

THE FLORIDA STATE UNIVERSITY  
COLLEGE OF ARTS AND SCIENCES

A ROUGH. WET RIDE:  
THE CIVILIAN GENESIS OF THE AMERICAN MOTOR TORPEDO BOAT

By  
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A Dissertation submitted to the  
Department of History  
in partial fulfillment of the  
requirements for the degree of  
Doctor of Philosophy

Degree Awarded:  
Fall Semester, 2009

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## ACKNOWLEDGEMENT

First, many thanks to my graduate committee at Florida State University. To my major professor Dr. James Pickett Jones, thank you for adding one more graduate student even though you had officially retired from the graduate game. It's always been comforting to know you were still teaching because I know as long as you are around I will not be the oldest person in the department. You will be teaching, guiding, and cajoling for decades to come and the university will be the better for it.

If this work has any literary merit it is largely attributable to my teacher and friend Dr. Michael Creswell. He consistently offered help when needed and was always available for counseling, academic discussion, and professional and scholastic development. The contacts he gave me at the Naval War College and Naval Historical Center helped set a course that decisively impacted this study. Mike has gained a well-justified reputation as an excellent editor of scholarly papers. He has helped many students polish their writing style, develop points to better support a thesis, and to eliminate repetition and contradiction. Numerous graduate students have commented upon his command of the language and his ability to hone and shape academic prose into a concise and cogent narrative. His suggestions regarding style, context, and content have consistently been discerning and valid and this study is better because of it.

Mike introduced me to Dr. Randy Papadopoulos of the Naval History Center (NHC) and it was because of Randy's efforts I was able to obtain and copy Tredennick and Harrison's rare *An Administrative History of PTs in World War II*. Randy's reaction was typical of the historians, navalists, and history buffs I met along the way. He did not know me from Adam yet he gave freely of his very limited time to show me around the Washington Navy Yard, gave me an escorted tour to John Kerry's PCF (patrol craft, fast), provided access to the NHC library, made recommendations that have shaped the course of this study and opened numerous other doors. Ed Marolda and Mike McDaniel of NHC took time from their hectic schedules to lend direction, assistance, and discuss naval small craft. Their kindness is deeply appreciated.

Dr. Jonathan Grant has become the department's patron saint of unconventional history students. Having him on the committee inspired me to study the naval actions of the

Russo-Japanese War – something I had long wanted to do anyway. In the process, I learned a lot about the place of torpedo boats in early 20<sup>th</sup> century naval warfare and the ironic disparity between their actual combat efficacy and the fear they could inspire in their opponents.

A special thanks to Dr. Peter Garretson who came aboard at the last minute to fill in after another professor moved to more serene pastures. I met Pete eight years ago and he immediately impressed me as a true scholar and gentlemen. In fact, if you look up the definition of gentleman in Webster's there will be a picture of Pete Garretson next to it. He is one of the reasons I decided to study at Florida State.

Dr Jeff Chanton sat in as outside University representative to add scientific clarity, purpose, and nautical knowledge to this gathering of landlubbers. When I first tried to contact him, Jeff was unavailable, being offshore on a boat. That was about the best recommendation anyone could have given and I am grateful he signed on.

This educational experience has been pay-as-you-go and for that I have to thank the patrons of my mobile marine repair service, The Boat Doc, and especially my friend Armand Cognetta. He and many other satisfied customers have kept me afloat financially over the past seven years. Thank you all very much. My customers were the most important ingredients in this venture and without their financial support it almost certainly would have faltered.

Alyce Mary Guthrie and her organization, PT Boats Inc., were consistently helpful and a source of up to date information on the status of surviving PT boats and veterans. Numerous veterans agreed to be interviewed about their experiences and they were decidedly illuminating. They told me of things not found in the books – until now. And to those men, I extend this apology for taking so long to transcribe the interviews. It is mighty difficult to type when you are doubled up with laughter – or tears.

There are not only many veterans still actively involved in this organization but through PT Boats, Inc I encountered hundreds of other PT aficionados who had not even been born when the last boat was struck from the list. Notable among them are Jim Melanson, Frank Andruss, Jr, T. Garth Connelly, Al Ross, Chip Marshall and many others ... all of whom have given useful information that is incorporated in this work

They were especially supportive in tracing the fate of the boats that were sold as surplus in the states after the war.

Joan Denman and the staff of Florida State's Institute on World War Two and the Human Experience gave freely of their time and knowledge. This archive is a highly valuable resource for any scholar seeking to move beyond headlines and pulp history to discover the personal impact of war. Through the letters of those who lived the war, it was possible to develop an intimate connection with the men and women of the greatest generation. Joan was especially accommodating and ever ready to tell me of a newly acquired source that might be of value. It was great working with her.

Dr. Sandra Norman and Dr. Stephen Engle of Florida Atlantic University played a major role in my decision to pursue doctoral studies. They fostered an atmosphere of academic exploration that encouraged me to go on from their master's program to doctoral work at FSU. Sandy always knew that my work with her was just the beginning of the journey in spite of my repeated protestations to the contrary.

I wish to express my gratitude to the staff of Navy Records at the National Archives - Rebecca A. Livingston, Charles W. Johnson, and Stephanie Richards - who led this stumbling novice through files that I feel certain have not been read since 1945. Their guidance and suggestions were crucial in documenting the results of the Plywood Derbies and finding evidence of favoritism and corruption in the 1938 design contest.

My cousin Bill Barnes and all the gang at Bay Pointe Marina will probably be surprised to discover how much they are responsible for the completion of this study. I bunked aboard *Trouble*, his 46' Beneteau sloop, on my numerous research trips to Norfolk, the Mariner's Museum, Annapolis, and the National Archives. It seemed quite natural to be sleeping aboard a boat while researching military small craft. The experience was enhanced by the knowledge that only a few hundred feet away were the gray ships and stolid landing craft of the U.S. Navy's Little Creek Amphibious Base. The gentle lapping of the waves against the hull lulled me to sleep each night so I could be ready for the next day's work. It is fitting that the writing both started and ended on *Trouble's* salon table.

