

HOW THE SUCCESS OF THE CSS *HUNLEY* INSPIRED THE DEVELOPMENT OF
THE UNITED STATES NAVAL SUBMARINE FORCE

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fulfillment of the requirements for the
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MASTER OF MILITARY ART AND SCIENCE
Military History

by

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ABSTRACT

HOW THE SUCCESS OF CSS *HUNLEY* INSPIRED THE DEVELOPMENT OF THE UNITED STATES NAVAL SUBMARINE FORCE, by LT Jesse P. Petty, 109 pages.

The entire nation took notice the moment the news broke of the CSS Hunley's historic sinking of the slope of war Housatonic. More to the point, the hearts and minds of inventors and engineers the world over were captured, and an era of development and innovation had begun. The evening of February 17, 1864, shaped the naval policies and government viewpoints regarding submarine warfare over the course of the next three decades. Extraordinary individuals such as Simon Lake, John Holland, and Thorsten Nordenfeldt were inspired by the events of the American Civil War and developed some of the most technologically advanced machines of the time. These innovators, along with many others, sought to motivate the naval powers of the time to implement this new and unique form of warfare. However, misguided engineers and tragic accidents led to skepticism and delays to innovation. Undaunted, these engineers continued to gain momentum and notoriety for their designs, resulting in the United States Naval Department commissioning the nation's first submarine, the USS Holland.

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CHAPTER 1

INTRODUCTION

During the American Civil War, the odds of victory for the Confederacy had swung decidedly in favor of the Union forces by January 1, 1863. In the following months, all of the Confederate principal armies would be defeated on the field of battle. Lee's army, following its costly victory at Chancellorsville in May, would be tactically and strategically beaten in the Gettysburg campaign. Gen. Braxton Bragg and Lt. Gen. John C. Pemberton would also suffer crushing defeats at Chattanooga and Vicksburg respectively. Pemberton's defeat would prove quite costly as it granted Northern Control of the Mississippi River from St. Louis to New Orleans. Ironically, the largest contributor to the success of the Confederate Navy was the Federal blockade of all major southern ports. This strategy set in motion a chain of events that brought about desperate but groundbreaking advancements in naval warfare that eventually led to the building of the world's first successful submarine.

Southern soldiers with families behind enemy lines were greatly affected, and desertions were quite frequent as a result. This feeling of desperation may have been what drove two sailors to steal a skiff and desert to the Union Army. On January 5, 1864, Seaman Shipp and Belton surrendered themselves to the Federal Navy and provided information about the Confederate Navy's plans of attack which included defense against ironclads, blockade defense, and shore-based batteries.¹ The most intriguing information

¹ Mark K. Ragan, *Submarine Warfare in the Civil War* (Mason City, IA: De Capo Press, 1999), 176.

included details of a steam-powered submersible vessel capable of delivering an explosive torpedo directly to the hull of a ship without ever having come to the surface. Upon receiving this account, Admiral Dahlgren, Commander of the South Atlantic Blockading Squadron, issued specific details on how to combat this type of unconventional warfare. “I have reliable information that the rebels have two torpedo boats ready for service, which may be expected on the first night when the water is suitable for their movement. One of these is the *David*, which attacked the *Ironsides* in October; the other is similar to it.”² Admiral Dahlgren went on to describe the capabilities of the *CSS Hunley*, a technologically advanced vessel capable of breaking through the blockade and delivering a fatal blow to any ship moored in Charleston Harbor. Admiral Dahlgren continues,

The ironclads must have their fenders rigged and their own boats in motion about them. A netting must be dropped overboard from the ends of the fenders, kept down with shot, and extending along the whole length of the sides; howitzers loaded with canister on the decks and a calcium for each monitor. The tugs and picket boats must be incessantly upon the lookout, when the water is not rough, whether the weather be clear or rainy.³

The *CSS Hunley* was a technological marvel. Horace L. Hunley, James McClintock, and Baxter Watson were the innovators and designers behind the Confederate torpedo boat concept that would eventually lead to the sinking of the USS *Housatonic*. The three innovators collaborated on an earlier concept, the submarine

² Official Records of the Union and Confederate Navies in The War of The Rebellion, Series I, volume 15, South Atlantic Blockading Squadron October 1, 1863–September 30, 1864 (Washington DC: United States Naval War Records Office, 1880), 226-227.

³ Ibid.

Pioneer, in 1861 to defend the city against Federal forces, and later constructed two submarines at Mobile, Alabama: the *American Diver* and the *Hunley*. The submarine was taken to Charleston, South Carolina, in August 1863. On February 17, 1864, after many trials and difficulties, including two fatal accidents, the second of which claimed the life of Horace Hunley himself, the refurbished torpedo boat was ready for employment off the coast of Charleston harbor. She had a new captain, LT George E. Dixon, and a crew of seven able-bodied and well-trained sailors. As the sun set on February 17, 1864, LT Dixon watched from a distance as the new sloop, *Housatonic*, bobbed at anchor in the heavy sea off Sullivan's Island.

The USS *Housatonic*, a technological marvel in her own right, was a screw sloop-of-war of the Federal Navy. Named for the Housatonic River in New England, the *Housatonic* was launched on November 20, 1861, at the Boston Navy Yard in Charlestown, Massachusetts. She arrived at Charleston Harbor in September of 1863 and took part in many successful missions along the southern portion of the Confederate blockade including the capture of the *Princess Royal* and the capture of the *Georgiana*. While LT Dixon and his crew patiently waited for the cover of night, Capt. Charles Pickering, Commanding Officer of the *Housatonic*, ordered his crew to keep a vigilant lookout. He ordered his Officer of the Deck, John Crosby, to ensure his six

lookouts understood their immediate actions at the first sign of anything suspicious. They were to send for him at the first sign of trouble immediately.⁴

Once the sun had disappeared over the horizon, Dixon set off with clear intentions of destroying the *Housatonic*. His crew entered the submersible vessel through the forward hatch, and he followed behind. Once inside, Dixon lit a candle to view the compass and ordered his men to crank away on the metal bars which turned the shaft connected to the propeller. These hand cranks were the sole means of propulsion which moved the boat slowly and deliberately to her target. Once the *Hunley* completed her mission, Dixon was to signal the Breach Inlet in the form of a waving lantern which would, in turn, be met with a return beacon which would guide her safely back to shore.⁵

At about 2045, John Crosby saw something peculiar on the water which was initially mistaken for a porpoise. As the form drew closer, it unnerved Crosby; he ordered the quartermaster to look through the glasses. The quartermaster saw nothing, but an instant later saw something penetrate the surface coming towards the ship from the starboard side. Immediately Crosby gave the order to slip the chain and back the engine. The sighting may indicate that Dixon decided to surface for a final observation before proceeding with the final approach. As the *Hunley* drew near the *Housatonic*, lookouts on the starboard side fired their rifles at the mysterious craft that was quickly closing on them. The yelling and rifle fire brought Capt. Pickering to the deck. As he peered over

⁴ “The Loss of the Housatonic,” in *The United States Army and Navy Gazette and Journal of the Regular and Volunteer Forces*, L-1863-'64 (New York: Publication Officer No. 29 Park Row, 1864), 467, accessed December 19, 2016, <https://archive.org/details/unitedstatesarmy00chur>.

⁵ Ibid.

the side, he could see a torpedo fixed at a right angle to the ship and ordered the ship astern. All able-bodied hands, including Pickering, began firing at the torpedo to no avail during the sloop's final moments of life.⁶

An explosion rocked the crew of the *Housatonic* which now had a gaping hole in her starboard side through which frigid water rushed in. Crew members desperately struggled through the rising cold water to find a hatch to escape through. Within three minutes, the *Housatonic* was completely submerged, and five crew members had perished.

Onboard the *Hunley*, the crew undoubtedly felt the shockwave from the explosion caused by the 130-pound torpedo. Reports from the crew of the *Housatonic*, which range in detail due to the high stress of the event, indicated that the *Hunley* was much closer than intended upon detonation of the torpedo. The *Hunley* was equipped with an innovative design for armament, the spar torpedo. The spar torpedo was designed to be affixed to the hull of an enemy ship via a barb much like a harpoon. The torpedo containing 130 pounds of explosives was attached at the end of the spar and fitted with a barb on its end. The spar, made of iron, was mostly hollow and measured seventeen feet in length. The spar was mounted with a y-shaped joint at the bottom of the bow. A wooden boom was used, but only as a support for a line holding the lower spar in place.⁷ The intent was to ram the spar torpedo into the hull of a ship. As the vessel backed away, the torpedo detached from the spar. A tow-line from the torpedo to the submarine would

⁶ Ibid.

⁷ Ragan, 171.

pay out as the submarine backed. The line would detonate the warhead once the submarine was at a safe distance. On February 17, 1864, this innovative design proved successful as the crew on board the *Hunley* furiously cranked the propeller. As the sub pulled away, an explosion assured them their mission was a success.

The follow-on events remain a mystery. The *Hunley* surfaced long enough for Dixon to signal the shore of Sullivan's Island with a blue magnesium light which indicated a successful mission. The shore crew returned signal with fires and anxiously awaited *Hunley*'s return, but minutes after her historic achievement, Dixon and his brave crew were lost to history. Little did Dixon, his dedicated crew, or H.L. Hunley's team of innovators know that this significant and historic achievement would capture the imaginations of innovators and designers around the globe. Additionally, they could not have known that the *Hunley*'s success on the evening of February 17, 1864, would inspire the innovation of submarine design globally, shape the policy and opinions of governments concerning submarine warfare over the course of the next three decades, and lead to the development of the U.S. Naval submarine force. This thesis will describe the inventors, submarines, and events that took place during the decades following the Civil War which link the success of the CSS *Hunley* to the commission of the USS *Holland* on October 12, 1900.

CHAPTER 2

PIONEERS OF SUBMARINE TECHNOLOGY

The destruction of the sloop-of-war *Housatonic*, off Charleston harbor, demonstrates very conclusively that the Rebels have anticipated us in the practical application of engines of submarine warfare. The fact is a mortifying one, but it should invite our inventors to perfect more speedily the appliances which have already been partially developed.

— “Loss of the *Housatonic*,” *Army and Navy Journal* (March 5, 1864)

It is clear that both Northern and Southern forces took notice the moment the news of the *Housatonic* broke. More to the point, the hearts and minds of inventors and engineers the world over were captured spurring and an era of submarine development and innovation. The American Civil War benefitted greatly from the technological advancements of the Industrial Revolution. Railways and telegraphic lines extended the operational reach and lines of communication. Ironclad warships, warships with steam-powered propulsion, torpedo boats, semi-submersible vessels, and underwater mines all saw the first widespread employment during the War of the Rebellion. The strategic use of these technological advancements varied between the Northern and Southern forces. The most glaring difference in strategic use came in the form of the submersible and semi-submersible vessels.

Charleston was the largest port in the South and was home to the strategically important Fort Sumpter. Thus, the focal point of the Northern blockade and naval strategy quickly became the port at Charleston.⁸ As the war progressed, the blockade of the Charleston Harbor became more fortified, allowing fewer blockade runners through.

⁸ *Ibid.*, 8.

The blockade also prevented the Southern forces from receiving war materials from abroad. The South, facing an overwhelming naval presence in the form of the Union blockade, was forced to search for new and unique options for breaking through the blockade. The Confederates also lacked the means to construct a naval fleet capable of taking on the Union Navy on even terms. The strategy formulated by C.S. Secretary of the Navy, Steven Mallory, included the use of armored vessels and underwater mines to disrupt the Union blockade. The Confederates began modifying traditional surface craft to allow for the delivery of torpedoes. Steam powered semi-submersible boats with smokestacks that could be retracted – referred to as “Davids” – also emerged.

The David class torpedo boats were steam powered with a partially enclosed hull. Davids could ballast down to partially submerge which allowed the vessel to conceal itself while attacking an unsuspecting ship. Davids were not true submarines because they were only semi-submersible.⁹ When ballasted, only the smokestack and a few inches of the hull were visible above the water line. David boats had varying levels of success; the most notable of which was an attack on a steamer participating in the blockade of Charleston. On the night of October 5, 1863, CSS *David*, commanded by Lieutenant William T. Glassell, departed Charleston Harbor to attack the ironclad steamer USS *New Ironsides*. The semi-submersible boat approached undetected until she was within fifty yards of the steamer. The CSS *David* plunged ahead to strike as her spar torpedo detonated under the starboard quarter of the ironclad. The explosion sent a high column of water into the air which, when it rained down, extinguished the boiler fires of the

⁹ Farnham Bishop, *The Story of the Submarine* (New York: The Century Co., 1916), 38.

Confederate vessel. With her engine dead, CSS *David* remained alongside the USS *New Ironsides* while small-arms fire rained down upon her.¹⁰ Believing that the vessel was lost, she was abandoned, but the assistant engineer swam back to the craft and climbed on board. The assistant engineer and navigator, who did not abandon the craft because he could not swim, succeeded in getting the torpedo boat's engine working again.

Remarkably, the torpedo boat escaped and navigated up the channel to safety. Seaman James Sullivan and Glassell were captured. USS *New Ironsides*, though not sunk, was damaged by the explosion and one crew member was lost due to a gunshot wound.¹¹

CSS *David* and the CSS *Hunley* were engineering marvels during an era of innovation in warfare. The success of these vessels was the result of almost a century of inventors and engineers willing to risk their finances and their lives. Although this new technology was widely unfamiliar, to say it was untested would be inaccurate. The CSS *Hunley* did not simply shove off from Charleston harbor on the night of her historic voyage without painstaking testing and sound engineering; characteristics that remain at the forefront of the submarine force to this day. The advances and efforts undertaken by

¹⁰ R. Thomas Campbell, *Hunters of the Night: Confederate Torpedo Boats in the War Between the States* (Philadelphia, PA: Burd Street Press, 2001), 166.

¹¹ Official Records of the Union and Confederate Navies in The war of The Rebellion, 12–13.

key inventors, pioneers, and engineers in the time between the American Revolutionary War and the American Civil War were crucial to the CSS *Hunley*'s success.

David Bushnell, a graduate of Yale, designed and built the first submarine to attack an enemy warship.¹² Due to its odd shape and striking resemblance to a sea turtle floating vertically in the water, it was dubbed the *Turtle*. The submarine was operated by Sergeant Ezra Lee during the American Revolutionary War. The *Turtle* was designed to be towed into the vicinity of an enemy vessel; a foot-operated valve was opened to let in enough water to completely submerge and remain buoyant. The valve would then be closed, and the vessel would move in under an unsuspecting enemy ship by cranking the two propellers – one for forward propulsion and one for vertical movement or depth control – turned by a foot pedal. The operator would then drill into the hull to attach a 150-pound keg of gunpowder with a clockwork detonator, crank in the reverse direction to get away, and then operate a foot-pump to de-ballast or get the water out of the hull causing the submarine to re-surface.¹³

On September 7, 1776, in the darkness of the early morning hours, the *Turtle* conducted a historic attack on the British ship, HMS *Eagle*, in New York harbor. The *Turtle* remained undetected upon her approach, but the drill was unable to penetrate the hull of the British warship. There was much speculation as to the reason for the failure – possible the drill hit an iron strap. Sergeant Lee had become disoriented, and soon the vessel bobbed to the surface. Although the *Turtle* was spotted by a lookout, Sergeant Lee

¹² William Barklay Parsons, *Robert Fulton and the Submarine* (New York: Columbia University Press, 1922), 23.

¹³ Bishop, 15.

managed to escape. David Bushnell had successfully proven that not only could a submarine be utilized in naval warfare, but he had demonstrated how the use of positive buoyancy, underwater navigation, and delivery of ordnance could make the submarine a formidable naval war machine.

In 1797, Robert Fulton, a marginal American artist but successful inventor, was living in Paris. He suggested the use of a submarine, the *Nautilus*, to be employed by the French Navy against Britain.¹⁴ Much like the *Turtle* before her, the *Nautilus* traveled undetected under the hulls of British warships and attached a powder charge which would explode upon escape. The French government rejected the idea, believing it an atrocious and dishonorable way to conduct naval warfare.¹⁵ Undaunted, Fulton predicted that this type of warfare would have such an impact on seaman of the day that they would be completely devoid of confidence, rendered useless, and frozen with terror at the thought of such a vessel's destructive powers.¹⁶ In 1800, Robert Fulton was able to build the *Nautilus* at his expense, but expected payment for each British ship destroyed. He made some successful test-dives to depths of twenty-five feet for up to six hours in duration. The vessel was ventilated via a tube to the surface which allowed for longer periods under the surface than her predecessors.¹⁷ His trials were conducted on the Seine and, ultimately, he obtained government sanction for an attack. Her lone voyage was

¹⁴ Parsons, 23.

¹⁵ *Ibid.*, 28.

¹⁶ *Ibid.*, 37.

¹⁷ *Ibid.*, 136.

unsuccessful due to wind and tide issues which enabled two British ships to elude the slow vessel.¹⁸

Nautilus resembled an elongated version of the *Turtle* with a larger propeller. However, Fulton gave her a mast and sail for use on the surface so that she would not have to be towed out to open ocean. In trials, *Nautilus* achieved a maximum sustained underwater speed of four knots which was comparable to the *Turtle*.¹⁹ Fulton was given the rank of rear admiral and made several attempts to attack English ships, but he was unable to achieve the same level of undetected success as the *Turtle*. British ships saw him coming and simply moved out of the way. Relationships with French government officials quickly deteriorated, and Fulton broke up *Nautilus* and sold it for scrap. The name "Nautilus," immortalized by Jules Verne in 1870 in his novel, *20,000 Leagues under the Sea*, has been given to several submarines – including the world's first nuclear-powered submarine, the USS *Nautilus* in 1954. After the death of Robert Fulton in 1815, no significant developments in undersea warfare were made until the commencement of the American Civil War.²⁰

In 1900, the year the USS *Holland* was commissioned, a noted German marine engineer and naval architect Carl Busley, published a critique on the subject of submarine warfare and construction that he read before the German Society of Naval Architects and Marine Engineers that same year. A portion of this critique was cited in the *Engineer and*

¹⁸ *Ibid.*, 148

¹⁹ *Ibid.*, 34.

