, 2001
ISBN 27351-0807-4: 154 pages, various photographs and drawings, references, bibliography, paperback



INA's Richard Steffy describes this as one of the best recent monographs on ship construction, both because of the subject vessel and the comprehensive presentation. It describes an interesting boat excavated on the right bank of the Charente River in Northwest France. Aiming at the study of both the vessel and the environment in which it was conceived, built, and sailed, the authors present an immense amount of information in four pleasant chapters, written in an organized, clear, and easy style.

The Port Berteau II boat was a small trader built with timbers that were probably felled in the winter of 599–600 CE. Sometime in the seventh century, the vessel was left on the riverbank with the keel up while undergoing repairs or just for winter storage. For some unknown reason, it slid into the river and sank. In time the upturned bottom broke away, and sediment covered the upper part of the hull. The boat's remains were found in 1973, excavated between 1992 and 1997, and studied and reconstructed in 1998 and 1999. It is estimated to have been 14.29 m long and 4.8 m in beam, with a depth in hold of one meter. The shipwrights fastened the planks to the frames with treenails and to the posts with iron nails, at least in the upper works. Empty, with one ton of ballast, the boat displaced about 7.6 tons of fresh water. At full capacity, with the waterline 40 cm below the caprail amidships, it displaced 25.5 tons. The weight of the hull has been estimated at around 5.7 tons, and the total weight of the vessel empty, with rudder, masts, rigging, and anchors 7.6 tons.

The first chapter describes the larger study carried out by the French Centre National de la Recherche Scientifique (CNRS) in which the Port Berteau II vessel took part. Begun in 1971, the project includes a survey and inventory of all medieval sites of archaeological importance along the lower course of the Charente River. This tidal section of the Charente is strongly influenced by the maritime environment and was regularly penetrated by coastal craft. The second chapter studies the Port Berteau II archaeological site in relation to its fluvial environment, both from the physical and cultural viewpoints. The CNRS investigation sought to understand the landscape in which this vessel was built and sailed.

The third chapter is devoted to the shipwreck itself. A comprehensive description of the boat follows the presumed construction sequence, from the posts to the frames and planking, and then from the cross-beams to the decks and steering system. Particular attention is given to the fastening patterns and the runs of the hull strakes for their importance in the determination of the hull shape. A detailed analysis of the preparation of the timbers and the tool marks left by its carpenters completes the study. Vegetable fibers and an organic grease were used to caulk the planking seams, probably pressed into place from the outside.

Eric Rieth proposes a reconstruction of the vessel and analyzes its architectural characteristics in the fourth chapter. He sees these as functions of the many technical, economic, and cultural influences on the builders. A set of lines is proposed, together with a structural reconstruction. Evidence suggests that this vessel was built "frame-first" over a flat keel 10.3 m long. However, the structural importance of the planking, wales, and through-beams is not neglected. A strong case is made for the placement of two strakes over a small number of frames. Running around the turn of the bilge and at the level of the caprail amidships, these two natural runs defined the basic overall shape of the hull. Three appendices present studies on the nails, dendrochronology, and palinology. When I finished reading, I had to agree with Mr. Steffy's enthusiastic assessment of *L'épave de Port Berteau II.*

News & Notes

Graduates

The *INA Quarterly* would like to congratulate the following graduates from Texas A&M University in studies related to nautical archaeology. In May 2001, Christopher J. Cook, Danny Lee Davis, Adam Isaac Kane, and Mason Daniel Miller were awarded the Master of Arts. Madeleine Jean Donachie became a Doctor of Philosophy in December, 2001, after defending her dissertation "Household Ceramics at Port Royal, Jamaica, 1655–1692: The Building 4/5 Assemblage." Luis Filipe Montiero Viera de Castro became a Doctor of Philosophy for his research on "The Pepper Wreck: A Portuguese Indiaman at the Mouth of the Tagus River." He has recently become an Assistant Professor in the Nautical Archaeology Program. Asaf Oron received his Master's degree in December, 2001.

Editor Honored

The *INA Quarterly* Editor, Christine Powell recently represented the Nautical Archaeology Department as noted scholar in the 2001 celebration of the College of Liberal Arts.

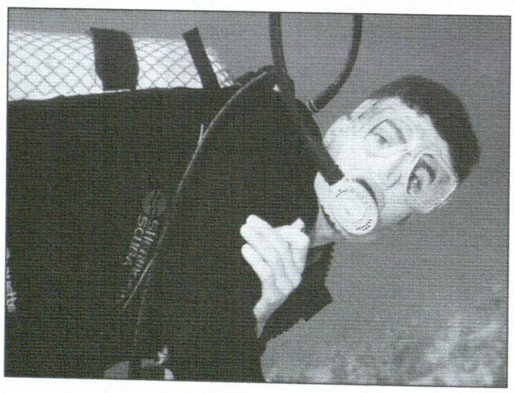
Normandy Update

An hour-long documentary about Brett Phaneuf's work in Normandy will air on BBC2 May 30 and the Discovery Channel June 5. It is called "D-Day Beneath the Waves." An upcoming *INA Quarterly* will carry a comprehensive Normandy article.