Dr. Doug Smith and Dr. Stan Carpenter of the Naval War College provided encouragement through their friendship and academic interest in this work. Paul Merzlak,

Tom Cutler, Bob Timberg, Robert Latture, Liese Doherty and the staff at the United States Naval Institute opened doors and gave support without even knowing it. Tom Wooldridge at the Naval Institute Library was especially supportive. Their kindness and interest was more helpful than they know and I welcome the opportunity to say so here.

A special thanks to Craig Symonds who never tired of my inquiries about the arcane means and methods of academia. Craig is the world's foremost scholar of the Civil War at sea and he has been very generous with his time and knowledge. Craig, it has been a pleasure to work with you and I look forward to a long, happy, and productive friendship.

Florida State University boasts excellent library holdings that far exceeded my expectations. The staff was consistently helpful – in fact, the term helpful may not do their efforts justice. My experience with the staff at Strozier was uniformly positive. A few of those I would like to thank include in alphabetical order: Marcia Gorin, Reggie Jones, Michael Luesebrink, Chuck McCann, Kevin Seeber, W. Malcolm Shackelford, Velma Smith at Interlibrary Loan, and Trip Wyckoff.

Cindy Purcell, President of Huckins Yacht Corporation and Frank Huckins's granddaughter, allowed me to roam through the company archives and examine a length Frank's drawings for PT 69 and the PT 95 series. She supplied written source material about the firm and Huckins's participation in the Plywood Derbies that are unavailable anywhere else.

The trail of the boats not only led to new friendships but also resurrected old ones. Reestablishing contact with my old friends (not to say that any of us are old) Bill and Janie Whitehurst was one of the highlights of this academic journey.

Many of us have moments of clarity when thoughts that have been spinning about the gray matter for months suddenly gel into a single, focused theme. My moment of clarity came while speaking with Tom Cutler, senior acquisitions editor at the Naval Institute Press. Tom is a highly accomplished author and veteran of Vietnam's brown water navy and his counsel had greater impact than he knew. Who knows why it happened when and where it did, but for better or worse the themes of this dissertation crystallized while talking with Tom one day in his Annapolis office. He gave me direction at a time when this study was clearly following in the wake of other scholars. He can take a lot of the credit if you find it valuable.

But foremost, thanks to my parents, Ed and Fannie. My earliest childhood memory is of walking hand in hand with my father along the banks of the Chesapeake and Albemarle Canal looking at boats. “Boatitis” became a chronic affliction and was compounded by nautical adventures with a series of small craft I owned as a teenager along with my brother Dave and our friend Melvin Jordan. We were mighty lucky to survive some of them. Of course, living in a Navy town and spending countless hours and days on Norfolk’s many naval installations did nothing to relieve this malady. Curtis Nelson who wrote *Hunters in the Shallows*, an excellent examination of the development of the Elco PT boat, confessed that after seeing the movie *PT-109* and reading Robert J. Donovan’s *PT 109, John F. Kennedy in World War II* he was always fascinated by these “small, fast craft with the hornet’s sting.” It is a response common to those of us who study them and of those who sailed them. When I saw *PT 109* the hook was set deep.

My folks unknowingly made things worse when we moved close to the river. Every day they would send my brother Dave and me out to play with the caring admonition “Don’t you boys go anywhere near that water.” The “water” they were talking about was the eastern branch of Norfolk’s historic Elizabeth River. But we were drawn to it and it was hopeless to think parental decree could ease that hunger. David retired as a Chief Warrant Officer from the Coast Guard several years ago. I have been in the boat business as a broker, systems technician, and captain for over twenty-five years and am really happy only when on or close to salt water. So parents, let that be a lesson about the guidance you give your children. Use caution or you may end up with a wharf rat(s) in the family.



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## ABSTRACT

Dwight Eisenhower once warned of an insidious collusion between industry and government that threatened to become master of United States domestic and foreign policy. His warning came too late, of course, for the threat had already become reality before he spoke. But there were and are positive elements to the merger of interests, and one of them was the infusion of civilian small craft expertise into the arena of national defense.

This dissertation is an overview of the evolution of small combatant craft in the United States Navy and demonstrates that the most successful of these boats have consistently come from the civilian sector. The history of this intercourse is traced from its origins in the American Revolution through its ultimate incarnation of the motor torpedo boat of World War Two. Experience in Vietnam and ongoing counter-terror and drug interception operations worldwide, demonstrates conclusively that rugged, efficient boats for security, patrol, and combat are still an essential factor in law enforcement, homeland defense, and power projection, and the services have come to rely increasingly upon the domestic small craft industry to supply them.

## CHAPTER 1

### INTRODUCTION

Few warships have elicited the emotional response of the little motor torpedo boats (MTB) of the Second World War II, the PTs. These boats hold a special appeal to Americans. In their celebrated fight to hold the line against the capital ships of the Imperial Japanese Navy they epitomized the story of David and Goliath – boats of wood versus mammoth ships of steel. Because of this antecedent, and because they made their biggest headlines at a time when America was desperate for heroes and victories, the adventures of PTs and their crews established an aura that left them surrounded by myth, legend, and misinformation. Today, the student of torpedo boat warfare and development faces an uncommonly large task in sifting the real from the fanciful.<sup>1</sup>

Recent scholarship reveals that the list of kills originally claimed by the boats, and readily magnified by well-intentioned wartime journalists, was greatly exaggerated. Indeed, it is now commonly accepted that in the first two years of the war the boats were relatively inefficient torpedo platforms for at least three reasons: their antiquated Mark

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<sup>1</sup> R. William Brown, "They Called Her 'Carole Baby,'" *Naval History* 15(5) (October 2001):23-25. Edgar D. Hoagland, "PT Boats Raid Bongao Island," *Naval History* 13(3) (1999): 42-45. Hoagland's account of a PT raid he led in March 1945 shows why these boats and their crews captured and held the public's attention for the duration of the war and the decades that followed. Edgar Hoagland, *The Seahawks*, (Presidio Press, 1999). This is an account of the author's wartime experiences in PT boats. Bern Keating, *The Mosquito Fleet*. (New York: Scholastic Book Services, 1963), 7-8. William L. White, *They Were Expendable*, (New York: Harcourt, Brace, and Company, 1942). White's book was based largely on interviews with officers at the Motor Torpedo Boat Training Center at Melville, Rhode Island, the major PT training base. Foremost among them was John Bulkeley, former squadron commander of the unit that got Douglas MacArthur out of Corregidor. Bulkeley was a national hero at the time, had been promoted and awarded the Medal of Honor, and his enthusiasm for the boats gave the public an inflated idea of their value. Bulkeley laid claim to two light cruisers, two transports, an oil tanker, and numerous barges and landing craft as falling before his squadron's torpedoes and guns. Keating says that studies of Japanese archives give no evidence of ship sinkings in the actions reported by Bulkeley's Squadron Three (Ron3). The 1945 production of *They Were Expendable* starring John Wayne and Robert Montgomery institutionalized the fiction of small boats killing big ships as a matter of routine. Montgomery had been a PT skipper in the war and probably knew better.