²⁰ Herbert C. Fyfe, *Submarine Warfare Past and Present* (London: E. Grant Richards Publishing, 1907), 117.

Chief of the United States Navy, Rear-Admiral George W. Melville's article "The Submarine Boat: Its Promises and Performance.

Of all the branches of ship construction, the ignorant have devoted most of their energy to the designing of submarine boats. Furthermore, it is noticeable what little interest in construction of this kind has been taken by legitimate builders and designers in the different shipyards of all countries in past years. Latterly, the navies of several countries have interested themselves in the question as to the outlook of the submarine boat in naval warfare; and, since then, the builders have taken a more earnest interest in the different questions, so that it is possible to tabulate the different qualities and properties which the modern submarine boat requires.²¹

Although Carl Busley did not believe that submarine boat technology would be the future of naval warfare in Germany, he was correct in his assumption that only qualified engineers with a background in shipbuilding should be taken seriously in the construction and design of submarine technology. These shipbuilders must also qualify their inventions with specific properties associated with submarine boat construction that will ensure success. What were these properties? Clearly the ability to sustain life while submerged is an obvious characteristic that need not be explored, nor is the ability to simply submerge. Every vessel ever designed or built can become a submarine at least once. However, the capacity to submerge in a controlled manner and remain in control of one's buoyancy for an extended period is a vital characteristic, as is the ability to submerge with a source of breathable air. Basic principles of hydrodynamic design of the hull and its construction are a key property along with a propulsion system, and navigation.

²¹ George W. Melville, "The Submarine Boat: Its Promises and Performance," *The North American Review* 172, no. 533 (1901): 586-587.

Buoyancy

From the very early designs of the submarine much effort and research was conducted to ensure that a vessel could fully submerge in a body of water, perform a function, and return to the surface when desired. The science behind this research was one of buoyancy and positively or negatively controlling buoyancy to control descent. David Bushnell and his design of the *Turtle* mastered the method of controlling buoyancy through lead plates fixed to the bottom of the vessel to control the depth.²² It was not until John P. Holland began experimenting with his early designs did math begin to support the science behind ballasting submarine boats. Holland was an Irish engineer who developed the first submarine to be formally commissioned by the U.S. Navy, as well as the first Royal Navy submarine. He experimented with the ideas of positive buoyancy with his first design of the *Fenian Ram*, built in 1881. The *Fenian Ram* was designed for use by the Fenian Brotherhood, the American counterpart to the Irish Republican Brotherhood, against the British. The boat's construction and launching were funded by the Fenians' Skirmishing Fund. The *Ram* was officially *Holland Boat II*, but the role of the Fenians in its funding led to the New York *Sun* naming the vessel the *Fenian Ram*. The vessel did not take on ballast until she sank like other contemporary submarines; rather, she maintained positive buoyancy and simply tilted her horizontal planes so that her forward motion forced her under. The positive buoyancy maintained by the *Ram* was critical to controlling her descent and was a feature exclusive to the *Fenian Ram*. The issue of longitudinal stability plagued contemporaries such as Goubet in

²² Bishop, 15.

France, and future rivals Garrett and Nordenfeldt. Holland's fundamental principle relied on a fixed center of gravity and a constant reserve of centrally located positive buoyancy.²³

Holland understood that a controlled descent not only relied heavily on the ability to control ballast being brought into the vessel but that it was also important to control the stability of the boat by understanding the center of gravity and center of buoyancy and their effects. Center of gravity is the point in a body where the gravitational force may be taken to act, whereas the center of buoyancy is the center of gravity for the volume of water which a hull displaces.²⁴ Holland understood through his testing of his first submarine design, *Holland Boat I*, that when the vessel was upright the center of gravity and center of buoyancy are on the same vertical line, making the hull stable. When the boat tilted at an extreme angle, the center of buoyancy moved to a position where the center of buoyancy and center of gravity created a moment that worked in the same direction which would cause the vessel to capsize. By moving the hydroplanes to the after portion of the boat and distributing weight via tanks throughout the submarine, he was able to maintain buoyancy while submerged and affected a change in the center of buoyancy.²⁵ The principle of submergence through porpoising, first introduced by Robert Fulton's *Nautilus*, was the basis for all of Holland's designs. Holland believed this to be

²³ Richard Knowles Morris, *John P. Holland, 1841–1914: Inventor of the Modern Submarine* (Columbia, SC: United States Naval Institute, 1966), 39.

²⁴ *Ibid.*

²⁵ *Ibid.*

the most efficient way for a submarine to submerge.²⁶ He had many failed attempts with lateral hydroplanes as a means of even keel submergence, but found them to be cumbersome, restricted speed, and required too much power to submerge the submarine.²⁷

Survivability

Another principle key to the successful operational submarine is the ability to submerge with a source of breathable air for a considerable amount of time. Simon Lake, an American inventor, engineer, and naval architect who obtained hundreds of patents for advances in submarine and naval design famously experimented with compressed air, extending the longevity of the crew to remain underwater. Lake, considered one of the fathers of the submarine navy, also competed with John Holland to design and build the first submarine for the United States Navy. In his book, *The Submarine in War and Peace*, Simon Lake stated,

The question of air supply was at one time one of the most difficult problems to solve on paper with which early experimenters with submarines had to contend. There was no exception in my case. I thought it would be possible to remain submerged only a short time unless I provided some sort of apparatus to extract the carbonic acid gas and restore oxygen to the air after breathing and exhaling the air in an enclosed space like a submerged vessel. I took up the question with various physicians and with a professor of physiology at Johns Hopkins University, and, according to their information and textbooks, it would be a very difficult matter to carry sufficient air to remain submerged without change of air except for a very short time.²⁸

²⁶ Ibid.

²⁷ Ibid.

²⁸ Simon Lake, *The Submarine in War and Peace* (Philadelphia, PA: J. B. Lippincott Co., 1918), 49.

Simon Lake performed an experiment in which he sealed himself inside an air-tight box. All research conducted at the time stated that a human required anywhere from fifteen hundred to three thousand cubic feet of air per hour. Lake's box was only twenty-four cubic feet. Lake was determined to find how little air a human required in order to extend the amount of time a crew could remain submerged before all of the supplied air would be converted into carbonic acid gas and the crew would suffer dire effects. After forty-five minutes in the box, Simon Lake determined that half of the air had been consumed by lighting a match and measuring the height of flame at varying heights within the box. This experiment proved that the longevity of the air within a submarine could be extended far beyond what was previously thought. Simon Lake's method for controlling the amount of breathable air onboard through compressed air tanks was hardly a novel concept. However, his methods of controlling and measuring the amount of breathable air within the submarine were innovative. Lake recalled his experiments with the box in his early testing of some of his submarine designs:

On completing the *Argonaut* in 1897 we amplified these experiments, five men remaining hermetically sealed in the *Argonaut* for a period of five hours without admitting any air from our air storage tanks, and later on in the *Protector* eight men remained submerged for twenty-four hours, no fresh air being admitted during the first twenty hours. As the volume of air space in the *Protector* was about three thousand cubic feet, this averaged about eighteen cubic feet per man per hour. Without the definite knowledge of my previous box experiment it is very doubtful if the crew would have consented to remain submerged so long without renewing the air supply, so great is the effect of imagination.²⁹

²⁹ Ibid., 50.

Propulsion

Propulsion is a critical principle for a submarine to be considered a successful design. Early designs of man-powered foot pedals and hand-cranked propellers had their place in history as innovations of their time. However, for a submarine to be considered a marvel of modern technology, drastic improvements in propulsion were required in the period following the American Civil War. For the submarine to be considered an instrument of war, the propulsion system needed to compete with the steam-powered war machines that occupied the navies throughout the world. In 1874, John Holland had already begun production on his first submarine design, the *Holland Boat I*, when he decided to move his operation to an engine shop in Peterson, New Jersey. The reason for this transfer of the operation was to begin installation of the newly patented petroleum engine designed by George Brayton.³⁰ George Brayton was an American mechanical engineer who lived with his family in Boston and had recently introduced the constant pressure engine. This engine was the basis for the gas turbine, and his design of constant pressure is now referred to as the Brayton cycle.

Brayton cycle engines were some of the first internal combustion engines used for motive power. John Holland used a Brayton engine to drive the *Holland Boat I*, which became one of the world's first self-propelled submarines.³¹ A principle obstacle which plagued engineers since the earliest submerged tests of Van Drebbel in the Thames River

³⁰ Morris, 27.

³¹ Ibid., 31.

in the 1620s was propulsion power.³² The discovery of a petroleum engine which could replace the man-powered vessels of the day held promise. Although Holland saw limitless possibilities in this new found technology, he was not without skepticism and went to great lengths to ensure that his initial tests of *Holland Boat I* did not fail due to propulsion related issues. The Brayton engine did not live up to Holland's expectations regarding the specifications claimed by the designer. The two-cylinder engine was mounted on an angle iron in the central compartment with slide valves which opened into a single pressure chamber. The issue was that nothing seemed to work to induce the engine to explode gasoline once the vessel was submerged.³³ Holland, refusing to be defeated, attached a rubber hose to the top pressure chamber and ran it through a water-tight hole. The hose was run over the side of a small steam launch operated by an engineer that assisted Holland during production and testing of *Holland Boat I*. Although initial tests of the Brayton engine did not go smoothly, Holland was not deterred. Holland believed that the Brayton petroleum engine could be perfected despite the fact that it was a failure during testing. Holland was no longer limited to propulsion through foot pedals or manual power as were his predecessors.³⁴

During the following decade, Holland continued to experiment with petroleum-based engines to power his designs. After experiencing difficulties with Plunger, his fifth submarine, Holland began work on his follow-up, the Holland VI. For this design,

³² Parsons, 7.

³³ Morris, 29.

³⁴ *Ibid.*, 32.

Holland utilized a small, lightweight gasoline engine for propulsion. The engine turned a propeller while the boat was surfaced, and ran a generator to charge batteries which were necessary to run an electric motor while submerged.³⁵ Ultimately, Holland's efforts proved successful, and he was able to persuade the Navy in April of 1900 to purchase this submarine.

John Holland was not the only inventor determined to improve upon a means of submerged propulsion. In 1878, the *Resurgam*, a small submarine which maintained equilibrium through pushing water into a cylinder and forced it out with a movable piston, was built by Mr. G. W. Garrett of Liverpool. Garrett followed this design with a larger vessel called the *Resurgam II* which utilized forward diving rudders as the primary means depth control similar to the Confederate *Hunley*. The *Resurgam II* also had a novel means of propulsion which included a large steam boiler that stored heat while submerged which allowed the vessel to make submerged runs of several miles before the fires shut down. Unfortunately, the *Resurgam II* was lost during experimental testing in 1880.³⁶

In 1885, Prof. Josiah L. Tuck built a submarine called the *Peacemaker*. The *Peacemaker's* lone contribution was a caustic soda boiler for generating steam for submerged operation. Tuck's design, however, was not ideal because it did not have diving planes and the captain commanded the submarine while wearing a diving suit with no conning tower. A disaster nearly took place during one of her test runs in 1885, when

³⁵ Ibid., 81.

³⁶ Lake, 158.

water leaked through the gasket of the clutch. A hysterical member of the crew had to be subdued, and Tuck, left with very little option, struck the crew member with a hammer when the crew member could not be calmed. With that, Professor Tuck simply flooded the hull to equalize pressure within the vessel allowing the crew to escape.³⁷

Torpedo Delivery

The ability to deliver munitions was also improved in the decades following *Hunley's* spar torpedo. Thorsten Nordenfeldt built a pair of thirty meter long submarines with twin torpedo tubes for the Ottoman Navy – *Nordenfeldt II* in 1886 and *Nordenfeldt III* in 1887. *Nordenfeldt II* became the first submarine in history to fire a torpedo while submerged under water.³⁸ Nordenfeldt improved on his designs in 1887 with the *Nordenfeldt IV*, which had twin motors and twin torpedo tubes.³⁹

Navigation

Lastly, navigation proved to be the most difficult principle to master in the decades following the American Civil War. Experimentation in the areas of depth control, stability, and propulsion continued throughout the world, but advances in navigation seemed to plague almost all who ventured into submarine design. Simon

³⁷ Morris, 84.

³⁸ Fyfe, 223.

³⁹ *Ibid.*, 224.

Lake's solution to this problem appears to be rudimentary when compared to his contemporaries:

Like Mr. Holland, I also had difficulty on our first submergence in always knowing where we were going. Our compass was first installed in the boat itself, where it was surrounded by steel. The compass adjuster had searched for and found what he considered the most neutral place in the ship to install the compass, and had adjusted it by magnets in the usual manner, but it was too "loggy" for 180 correct navigation and we were forced finally to install it in a bronze binnacle directly over the conning tower, where it could be viewed by mirrors from the steersman's station. This cut out most of the adjusting magnets, and the compass was nearly accurate on all courses. Submarine navigation - thus became reliable.⁴⁰

Holland's solution to submerged navigation was a little more scientific. Holland tested his *Fenian Ram* time and time again attempting to perfect the principles and effects of the center of the buoyancy on the vessel; however, the tests were compromised by the difficulty of steering a straight compass. When the submarine dove at an inclination of greater than fifteen degrees, the compass needle would swing around rapidly and become unreliable. Once the submarine leveled off on an even horizontal plane, Holland found that he would be up to ninety degrees off course. The erratic action of the compass was due to the incline from a horizontal position when diving. It could not be corrected in his early designs because the compass needle position was mounted near the considerable masses of iron that were likely to have their position changed while the vessel was submerging.⁴¹ Holland's solution came in the form of a feature of his own design, a patent for triangular drag. This feature, which kept the submarine on course when under water, utilized a hand steering gear and drag against the rudder while diving to maintain

⁴⁰ Lake, 180.

⁴¹ *Ibid.*, 165.

course. If any course adjustments were made during this ascent, the drag would produce a swinging motion against the rudder, and the rudder would turn in the opposite direction which would return the submarine to her original course.

A contemporary of John Holland and Simon Lake, Isaac Peral had been working on solving the problem of underwater navigation. In 1884, Lieutenant Isaac Peral y Caballero submitted a design for a submarine boat, the *Peral*, to the Spanish Navy. The *Peral* was the first electric battery-powered submarine and the first fully capable military submarine with one torpedo tube and an air regeneration system. She was also the first submarine to incorporate a fully reliable underwater navigation system. In order to navigate, the *Peral* utilized a bronze magnetic needle installed in the ceiling of the turret. This design eliminated any electrical interference to compass driven navigation. Peral also devised a periscope, which was a fixed tube on the turret. This periscope utilized a series of prisms, which would project images within the submarine. However, conservatives in the Spanish naval hierarchy terminated the project despite two years of successful tests.⁴²

Even after the United States commissioned the USS *Holland* in 1900, many senior leaders within the U.S. Navy remained skeptical of her ability to accurately navigate while submerged. Rear-Admiral Melville, who was one of these skeptics, wrote,

The inherent defects which confronted the inventors of a hundred years ago still exist in the submarine type. Broadly speaking, the craft is still without an eye to direct her movements. The compass on a submarine boat must, of necessity, be an

⁴² Fyfe, 280.

unreliable instrument. As it must be placed near masses of iron or steel which are liable to be moved, there must be a constant change of directive force.⁴³

Although Rear-Admiral Melville was correct in his assessment of difficulties in submerged navigation that plagued engineers throughout the preceding decades, there is no record of the USS *Holland* having any navigation-related issues throughout her service life.

The decades following the American Civil War were the most productive regarding submarine design, development, and innovation. No other period in history saw engineers and inventors from around the world design instruments of war with an eye for innovation and science as was seen in the 1870s through the 1890s. Contemporaries pushed the bounds of previous notions to develop new concepts of buoyancy in water: transfer of weight, the stability of an object in motion, hull design, means of propulsion, and innovative approaches to navigation. Without these basic principles, and the innovations seen during the era, the United States would not have considered submarine warfare as a viable means of naval warfare for some time.

⁴³ Melville, 588.

CHAPTER 3

SETBACKS TO INNOVATION

If some of the large number of experimenters who endeavored to construct submarine boats since that time had contended himself with closely copying the valuable features of Bushnell's vessel, instead of starting out with radically new and plans, and without having any experience to guide him, we should have had success to record instead of an almost unbroken list of failures.⁴⁴

— John P. Holland, Inventor of the Modern Submarine

Many successes in submarine warfare design, development, and innovation took place in the decades following the American Civil War. Inventors such as George W. Garrett, Thorsten Nordenfeldt, and Josiah L. Tuck and engineers such as John Holland and Simon Lake, who are considered the fathers of submarine warfare, were keys to these developments. These innovators were inspired by the brave actions of LT Dixon and his crew of the *Hunley* and the immortal words of Jules Verne who brought submarines to full public consciousness in his novel *Twenty Thousand Leagues Under the Sea*.⁴⁵ A submarine-wielding tyrant, Captain Nemo, employed his *Nautilus* to sink the then-fictional USS *Abraham Lincoln*. Verne's research was remarkable in that he even computed the compressibility of seawater as .0000436 pounds per square inch for each 32-feet of depth. Given all of the awe-inspiring innovation, one would assume that governments and naval powers the world over would employ these inventors and engineers to design and construct these fascinating machines of modern warfare to build

⁴⁴ Morris, 5.