Correction

The shipwreck pictured in figures 3 and 4 in the *Quarterly* 28.3:24 is actually an 80–60 BCE Roman shipwreck and not a fourth-century BCE Roman shipwreck as stated.

Erkut Arcak Endowed Graduate Fellowship



With his unfailing reserves of energy and enthusiasm, Erkut Arcak pursued the dream of becoming a Professor of Nautical Archaeology. While earning a degree in his native Turkey, he worked on several INA projects there. In the fall of 1998, he enrolled in the Nautical Archaeology Program at Texas A&M University, where his thesis research was on the Ottoman imperial galley Kadırga. All who knew Erkut foresaw a promising career in the field, frustrated only by his untimely death on June 9, 2001 at the age of thirty (*INA Quarterly* 28.3, 28-29).

In honor of Erkut, family and friends have announced the establishment of the Erkut Arcak Endowed Graduate Fellowship within the Nautical Archaeology Program. This fellowship will help other Turkish students, and students studying the nautical archaeology of Turkey, to fulfill their dreams at A&M.

If you would like to contribute, please contact Cory Arcak at cory@msc.tamu.edu or send contributions to:

Texas A&M Foundation
Erkut Arcak Endowed Graduate Fellowship
401 George Bush Dr.
College Station, TX 77840-2811

Please specify "Erkut Arcak Endowed Graduate Fellowship" on the contribution.

FROM THE PRESIDENT

By now you've probably noticed a stunning difference in the *INA Quarterly,* namely, the cover! It's the first of many changes that our former INA Development Committee suggested we incorporate in coming issues. Along with keeping you up-to-date on our numerous archaeological projects, we want to provide occasional activities that will stimulate your imagination. Hence, the inclusion of a puzzle in this volume of the *Quarterly* that—although not guaranteed to replace the *New York Times* crossword puzzle—will at least challenge your nautical vocabulary and our efforts to develop a series of educational activities. Many thanks to our Editor, Christine Powell, who does a splendid job with each volume, and who now wears an additional hat, that of "Lieutenant" in the "Midshipman's Corner." Please feel free to send us your comments "whatever they be" and let us know how you feel about the scope and quality of the publication. Your readership is important and we value your suggestions.

I'm delighted that this volume of the *Quarterly* brings together several well known scholars in the field of underwater archaeology. We are fortunate indeed to see their articles published in a theme issue on the Civil War. The cutting-edge naval technologies the authors describe invite us to consider how seafaring has shaped the world in which we live. It is sobering to consider that less than one hundred years after its birth, these United States trembled on the brink of dissolution over a series of issues that culminated in one of history's most horrific wars. Yet, when we consider the outcome of that prolonged and dreadful engagement, we must acknowledge that waterborne vessels played no small part in securing and maintaining these united and democratic states.

John Broadwater, Manager of the *Monitor* National Marine Sanctuary, shares with us his experiences with the investigation of *USS Monitor,* the Union ironclad that made history by engaging the *CSS Virginia,* her counterpart within the Confederacy, at the now famous sea battle in Hampton Roads, Virginia, on 9 March 1862. Later that year, in the fury of rising wind and waves, Captain John Pyne Bankhead ordered the red lantern hoisted on the turret, signaling, essentially, the end of this "little cheesebox on a raft" in the early morning hours of 31 December.

Dr. Robert Neyland, a Texas A&M University Nautical Archaeology Program (TAMU/NAP) graduate, heads the team that raised the *Hunley* and is now responsible for its conservation and publication. Several former TAMU/NAP graduates have assisted Dr. Neyland in telling of the valiant efforts of Lieutenant George Dixon and his crew as they sought to turn the tide of Union seapower that fateful night outside Charleston Harbor.

INA's staff archaeologist, J. Barto Arnold, continues to keep you up-to-date on his excavation of *Denbigh*, now in its third season in Galveston, Texas. Barto's persistent work in the zero-visibility water of Galveston Bay has yielded few artifacts, but a wealth of information about the vessel and the role that blockade runners played during the waning days of the Confederacy and the war.

So, enjoy our first colored cover, Conrad Wise Chapman's painting of the Confederate submarine *H. L. Hunley.* As you read through this volume of the *Quarterly,* please know how much we appreciate your support of INA. You, reader, are the heart and soul of this marvelous institution!

All the best,

Jerome Lynn Hall