VIII torpedoes, inexperienced crews, and lack of radar. The failings of the Mark-VIII and Mark-XIV torpedoes became notorious among submarine and PT crews in the early years of the war. Obstinacy and false economy in the Bureau of Ordnance led to brave crews putting to sea with defective weapons and unquestionably led to the loss of hundreds, probably thousands, of American lives. The reaction of the naval authorities in Washington to plaintive reports from the Pacific was little short of criminal. The boat's real contribution came only after the main torpedo armament was altered and the number and caliber of guns was increased. As gunboats, they did yeoman service from the Solomon's through the Philippines, interdicting Japanese barge and small craft traffic and severing the lines of communication that fed supplies and reinforcements to their besieged island outposts.

Some PTs in the Pacific were stripped of torpedoes and depth charges altogether, and all the boats received heavier armament than that for which they were designed. By late in the war most carried a 40mm Bofors on the stern, a modified Air Corps 37mm automatic gun on the bow, one or two 20mm guns, numerous 0.50 cal. Machine guns, plus the Mark XIII torpedo. They became ton for ton, the most heavily armed vessels in the U.S. inventory. This gunboat duty was less glamorous than the torpedo boat role that had made them famous, but the extreme close quarters action was arguably more dangerous. It was here that they made a vital contribution to the war effort and saved the lives of countless marines and sailors by choking off Japanese supply routes and attacking shore based installations.<sup>2</sup>

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<sup>2</sup> Curtis L. Nelson, *Hunters in the Shallows, A History of the PT Boat*, (Washington: Brassey's, 1998). Nelson spends relatively little time in his book recounting PT operations, a subject that has already received considerable attention from other writers. Instead, he focuses on the political, economic, and military factors involved in creation of the PT program and how the boats evolved throughout the war. His account is unique in that it addresses the political maneuvering that brought the program to fruition and gave Elco the lion's share of production. There are numerous accounts of PT operations, many concerned solely with the Pacific theatre but others examine the European and American Theatres as well. Robert J. Bulkeley, Jr. *At Close Quarters: PT Boats in the United States Navy*. (Washington: Government Printing Office, 1962). The best account of the saga of the PTs, from concept through design and operations and evolution from the 1930s through 1945. The author, no relation to Lt. Cdr. (later Vice Admiral) John Bulkeley, was an active duty naval officer who wrote a definitive report of PT operations for the Department of the Navy in

Until the mid-1930s the value of torpedo boats for U.S. purposes was widely considered dubious and thus development of the type was ignored. Changes in geopolitics and strategic concepts in the decade preceding the war led to a reexamination of MTB capabilities at several levels within the naval establishment. After experimenting with foreign and domestic craft, the Navy held surveys and sea trials of the various prototypes in July and August 1941. These tests would enter the naval lexicon as “The Plywood Derbies.” They led to the refinement and standardization of PT hulls and engines and gave valuable guidance for future development. However, the road to a fully functional and efficient PT fleet was not smooth and straight. Due to changes in U.S. naval doctrine and strategic outlook in the last decade of the 19<sup>th</sup> century, there were times when it appeared that these nimble, hard hitting, and inexpensive little boats might never be more than the daydreams of a few farsighted naval officers.<sup>3</sup>

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1946. *At Close Quarters* is fundamentally the updated civilian version of that report. It was, and remains, the primary secondary resource for the study of American motor torpedo boat operations though Bulkley is reluctant to analyze operations or be critical of anyone involved. His account is somewhat sanitized which detracts from its value as a text of lessons learned. William Breur, *Devil Boats: The PT War Against Japan*. (Novato, CA: Presidio Press, 1987), An exciting account of PT operations in the Pacific. Dick Keresey, *PT-105*. (Annapolis, Naval Institute Press, 1996). Dick Keresey was typical of the skippers recruited by Bulkeley - tall, well educated, but with no sea or boat experience whatsoever. He ran PT 105, an 80' Elco sister ship to John Kennedy's PT 109 and served alongside Kennedy in several actions. He gives an excellent first hand account of the life and times of PT sailors in the first two years of the war. A superb primary source. David E. Cohen, “The Mk-XIV Torpedo: Lessons for Today” *Naval History* (Winter 1992):34-36.. Robert J. Donovan, *PT-109: John F. Kennedy in World War II* (New York: McGraw-Hill, 1961). Donovan may have been politically motivated but he produced a well-researched examination of Kennedy in the Pacific. Later produced as a movie with Cliff Robertson. As an interesting sidelight, Warner Brothers was unable to find any PTs to use in the movie – they had all been destroyed, converted for other uses, or sold off. They used 65-foot rescue boats accurately converted to look like an 80-foot Elco.

<sup>3</sup> Robert Bulkley, *At Close Quarters*, 52-57. Bulkley's chapter on PT development is drawn largely from an unpublished work by Frank A. Tredennick, Jr. and Harrison L. Bennett, *An Administrative History of PTs in World War II*. (Washington: Office of Naval History); Keating, *The Mosquito Fleet*, 8-9; Nelson, *Hunters in the Shallows*, 58, 108; Peters, “The PT Boat”, 3-4.