⁴⁵ Ibid., 6.

an unmatched naval power. However, forward thinking minds were few and far between. Skepticism regarding the utility of the submarine was prevalent around the world.

Most inventors, some of whom held hundreds of patents in the area of submarine design, were unfunded and ignored by governments and admiralties throughout the world. Most of these pioneers used private financial backing or funded the projects themselves hoping that their governments would become enlightened to the prospect of having a silent and formidable vessel protecting their harbors and defending their warships. In almost all cases, this did not occur and these innovators either moved on to more lucrative endeavors, or completely lost their savings. What obstacles did these pioneers have to overcome? Why did it take so long for governments to support this form of warfare? In fact, the reason governments did not put much stock in submarine employment had as much to do with the failures of these inventors as it did their successes. This chapter will explore the almost comical failures of some the lesser and well-known inventors, along with the horrific tragedies that occurred while testing these newly designed vessels to give a clear understanding of the viewpoints of the major naval powers of the era, and the decisions governments would make regarding submarine technology and employment.

LT Dixon and his courageous crew have been immortalized in books and film for their brave actions on the night of February 17, 1864. Tragically, however, LT Dixon and his crew were not the first crew of the *H.L. Hunley*, nor were they the first crew to lose their lives in an effort to prove that the submarine had a future in naval warfare. In August of 1863, as the Union pounded Charleston with cannon fire, growing angst among Confederate defenders could only be abated with a decisive naval victory. The

leadership of the Confederate military viewed Horace Hunley and his small group of engineers as prominent businessmen, with too little military or naval experience to be in control of a weapon that had the potential to save Charleston from the Union attack. Thus, the Confederate military seized the torpedo boat and turned it over to the Confederate Navy.⁴⁶ On August 29, 1863, the Confederates, now in control of the *Hunley*, gathered a volunteer crew of men to man her. The captain of the small submarine was Lieutenant John A. Payne, a veteran of the Confederate Navy assigned to the Charleston-based ironclad *Chicora*, who along with eight brave civilian men volunteered to man this odd cigar-shaped vessel in the hopes of breaking through the Union blockade at Charleston.⁴⁷

After weeks of preparation, the *Hunley's* volunteer crew with a naval officer at the helm, prepared for a nighttime attack on a Union warship. However, disaster struck and the *Hunley* submerged off the end of Fort Johnson wharf and did not recover. Four crew members escaped the submarine and swam to shore, including LT Payne; the other five drowned.⁴⁸ A surviving crew member, Charles H. Hasker, later reported that LT Payne inadvertently stepped on the lever controlling the dive planes which caused the submarine to submerge while her hatches were still open, which flooded the vessel.

Hasker recalled his experience with Simon Lake years later,

She had been trimmed down so that she had very little freeboard, and as she gained headway she started to "shear," due to her peculiar flatiron-shaped bow. Lieutenant Payne, who was in command, attempted to throw the towline off the

⁴⁶ Ragan, 138.

⁴⁷ *Ibid.*, 141.

⁴⁸ *Ibid.*, 143.

hatch combing, but got caught in the bight of the line. On his struggle to free himself he knocked a prop from under the tiller of the horizontal diving rudder, which had been set to hold the bow up. As soon as the prop was knocked out the tiller dropped down and inclined the horizontal rudder to dive, and the vessel dove with her hatches open.⁴⁹

The Confederacy was undaunted. Within seventy-two hours of the fatal accident, work began to salvage the *Hunley* and exhume the crew members from their iron coffin. The *Hunley* needed a second crew for a second attempt to attack the Union blockade. Horace Hunley urged the Confederate Navy to man the sub with a crew from Mobile who was familiar with the *Hunley's* operations in order to avoid a second catastrophe.⁵⁰ Hunley went straight to the machine shop where the submarine had been designed and built in order to enlist a crew to man the vessel. Hunley was in charge of operating the vessel along with eight employees from the machine shop in Mobile, but even their experience proved futile. On October 15, 1863, the *Hunley* submerged while testing operations in a routine diving exercise. Yet again, an accident occurred, and all eight men on board, including Horace Hunley himself, lost their lives.⁵¹ The ill-fated *Hunley* was once again salvaged. The salvage team was shocked to find that the *Hunley* sat on the ocean floor bow down at a thirty-degree angle. The *Hunley* had plowed nose-first into the seabed.⁵² Little is known about the accident itself, but it appeared that the forward ballast tank had filled and spilled over the top causing the bow to become far heavier than could

⁴⁹ Lake, 38.

⁵⁰ Ragan, 130.

⁵¹ Official Records of the Union and Confederate Navies in The War of The Rebellion, 692.

⁵² Ragan, 144.

be overcome. Despite the second fatal tragedy concerning this small torpedo boat, a new crew of volunteers stepped forward. LT George Dixon would command the *Hunley* and her crew on what would become her historic final mission.⁵³

In all, the *Hunley* claimed the lives of twenty-one brave young men in her attempt to prove to the world that submarine warfare could be employed to defend or attack unsuspecting surface vessels. In that regard, the *H.L. Hunley* was successful. However, skeptics such as Admiral O'Neil, the Chief of the Bureau of Ordnance of the U. S. Navy Department and a well-known submarine skeptic, was quoted in Rear-Admiral George Melville's article, "The Submarine Boat: It's Promises and Performances," saying the submarine had "never shown the ability to do anything more than run at a slow speed on the surface and make submerged runs of short duration at much slower rate of speed, always, in carefully selected localities, and under most favorable conditions. This is the sum of her performances, which I am unable to accept as sufficient evidence that such boats are useful and efficient instruments for naval purposes."⁵⁴ For submarine technology to become more than a footnote to an era of innovation in warfare, innovators the world over would have to overcome the opinions of influential individuals such as Admiral O'Neil. Sadly, the failures of these innovators fueled these opinions even before the Civil War had concluded.

The North's envisioned use of the submarine differed significantly from the Southern vision. The Union saw opportunity in the concept of submarine warfare, not as

⁵³ Official Records of the Union and Confederate Navies in The War of The Rebellion, 799.

⁵⁴ Melville, 585.

a weapon of modern warfare, but as a vessel that could be made to do much heavy lifting required to better position the instruments of war in a naval battle. The opportunities for the Union to use the submarine as an offensive weapon were far fewer. Union naval planners determined that the submarine was better suited for destroying underwater obstructions in southern harbors, or salvage operations.⁵⁵ However, in the autumn of 1861, the United States Navy employed the firm of Neafie & Levy to build a submarine based on the design by the French engineer Brutus de Villeroi. Villeroi also acted as a supervisor during the first phase of the construction. According to Herbert C. Fyfe, from the Royal Institution of London, “In particular the North desired to blow up the Confederate Merrimac in Norfolk Harbor. It has been stated that \$10,000 was to be paid for the boat when finished and an additional \$5,000 for each successful attack with her.” Fyfe continues, “Before they [Federal Navy] could learn the art of navigating the vessel the Frenchman, taking his gains with him, left the country.”⁵⁶ This investment with no return could have been a contributing factor to the U.S. Naval Department’s reluctance to invest in submarine development in the coming decades. Another exception to the Union’s submarine employment was a submarine expedition launched up the James River in 1862.⁵⁷ According to the Farnham Bishop, author of *The Story of the Submarine*,

The North had a hand-power[ed] submarine that was built at the Georgetown Navy Yard in 1862. It was designed by a Frenchman, whose name is now forgotten but might have been a contemporary of Cornelius Van Drebbel [A Dutch engineer and builder of the first navigable submarine in 1620.] Except that its hull was of steel instead of wood and greased leather, this first submarine of

⁵⁵ Ragan, 257.

⁵⁶ Fyfe, 187.

⁵⁷ Ragan, 255.

the United States Navy was no better than the eel-boat of the seventeenth century.⁵⁸

The vessel Bishop was unceremoniously referencing was the *Alligator*.

The *Alligator* was not of the same design as the *Hunley*, but it would serve a similar purpose. Built of steel plates, she was thirty-five feet long and six feet in diameter. The *Alligator* submerged by bringing ballast into tanks similar to the *Hunley* but was propelled via eight pairs of oars that extended through the hull. Sixteen men operated the oars that opened and shut like leaves in a book, which was able to achieve two knots while submerged. The *Alligator* was not an advancement in submarine innovation at the time, but the oxygen system was a state-of-the-art design and was the first operational submarine to have an air purifying system. This system was the *Alligator*'s lone contribution to the science of submarine warfare and design. On July 3, 1862, the *Alligator*'s oars were replaced with a hand-cranked screw propeller at the Washington Navy Yard, thereby increasing her speed to four knots.

On March 18, 1863, President Lincoln observed the submarine in operation along with Rear Admiral Samuel Francis Du Pont who became interested in the submarine while in command of the Philadelphia Navy Yard early in the war. Lincoln decided that the *Alligator* might be useful in carrying out his plans to take Charleston, South Carolina, the birthplace of secession.⁵⁹ Du Pont heavily promoted engineering studies at the United States Naval Academy, to enable more mobile and aggressive operations. During the war, he played a significant role in making the Union blockade effective. However, Du Pont

⁵⁸ Bishop, 41.

⁵⁹ Ragan, 70.

was controversially blamed for the failed attack on Charleston, South Carolina, in April 1863.⁶⁰ On March 30, 1863, Rear Admiral S. P. Lee, acting Commander of the Northern Blockading Squadron, in correspondence with the U.S. flagship *Minnesota*, ordered the *Alligator* towed to Port Royal for employment.

Choose favorable weather and proceed on your way to Port Royal, agreeably to your orders from the Navy Department. You will take in tow a submarine boat *Alligator* and deliver her to Rear Admiral Du Pont on your arrival. On your way down you will communicate with one of the blockading vessels off Washington and deliver the articles and dispatches entrusted to you for that portion of this squadron.⁶¹

Acting Master John F. Winchester, who then commanded the *Sumpter*, was ordered to tow the submarine to Port Royal, South Carolina, and the pair got underway on March 31. On April 2, 1863, inclement weather forced *Sumpter* to cut *Alligator* adrift off Cape Hatteras thus ending the Federal Navy's foray into submarine warfare during the war.⁶² This failure, no doubt, left a lasting memory of failure in the minds of many senior leaders within the U.S. Naval Department.

In the time following the conclusion of the Civil War scarcely a year went by without a newly designed and constructed submarine. In 1916, author Farnham Bishop described these designs,

Some were surprisingly good, others were most amazingly bad, but none of them led to anything better. Inventor after inventor wasted his substance discovering what Van Drebel, Bushnell, and Fulton had known before him, only to die and

⁶⁰ *Ibid.*, 109.

⁶¹ Official Records of the Union and Confederate Navies in The War of The Rebellion, 636.

⁶² Ragan, 102.

have the same facts painfully rediscovered by someone on the other side of the earth.⁶³

The most glaring example of this lack of progress which led to cynicism within the United States government was Oliver Halstead's *Intelligent Whale*.

The *Intelligent Whale* was a hand-cranked submarine, built on the design of Scovel Sturgis Merriam in 1863 by Cornelius Scranton Bushnell (unrelated to David Bushnell from *Turtle* fame).⁶⁴ Cornelius Bushnell was an American railroad executive and shipbuilder who was instrumental in developing ironclad ships for the Union during the Civil War.⁶⁵ However, Bushnell was no longer involved in the *Intelligent Whale* by the time any actual attempts to deploy the vessel were made. In April 1864, the American Submarine Company took over the construction of the vessel from Bushnell, but construction was delayed, and the building cost overran the initial estimate by \$45,000. This led to a series of lawsuits which further delayed completion.⁶⁶ On September 23, 1865, the trustees of General Nathaniel Norris Halstead and Col. Edward W. Serrell in

⁶³ Bishop, 56.

⁶⁴ Ibid.

⁶⁵ James P. Delgado, *Misadventures of a Civil War Submarine* (Collage Station, TX: Texas A&M Press, 2012), 69.

⁶⁶ Lake, 156.

Newark, New Jersey, received a decision granting them control of the *Intelligent Whale*. Halstead was able to bring the construction of the project to completion by April 1866.

Many viewed the craft to be no more modern or “intelligent” than Fulton’s Nautilus more than sixty years prior.⁶⁷ The *Whale* submerged by dropping two anchors to the ocean bed and warping the submarine down to the desired depth. The fat, cigar-shaped vessel used manpower to crank the screw and had the ability to release a diver from a hatch built into the bottom. The diver would then attach a mine to the hull of a hostile ship.⁶⁸ On the strength of a few successful trial runs, and the backing of Bushnell, the United States Naval Department appointed a commission comprised of senior leaders. Commodore C. M. Smith, Commodore Augustus L. Chase, Chief of the Bureau of Ordnance, and Edward O. Mathews, Chief of the Torpedo Board, were appointed to examine the merits of the *Intelligent Whale* and provide feedback as to whether the U.S. Navy should further their interest in the vessel. The appointed commission confirmed the ship’s capacity and efficiency and recommended purchasing the vessel, which the United States Government did, for \$50,000. Additionally, the government contracted Halstead to provide any and all operating procedures and system designs for any competent person or persons to operate her. Halstead was to provide this information before any payment was to be made.⁶⁹ Halstead also retained the right to apply for additional compensation as required from Congress. He carried out the requirements detailed in the contract, and on

⁶⁷ Bishop, 56.

⁶⁸ Ibid.

⁶⁹ Lake, 156.

May 27, 1870, the government took possession of the *Intelligent Whale* and compensated Halstead an additional \$12,050 as contracted. Shortly after this, on July 2, 1871, Halstead was killed due to his involvement in a love triangle. The murder hurt *Intelligent Whale's* chances of successful trials.

The Secretary of the Navy ordered tests of the *Intelligent Whale* in the late summer of 1872, despite not having Halstead's expertise to fall back on. Vice Adm. Stephen C. Rowan, Commandant of the New York Navy Yard, Commodore Edward T. Nichols, Captain William D. Whiting, Inspector of Ordnance at the Navy Yard, and Captain Somerville Nicholson, Commander Weld N. Allen, Commander David B. Harmony, and Lieutenant Commander C.M. Schoomaker, captain of the side wheel steamer and station ship USS *Frolic*, oversaw the submarine's trials on September 18. Abraham Halstead, the nephew of Oliver Halstead and a navy yard-worker, also manned the submarine during the test. Tragically, the packing material around the hatch was defective and *Intelligent Whale* immediately began taking on water.⁷⁰ Additionally, difficulties arose when the tide pushed the boat under the derrick that was tending her, which prevented her from returning to the surface. A group of shipyard workers was gathered to help free the craft. The boat surfaced, half filled with water, allowing the

⁷⁰ Undersea Warfare Magazine. "The Untold Story of the Intelligent Whale," 2008, accessed December 21, 2016, [http://www.cmwc.navy.mil/subfor/underseawarfare/magazine/Issues/Achives/Issue 38/whale.html](http://www.cmwc.navy.mil/subfor/underseawarfare/magazine/Issues/Achives/Issue%2038/whale.html).

crew to escape.⁷¹ Without ever traveling or accomplishing anything, the *Intelligent Whale* was classified a failure. A damning verdict was issued by the committee,

As a practical instrument of warfare it is utterly useless. The boat not having been successful, the Hon. Sec. of the Navy refused to pay any more money, since which time the whole matter has been abandoned.⁷² Oddly, the *Whale* began to gain an unfair reputation. Although no lives had been lost during her trials, wild stories were told and printed until the imaginary death toll was reported as high as forty-nine.⁷³ The *Intelligent Whale* became a historical curiosity. Today, despite remaining outdoors for years, the condition of *Intelligent Whale* is extremely good for a vessel a century-and-a-half old. Her interior fittings remain much as they were when drawn by Barber. Despite her many flaws and failures, the *Intelligent Whale* stands as a symbol of private enterprise in advanced armaments and the Navy's interest in improving weapons systems. On April 15, 1999, the *Intelligent Whale* was relocated to the National Guard Militia Museum in Sea Girt, New Jersey, after being on display at the Brooklyn Navy Yard until 1968.⁷⁴

The case of the *Intelligent Whale* represents the United States government was willing to invest in this new and exciting type of warfare. Historian Richard Morris observed, "The United States government, mindful of the psychological effects of the Confederate *Hunley's* attack on the *Housatonic* during the Civil War, was willing to invest in Halstead's *Whale*."⁷⁵ However, the lackluster return on investment fueled the cynics in key positions in the U.S. Naval Department. Failures in submerged operations and design were not limited to the United States. In April 1863, Captain Siméon Bourgeois and naval constructor Charles Brun brought out for the French Navy the

⁷¹ Undersea Warfare Magazine, 2008.

⁷² Delgado, 145.

⁷³ Bishop, 56.

⁷⁴ Undersea Warfare Magazine, 2008.

⁷⁵ Morris, 19.

largest submarine built to that point in time. They boasted that it was the most completely equipped submarine that was produced during the nineteenth century.⁷⁶

Le Plongeur was a French submarine launched on April 16, 1863. She was the first submarine in the world to be propelled by mechanical power. Designed by two Frenchmen, Captain Bourgois and M. Brun, *Le Plongeur* was one hundred and forty feet long, ten feet in depth, and twenty feet beam, with a displacement of over four hundred tons which was significantly larger than any submarine constructed before her time.⁷⁷ Her propulsion system consisted of eighty horse-power compressed-air engines. “The compressed air was carried in air tanks at a pressure of one hundred and eighty pounds per square inch, but emptied far too quickly which caused issues during trials.”⁷⁸ For ballast and submergence, the *Le Plongeur* utilized water-ballast tanks to reduce the vessel's positive buoyancy. Her final adjustment for displacement was controlled by manipulating cylinders to be put in equilibrium with the water she displaced. It was hoped that by controlling her equilibrium in this fashion, she could then be steered in any direction by the vertical and horizontal stern mounted rudder.⁷⁹ “Theoretically this is an ideal method for submerged control, but in practice it works out badly. When a vessel has

⁷⁶ Fyfe, 284.

⁷⁷ Lake, 153.

⁷⁸ Ibid.

⁷⁹ Ibid., 154.

little stability, there are so many disturbing influences to cause the ship to take on dangerous angles in diving.”⁸⁰

Essentially, *Le Plongeur* proved that one could design and build any vessel to submerge, and through a few simple engineering principles, the vessel can be kept airtight. However, while it is possible to submerge a vessel by simply filling ballast tanks, it cannot maintain buoyancy or control of the vessel without some means of holding it in place, such as hydroplanes. Without any proven depth keeping system, the crew of *Le Plongeur* was unable to control her as she continued to porpoise up and down while submerged. During one of her trials, she navigated horizontally for a great distance only to find that *Le Plongeur* had been sliding along the ocean floor.⁸¹ A crude pair of diving planes were attached to *Le Plongeur* afterward which produced better results. However, the inefficiency of the compressed air engine persisted and caused *Le Plongeur* to be condemned and turned into a water tank.⁸² Despite these failures, the French continued to make strides in the area of submerged warfare in the coming decades due to support from senior leaders within the French Navy, unlike the United States and Great Britain. However, London was home to another inventor in the late 1860s that produced a series of steam-powered torpedo boats.

Thorsten Nordenfeldt was a Swedish inventor and industrialist who, like Holland, contributed to the body of knowledge of his contemporaries and built many submarines.

⁸⁰Ibid.

⁸¹Bishop, 57.

⁸²Ibid.

Nordenfeldt was determined to demonstrate how a vessel submerged in a body of water, can displace weight and compensate for torpedoes being released from his revolutionary torpedo tube design. Greek, Turkish, and Russian navies purchased submarines of his design after their worthiness was demonstrated during maneuvers. However, these governments quickly realized that Nordenfeldt's theories were somewhat flawed, and his designs did not perform as advertised despite his innovative design for torpedo delivery and steam-powered propulsion. Nordenfeldt theorized that a submarine should descend and ascend at an even keel, and an angle taken while submerged would result in an undesired effect that could prove fatal. His vessels submerged via water being brought in ballast tanks at an even rate until only the conning tower penetrated the surface. Then, an operator would revolve vertical propellers and drive the boat straight down while remaining on an even keel.⁸³ As Nordenfeldt theorized, this could be the only truly safe way to submerge a vessel; however, this led to some truly terrifying trial runs for the crew on board his submarines. If either of the vertical propellers rotated any faster than the other, or any weight was distributed unevenly, the consequences would be dire.

Greece purchased the *Nordenfeldt I* after a moderately successful demonstration. The Turkish navy, Greece's principal naval rival, purchased Nordenfeldt's following submarine designs, the *Nordenfeldt II* and *Nordenfeldt III*. In 1887, the two vessels were shipped to Turkey in sections, but only the *Nordenfeldt II* was reconstructed and tested. At one hundred twenty-five feet long, she was twice as long as her predecessor, the *Nordenfeldt I*, and had a propeller forward and aft to maintain her even keel

⁸³ Fyfe, 218.

submergence.⁸⁴ As previously discussed, her innovative torpedo tubes made her a formidable surface driven vessel capable of discharging Whitehead torpedoes. Improved in 1866 by Robert Whitehead from a design by Giovanni Luppis of the Austro-Hungarian Navy, the Whitehead torpedo was the first self-propelled torpedo ever developed. Many naval services procured the Whitehead torpedo in the 1870s including the United States.

While testing the *Nordenfeldt II* for the Turkish Navy, the crew was able to see firsthand how flawed Nordenfeldt's theory was by simply walking forward from the aft engine room. The bow began a slow downward angle as everything held within began to tumble forward causing more and more weight to drive the boat at a downward angle.⁸⁵ Turkish crew members, tools, water from the steam boilers and ballast, as well as anything else that wasn't bolted down became a missile hazard and provided forward ballast. The crew within began to climb to the rear of the submarine to level her keel only to find that her stern became too heavy to maintain an even trim. This see-saw motion continued until she fired an errant torpedo that never found a target. The recoil of the launch along with the sudden distribution of weight allowed the crew to use steam pressure to blow the ballast tanks dry and return to the surface.⁸⁶ Astonishingly, the Turkish Navy purchased the craft, but they were never able to control her nor man a crew willing to take her in open ocean. Although Nordenfeldt is considered an innovator

⁸⁴ Ibid., 224.

⁸⁵ Bishop, 63.

⁸⁶ Fyfe, 222.

whose contributions to armament and propulsion allowed him to stand out amongst his contemporaries, his submarines failed to live up to their design.

There was doubt whether submarine warfare would become anything more than a carnival exhibition of a daring inventor willing to risk his life, along with a small crew of equally brave souls, to demonstrate how a vessel can be submerged, driven for a short time, and resurfaced with no ill effects. This was the opinion of most governments who allowed private engineers and inventors to design and build their odd looking vessels freely in the hopes of gaining some recognition and, ultimately, have one of their designs commissioned. Although this seemed to be the shared opinion among most significant naval powers regarding the submarine boats themselves, their viewpoints toward submarine warfare differed, specifically in Europe. Many factors contributed to these differing opinions including viewpoints on naval warfare itself, a willingness by governments to allow for an innovative approach to solving complex naval related problems, and support from senior government officials. An examination of a few naval powers reveals these differences.

Great Britain

An article published in the early part of the nineteenth century in the *Naval Chronicle* described Fulton's designs and submarine theories. The author describes his submarine boats as, "revolting to every noble principle," and Fulton himself as a "crafty, murderous ruffian," and his patrons as "openly stooping from their lofty stations to superintend the construction of such detestable machines, that promised destruction to

maritime establishments.”⁸⁷ In the nineteenth century, Great Britain was a great naval power whose vessels of naval warfare and operational reach were undeniable, but to say that the Admiralty had an eye for the future and innovation would be a false statement. Many English dignitaries shared the viewpoints of the writer of the article published in the *Naval Chronical* and considered submarine warfare as immoral, or simply put, “un-English.”

Our invincible ships of the line may give place to horrible and unknown structures, our projects to catamarans, our pilots to divers, our hardy, dauntless tars to submarine assassins; coffer, rockets, catamarans, infernals, water-worms, and fire-devils! How honorable! How fascinating is such an enumeration! How glorious, how fortunate for Britain are discoveries like these! How less worthy of being adopted by a people made wanton by naval victories, by a nation whose empire are the seas!⁸⁸

Fair play and good form were at the forefront of British warfare, and war itself was considered a necessity, an endeavor which should be waged fairly while enemy vessels are within sight of one another. The article continues,

But no light has been thrown upon the newest engine of warfare. It is thus possible for men to hold different opinions as to the value of submarine fighting, and we consequently find that there are numerous people who, whilst they would not go so far as to declare mines, torpedoes, and submarine boats unlawful, yet consider them as methods better fitted to the requirements of other nations than to those of the Mistress of the Seas.⁸⁹

The era following the American Civil War marked the first time that a perceived weaker naval power could challenge the “Mistress of the Seas” and her massive battleships in unmatched quantity. Utilizing a submersible vessel armed with the Whitehead torpedo,

⁸⁷ Fyfe, 27.

⁸⁸ Ibid., 29.

⁸⁹ Ibid.

these weaker naval powers could defend harbors, prevent blockades, and challenge these massive warships.

Admiral of the Fleet John Jervis, First Earl of St Vincent, served throughout the latter half of the eighteenth century and into the early nineteenth as an admiral in the Royal Navy and a Member of Parliament. He was an active commander during the Seven Years' War, American War of Independence, French Revolutionary War, and the Napoleonic Wars. When discussing Fulton's submarine, he stated, "a mode of war which they, who commanded the seas, did not want, and which, if successful, would deprive them of it."⁹⁰ However, in the later nineteenth century, Great Britain, somewhat begrudgingly, entered into the arena of submarine warfare by adopting mines, torpedoes, and submarine boats seemingly because other nations and naval powers adopted them. In 1907, Herbert C. Fyfe, historian and author of *Submarine Warfare Past and Present* argued,

What the future has in store none can foresee, and until the next great struggle between first-class powers the value of this modern engine of warfare may remain doubtful. All that is certain at present is that Great Britain cannot afford to dispense with submarine boats, and has no intention of doing so.⁹¹

Great Britain may not have been inspired by the events at Charleston Bay and the American Civil War in the traditional sense, but the Admiralty understood what the Confederates' demonstration of undersea warfare meant for their fleet of wood-hulled

⁹⁰ Ibid., 30.

⁹¹ Ibid., 31.

ships. Lord Clarence Edward Paget, who commanded the *Princess Royal* at the bombardment of Sebastopol, argued,

The five hundred and eighty English warships then in existence were sent into the Cork Harbor; and if the little American *Monitor* were to get in there, too, at the same time; and also if a suitable chain boom were fixed so as to enclose the whole lot, that the same little *Monitor* [semi-submersible David class torpedo boat] could send them all to the bottom within a few hours without being compelled to fire a single shot.⁹²

Lord Paget spoke these words in front of the House of Commons in support of a motion to re-appropriate \$75,000,000 toward improvements to vessels in the inventory and begin building armor-clad ships. The Admiralty proposed the construction of four ironclad ships following Lord Paget's recommendation.⁹³

Of all the naval powers of the late nineteenth century, Great Britain participated in the least amount of trial testing, funding, or interest in the slightest in submarine warfare. The first occasion Parliament involved itself in the prospect of submarine navigation was the trial of the *Nautilus* (not of Robert Fulton fame). James Ash and Andrew Campbell constructed their craft, the *Nautilus*, in 1886. It was sixty feet long with a thirteen horsepower engine that was powered by fifty-two batteries. During trials in Tilbury, England, the *Nautilus* submerged and settled dockside in the mud. The thick mud prevented the submarine from operating until the entire crew moved to one end of the submarine allowing the other end to free itself from the mud. The *Nautilus* righted itself, and the submarine was brought to the surface, but the crew had been through enough and

⁹² Lake, 88.

⁹³ Ibid.

the *Nautilus* did not submerge again.⁹⁴ “Lord George Hamilton, First Lord of the Admiralty, described the incident in the House of Commons, and described the submarine as, “an erratic toy to whose mercy no wise man would entrust his person.”⁹⁵ Even though nations throughout Europe began purchasing submarine designs, and inventors such as Nordenfeldt were working on trials close to English harbors, England had no more interest until May of 1900 when technical advisors to the Admiralty began to urge senior leaders to consider their stance on submarines and torpedo warfare. The viewpoint of the Admiralty in the early part of 1900 is best explained in an answer given by the First Viscount Goschen, George Goschen, to a question put by Captain Norton on April 6, 1900,

Close attention has been given by the Admiralty to the subject of submarine boats. The submarine boat, even if the practical difficulties attending its use can be overcome, would seem so far as the immediate future is concerned to be eventually a weapon for maritime Powers on the defensive, and it is natural that those nations which anticipate holding that position should endeavor to develop it. The question of the best way of meeting its attack is receiving much consideration, and it is in this direction that practical suggestions should be valuable.⁹⁶

Throughout 1900 and the early part of 1901, the Admiralty fielded questions and remained vague as to the viewpoints and future of submarine vessels, and testing platforms. Then, on March 1, 1901, the First Lord of the Admiralty released a statement,

Five submarine vessels of the type invented by Mr. Holland have been ordered, the first of which should be delivered next autumn. What the future value of these boats may be in naval warfare can only be a matter of conjecture. The experiments with these boats will assist the Admiralty in assessing their true

⁹⁴ Fyfe, 231.

⁹⁵ Ibid.

⁹⁶ Ibid., 232.

value. The question of their employment must be studied, and all developments in their mechanism carefully watched by this country.⁹⁷

Advances made by foreign naval powers, specifically the French Navy, pressured the British Navy to enter into an era of submarine warfare by purchasing five Holland type submarines identical to the USS *Holland* submarine purchased by the United States Navy. On November 2, 1901, the first British submarine was launched at the industrial town of Barrow without any ceremony, although representatives from the Admiralty were present.

France

When Robert Fulton went before the French Admiralty with his designs for the *Nautilus*, he was not met with the same enthusiasm that the French would adopt in later years. When Fulton described how his design could destroy a British ship while submerged, one French Admiral was quoted as saying, “Thank God, France still fights her battles on the surface, not beneath it!”⁹⁸ However, that sentiment changed fairly rapidly once the events of the *Hunley* were reported. The French government’s willingness to fund and patiently allow inventors the opportunity to demonstrate their designs had a significant impact on naval powers who seemed much less willing to implement submarine warfare in the later part of the nineteenth century.

The French Navy had become interested in unconventional approaches to naval warfare in its attempts to face the numerically superior Royal Navy. The French adopted

⁹⁷ Ibid.

⁹⁸ Lake, 82.

the torpedo and submarine boat for use against battleships at an early stage. The French were fascinated by the possibility of approaching undetected to within torpedo range as demonstrated by the Confederates.⁹⁹ The French approached this new form of submerged operations by following progress closely and encouraging experiments, inspiring men of science and engineers to continue to pressure governments to fund their designs. This put pressure on other naval powers to listen to these inventors or risk having the French Navy become the significant naval power in Europe.

French rivals, Great Britain, acknowledged France's forward thinking regarding undersea warfare in an article written for a British magazine, *The Yacht*, at the turn of the century which stated,

We have seriously believed that all the great modifications that have been brought about in the construction of submarines is the result of the important changes which the last fifty years of the past century have produced in the art of naval warfare. All these changes have been sought out, experimented upon, studied, and finally realized by France, who has also been the first to apply them. These results have established in a brilliant and incontestable manner the skill of our engineers; but our rivals have not only appropriated the results of our labors; they have not been slow to place themselves on equal terms with us, and finally to excel us in the application of these discoveries. . . . We have been only the humble artisans working for them to establish their superiority.¹⁰⁰

This approach began with Admiral Aube, the French Minister of Marine, in the late nineteenth century. Admiral Aube believed that the future of the French navy was defense of the shores and not competing with England by building larger and larger vessels with numbers in the hundreds.¹⁰¹ He acknowledged that France would not surpass

⁹⁹ Fyfe, 262.

¹⁰⁰ Ibid., 263.

¹⁰¹ Ibid., 258.

England as a naval power in this fashion. Admiral Aube theorized that in order to become an “Empire of the Sea” a naval power must demonstrate “invisibility, divisibility, and number.”¹⁰² The Confederates ability to disrupt the Union blockade, as well as the psychological effects of undersea warfare during the American Civil War supported the admiral’s theory. However, the admiral had many detractors. In 1886, Admiral Aube requested the submission of designs for submarine construction. This request was met with ridicule by senior advisors, and experts declared that submarine vessels would never become warships. They declared that submarines could only serve as diving bells and that submerged navigation was best left to the imagination of authors such as Jules Verne and not serious mariners.¹⁰³ The admiral stood by his vision and continued to support innovators, and fund submarine designs throughout the late nineteenth century.

In 1885 French designer Claude Goubet built a battery-operated submarine which was too awkward and unstable to be successful. He followed it up in 1901 with *Goubet II* which was also small, electric, and not very useful.¹⁰⁴ The first real attempt at the French establishing naval superiority through submarine warfare came in the form of the *Gymnote*. The *Gymnote* was inspired by the earlier designs of *Le Plongeur* and was one of the world's first all-electric submarines for means of propulsion.¹⁰⁵ The *Gymnote* holds

¹⁰² Ibid., 276.

¹⁰³ Ibid., 257.

¹⁰⁴ Ibid., 287.

¹⁰⁵ Ibid., 264.

the distinction of being the first submarine accepted by a naval power.¹⁰⁶ She was developed by Henri Dupuy de Lôme, but de Lôme passed away just after completing the design. Gustave Zédé brought the plans before Admiral Aube who signed a contract to have the submarine built. Engineer Arthur Krebs developed the electric engine for the *Gymnote*, along with the first naval periscope and the first naval electric gyrocompass which, by all accounts, did not work satisfactorily. The *Gymnote* was launched on September 24, 1888, and was built with a steel hull, a lead detachable keel, and three hydroplanes along each side. The design was similar in theory to Nordenfeldt's even keel diving principle and had very similar erratic results when submerged. She would gain downward angles of thirty degrees before the helm would be able to right the craft. This caused undue fatigue on operators making it very difficult to remain submerged for long durations.¹⁰⁷ Many alterations were made throughout the later part of the nineteenth century including movement of hydroplanes, torpedo tubes, and hull and rudder designs. The experimental vessel made over 2,000 dives, using 204 cell batteries.¹⁰⁸ The *Gymnote* contributed to the intellectual capital of her contemporaries of the time through her alternate means of propulsion and navigation; however, she was never considered an advancement in warfare.

France's next attempt at submarine warfare was the *Gustave Zede*, named for the recently deceased engineer who brought the *Gymnote* to fruition. After working on its

¹⁰⁶ Ibid., 266.

¹⁰⁷ Ibid.