Before the Navy's intellectual and material renaissance in the 1890s, two doctrines dominated US naval planning – commerce raiding and coastal defense. Thus, ships were designed to fulfill the same roles as those played by the wooden frigates of the early republic - showing the flag during times of peace, defending the coast, and destroying the enemy's commerce during war. Fleet actions involving capital ships lay outside of American planning because of the expense involved and the unlikelihood that the country would need such weapons or could financially support a fleet large enough to be successful against a major rival. With no colonies to support, such a projection of power made little sense.<sup>4</sup>

Along with commerce raiding, coastal defense was a naval priority. It was a mission that dated to the War of Independence, and had been at the forefront of naval spending ever since. Coastal defense was deemed to be a combined arms function with static fortifications backed by relatively shoal draft coastwise vessels such as President Thomas Jefferson's beloved but ineffectual gunboats. The monitors of the post Civil War period were primarily harbor security vessels that continued this defensive, localized mindset.<sup>5</sup>

The rise of American imperialism in the late 19<sup>th</sup> century radically altered the Navy's mission. Prodded by the writings of Alfred Thayer Mahan, implemented by such luminaries as Professor James B. Soley and Admiral Stephen B. Luce, and supported politically and financially by no less a figure than Theodore Roosevelt, the new doctrine held that expanding overseas interests in possessions and trade mandated the projection of American naval power beyond the national littoral. United States interests now required that the Navy not only protect the mainland but control the sea lanes as well. This mission called for a new type of fleet and finally brought the country into the era of the steam powered, steel-hulled dreadnought class of capital ship, characterized by fewer

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<sup>4</sup> Harald Fock *Fast Fighting Boats, 1870-1945. Their Design, Construction, and Use*. (Lymington, Hampshire, England: Nautical Publishing Company, 1978). 80; Curtis Nelson, *Hunters in the Shallows*, 58.

<sup>5</sup> Ibid.

guns but of larger caliber, with armor protection, and high speed. This battleship-oriented doctrine would control U.S. war planning and ship construction for decades.<sup>6</sup>

Meanwhile, foreign navies took advantage of changing technologies to experiment with fast, short-range craft to serve as adjuncts to their main battle fleets. Two of the most important developments were the invention and refinement of the self-propelled torpedo and the internal combustion engine. By coupling these new devices into a high speed, low profile, planing wooden hull the torpedo boat became a force to be feared. Italy enjoyed notable success in the First World War and the England's coastal motor boats (CMB) made headlines with their operations in Belgian ports. Although the United States made note of these actions, it took little interest. American officials thought that limited resources should be used to build vessels capable of going to sea as well as making coastal torpedo attacks. This philosophy became more entrenched during the anti-military backlash of the 1920s and with the economic constraints imposed by the Great Depression. It was the rise of fascist regimes in Europe and Japanese aggression in China that caused well-placed government and naval officials to consider the possible demands of the oncoming conflict that increasingly seemed inevitable. Reevaluation of MTBs became part of this process. They would soon become part of the fleet.<sup>7</sup>

This work is a narrative of the design and development history of the American motor torpedo boat, the PT, of World War Two and how it came to be an integral player in that conflict. It includes operational history when relevant but is primarily an overview of the political, military, and technological events and developments that led to the creation of

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<sup>6</sup> Robert J. Bulkley, Jr, *At Close Quarters*, 39; Norman Friedman, *U.S. Small Combatants* (Annapolis: Naval Institute Press, 1987), 98-99; Nelson, *Hunters in the Shallows*, 59-60, 62, 69.

<sup>7</sup> Letter from Chairman, General Board to Secretary of the Navy, 14 April 1937, General Board of the Navy Files, 420-14, G. B. Serial No. 1740; Bulkley, *At Close Quarters*, 38-42; Harald Fock *Fast Fighting Boats*. Fock gives an excellent study of torpedo boat development in foreign navies during and between both world wars. Norman Friedman, *U.S. Small Combatants*, 97-99; Curtis Nelson, *Hunters in the Shallows*, 62-63. Sidney A. Peters, "The PT Boat," *Bureau of Ships Journal* (August 1953): 3; Hyman Roudman, "The Evolution of New Fleet Tactics," *Military Affairs* 7(4) (Winter 1943): 197-198; Theodore Ropp, "The Modern Italian Navy," *Military Affairs* 5(2) (Summer 1941): 104, 105, 110, 112; Larry R. Smith, "Evolution of the Torpedo Boat," *Military Affairs* 23(2) (Summer 1959): 101.



motor torpedo boats for the United States navy. While studying the secondary literature, speaking with PT veterans of World War II and brown water vets of Vietnam, and digging through dusty files in the National Archives to learn more about the boats, four consistent themes became apparent.

First, the corporate culture that traditionally dominates the naval establishment, both active duty and civilian, has little knowledge of or regard for small craft and inshore and inland warfare capabilities. On those occasions when a shallow water or riverine campaign was judged necessary for victory, the Navy found itself scrambling to establish a force from scratch. This crisis management mind set was usually replete with all the attendant experimentation, confusion, trial and error, and waste of resources one might expect. It was not that there was anything lacking in the personnel charged with the effort. The problem was simply that they came from a big ship, blue water corporate culture. Small craft and brown water operations were, and are, generally as alien to them as a Cessna 152 is to the senior pilot of a Boeing 767. Both aircraft fly but that is where the similarity ends. The Navy's institutional amnesia has insured that there is no corpus of knowledge bequeathed by previous generations of officers to their descendants. The numerous lessons learned, the knowledge gained in the factory and in the field, fail to be passed on because historically there is no permanent place for small craft operations in the US Navy.

Second, previous scholarship in the field has missed significant points and sources. Researchers leave telltales marking their passing and from the condition of files in the National Archives and other primary sources it became obvious most of the vital primary matter involved had not been touched since it was filed generations ago. In interviews with PT and Vietnam veterans it became clear that this was a unique and valuable source that had largely gone unharvested by other writers.

Third, most of the secondary literature was written by scholars and popular historians lacking practical, first-hand small boat experience. Their prose and studies are often excellent but the final product is handicapped by not having experienced the ocean "at close quarters." Absent a personal knowledge of navigation, boat handling, ships systems, and weaponry it can be hard to understand the intricacies of small craft and difficult to fathom the challenge of operating and maintaining them in a combat

environment. Having lived a lifetime on the water it is fair to say that this is a work about and by sailors and is written from the perspective of a small craft skipper.

Last, historically the Navy does a fine job of building ships but obtains mediocre results when it turns its attention to small combatants. The U.S. Navy's most successful small craft have consistently come from the civilian sector. The title of this work may be somewhat misleading. With the exception of a brief mention of yachts converted to patrol craft in World War I, the eighteen PT boats built by Jacksonville, Florida's Huckins Boat Company, and the Nathaniel Herreshoff designed torpedo boat USS *Stiletto*, the reader will find few recreational vessels herein designed as such from the keel up. However, the central theme of this work is that, throughout the history of the United States, most of small craft wearing Navy gray have come directly from, or been the successors of civilian boats.

It could have easily been expanded to include other types as well. After all, the landing craft of World War II came from or were inspired by designs from New Orleans PT builder Andrew Higgins. The Navy's early efforts in this realm were halting and unsuccessful. It was Higgins and enlightened elements in the Marine Corps that helped United States forces obtain the boats needed for each step of the drive to Japan. Dwight Eisenhower said of Higgins that he was "the man who won the war" and the landing craft he designed were based upon civilian work and hunting boats he built for use in the Louisiana bayou country. Like the venerable DC-3, these ungainly but versatile craft have known many modifications and incarnations yet they remain vital elements of our amphibious capability over half a century after the first plans flew off Higgins's drafting table.<sup>8</sup>

Numerous yachts and civilian small craft were "acquired" by the Navy and Coast Guard in both world wars. They served as harbor and coastal patrol craft with some in gunboat garb while others took on the duties and armaments of anti submarine warfare. They are not included in this narrative because they were intended from the keel up as civilian craft and their use as warships was an anomaly. It was a short-term measure intended as much to reassure a shaky population as to help hold the line until the Navy

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<sup>8</sup> John Heitman. "The Man Who Won the War: Andrew Jackson Higgins." *Louisiana History* 34, no. 1 (1993): 35. As drawn from a conversation between Stephen Ambrose and General Dwight Eisenhower.

could build suitable ships of steel. Torpedo boats, however, have a lengthy design, development, and operational history. As a class, they have been more influenced by the recreational boating industry than any other combatant. Therefore, a study of their history is actually a case study of how to harness the expertise and capabilities of the domestic small craft industry to serve the national defense.

Although this is not an operational history, in order to understand and appreciate the magnitude of the technical, tactical, and logistical challenges facing the designers, builders, and operators of these craft it is necessary to include details of how they actually fared in combat. The boats were proven or discarded based upon their performance in the only arena that counts and by studying their experiences we can better appreciate their achievements. The text is organized chronologically and some time periods and the operational data of some periods may be more fully detailed than for others. The contrast between the rather comprehensive descriptions of pre-World War II activities compared to the concise review of US Navy PT operations in the Pacific is illustrative.

Sources on PT operations fill library shelves. They include unit histories, personal memoirs, numerous illustrated histories, and technical reviews. There is hardly a need to repeat their information here. For more detailed operational data on PT boats in World War II there is no better source than Robert Bulkley's "At Close Quarters" which is discussed in the bibliographic essay. The experiences of the early American inventors are less readily available so there will be focused examination of the period between 1865 and World War I.

I recall reading a book about driving fast outboard motor boats as a child. The title and author have long ago sunk into the distant recesses of adolescent gray matter but one sentence has stuck with me throughout life. Speaking of racing the author wrote "In order to succeed at this game you need tenacity and a strong distaste for following in another man's wake." The same could, and should, be said of the study of history. This is the first treatise to focus upon the relationship between the small craft industry and the naval establishment. Other writers have touched upon it but insofar as I know, it has never been the central theme of a book, dissertation, or even a scholarly article. I have attempted to retain this sense of originality in gathering supportive material.

In pursuit of primary sources, I have sought to include information gleaned from the archaeological record. Men may deceive but the earth never does and I remain hopeful that someday we may recover the remains of a 19<sup>th</sup> century torpedo boat to help illuminate this period in their development. Unfortunately, this hope has largely been in vain. Only three pre-World War II boats survive – Commander Luigi Rizzo’s MAS boat on display in Rome; PT 8, an experimental boat built in 1940 and the only aluminum PT built until 1946, largely unmodified and under private ownership in Louisiana; and a Romanian boat whose current status is unknown. Therefore, the most accurate knowledge available about the early boats comes from the words of the men who built and operated them. So while I have studied the applicable secondary literature, there is a tendency to let the primary sources take precedence. This is especially true when describing the vessels themselves. Men may tend to inflate their courage or achievements but there is slight motivation to lie about construction methods or details.

When referring to ship names and designations I have elected to follow what Admiral Samuel Eliot Morrison claims was once standard naval practice – to avoid articles preceding a name and to recognize the object as an individual entity with a proper name. Hence, USS *Wachapreague* will never be referred to as “the” USS *Wachapreague*. Any mariner will affirm that a ship, like a person, is much more than an inanimate mass of matter and it is no more proper to refer to it otherwise than it would be to speak of “the” George Washington or “the” New York City. Likewise with number vessels such as PT 109, you will not see “the” PT 109. While I wax about this topic let me offer to correct a technique often found in secondary works, namely, there is and never was such a thing a USS PT 109 or the abbreviation USS as prefix to any American PT boat. The designation USS is reserved for commissioned vessels only and the PTs were commissioned not as individual boats but as squadrons of eight to twelve boats.

This work is meant for a particular audience – those interested in small craft and naval history of course, but more specifically, the men and women charged with planning, building and leading the coastal/riverine forces of the United States Navy. Hopefully, they will find this a helpful guide to lessons learned from the triumphs and failures of over two hundred years of American blue jackets and four centuries of American shipbuilding. Some may feel the theme is overdone by going as far back as 1775 but

Careful study shows there is much to be learned from the deeds of our ancestors. The inventiveness and courage of the determined, often desperate, men who first sortied in frail small boats against the floating leviathans of their enemies was just as much a crucial element of small boat warfare then as it was in 1943 and 1969. It is a fact that remains unchanged today. Riverine and coastal warfare using direct fire weapons at short range is as close as a modern sailor can get to experience the intensity and dangers of 18<sup>th</sup> century naval warfare. It is a valuable thing to understand and that is reason enough to relay their stories and pay them due homage.