¹⁰⁸ Ibid.

design Zede died in 1891 following an explosion during development of an experimental torpedo.¹⁰⁹ The *Gustave Zede* was launched on July 1, 1893, at Toulon, France, although did not formally enter service with the French Navy until May 1900 after a long series of trials and design alterations.¹¹⁰ The *Gustave Zede* stands as a prime example of the patience that the French Navy displayed. Spanning two decades of failed tests, the French eventually crowned her a success after twelve years. The *Gustave Zede's* history demonstrates France's determination to develop submarine technology. When she was first launched it was a failure in almost every respect, and only after many years of alterations to the design and improvements, was the *Gustave Zede* considered to be serviceable. Initially, the issue was that the operator could do nothing to submerge the vessel, but when she finally did submerge, she did so at a thirty-degree angle all the way down to the bottom of ten fathoms of water.¹¹¹ Surprisingly, the Committee of Engineers on board at the time did not condemn the *Zede*, or advise the government to spend no more money on the vessel.¹¹² Designed very similarly to the *Gymnote* with the exception of her size, the *Gustave Zede* was ten feet nine inches in diameter and one hundred forty-eight feet long. Most contemporary innovators believed these extreme design proportions

¹⁰⁹ *Ibid.*, 267.

¹¹⁰ Lake, 162.

¹¹¹ Fyfe, 269.

¹¹² Lake, 162.

led to the difficulties in stabilization and accounted largely for her erratic behavior when submerged.¹¹³

Regardless of the failed attempts at implementing submarine technology until the early twentieth century, Admiral Aube stayed true to his ideals and was later considered a pioneer in his innovative approach to building his naval force. The Royal Navy was, of course, the target, but the Royal Navy itself could never be matched by conventional forces. In 1879 Aube wrote,

[Armored] ships had their day and a new navy was needed to fight a running battle and wage war against commerce, Charmes declared that giant battleships no longer reigned supreme but would be replaced by myriads of tiny craft, la poussiere navale, mere specks of dust as others saw torpedo boats.¹¹⁴

After the admiral's death in 1890, his ideals and theories were not continued. M. A. Saissy, a French journalist, was an advocate of the late admiral and construction of the submarine in France. He wrote a preface to M.M. Forest and Noalhat's article, "Les Bateaux Sous-Marins," in which he paid tribute to the efforts of Admiral Aube to provide his country with a submarine fleet. "Had we but followed his ideas," he wrote, "had we but carried out his plans, not only would the defense of our coasts and of our colonies be assured against attack, but France would be at this hour the greatest naval power in the world."¹¹⁵

¹¹³ Ibid., 163.

¹¹⁴ Richard Compton-Hall, *The First Submarines: The Beginnings of Underwater Warfare* (Phoenix Mill, UK: Sutton Publishing, 1983), 85.

¹¹⁵ Fyfe, 257.

Other Naval Powers

Although the major powers of the world viewed submarine warfare as a weaker form of naval combat, by the turn of the century the majority of these major powers and secondary powers had submarines under construction. France, Great Britain, Russia, Japan, and Italy had dozens of submarines in testing and under construction. It was believed that secondary naval powers could use submarine warfare as a means to close the gap in the size and production of warships.¹¹⁶ Herbert Fyfe explained this attitude toward secondary naval powers,

Up to the present time the secondary Powers, though some of them have experimented with submarine boats, have been mostly content to observe the attitude of the greater Powers, and to await the results attained. Holland, Sweden, Norway, Denmark, Spain, Portugal, Greece, Turkey, Romania, and Bulgaria cannot think of building the huge battleships which have been laid down by the greater Powers, and there are many who think that they would be well advised to devote more attention to the possibilities of submarine warfare.¹¹⁷

In Spain, the *Peral* had demonstrated the ability to navigate underwater via innovative navigational design, as well as being one of the first submarines to utilize electric battery-power as a source of propulsion in 1889.¹¹⁸ The *Peral* had two years of successful testing including firing a torpedo at an old hull placed at a distance of greater than two miles from shore in Cadiz Bay while remaining submerged.¹¹⁹ The *Peral* was subsequently reported in articles around the world to have successfully accomplished this

¹¹⁶ Ibid., 279.

¹¹⁷ Ibid.

¹¹⁸ Ibid., 280.

¹¹⁹ Ibid.

feat. Rising tensions between the United States and Spain may have been another contributing factor to the United States reconsidering its stance on undersea warfare and submarine construction.¹²⁰ In Spain, nothing further appears to have been done regarding the matter, and no other submarines were manufactured.

Russia made several attempts to incorporate submarine warfare into the defense of their ports by purchasing designs, however most met with failure in the later part of the nineteenth century. By the turn of the century Russia was confident that they had a submarine boat worthy of commission and manufacturing, the *Delfine*. The *Delfine* was designed by Ivan Grigoryevich Bubnov, Lieutenant I.S. Goryunov, and Lieutenant M.N. Beklemishev. The *Delfine* was sixty-four feet long with a beam of eleven feet. A gasoline-electric motor that created one hundred-twenty horse-power turned a single shaft as a means of propulsion.¹²¹ Launched in 1902, the *Delphine* entered service in 1903 and suffered a similar fate in testing as the *Hunley* decades before. While undergoing her first sea trials, *Delfine's* ballast tanks were faulty and it took twelve minutes to complete her dive, which foreshadowed future events for the vessel.¹²²

On June 29, 1904, the submarine submerged in the Neva River during a test dive. With thirty-five men onboard, much more than her usual crew of eight, caused difficulties in distributing weight. As the conning tower hatch was ordered closed, water was taken in via a steamer that had passed. This frightened one crew member who

¹²⁰ Morris, 58.

¹²¹ Fyfe, 281.

¹²² Lake, 66.

attempted to escape but got stuck in the hatch as the vessel submerged. The crew member's body prevented closing the hatch and water rushed in. The crew was able to open the conning tower hatch enough to allow twelve men to escape before the *Delfine* was completely filled with water. The captain and twenty-four crew members were killed.¹²³

In 1850, the German port of Kiel was under blockade by the Danish Navy. Prussian Army Corporal Wilhelm Bauer persuaded a shipbuilder to construct his design for a blockade-breaking submarine which he called *Brandtaucher*.¹²⁴ The craft was made of riveted sheet iron, and its means of propulsion was a two-man-power treadmill which drove a propeller while a third crewmember steered. Buoyancy was controlled by ballast tanks, and trim was adjusted by moving a sliding weight along an iron rod. On its maiden voyage, *Brandtaucher* was sufficiently threatening enough to cause the blockading force to move farther out to sea but did little else in the way of actual warfare.¹²⁵

On a subsequent submerged run, the boat plunged sixty feet and got stuck in the muddy bottom after the sliding weight slid too far forward. Water pressure was too great to allow Bauer and his crew to open the hatch, and, with water rushing in through the damaged hull, they waited until the incoming water had raised the internal pressure enough to open the hatch. After an unimaginable six hours in cold darkness, they opened the hatch and were brought to the surface in a bubble of escaping air inadvertently

¹²³ Ibid.

¹²⁴ Compton-Hall, 161.

¹²⁵ Lake, 151.

making Bauer a pioneer in submarine escape procedures.¹²⁶ In 1864, Bauer proposed that follow-on submarine designs be powered by an innovative, but not yet practical, internal combustion engine. All told, he spent twenty-five years developing and proposing submarines on behalf of six nations: Germany, England, Austria, the United States, Russia, and France. His humble origins, repressive personality, and his lowly army rank were a severe handicap in dealing with the aristocratic senior leaders who ran most of the navies of the day.¹²⁷ Virtually ignored by his native Germany in his lifetime, Bauer became a posthumous hero in the Nazi era. The German Navy Department hesitated before beginning the building U-class submarines at the turn of the century. Although many believe that experiments did take place, it is clear that much knowledge was gained from the experience of other nations.¹²⁸

Although casualties are a consequence of war, most nations believe that casualties during peacetime operations cannot be a consequence of innovation. Many countries saw the submarine as an unnecessary risk to life, and many of the submarines built and tested during the late nineteenth century produced folly in the form of comical stories of wild-eyed inventors attempting to control a submerged contraption beneath a body of water. The tragedy of lives lost while testing vessels supported claims from governments and admiralties that this form of warfare was not worth pursuing, and set roadblocks in place for serious innovators, pioneers, and engineers whose designs would shape the future of

¹²⁶ Compton-Hall, 161.

¹²⁷ Ibid.

¹²⁸ Fyfe, 282.

submarine warfare. They also serve as lessons learned to contemporary and future inventors as to the dangers of navigating the depths.

CHAPTER 4

ELITE DESIGN IN COMPETITION

To simply list all of the submarine designs realized, and the hundreds that never made the transition from imagination to steel between the end of the American Civil War and the commission of the USS *Holland* in 1900, would not do justice to the story of the American submarine. Understanding the significant contributions, the scientific marvels, the determination, and the significance of the innovators behind these marvels is critical to understanding the decisions that faced the United States government. As was the case with the French and British Admiralties, the United States Naval Department had its own views and experience with undersea warfare. Just like those naval powers from across the Atlantic, it took extraordinary individuals with a passion for the science of undersea warfare, and a determination unmatched in other fields of engineering and science to ultimately meet the standards of operation expected by the U.S. Navy. This chapter will detail the competition between John P. Holland and Simon Lake, who are recognized as the key contributors to the implementation of submarine warfare in the United States, and their experiences in dealing with skeptical government officials and policy which was as significant as the submarines they built.

John P. Holland

John P. Holland was most likely born on February 24, 1841, in Liscannor, County Clare, Ireland. Official birth records were not kept until the following year and John Holland is not mentioned; however, many drawings by Holland list that date as his

birthday.¹²⁹ By the time Holland was ten, he had lost a brother and two uncles to cholera in the year of the Great Famine. After his father's untimely death, Holland attended St. Macready's National School in Limerick. Holland applied himself in his studies, and his aptitude for physical science was recognized by the teaching Brothers. Holland was noted for having odd study habits that included climbing trees to study, but he was focused on a career at sea having passed a navigation exam in 1853. However, his career as a mariner was stopped short due to his poor eyesight. Holland recalled, "No one would trust me even to row a two-oared boat, much less navigate a ship."¹³⁰

While teaching in Limerick, Holland joined the Christian Brothers. Teaching afforded him the opportunity to satisfy his curiosity about the natural world, and develop his aptitude for mechanical, drafting, and mathematical application. Like most Irishmen of the time, his attention was turned to the Civil War in North America. The war was of great interest to Holland because of the stories of great and powerful ironclad warships such as the *Merrimack*, and he realized that ships of this design would be of great interest to the British fleet.¹³¹ Holland was inspired by the battle between the *Monitor* and the *Merrimack* and the *Hunley's* attack on the *Housatonic*. He began experimenting with different designs of submersible vessels that could deliver munitions under the waterline of these ironclad vessels, an area, he believed, that would be vulnerable to attack given the success of the Confederate *Hunley*. Holland was motivated to pursue submarine

¹²⁹ Morris, 13.

¹³⁰ Ibid., 16.

¹³¹ Ibid., 17.

designs and experiments, and while he was in Cork, he was fortunate to have an excellent science teacher in Brother Dominic Burke who encouraged Holland in his designs for a submarine. In early 1859 Holland completed his first draft for a submarine design which utilized theories that he never radically changed.¹³² Holland sketched principles and experimented with iron-made, one-man vessels. Holland also conducted experiments with a clock-driven submarine submerged in a large wooden tank filled with water.¹³³ Due to poor health, he left the Christian Brothers in 1873 for the United States. Holland's interest in flying and his knowledge of aeronautic principles set him apart from his contemporaries in later years. His understanding of reaction-equal-to-weight theory helped improve his designs for submersible vessels.¹³⁴ Holland was convinced that future battles in naval warfare would be won by the naval power that implemented submarine and torpedo warfare to attack ironclad battleships at close range.

Holland began to teach again at St. John's Catholic School in Paterson, New Jersey. It was during this time that Holland submitted his first designs for a submarine to the United States Naval Department. Holland drafted a description of a submersible vessel and how it could be navigated underwater via ballast and air reservoirs. The paper was submitted to Captain Edward Simpson at the Torpedo Station for comment. After a series of back and forth correspondence on the matter, Captain Simpson finally replied,

¹³² *Ibid.*, 22.

¹³³ *Ibid.*, 19.

¹³⁴ *Ibid.*, 18.

“To put anything through in Washington was uphill work.”¹³⁵ This type of response from the U.S. Navy would remain a constant theme throughout the remainder of Holland’s career. Holland decided then to turn his attention to his homeland. Holland’s brother, Michael, had been introduced to the Fenian movement, which had organized a “skirmishing fund” administered by John Devoy.¹³⁶ Devoy was an Irish rebel leader and exile who dedicated his life to the cause of Irish freedom and played a significant role in the rebellion of 1867. The Fenians’ sense of nationalism backed with force influenced the determined and innovative engineer to collaborate on a project to construct a submarine to attack the British Navy.¹³⁷

Holland had an opportunity to realize his life’s ambition and test his theories of hydrodynamic design. His first submarine, the *Holland I*, was planned in St. John’s School and it was built in Todd & Raftery’s machine shop in Paterson, New Jersey. Little is known, other than a few drawings, of the original design.¹³⁸ This is due to the secrecy that was required to work on the craft given its purpose. Holland knew all too well the value of secrecy in this type of work from his dealings with the United States government. Not that one could hide an operational submarine, they tended to attract quite a crowd during testing. However, the plans and system designs from Holland’s

¹³⁵ Morris, 51.

¹³⁶ Ibid., 30.

¹³⁷ Ibid., 19.

¹³⁸ Ibid., 22.

early designs were kept secure, and the local papers could report only that some wealthy associate of Holland's had funded the project.¹³⁹

Launched on May 22, 1878, *Holland I* was fourteen feet, six inches long and was powered by an early version of the George Brayton petroleum engine. The submarine was brought down to the Passaic River and launched before a large audience.¹⁴⁰

Complications related to the Brayton engine, buoyancy problems due to the fresh water of the river, and intake plugs that caused the vessel to submerge in an uncontrolled fashion limited initial trials, but Holland was not discouraged and pushed forward with testing. Regardless of the initial complications, the Fenians were impressed and voted more money to develop a boat suitable for war. Holland removed the useful parts from *Holland Boat I*, and scuttled her, figuring that it was cheaper to start fresh rather than take her out of the water and put her in storage.¹⁴¹

Due to his accepting extra funds from the Fenian Brotherhood, Holland was very cautious and gave very little information to newspapers. Holland stated many times that he thought British spy's were posing as reporters.¹⁴² A reporter from the *New York Sun*, unable to get information from Holland, but knew of his Fenian connection, labeled the invention the *Fenian Ram*.¹⁴³ Work began on May 3, 1879, but was delayed almost

¹³⁹ Morris, 27.

¹⁴⁰ Ibid., 28.

¹⁴¹ Ibid., 31.

¹⁴² Ibid., 30.

¹⁴³ Bishop, 73.

immediately by arguments from employees within the Delamater Iron Works, New York, where the submarine was being built. Holland became frustrated, and expressed his displeasure with the biting wit that was characteristic of most of his writing,

Many objections were urged against her, especially by men who should have known better, but the trouble with them was almost the same as I encountered later among the staff of the navy, viz: they were, almost without exception, of English, Welsh, Scotch descent, experienced in all kind of shipbuilding.¹⁴⁴

The *Fenian Ram* was launched in May 1881. It was thirty-one feet long and used a fifteen horse-power engine as a means of propulsion. During extensive sea trials, Holland made numerous dives which helped him perfect his theories on buoyancy. He also test-fired a mounted gun using dummy projectiles.¹⁴⁵ However, due to funding disputes within his Fenian backers, which led to disagreements over payments from the Brotherhood to Holland, the Fenians stole the *Fenian Ram* and the *Holland III* prototype in November 1883. The submarine was taken to New Haven, Connecticut, but the Fenians discovered that no one but Holland himself knew how to operate her. Unable to operate the vessel, the Brotherhood had the *Ram* towed into a shed on the Mill River.¹⁴⁶

Holland no longer had financial backing of any kind. However, the success of his *Fenian Ram* had earned him a reputation and, to a lesser extent, notoriety among military circles in America. While working as a draftsman in Reynold's Iron Works in New York City in late 1883, Holland worked alongside an aging George Brayton in order to improve the Brayton petroleum engine within the *Ram*. Holland received an invitation to

¹⁴⁴ Morris, 36.

¹⁴⁵ *Ibid.*, 40.

¹⁴⁶ *Ibid.*, 47.

dine on board a flagship at the Brooklyn Navy Yard.¹⁴⁷ It was at this event that Holland met with a young officer, Lieutenant William W. Kimball, who would become a supporter of Holland, who by now was forty-three but as motivated as ever to continue his pursuit of the perfection of undersea warfare. Kimball's desire was that Holland remain in his current position and remain patient for the U.S. Navy Department to recognize the importance of submarine warfare, and the significance of the tests Holland had performed on his previous iterations of submarine boats. As it were, Holland could not afford to sit idly by and accepted an offer from Lieutenant Edmund L. Zalinski, Fifth U.S. Artillery, who wished to prove the merits of his armament by fixing one of his guns to one of Holland's designs. In Kimball's supplementary chapter to Frank T. Cable's *The Birth and Development of the American Submarine*, Kimball recalled,

Holland waited. I was bound southward. Just before sailing, Zalinski came to me and asked who knew anything about submarines. I told him that Holland was far and away the best submarine man in the United States, if not in the world, but that he, Zalinski, was to keep hands off, as the Navy Department might make Holland an offer.¹⁴⁸

Holland accepted Zalinski's offer for a position in his Pneumatic Gun Company, but unbeknownst to Holland at the time, this decision was one he would come to regret later in life.¹⁴⁹ Holland sent a message to Kimball explaining that due to lack of financial backing, he could no longer remain patient and wait for a naval contract. There was no way to know at the time, but had Holland continued to wait for a naval contract, and had

¹⁴⁷ *Ibid.*, 50.