The United States Navy spends little time instructing or encouraging sailors to learn about or use small craft. This is unfortunate in that all too many naval personnel never develop the spiritual intimacy with the sea that can only come from being physically close to it, as in a small boat. Through my own experiences, I have attempted to convey some of that feeling in these pages. Throughout the research and writing of this book the tasks, the needs, and the gravity of the challenges facing modern coastal/riverine sailors have been a prime motivating factor. If what those sailors and their leaders read here helps them to be more effective and efficient in the mission of national defense, then the effort that went into this study will have been time well spent.

## CHAPTER 2

### SMALL BOATS AND INFERNAL MACHINES: American Torpedoes and Torpedo Boats, 1775-1861

On a strangely quiet March evening in 1942, a handful of wooden torpedo boats, identified in United States Navy nomenclature as PTs, rendezvoused with engines idled off the northern tip of Corregidor, The Philippines. These worn, poorly maintained, and tired little mahogany craft represented much of what remained of the U.S. Asiatic Fleet. For months they had performed yeoman service for the U.S. forces besieged by the Imperial Japanese Army and Navy on Bataan Peninsula. They ran on sabotaged fuel that was full of wax and was constantly clogging filters and stalling engines. The three high performance, high maintenance twelve-cylinder Packard engines that drove each of them were operating far below peak levels but were kept in service by the dedication and ingenuity of their hard-pressed crews. Their hulls were tortured by the pounding of high speed running and the crews were stressed by the demands of constant operations, lack of sleep, reduced rations, and the growing knowledge that their tactical position was an impossible one.<sup>9</sup>

But on that fateful evening, their mission would galvanize public opinion and raise morale at home in a season that had seen nothing but defeat. In the process, the boats and the men who stood on their decks would become modern swashbucklers in the eyes of the American people and they would be inducted into a place of honor in the realm of naval legend.

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<sup>9</sup> William B. Breuer, *Sea Wolf: A Biography of John D. Bulkeley, USN* (Novato, CA: Presidio Press, 1989), Chapters 3 and 4 detail Ron 3's actions in the first months of the war. Robert J. Bulkley, Jr. *At Close Quarters: PT Boats in the United States Navy* (Washington: Government Printing Office, 1962), 8-9, 16-17; Curtis L. Nelson. *Hunters in the Shallows: A History of the PT Boat* (Washington: Brassey's, 1998), 135-150; S.A. Peters, "The PT Boat", *Bureau of Ships Journal* (August 1953), 2; S.A. Peters, "The Motor Torpedo Boat", *Ordnance* (May-June 1954), 943; William L. White, *They Were Expendable* (New York: Harcourt, Brace and Company, 1942), 119.

That night Lieutenant John Bulkeley and Motor Torpedo Boat Squadron (MTBRon) 3 plucked General Douglas MacArthur, his family, and select members of his staff out of Manila Bay and ran south under cover of darkness through increasingly rough seas. Hiding by day and operating mainly at night, Ron3 delivered MacArthur and his party to the southern Philippine island of Mindanao. There the passengers disembarked and completed the trip to Australia by air. MacArthur would soon begin to organize both the defense of Australia and a push north across New Guinea. Ron 3 would exhaust itself getting him out and all four vessels would eventually be lost in the process or shortly thereafter. Bulkeley would win promotion and the Medal of Honor for this bit of handiwork. The boats he loved would be embraced by the American public and go on to play a vital part in the war in both Europe and the Pacific.<sup>10</sup>

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<sup>10</sup> William Breur. *Sea Wolf: A Biography of John D. Bulkeley, USN*, 59-66; Robert Bulkley, *At Close Quarters*, 16-18; Frank D. Johnson, *United States PT-Boats of World War II in Action* (Poole, Dorset, UK: Blandford Press, 1980), 6. This was the beginning of a stunning career for Bulkeley. He returned to the states supposedly to advise on the PT program but also to tour the country raising morale and selling war bonds. He soon returned to the Pacific as a Lieutenant Commander and held positions of increasing responsibility. Later assignments took him to the European theatre where he commanded destroyer USS *Endicott* during Operation Overlord. Bulkeley bore a special grudge against the Japanese for two reasons – he had been aboard a gunboat adjacent to *USS Panay* when that vessel had been sunk by Japanese aircraft in 1937 and had watched them strafe the surviving American crewmen as they swam away. He had met his future wife while on this assignment and her father disappeared into the hands of the Japanese army and he was never seen again. Bulkeley stayed in the Navy after the war rising to the rank of Vice Admiral. He passed away in 1996. He was an action-oriented man of extraordinary courage who excelled at close quarters fighting. He had a gift for cutting red tape that occasionally ruffled feathers in the naval establishment. Some say he also had a tendency toward self-promotion but this might be sour grapes. Breur describes him as a mission-oriented leader who played a vital role in raising Navy readiness in the 1960s and 1970s. During his lengthy tenure as President of the Board of Inspection and Survey he offended many peers and superiors by revealing truths they would rather have remained hidden. White, *They Were Expendable*, New York journalist W.L. White knew a great story when he saw it and in 1942 interviewed many of the officers of Ron 3 at the MTB Training Center in Melville, R.I. His account of their saga is highly dramatic and contains numerous errors, most of them outside the author's control. But his book served to make the American public think that PT skippers and crews were akin to knights of the sea and that PTs could do anything. The book was made into a motion picture in 1944 starring Robert Montgomery and John Wayne. Montgomery had been a PT skipper in the war. This movie may contain the only film

Considering that America would shortly take the boats to heart, it is perhaps surprising to learn that only two years before this dramatic rescue there had been no American torpedo boats, *motor* torpedo boats to be exact, known internationally as MTBs. This situation was the result of United States naval policy that emphasized a war plan based on the concept of large battleships engaged in a single decisive battle for control of the sea lanes. U.S. policy and strategic doctrine assumed that the distance between North America and potential European or Asian threats would allow substantial warning of attack and permit time to gather a force to counter that danger. Since 1890, the Navy had eschewed the concept of coastal defense and called for a battle force that would decisively meet and defeat an adversary well offshore, in enemy waters if possible. Under these conditions, there was no role for small, short range, high-speed torpedo carriers of questionable seaworthiness. However, this Mahanian notion of a battlefield decision through major actions of massed surface fleets fighting away from the littoral had not always been the ruling U.S. naval doctrine.<sup>11</sup>

For the first century of its existence, the American republic and its Navy had adopted a policy of *guerre de course*, wherein large fleet actions were to be avoided. Instead, U.S. naval resources would concentrate on coastal defense and commerce raiding. With no overseas colonies to protect, succeeding generations of policy makers determined that it was beyond the needs and financial capabilities of the United States to maintain a fleet

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footage of Huckins PTs. Nelson. *Hunters in the Shallows*, 135-150; Nelson gives a very negative view of MacArthur's use of Ron 3, saying that his ride south wasted it as a fighting unit and doomed its officers and men. Using the same sources, this writer reached a completely different conclusion. MacArthur's motives and reasoning remain a secret that died with him in 1962. At any rate, Ron 3 was largely finished already. Tired engines, worn equipment, absence of spare parts, short rations, and lack of torpedoes had reduced combat efficiency. Even when operating at their peak, the boats had been misused as message and mail runners. Nelson writes there was some talk about driving the boats to China, but given the high level of Japanese activity in the South China Sea, their control of Indo-China, Formosa and the Hong Kong region, chances for success were considerably lower than going south. One thing is certain: had Ron 3 stayed at Corregidor it would have been destroyed and its men included in the Bataan Death March. By driving MacArthur to Mindanao, some of them were saved, the nation was galvanized, and the boats were immortalized.

<sup>11</sup> Norman Friedman, *U.S. Small Combatants* (Annapolis: Naval Institute Press, 1987), 11.



large and efficient enough to successfully engage the navy of a major European power. Instead, cruising frigates and lighter ships, augmented by privateers, were dispatched to wreak havoc upon enemy merchant shipping. For the new republic, this was deemed to be the most effective way to combat a much larger naval power.<sup>12</sup>

In fulfilling the mission of coastal defense, inventive Americans found a place for the use of launches equipped with spar torpedoes, or towing explosive devices against enemy hulls. Until the widespread acceptance of the “self-propelled” torpedo, the term was used to include these explosives carried or attached to vessels as well as static fixed or floating explosives now known as mines. Whether towed behind a launch, anchored in a harbor, bolted to the end of a spar, or cruising under their own power, they were all torpedoes to the navalists and inventors of the 19<sup>th</sup> century.

Many of these visionaries had experimented with marine explosive devices and delivery systems since the earliest days of the republic but the concept had earlier, European origins. The documentation is open to question, but it seems certain that sometime after 1618 Dutchman Cornelius van Drebbel introduced the spar torpedo, which he called a water petard, and installed it on a low freeboard, turtle-decked craft that looked much like an “overturned boat...propelled by two pairs of oars.” It was demonstrated before King James I in 1620 and was employed with modest success at La Rochelle in 1626. The English soon lost interest in this first documented torpedo boat but their brethren in the North American colonies were destined to explore the scheme farther and eventually make it effective.<sup>13</sup>

The first major developments occurred in 1775 as the rebellious colonies sought means to contest the power of the Royal Navy. Though this study is concerned with surface craft, the creativity behind a submarine built at the time helps illustrate the challenges that faced all torpedo boat designers and crew. David Bushnell’s one-man

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<sup>12</sup> George W. Baer, *One Hundred Years of Sea Power: The U.S. Navy, 1890-1990*, (Stanford: Stanford University Press, 1994), 17, 62, 67, 77, 190; Kenneth Hagan, *This People’s Navy: The Making of American Sea Power* (New York: Free Press, 1991), xi, 20, 52, 80, 179; Nelson, *Hunters in the Shallows*, 3, 58.

<sup>13</sup> Edwyn Gray, *Nineteenth-Century Torpedoes*, 4, 5.

submersible, *Turtle*, was the first known American craft to attempt to destroy a ship with an external explosive device. On 5 September 1776, Sergeant Ezra Lee took *Turtle* into the waters off Staten Island, New York and attempted to attach a mine to the bottom of HMS *Eagle*, flagship of the British squadron.<sup>14</sup>

For centuries the myth persisted that he failed because he was unable to bore into the ship's planking since *Eagle*'s bottom had been sheathed in copper as a measure against marine organisms. Yet, the records show that HMS *Eagle* was not sheathed until 1782. It appears instead that Lee was running low on air, having difficulty reaching his target and, afraid of being detected, he abandoned the effort. Two more attempts were made but they were unsuccessful and it is believed the Continentals destroyed the diminutive submarine when they evacuated New York. Despite the setbacks, Bushnell retains credit for proving that gunpowder could be detonated underwater.<sup>15</sup>

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<sup>14</sup> A.C. Davidonis, "Harbor Forcing Operations," *Military Affairs* 8(2) (Summer 1994), 81; William James Morgan, ed., *Naval Documents of the American Revolution*. vol. 6 (Washington: Government Printing Office, 1972), 1499-1511; Lincoln P. Paine. *Warships of the World to 1900*. (Boston: Houghton-Mifflin Company, 2000), 176-177.; U.S. Navy. Bureau of Naval Personnel. *Principles of Naval Engineering, NavPers 10788- B*. (Washington: Government Printing Office, 1970) 12.

<sup>15</sup> A.C. Davidonis, "Harbor Forcing Operations," *Military Affairs* 8(2) (Summer 1994), 81; Edwyn Gray, *The Devil's Device: Robert Whitehead and the History of the Torpedo*. (Annapolis: Naval Institute Press, 1991), 67; Edwyn Gray, *Nineteenth-Century Torpedoes*, 5; William James Morgan, ed., *Naval Documents of the American Revolution*. vol. 6 (Washington: Government Printing Office, 1972), 1499-1511, hereinafter referred to as NDAR; Lincoln P. Paine. *Warships of the World to 1900*. (Boston: Houghton-Mifflin Company, 2000), 176-177.; U.S. Navy. Bureau of Naval Personnel. *Principles of Naval Engineering, NavPers 10788- B*. (Washington: Government Printing Office, 1970) 12.