¹⁴⁸ Frank T. Cable, *The Birth of the American Submarine* (New York: Harper and Brothers, 1924), 318.

¹⁴⁹ Morris, 51.

the contract materialized as Kimball desired, submarine history in the United States would have been dramatically different. Holland's patents and designs would have been controlled by the U.S. Naval Department which would have helped the United States to maintain its lead in submarine technology leading into World War I. Additionally, this would have saved the American taxpayers in the long run because, in the hands of private investors, Holland's patent rights were able to be readily secured by foreign companies.¹⁵⁰ However, Holland was enthusiastic at the time, and accepted this new position. Holland's quiet genius and Zalinski's private capital combined to establish the Nautilus Submarine Company. Zalinski began advertising his ideas to mount his dynamite gun on a submarine of Holland's design throughout the Fifth U.S. Artillery. Oddly, it was support from Zalinski and the United States Army, and not the U.S. Navy, which made possible Holland fourth attempt at exploring the depths.¹⁵¹

It was during this time that Holland's contemporaries began testing their own versions of submarine boats. Nordenfeldt began his series of tests for his submarines that would eventually be purchased by the Greek and Turkish navies. Professor Tuck also began tests on his *Peacemaker*.¹⁵² Although Holland recognized the genius in the design of these vessels, he did not believe the theories behind the "even-keel" submergence were sound. Holland was hard at work on his fourth boat, the *Zalinski Boat*.

¹⁵⁰ Ibid.

¹⁵¹ Ibid., 52.

¹⁵² Lake, 160.

The *Zalinski Boat* was fifty feet long with a maximum beam of eight feet. The project was doomed from the start due to decisions that were made to save money. The hull was largely constructed of wood, framed with iron hoops, but she was equipped with a Brayton petroleum engine which provided motive power. The project was plagued by budgeting issues, as well as Zalinski mostly rejecting Holland's ideas on improvements; however, despite these problems, the submarine launched in September 1885. During the launching itself, a section of the ways collapsed under the weight of the boat, dashing the hull against the bay's bottom. The submarine was repaired and carried out several submerged trials in New York Harbor, but by 1887 the Nautilus Submarine Boat Company was out of business. The *Zalinski Boat* was torn apart, and the salvageable remnants were sold off to reimburse the disappointed investors.¹⁵³

The *Zalinski Boat* was not the only source of frustration in Holland's life which he refers to as his "lean years." In 1888 the United States Naval Department, seemingly willing to accept submarine navigation as a suitable form of warfare, released a list of criteria to be met for a submarine to be considered for purchase. Through Secretary of the Navy Whitney, an appropriation of two million dollars was to be granted to the winner of an open competition for a submarine that could meet the following specifications:

¹⁵³ Morris, 55.

1. Speed: fifteen knots on the surface, eight knots submerged
2. Power endurance: two hours submerged at eight knots, provisions for ninety hours
3. Ease of maneuvering: circle in no greater space than four times her length
4. Stability: assured normal or positive buoyancy at all times
5. Structural strength: sufficient to withstand pressure at a depth of one-hundred-fifty feet
6. Power of offense: torpedoes with a one-hundred pound charge of gun cotton..¹⁵⁴

Holland submitted a design through the support of the Cramps Building Company. The competition came down to a design from Holland and the design for Nordenfeldt's boat which he would eventually sell to the Russian Navy. Holland had received the announcement that he had won the government competition of 1888.¹⁵⁵ Unfortunately, Holland was unable to celebrate his victory because the Cramps Building Company could not guarantee Holland's design would meet all six specific requirements of the Navy. The Board in Washington withdrew its decision and recommended to Secretary Whitney that new designs be sought. The following year, the government reopened the contest and all previous design submissions were reviewed. Once again Holland's design was selected, but before a contract was issued, President Grover Cleveland's first administration came to an end. General Benjamin F. Tracy, President

¹⁵⁴ Ibid., 59.

¹⁵⁵ Fyfe, 248.

Benjamin Harrison's new Secretary of the Navy, reallocated the submarine appropriation to complete surface warships already under construction,

The Board, after careful consideration of the subject, reported that the two vessels could not be built within the limitation of \$2,000,000, and recommended that all the proposals for the submarine torpedo-boat be rejected; and the proposal of the Union Iron Works for the construction of the armored coast-defense vessel...should be accepted. In accordance with this report, the Department, April 23, 1889, rejected all the proposals for the torpedo-boat, and on June 14, entered into contract with the Union Iron Works for the construction of the armored coast-defense vessel.¹⁵⁶

In the following years, Holland took work as a draftsman for the Morris and Cummings Dredging Company after having contributed significantly to the study of aeronautic designs for Charles Morris in an attempt to build a practical airplane. Holland again demonstrated his genius in improved designs for propellers and placement that would give the craft the ability to sustain flight.¹⁵⁷ Holland also submitted a new design to the Navy for a submersible torpedo boat and continued to perfect his propulsion designs based on lessons learned from the *Fenian Ram*. In March 1893, with Cleveland back in the White House, Congress passed an appropriation for \$200,000 for an open competition with the same specifications required of the 1888 competition.¹⁵⁸ It was

¹⁵⁶ Benjamin F. Tracy, *Report of the Secretary of the Navy; Being Part of The Message and Documents Communicated to The Two Houses of Congress I* (Washington DC: Government Printing Office, 1889), 16.

¹⁵⁷ Morris, 62.

¹⁵⁸ *Ibid.*, 65.

during this open competition that Holland met a young engineer that would rival his designs and persist as his competitor for the remainder of his career, Simon Lake.

Simon Lake

Simon Lake's family had a storied history in the United States. He was a descendant of John Lake, one of the patentees and founders of Gravesend, now South Brooklyn, New York. Lake was also in the maternal line from Jeremy Adams, who settled in Cambridge, Mass., in 1632, and was one of the founders of Hartford, CT. Simon Lake was educated at the High School of Toms River, New Jersey., Clinton Liberal Institute, Fort Plain, New York, and in the Mechanical Course at Franklin Institute, Philadelphia. In 1883, once he completed his education, Lake worked at his father's machine shop in New Jersey and later became his partner.¹⁵⁹ Utilizing his engineering background and access, Lake was able to demonstrate his genius at a very young age. He invented the steering gear, the dredge, and other vessel appliances, of which many were built and primarily utilized by fishing and oyster vessels in the Chesapeake and Delaware bays.

Unlike Holland before him, Lake became fascinated with submarine navigation through fictional works and articles of the time. Lake was inspired by Jules Verne's *Twenty Thousand Leagues Under the Sea*, and began to design submarines with the hope that the U.S. Naval Department would purchase these designs based on his engineering acumen and extensive knowledge of success and failures of his contemporaries. Although

¹⁵⁹ Simonlake.com, "Simon Lake: Biographical Sketch," 2003, accessed December 28, 2016, <http://www.simonlake.com>.

Lake's fascination and designs began as early as fourteen, he would do nothing with these experiments until 1892. In his book *The Submarine in War and Peace*, Simon Lake recalled,

These plans were shown to my father at the time, who rather discouraged me in the matter on the ground that submarine navigation was something that great engineers had given a lot of attention to, and that I had better give more attention to my regular school studies than to fooling around with experiments of that nature, which was good advice.¹⁶⁰

Simon Lake designed and submitted plans to the Navy in 1893 along with John Holland and George C. Baker, who had recently demonstrated his submarine on Lake Michigan.¹⁶¹ Lake's design was the *Argonaut*, a submarine designed with the even-keel method similar to Nordenfeldt's which differed significantly from Holland's designs. She was thirty-six feet long and built of steel. She had a gas engine that turned a single propeller, a searchlight, and pumps for air and water.¹⁶² She was also designed with wheels to navigate the ocean floor vice porpoise through the ocean as in Holland's designs. Another attribute was a wet diving chamber that allowed a diver to leave and re-enter the submarine.

Like Holland before him, Simon Lake would learn that convincing the United States government of anything was an exercise in humility and patience. Lake's youth worked against him in this regard, and he blames his naivety and youth for his early failures at convincing the U.S. Naval Department to purchase his early designs, and not

¹⁶⁰ Lake, 120.

¹⁶¹ *Ibid.*, 162.

¹⁶² Fyfe, 289.

on any flaws in his design. He also cited his lack of government allies and financial backers for his early failures. Lake spoke of his difficulties dealing with Washington,

I was still a youngster, and knew nothing of the difficulties met by outsiders in getting hearings before government officials in Washington. On the appointed day, in June, 1893, on which the bids were to be opened I appeared in Washington with my plans under my arm, and was directed to the room adjoining the secretary's office, where a large number of people were assembled.¹⁶³

Lake was discouraged to learn that many of the men waiting alongside him were representing their interest in designs by Mr. Baker. Lake spoke with the son of Mr. Baker who was one of the gentlemen waiting,

Well then, who are all these other gentlemen present? He knew most of them and obligingly pointed them out to me saying, 'There is Senator So-and-so and Congressman So-and-so, and Mr. So-and-so the great lawyer,' etc. I then said to myself, 'Well, Lakey, it looks as though you were not going to have much of a show here.'¹⁶⁴

The level keel submergence of Lake's design was in direct competition with the counter-ballast porpoise design of Holland. The brief meeting in June 1893 on the day of submission was the first time these two pioneers of submarine design and technology had met. This competition would decide the future of the submarine force in the United States.

Competition

On the day of the competition, Holland's experience was very similar to Lake's. Holland had recently formed the John P. Holland Torpedo Boat Company and was incorporated under the laws of New York in early 1893. Holland was confident that his

¹⁶³ Lake, 120.

¹⁶⁴ Ibid., 121.

proven theories and the positive press he had received in recent years would win him the day; however, when Holland entered the waiting room, his confidence was shaken. An impressive gathering of people crowded into the Secretary of the Navy's office on the day of the competition. In an attempt to identify the competition he was able to identify a nervous Simon Lake and the confident George Baker.¹⁶⁵

George Baker, had significant power and influence over the committee. Although his designs were inferior to those of Lake and Holland, it was Baker's influence in Washington that many believed was the reason for the congressional appropriation in 1893.¹⁶⁶ Baker had begun construction of the *Baker Boat* in 1890 at the Detroit Boat Company, and he began trials on April 29, 1892, when Baker and the construction foreman submerged the boat for one hour and fifty minutes. A second trial was held on May 20, 1892, in the River Rouge in Michigan. They were accompanied by the editor of Western Electric, who following the trial, reported favorably of the small craft, but did list difficulties in depth keeping as a fault of the boat.¹⁶⁷ The *Baker Boat's* hull was wood, seven inches thick, and had dual means of propulsion. While surfaced, the boat was propelled using a small steam engine. The smoke stack for the boiler raised up when the boiler was in use but collapsed to a few inches tall, and the ends were closed watertight for submerged operations. When submerged, the submarine used a two-hundred twenty-volt electric motor which could develop fifty horse-power as a means of

¹⁶⁵ Morris, 67.

¹⁶⁶ Ibid., 70.

¹⁶⁷ Ibid.

propulsion. The motor operated as a generator to recharge two-hundred thirty-two batteries.¹⁶⁸ As the only competitor with an operation submarine at the time, Baker was in a unique position when the Navy Department opened the competition for the design of a submarine torpedo boat in 1893. However, in July 1893, *The New York Times* reported that John Holland was the winner.

Simon Lake did not give up his pursuit of government funding for the construction of his designs. After many attempts at meeting with government officials, Lake quickly grew sour of the treatment he received and the overall demeanor with which these officials seemed to operate. He vowed to never again seek out the United States government for any design or funding unless they sought him out first. Baker, however, did not submit as easily. When Baker received word that the board again preferred Holland's design, he delayed the outcome by remarking that Holland's design existed only on paper, and he used his influence to gain an audience of naval officials to witness a demonstration of his boat, already constructed. Baker invited Holland to demonstrate one of his designs as a form of competition. Holland declined, having already known, through former Secretary Whitney, that his design had received the approval of the Board.¹⁶⁹ Holland's unique combination of wit and genius showed through in his response,

If the newspaper description of Mr. Baker's boat is anywhere near accurate, I entreat you to examine the structure carefully before you submerge its center below twenty to twenty-five feet. My motive for this request is, I admit a very

¹⁶⁸ Bishop, 82.

¹⁶⁹ Morris, 68.

selfish one, of objecting to the risk of having to wait for a decision until a new Board can be appointed.¹⁷⁰

By studying Baker's designs, Holland theorized that due to the placement of the lateral propellers meant to keep the boat on an even keel while submerging, the submarine would have to travel a great distance before the vessel would be able to submerge.¹⁷¹ This was the distinct difference between Holland's porpoise submergence in which angles are places on the submarine to dive quickly, and the even-keel method of diving evenly and safely. Holland did not believe that this slow descent would be optimal in naval warfare which, he believed, would be fought by ships capable of remaining submerged for long durations and only surfaced for short durations. Baker's trials proved once again that Holland's designs were superior, and once again the Board was convinced of this. Baker's trial in September 1893 served only to justify a final recommendation to the Secretary of the Navy in favor of Holland. The Secretary mulled over his final decision for over a year during which Holland grew impatient. He began to explore patents in foreign governments in an attempt to force the hand of the United States and the decision to finally fund Holland's designs. Finally, on March 3, 1895, the Holland Torpedo Boat Company received the \$200,000 government contract to build a submarine for the United States Navy.¹⁷² The submarine was designed based on Holland's patent, his fifth submarine, the *Plunger*.

¹⁷⁰ Ibid., 69.

¹⁷¹ Ibid.

¹⁷² Ibid., 64.

Aftermath

Simon Lake continued to develop his invention, but, unlike his contemporaries, he predicted a valuable place in commercial transportation and pursuits for the submarine. He envisioned locating sunken ships and cargoes, successful navigation of Northern waters, reaching the Northern Pacific in the summer by traveling north above Russia from England, and north of Russia to Japan. He believed that submarines could navigate under any ice-flows encountered during the summer season. Other ice-bound waters, such as the Baltic Sea and the Great Lakes, could be navigated, even in closed seasons, by cargo-carrying submarines. He predicted extensive use of submarine navigation in the cultivation and recovery of oysters and other edible shellfish, pearl and sponge fisheries, and new and more efficient methods of charting and improving waterways.¹⁷³ Lake built and successfully demonstrated his first experimental submarine, *The Argonaut, Jr.*, in 1894. The success of these trials led to the formation of the Lake Submarine Company of New Jersey in 1895, which built his follow-on design, the *Argonaut*. Completed in 1898, the *Argonaut* was the first submarine to operate in open ocean successfully and drew a congratulatory telegram from Jules Verne.¹⁷⁴

John Holland quickly realized that working alongside the U.S. Navy was as frustrating as attempting to have one of his designs accepted by them. Holland constantly changed system designs to meet the ever demanding needs of the navy. The *Plunger* was the largest vessel he had built up to that point at eighty-five feet long and eleven and one-

¹⁷³ Lake, 262.

¹⁷⁴ *Ibid.*, 1.

half feet in diameter. Holland became frustrated with the navy's demands such as additional screws for increased surface speed (the *Plunger* had three screws), two independently mounted triple expansion engines which gave her a fifteen knot surface speed, and a large boiler, which took up much of the available living space, capable of bring steam pressure to twenty-five hundred pounds per square inch to power three surface engines.¹⁷⁵ She launched on August 7, 1897, and had difficulties from the start. As a result of her poor showing during trials in 1898, the *Plunger* was not accepted into service. Her complex steam plant made the craft uninhabitable due to over-heating. Holland decided to give up on the *Plunger* and independently fund his sixth submarine design hoping that the United States Navy would buy her outright.¹⁷⁶

Holland Torpedo Boat Company had run out of money due to continued improvements needed for the *Plunger*. Holland had teamed with a new set of benefactors in the newly formed Electric Boat Company.¹⁷⁷ The *Holland Boat VI* was his most successful submarine design to date. It was fifty-three feet long and driven by a forty-five horsepower gas engine for surface travel and a forty-five horsepower gas engine for submerged operations. It was manned by a crew of fifteen, and was equipped with a torpedo tube in the bow.¹⁷⁸ The first successful trial of the *Holland VI* occurred only a month before the Spanish-American War was formally declared. Holland invited service

¹⁷⁵ Morris, 75.

¹⁷⁶ Ibid.

¹⁷⁷ Ibid., 92.

¹⁷⁸ Bishop, 78.

representatives to witness his boat perform hoping that recent events in Havana would put pressure on the Naval Department. The first demonstration for the Navy included the firing of the dynamite gun, and was sufficiently successful enough that the following month Assistant Secretary of the Navy Theodore Roosevelt recommended to Secretary John D. Long that the Navy purchase the submarine,

I think that the Holland submarine boat should be purchased. Evidently she has great possibilities in her for harbor defense. Sometimes she doesn't work perfectly, but often times she does, and think in the present emergency we cannot afford to let her slip. I recommend that you authorize me to enter into negotiations for her, or that you authorize the Bureau of Construction to do so, which would be just as well.¹⁷⁹

A second and more elaborate demonstration was staged in Raritan Bay, New York for a formal Navy Board of Inspection following Roosevelt's recommendation. Although *Holland VI's* performance exceeded even Holland's expectations, the government drew back from making a purchase commitment. In response, Holland attempted, again, to force a decision by proposing publicly to demonstrate the effectiveness of *Holland VI*. Holland promised that his submarine would single-handedly sink the Spanish ships currently occupying Santiago de Cuba, requiring only that the Navy transport his boat to the Caribbean.¹⁸⁰ However, this was not the Civil War; the U.S. government could not wage war with private citizens utilizing vehicles of their own design. Despite the government's refusal of his offer, Holland continued a series of test runs and trails in New York Bay. Holland slowly and methodically improved on his design which prompted another official Navy trial in November 1899, demonstrated

¹⁷⁹ Morris, 87.

¹⁸⁰ Ibid., 90.

before the Naval Board of Inspection and Survey. *Holland VI* performed flawlessly, despite the Navy revising specifications for the operating performance.¹⁸¹ The Holland Torpedo Boat Company offered the Navy the *Holland VI* for \$160,000 while work continued. Navy officials continued to stall, citing that the purchase of any submarine under the 1896 appropriation required first accepting *Plunger*.¹⁸² Holland attempted to apply pressure by furiously lobbying Congress for support.

On March 14, 1900, *Holland VI*'s capabilities were demonstrated on the Potomac River to the Navy's General Board under Admiral George Dewey, who on April 27, 1898, had sailed from China aboard the USS *Olympia* with orders to attack the Spanish Navy at Manila Bay. On May 1, within six hours, he silenced the shore batteries at Manila, by sinking or capturing the entire Spanish Pacific Fleet. Remarkably, with the loss of only one life on the American side.¹⁸³ On the morning of the demonstration, he was joined by a large audience of Navy civilian officials, senators, and representatives. A week following the demonstration, Dewey testified to Congress,

I saw the operation of the boat down off Mount Vernon the other day [March 14, 1900]. And I said it then, and I have said it since, that if they [Spanish Navy] had had two of those things in Manilla, I never could have held it with the squadron I had...With two of these in Galveston, all the navies of the world could not blockade that place.¹⁸⁴

¹⁸¹ *Ibid.*, 93.

¹⁸² *Ibid.*, 107.

¹⁸³ Stephen Howarth, *To Shining Sea: A History of the United States Navy, 1775-1998* (Norman, OK: University of Oklahoma Press, 1999), 250.

¹⁸⁴ Morris, 109.

Subsequently, on April 11, 1900, the date now celebrated as the birthday of the U.S. Submarine Force, the Navy bought the *Holland VI* from the Holland Torpedo Boat Company. A contract was drawn between the Secretary of the Navy, John D. Long, and the secretary of the Holland Torpedo Boat company purchased the vessel for \$150,000 which officially made the United States the second naval power to implement submarine warfare as part of its naval force.¹⁸⁵ The contract also stipulated that if submarines of “improved Holland design” were made available, the cost was not to exceed \$170,000 each, which indicated that the United States government was willing to continue to strengthen its fleet with additional submarines. Additionally, the Appropriation Act of June 10, 1896, which was amended in 1899, provided for a second boat of the “Holland type” to replace the *Plunger*.¹⁸⁶ By June 1899, congressional hearings on submarine capabilities and employment, at which John Holland himself appeared as a witness, led directly to the passage of another appropriation act that provided for the purchase of five more boats.¹⁸⁷

No document, statement, or article has shed as much light on the conflicted agenda and attitude of the United States Naval Department regarding the submarine during the late 1800s as the trials and tribulations that Simon Lake and John Holland experienced in an attempt to have their submarine designs purchased by the U.S.

¹⁸⁵ John Davis Long, *Report of the Secretary of the Navy; Being Part of The Message and Documents Communicated to The Two Houses of Congress I* (Washington, DC: Government Printing Office, 1899), 584-585.

¹⁸⁶ Morris, 111.

¹⁸⁷ Long, 40.

government. As a testament to their perseverance and determination, they were not swayed in their belief that submarine technology was the future of naval warfare and, despite their differing opinions on submarine operation and direct competition, remained respectful of one another. As John Holland achieved ultimate success during the conclusion of the nineteenth century, Simon Lake's potential and genius had not yet been fully recognized. The twentieth century would prove very prosperous for Lake as he began to develop his submarine designs.

CHAPTER 5

UNITED STATES NAVAL PERSPECTIVE IN THE LATE NINETEENTH CENTURY

To put anything through Washington is uphill work.
— Captain Edward Simpson to John P. Holland

The priorities and direction of the post-Civil War navy were very difficult challenges for the United States government. By December 1864, the Federal Navy had over 50,000 uniformed sailors and 671 warships.¹⁸⁸ These staggering numbers, second only to the British Royal Navy, were due to the requirement to blockade 3,549 miles of Atlantic and Gulf coastline including all major ports. These numbers were not sustainable and downsizing the navy, both in number of ships and personnel, was among the first priorities for the U.S. Navy following the Civil War; but there was no clear strategic direction. This chapter will outline the lack of direction that befell the U.S. Navy in the decades following the Civil War which impacted submarine implementation. Additionally, this chapter will explore how submarine innovation managed to overcome skeptics in the military, the government, and the American public.

The unique position the navy found itself in was the result of a decision made on April 19, 1861, when President Lincoln issued a Proclamation of Blockade against Southern Ports.¹⁸⁹ A Blockade Strategy Board was formed, comprised of a joint Union

¹⁸⁸ Gideon Welles, *Report of the Secretary of the Navy; Being Part of The Message and Documents Communicated to The Two Houses of Congress I* (Washington DC: Government Printing Office, 1865), XIII.

¹⁸⁹ Gideon Welles, *Report of the Secretary of the Navy; Being Part of The Message and Documents Communicated to The Two Houses of Congress I* (Washington DC: Government Printing Office, 1864), V.

military-navy commission, in order to make plans for seizing key Southern ports to utilize as Union bases of operations, and to expand the blockade as the war continued. The Board met for the first time in June 1861 in Washington, DC under Captain Samuel F. Du Pont. Due to the limited size of the navy, the initial phase of the blockade concentrated only on the Atlantic Coast. The capture of Port Royal, South Carolina, was critical to the early success of the blockade, and provided the Federals with repair and maintenance facilities in good operating condition.¹⁹⁰ Port Royal became the base of operations for further expansion of the blockade early on and allowed the blockade to expand farther down the Atlantic coastline. Another strategic victory came in the form of Ship Island, Louisiana, which gave the Union Navy a port from which to secure the entrances to both the Mississippi River and the bay at Mobile.¹⁹¹ The Union Navy gradually extended its operational reach throughout the Gulf of Mexico and along the Texas coastline.

The Union blockade would be the largest ever attempted with 180 ports stretched across 3,549 miles of Confederate coastline.¹⁹² Although the Confederates had the blockade to defend against, the Union Navy had its own unique challenge in the form of its ability to execute the blockade effectively. The United States Navy had only forty-two warships in active service at the time of the Proclamation of Blockade, and another forty-

¹⁹⁰Gideon Welles, *Report of the Secretary of the Navy; Being Part of The Message and Documents Communicated to The Two Houses of Congress I* (Washington DC: Government Printing Office, 1862), 10.

¹⁹¹ *Ibid.*, 271.

¹⁹² Howarth, 183.

eight in various states of repair.¹⁹³ Half of these were sailing ships, and most were technologically outdated. Truly, the Union had only three ships suitable for blockade duty. The Navy Department, under the leadership of Navy Secretary Gideon Welles, quickly moved to expand the fleet in terms of personnel and ships. U.S. warships patrolling abroad were recalled while a massive shipbuilding program was launched. Additionally, many civilian merchant and passenger ships were purchased for naval service and captured Confederate blockade runners were commissioned into the Union Navy. The Navy Department had added hundreds of steamers and sailing vessels by the end of 1861 which contributed to the 427 ships participating in the blockade.¹⁹⁴ Also, and an additional fifty-two modern warships were under construction. There were 102 sailing ships and 282 steaming ships by November 1862, and by war's end, the Union Navy totaled 671 ships, 51,500 Sailors, and 60 ironclad ships of the *Monitor* class making it the second largest navy in the world.¹⁹⁵ The post-Civil War era in the United States Navy brought about a time of decline largely due to conflicting opinions between the old and new officers, the necessity of the number of ships currently in inventory, and the industry of shipbuilding. Given the amount of change in the decades following the Civil War, along with a focus on reforming composition and size, the future of submarine warfare was as bleak in the United States as it had been anywhere else in the world.

¹⁹³ Ibid., 182.

¹⁹⁴ Welles (1862), 26-28.

¹⁹⁵ Gideon Welles, *Report of the Secretary of the Navy; Being Part of The Message and Documents Communicated to The Two Houses of Congress I* (Washington DC: Government Printing Office, 1863), XXIII.

In the years following the Civil War, the United States Navy fell into decline. The bloody conflict generated a necessity for innovation and technological advances in naval design. The nation was too exhausted from war to continue to sustain and fund naval technology. Also, attention was focused on reconstruction in the south and westward expansion.¹⁹⁶ While naval powers from around the world used the lessons learned from the American Civil War as an opportunity to expand with iron and steel-hulled armored ships and improved steam engine technology, the United States Navy senior officers were content with the undemanding mission of showing the flag in foreign ports. The country's once impressive battle fleet had been neglected by the Johnson, Grant, and Hayes Administrations with little help from Congress by way of funding. By the late 1870s, no new class of warship was under construction, and the warships in the inventory were suffering badly from rust and decay.¹⁹⁷ The ships also had significant manning and training related issues. Even the vessels that remained were severely lacking in speed, armor, and ordnance when compared to the modern warships being produced in Europe. The United States Navy was inferior in size and quality to all major European nations and several Latin countries by 1881. Even the U.S. Navy's ability to stand up successfully against the Chinese fleet was in doubt. In his first report as Secretary of the Navy,

¹⁹⁶ Howarth, 218.

¹⁹⁷ Ibid, 219.

William Chandler noted that the United States owned only “one first-rate ship, the *Tennessee*, of 4,840 tons displacement.”¹⁹⁸ Chandler continued,

These vessels are credible in their appearance, commodious in their quarters for officers and seaman, well adapted for ordinary naval exercises, and useful for displaying the national flag upon the seas and in the harbors of the commercial world. But they are of low speed; their engines are not modern, only fourteen being compound; and their steaming, maneuvering, and destructive powers are inferior to those of the present warships of other navies. It is not the policy of the United States government to maintain a large navy, but its reputation, honor, and prosperity require that such naval vessels as it possesses should be the best which human ingenuity can devise and modern artificers can construct. Our present vessels are not such, and cannot be made such.¹⁹⁹

The condition of the ships, along with the unglorified mission, bred complacency amongst the sailors and officers manning them. U.S. historian Thomas Reeves detailed the poor state of the U.S. Navy in his book, *The Gentleman Boss: The life of Chester Alan Arthur*,

To man this puny fleet, there were 1,817 naval officers, 59 to a ship, one for every five seamen. Many within this wholly disproportionate number owed their positions of high authority to political and social influence and were virtually immune to reprimand or dismissal. More than a few of those with attractive commands were known to regard the ships under their control as private yachts. Nine navy yards and five naval stations stood ready to repair the almost comic flotilla, employing nearly 4,500 workmen and had cost the federal government more than \$54,000,000 through mid-1882. Chandler complained of ‘extravagant expenditures’ and vowed sharp reductions.²⁰⁰

¹⁹⁸ William Chandler, *Report of the Secretary of the Navy; Being Part of The Message and Documents Communicated to The Two Houses of Congress I* (Washington DC: Government Printing Office, 1882), I.

¹⁹⁹ Ibid.

²⁰⁰ Thomas Reeves, *The Gentleman Boss: The Life of Chester Alan Arthur* (Newtown, CT: American Political Biography Press, 1975), 338.

In addition, the experienced sailors and officers that comprised the United States Navy only had experience with blockading ports along the Atlantic coast. Soon after the war it was widely agreed that this type of warfare on the scale of the Civil War would not be how wars would be fought in the future. "We all know the navy, since the necessity of maintaining the blockade and chasing pirates has been over, have only had a holiday season," said one senator in 1868. "I think we can indulge in a little less gala parade on the oceans and lay up more of our vessels."²⁰¹ Historian and author Stephen Howarth wrote,

The degradation of the Navy in the public esteem became a self-fulfilling prophecy. The Navy was not seen to be needed, so funds for construction and repair were withheld and ships sold; because there were no funds to keep them in shape, the remaining ships became more and more bedraggled; looking useless confirmed the belief that they were useless; and the vicious circle began again.²⁰²

During the late 1870s and early 1880s, the stage was set for naval modernization. Aggressive junior officers pressed for new ships, and one unnamed officer in a foreign port complained,

The harbor here has ten immense ships of war, and we with our unpainted sides make a sorry figure. It makes me sorry to think we are such small potatoes compared to them. I cannot tell you how disappointed I am in the *Trenton*. I had hoped to get at least on board a ship of war which might at least not be sneered at in the comparison of our ships with those of foreign navies, but alas! The *Trenton* is a failure comparatively.²⁰³

These young officers published a series of professional papers which to businessmen, congressmen, and the American public outlined the advantages of a strong navy. Not

²⁰¹ Howarth, 219.

²⁰² Ibid.

²⁰³ Ibid., 220.

surprisingly, they won supporters among shipbuilders, steel firms, weapons manufacturers, and merchant ship-owners. These young officers did not stop with the construction of improved surface vessels. Many were in attendance during the trials in New York harbor to bear witness to the innovations of submarine technology, and reported back favorably as to what they saw. In September 1872, a young officer reported back to the Brooklyn Navy Yard a detailed description of the *Intelligent Whale* stating, “It is known at the yard as the *Intelligent Whale*. It certainly does not derive the name from its size in comparison of other vessels.”²⁰⁴ Many officials in the Navy department that had an eye toward the future believed that submarine warfare could help subsidize a depleting fleet and, at a portion of the price of a surface warship, could serve as the remedy to a funding stream that was severely lacking. This is why the failures of the *Intelligent Whale* were not just merely one submarine’s folly in an attempt to gain a government contract and enter into an era of submarine warfare, it represented a failure of a new generation of officers, who had put quite a bit of funding in her, to convince the stubborn senior officials in the United States Naval Department that a change in culture was needed. After many failed tests and unimpressive demonstrations in front of senior naval officials, a committee was formed to determine if the *Intelligent Whale* could serve as a useful tool in naval combat. A damning verdict was offered by the navy’s Chief of the Bureau of Ordnance in 1877, “As a practical instrument of warfare it is utterly useless.”²⁰⁵

²⁰⁴ Delgado, 144.

²⁰⁵ *Ibid.*, 145.

By the early 1870s most of the ironclads from the Civil War were in reserve, leaving the United States Navy virtually without an ironclad fleet. A diplomatic dispute occurred from October 1873 to February 1875 between the United States, Great Britain, and Spain known as the *Virginius* Affair.²⁰⁶ Toward the beginning of this dispute, a Spanish ironclad was anchored in New York Harbor, leading to the painful realization on the part of the United States Navy that it had no warship that could defeat such a capable warship. The Navy quickly issued contracts for the construction of five ironclads, and accelerated the repair program already in existence for several more. Four *Amphitrite*-class Monitors and the USS *Puritan* were later built as a direct result of the *Virginius* war scare.²⁰⁷ By the 1880s, influential members of the House and Senate began to support new naval construction of warships as congressional investigations revealed the poor condition of the existing fleet. In 1882, on the recommendation of an advisory panel, the Secretary of the Navy, William H. Hunt, requested funding from Congress for the construction of more modern warships. The request was rejected initially, but the following administration supported the request when President Chester A. Arthur and his Secretary of the Navy, William E. Chandler, both called for the building of modern warships.²⁰⁸ Chandler urged Congress to allow for funding of these new and modern warships utilizing surplus from the Federal Treasury which, despite a momentary contraction in the middle of the decade, averaged more than \$100 million a year. In 1883

²⁰⁶ Howarth, 223.

²⁰⁷ *Ibid.*, 224.

²⁰⁸ Chandler, 9.

Congress, drawing upon this surplus, authorized the construction of three steel cruisers and a dispatch boat. These ships became known as the ABCD vessels (USS *Atlanta*, *Boston*, *Chicago*, and *Dolphin*), and served as the foundation for what became known as the "New Navy."²⁰⁹ In 1885, two more protected cruisers, the USS *Charleston* and USS *Newark*, which were the last American cruisers to be fitted with a sail rig, were authorized. Congress also approved the construction of the first battleships in the Navy, the USS *Texas* and USS *Maine*. The ABCD ships proved themselves to be capable vessels, and the four cruisers were organized into the Squadron of Evolution, also known as the "White Squadron," which was used to train a generation of sailors and officers.²¹⁰

By the late 1880s, the United States Navy was garnering attention and was receiving funding to continue building a fleet capable of returning the United States Navy to a dominant force once again. Benjamin F. Tracy was noted for his role in the creation of the "New Navy", a major reform of the naval service.²¹¹ Like President Harrison, Tracy supported a more offensive minded naval strategy, rather than on coastal defense. Naval theorist Captain Alfred Thayer Mahan, who was a professor at the Naval War College, was a key ally in the effort. With the success of his book, *The Influence of Sea Power upon History, 1660–1783* in 1890, Mahan supported the construction of a "Blue-Water Navy" that could do battle on the high seas.²¹² In Tracy's opinion, however, ships

²⁰⁹ Chandler, 3.

²¹⁰ Tracy, 35.

²¹¹ Howarth, 241.

²¹² *Ibid.*

of all classes and sizes would still be needed. In the report of the Secretary of the Navy to Congress in 1889, Tracy stated that smaller cruisers and frigates were required for coastal patrols, and large steel cruisers for wartime engagement. However, in the same report, Tracy canceled the appropriation for submarine construction and further delayed the development and implementation of submarine technology in the United States Navy.²¹³

Tracy considered the makeup and construction of the “New Navy” and had determined that without a formidable submarine force, the Navy itself could not be considered as such. By the end of Tracy’s report that year, he made one final plea for an improved Navy, and was very direct about the current state despite improvements made throughout the decade,

Notwithstanding the progress of the last eight years, it must not be forgotten that the fleet has still only a nominal existence. During the past year, four ships have been added to the list, and seven have been or will shortly be removed. At no previous time in the present century has the country been so powerless at sea. The wooden ships are a makeshift, and will soon cease to even be that. The old Monitors are worse than useless.²¹⁴

Tracy had described the reality of the previous two decades of neglect to the fleet, but he also offered his vision for the future,

The force actually available at the present time comprises eight wooden vessels, of no great fighting power because of their weakness for defense. The main force has yet to be authorized. Until the United States has a fleet of twenty battle-ships with coast-defenders, cruisers, and torpedo-boats in suitable proportions for efficient defense, and an establishment in such working order, as to administrative machinery, officers, men, reserves, and vessels, that it can be brought without

²¹³ Tracy, 14.

²¹⁴ Ibid.

delay into effective action, the country cannot consider that it possesses a Navy; and a Navy it can never afford to be without.²¹⁵

By 1893, and with a new Secretary of the Navy, Hilary Herbert, the United States Naval Department considered submarine warfare as a viable form of warfare and worthy of the attention and funding,

The advantages of a submarine boat seemed to be such that the Department deemed it proper to bring the matter to the attention of Congress, which responded by authorizing the construction of a submarine boat.²¹⁶

Alfred Thayer Mahan was influential in justifying to the civilian government and the American public the need for an improved naval program through his books and lectures. As the frontier was closing, many Americans began to look outwards, to the Caribbean, to Hawaii, and the Pacific with the doctrine of Manifest Destiny as philosophical justification, many saw the Navy as an essential part of realizing what possibilities lay beyond the limits of the American continent. Mahan had his own views on submarine warfare and its development over the course of the coming decades,

The submarine, as so far developed, possesses particular value only in the cases where the fleet to which it belongs is not exposed; for when this comes out into the open it meets the enemy's submarines. In itself a new invention, it is but a step, though a more important one, in the progression of torpedo warfare.²¹⁷

In the three decades between the Civil War and the decision to purchase John Holland's sixth submarine design, submarine warfare gained United States Naval Department

²¹⁵ Ibid.

²¹⁶ Hilary A. Herbert, *Report of the Secretary of the Navy; Being Part of The Message and Documents Communicated to The Two Houses of Congress I* (Washington DC: Government Printing Office, 1893), 29.

²¹⁷ Alfred Mahan, *Mahan on Naval strategy; Selections from the Writings of Rear Admiral Alfred Thayer Mahan* (Annapolis, RI: Naval Institute Press, 1991), XXX.

support, along with support from influential officials such as Rear Admiral Mahan, and Congressional funding. However, convincing the American public that the odd submersible vessels being tested in harbors along the eastern seaboard would be a viable and formidable means of warfare proved difficult.

Articles describing the testing being conducted in New York Harbor and the Great Lakes were prevalent throughout the 1870s and 1880s. They described the submarines themselves as “odd cigar-shaped vessels” with equally odd inventors, and in most cases reported on the events in lighter tones that did not invoke visions of advances in warfare. When these reports did strictly report on the events and capabilities of the vessels themselves, they frequently confused reports of testing in other areas, as was the case during Holland’s trials of his first submarine. Many sources provided conflicting reports on where the submarine was built. Some stated that it was built on the East River, while others had various locations throughout New Jersey and New York. This is but one example of many where authors and reporters perpetuated error, leaving the subject of history in a haze of confusion.²¹⁸ In addition, these tests attracted crowds that seemed as eager to see an engineer quite possibly kill himself in the very invention that he spent his life developing, as they were in seeing a marvel of modern warfare. Comments such as, “I see that the professor has built a coffin for himself,”²¹⁹ were commonplace as skeptics littered the crowds and reporters were equally eager to report on the misadventures of these inventors.

²¹⁸ Morris, 22.

²¹⁹ Ibid., 28.

In a September 1877 article in *The Galaxy*, author Isaac Newton described in great detail his feelings toward the ethical issues related to submarine and torpedo warfare, and pleaded to leave behind this new found technological innovation in warfare. Newton stated,

The revolution in naval warfare thus foreshadowed is close at hand; indeed, it is not too much to say that the complete penalization of the vast navy of France during the late war with Germany, through fear of German torpedoes, shows that this revolution has already taken place, and that the days of ocean supremacy and of great navies have passed away. This momentous change has been brought about by the submarine torpedo, and instrument which assails the ship from underneath, below the water line.²²⁰

Newton continued to describe the historical significance of the usage of torpedoes in warfare and submarine development,

It was not until the overwhelming naval superiority of the Union aroused the Confederates to the consideration of some means of defense against this force, which traversed every river and sound in their territory, that this mode of defense, which has now transformed warfare, was actually given practical shape. The appearance of ironclads, invulnerable to any artillery that could be brought against them, was another reason which caused the Confederates, during the last years of the war, to devote great attention to perfecting a means of enabling them to thwart their enemies.²²¹

Newton provided historical examples of submarine development as a form of unethical warfare, and continued to describe the torpedo itself as a dastardly form of naval warfare similar to the feeling toward the use of gunpowder in Europe centuries before, and how theorists of the time believed that its application in warfare was “appalling.”²²² Newton

²²⁰ Isaac Newton, “Has the Day of Great Navies Passed?” *The Galaxy* 24, no. 8 (1877): 293.

²²¹ *Ibid.*, 294.

²²² *Ibid.*

cited other emphatic opinions of famous historical figures such as John Quincy Adams who viewed torpedo warfare as, “Cowardly, and no fair or honest warfare.”²²³

Newton, as is the case with most who study the history of modern submarine warfare, believed the American Civil War to be epitome of submarine warfare to that point in history, “A brief record of the work of the Confederate torpedoes ought to be read by everyone who wishes to comprehend the degree of development that submarine warfare had attained in this country so long ago as the close of the war.”²²⁴ Although Newton continues to describe the success that the Confederates had against the Union blockade in the form of submersible and semi-submersible vessels, he was of the opinion that these successes only served as examples of naval combat that is unethical and unfair, and not innovations in a new form of warfare.

As late as 1902, reporters continued to report on submarine innovation in magazines and newspapers with skepticism. One article in the *Journal of the American Society of Naval Engineers* reported, “It may, however, be found, in actual practice, that the capabilities of both surface and submerged boats have been overestimated, but that both, doubtless, will be found to have their places in warfare.”²²⁵

Further adding to the untrusting American public was the abundance of embellished stories that seemed to be routine when describing submarine development throughout the nineteenth century. Some of these stories, such as the story of the

²²³ Ibid.

²²⁴ Ibid., 296.

²²⁵ G. W. Baird, “Submarine Torpedo Boats,” *Journal of the American Society of Naval Engineers* 14, no. 2 (1902): 855.

mysterious New Orleans submarine described in Simon Lake's, *The Submarine in War and Peace*, in which a story of a submarine design from a wealthy planter during the Civil War was lost during testing, were meant to be humorous in nature. However, many of these stories became embellished over time and plagued submarine innovation for many years. Submarines were stigmatized as a vessel whose naval warfare capacity was limited to killing any inventor, engineer, or crew members foolish enough to submerge in one, as was the case of the infamous *Fool Killer*.

In the early 1850s, Lodner Phillips, a local shoemaker in Michigan City, designed and built a submarine with the hopes of selling it to the United States Naval Department, like so many hopeful inventors. Phillips' submarine was forty feet long and made of wood, copper, and steel weighing several tons.²²⁶ As most submarine designs of the time had hand-cranked propellers, the *Marine Cigar*, as Phillips originally dubbed her, was designed to be propelled by one operator. The design itself was enough to gain Phillips the patents needed to continue with constructing his vessel.²²⁷ There are many strange and isolated reports of its operation in news articles in 1852; however, these claims are not backed by any actual documentation or account. What is known is that Phillips' vessel sank in the Chicago River never having been recovered by Phillips himself. Stories began to build over time as the *Fool Killer* was said to have claimed the lives of up to forty men at the time that it was dredged out of the river by William Deneau in 1915. Deneau was a diver of some local celebrity who was helping lay cable along the river

²²⁶ Ragan, 262.

²²⁷ Ibid, 210.

bottom. Deneau claimed it was a vessel owned by Peter Nissen, who had become a celebrity in his own right having twice survived in vessels designed to take the cascade of Niagara Falls.²²⁸ It was assumed that Nissen had purchased the submarine from Phillips and had sunk it in the Chicago River; however, there is no record of this. Nissen, may or may not have been a clever inventor of survivable vessels, but there is little doubt that he was a shameless promoter of his various stunts.

In the end, he was found washed up on the shore of Lake Michigan in 1904 amongst the ruins of his latest invention having died of extreme exposure.²²⁹ Anyone having anything to do with the actual submarine having long since passed away, allowed Deneau to weave any tale he liked to make his discovery an attraction. Tales of crew members having lost their lives in the testing of the vessel continued to grow to the point that men weren't the only ones to have fallen victim to the legend; one legend claimed that a dog's remains were found inside the vessel when it was recovered.²³⁰

These side show attractions, which associated serious submarine innovators with stuntmen and fools with a death wish, fueled skeptics well into the twentieth century. Even serious attempts at submarine boat construction fell victim to urban legend. The *Intelligent Whale* was said to have claimed the lives of over forty men in her own right while displayed at the Brooklyn Naval Yard. While the American public was well informed of successful trials and wonders of submarine exploration throughout the latter

²²⁸ Patricia A. Gruse Harris, *Great Lakes' First Submarine : L.D. Phillips' Fool Killer* (Michigan City, IN: Michigan City Historical Society, 1982), 4.

²²⁹ *Ibid.*

²³⁰ *Ibid.*

nineteenth century, they were flooded with tales of futile attempts which contributed to their uninformed opinions.

Finally, another contributing factor to the United States Naval Department's hesitation to implement submarine warfare was the loss of the competitive advantage in shipbuilding the United States had enjoyed prior to the advent of iron-clad warships. Due to the need for sailing, merchant, and warships, the shipyards put a tremendous drain on stands of timber near the seaboard. The large oaks needed for bows and hulls and the tall pines required for masts became increasingly scarce in coastal regions. Aside from rising cost of materials, a significant threat to American shipbuilders was the development in Europe of ships made of iron.²³¹ Shipbuilders in the United States were not as efficient in building iron vessels as their European counterparts due to antimilitarism following the Civil War.²³² Still, the navy was reluctant to convert exclusively to iron, steam-driven vessels as historian Thomas Reeves states,

This ultraconservative class of professionals [senior line officers], jealous of its prestige and position, was prejudiced against steam power and did much to frustrate post war efforts by the engineer corps to modernize the service. A general order of 1869 required 'full sail power' for all new vessels, another threatened serious penalties for burning coal except in emergencies.²³³

Over the course of the following decades, Great Britain continued building the world's largest and most formidable navy comprised of massive iron vessels. The success of these large metal steamships stimulated the growth of iron shipbuilding in Europe.

²³¹ Reeves, 339.

²³² Herbert, 15.

²³³ Reeves, 339.

Before the 1880s, most warships had been built in government-owned naval yards which lacked the machinery and equipment needed to build modern steel vessels, and these plants were not as well funded as the civilian-run construction yards.²³⁴ Thus, the government turned to the private sector for the new construction program. Eight east coast shipyards submitted bids on one or more of the ABCD vessels, but the low bidder for each ship was the John Roach plant on the Delaware River. Secretary of the Navy Chandler awarded all four contracts to Roach, a decision which raised some eyebrows since Chandler had long served as Roach's personal attorney and they had political connections with one another in the Republican Party.²³⁵ These connections led to suspicions of favoritism in the awarding of the contracts, but Chandler argued he was merely accepting the lowest bids – as required by law.

Roach began work on the first ship in 1883, but numerous design changes, shortages of material, and delays in construction resulted in inflating costs well above original bids.²³⁶ Roach pressed the government for cash advances as he exhausted his line of credit and borrowed heavily to meet demands. Chandler was willing to continue to work with Roach, accelerating his payments, but when the Democratic administration of Grover Cleveland came to power in 1885, the friendly Secretary departed. After the USS *Dolphin* encountered numerous problems during sea trials, the new Secretary of the

²³⁴ *Ibid.*, 343.

²³⁵ *Ibid.*

²³⁶ *Ibid.*, 345.

Navy, William C. Whitney, was less willing to help out the Republican shipbuilder.²³⁷

Whitney stopped all payments on the contract, refused to accept the ship, and filed a lawsuit against Roach to recover the government funds already paid. Roach filed for bankruptcy in 1885 after his failed attempts at building warships drained his assets. A year and a half later, Roach passed away. To complete the remaining ABCD ships the navy had to commandeer Roach's yard and directly supervise construction.

In a report from the Secretary of Treasury in 1889, William Windom, stated,

It is but a few years since we stood first among nations in shipbuilding, and were excelled only by Great Britain in the amount of ocean tonnage. Now, so far as foreign trade is concerned, our shipyards are comparatively silent, and our flag has almost disappeared from the high seas. Once seventy-five percent of our tonnage was carried in our own ships; now eighty-seven percent is carried in foreign bottoms. Once our ocean commerce enriched our own countrymen; now our immense tonnage of exports and imports gives employment mainly to alien labor, and alien capital levies upon our people an annual tribute estimated at \$150,000,000 for freights and fares.²³⁸

Relatively speaking, the cost of building a submarine in the late nineteenth century paled in comparison to building a warship made from iron or steel. However, the Naval Department was willing to fund and contract new constructions and improvements so desperately needed to the fleet with little to no return and little public support for new construction.²³⁹ Given the public and political issues involved with improving the navy, it is not difficult to understand why the United States government was not willing to

²³⁷ Ibid.

²³⁸ William Windom, *Report of the Secretary of Treasury; Being Part of The Message and Documents Communicated to The Two Houses of Congress I* (Washington, DC: Government Printing Office, 1889), LIV.

²³⁹ Reeves, 350.

entertain submarine designs. Although the technology and innovation demonstrated during the 1870s and 1880s legitimized what most had recognized as early as the Civil War, the United States government could not afford to spend money on innovation when the fleet of warships currently in the inventory was in such a sad state of repair. President Cleveland lost the 1888 election to Benjamin Harrison, and the incoming Republican administration immediately announced its support for naval construction.²⁴⁰ The new Secretary of the Navy, Benjamin F. Tracy, was greatly influenced by the works of Captain Alfred Thayer Mahan of the Naval War College. Mahan stressed the need for a large fleet of battleships to defend the nation's sea lines of communication. To implement this strategy, Tracy proposed a long-range plan to have twenty capital ships constructed over the course of the following decade.²⁴¹ He proposed twelve new constructions for the east coast, and eight for the west coast, but this would prove too ambitious for the American public. However, the Naval Act of 1890 passed by Congress provided for three large battleships and a cruiser to begin construction.²⁴² Congress authorized two more cruisers and one more battleship during the remaining two years of the Harrison Administration. When Cleveland returned to office in 1893 he found a Naval Department focused on improvements, and, despite a severe depression, his administration convinced Congress to authorize another five battleships and numerous smaller vessels to begin

²⁴⁰ Long, 11.

²⁴¹ Tracy, 32.

²⁴² Herbert, 13.

construction.²⁴³ Among these smaller vessels to be constructed, was the country's first submarine. Thus, by the mid-1890s the construction of the "New Navy" was well underway.

Franklin D. Roosevelt summed up the future of the submarine in the United States Navy,

The submarine has come to stay. It has taken its place, not as the sole weapon in naval offense and defense, but as an adjunct to other weapons. That it is useful for coast defense, for commerce destroying, for scouting purposes, and as a part of the protection to and attacking power of a battleship fleet is established.²⁴⁴

The submarine had proven itself in the civil war as an innovative weapon that can be employed to attack naval vessels with devastating results. Captain Frank T. Cable, the captain of the USS *Holland* during early testing, fully realized the unlimited potential of submarine warfare,

No longer a fad or a toy, the submarine became, in the shape of the *Holland*, a "monster war fish," a "devil of the deep," a "hell diver," as the vessel came to be called. Strictly speaking, the boat was a torpedo, but a torpedo controlled in all its workings by human agency inside the craft, instead of being automatic in its operations.²⁴⁵

Following the *Hunley's* historic attack on the *Housatonic* the political, economic, and social landscape in the United States delayed further implementation of the submarine in the navy, but it did not deter the submarine innovators of the late 1800s

²⁴³ Tracy, 13.

²⁴⁴ Franklin D. Roosevelt, "The Future of the Submarine," *The North American Review* (1915): 508.

²⁴⁵ Frank Cable, "The Submarine Torpedo Boat *Holland*: First Submarine to Become a Part of the United States Navy," *Proceedings* (February 1943), accessed January 17, 2017, <https://www.navalhistory.org/2013/04/11/april-11-1900-the-first-submarine-of-the-navy-uss-holland-ss-1>.

from pushing the bounds of imagination. Through inspiration, imitation, and improvements made over the following three decades, the *Hunley's* successful attack directly led to the United States submarine force.

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