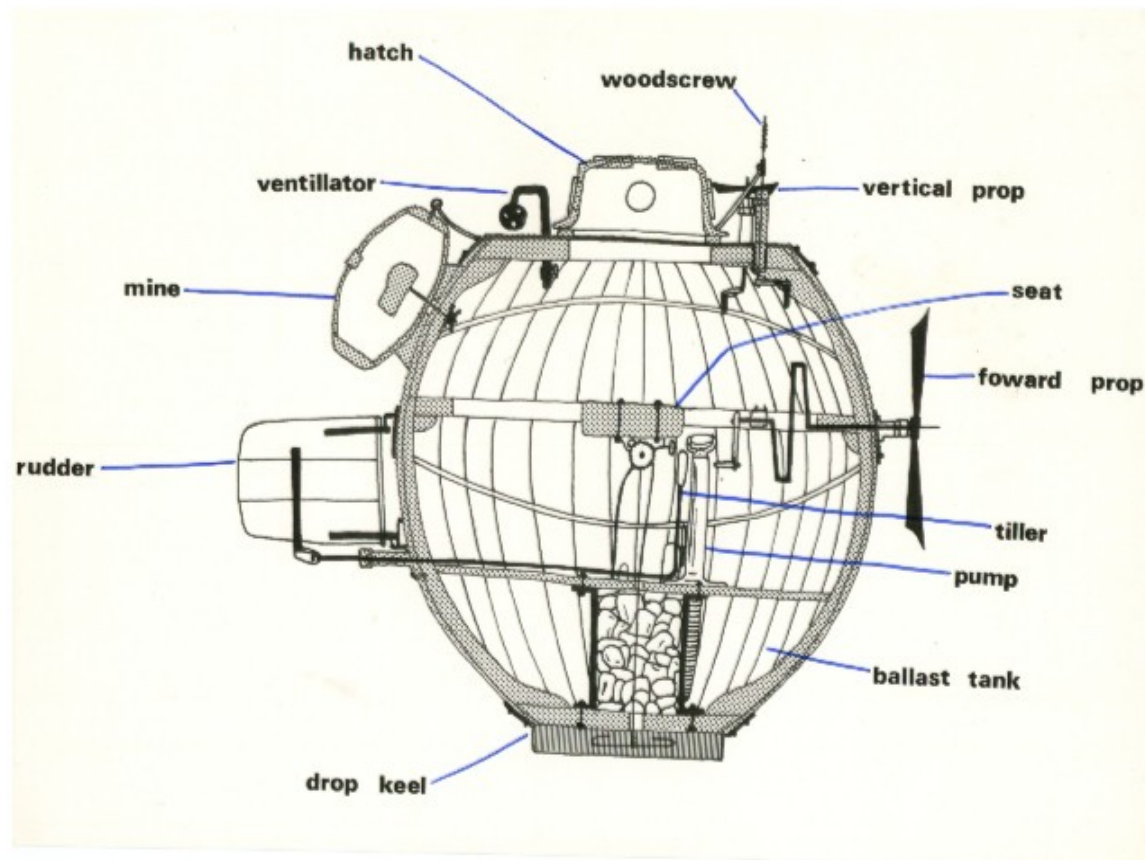


Figure 1: Bushnell's *Turtle*. No original plans or drawings are known to exist.  
[www.ctrivermuseum.org](http://www.ctrivermuseum.org)

*Turtle* was a remarkably original, although ultimately unsuccessful, work of genius. Bushnell was a native of Saybrook, Connecticut, a graduate of Yale (Class of 1775) and a man “noted for his studious habits, great inventive genius, and eccentricity.”<sup>16</sup> He became interested in submarine warfare while in college and continued his work after graduation. With encouragement and monetary support from the Continental Army and the Connecticut Governor and Council of Safety, Bushnell designed and constructed not only a submersible war craft but also the highly original weapon that made it so

<sup>16</sup> George Washington wrote to Thomas Jefferson on 26 September 1785 that “I then thought, and still think, that it was an effort of genius but that too many things were necessary to be combined to expect much from the issue against an enemy who are always on guard.” J. S. Barnes. *Submarine Warfare: Offensive and Defensive*. (New York: D. Van Nostrand, 1869) 17, 25.

dangerous. Though no plans of either vessel or torpedo/mine are known to survive, Bushnell submitted an extensive written account of both to the American Philosophical Society on 8 June 1798.<sup>17</sup>

He wrote that the hull resembled the carapaces of two tortoises joined together to form a clam-like shape. To continue with the analogy, the aperture for the animal's head formed an elliptical hatch just large enough to admit a small man – the sole crewman of the boat. The operator sat upright upon a seat set high enough for him to peer through thick glass ports in the hatch coaming and to rise up occasionally while on the surface to obtain bearings. This thwart also gave support to the hull to prevent it collapsing from pressure when submerged. Three of the ports were opening ones to provide ventilation as well as light. Two short snorkels containing valves that closed the tubes when submerged and opened again on the surface provided additional ventilation.<sup>18</sup>

*Turtle* was propelled by what Bushnell called an “oar formed on the principle of the screw” turned by a crank set in front of the operator and affixed to a shaft protruding through the front of the vessel. A similar device was mounted through the deck above the coxswain's head and was used to aid the movement of the boat vertically. Primary depth control came not from the vertical propeller but from a ballast tank built into the bottom of the hull. A foot-operated brass valve could be opened allowing the entry of water. Two brass pumps, much like modern manual bilge pumps, removed the water to reduce depth or maintain equilibrium. *Turtle* carried lead inside and out and the 200-pound exterior ballast was detachable from within for rapid surfacing in an emergency. A rudder was attached to a tiller that pierced the hull and lay at the operator's right side. Bushnell wrote

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<sup>17</sup> William Bell Clark, *NDAR*, vol. 1, 1088-1089, vol. 2, 1050. Dr. Benjamin Gale to Benjamin Franklin dated 7 August 1775 gives an account of Bushnell's activities and shows that *Turtle* was in operation by that date. *NDAR*, vol. 2, 1050-1051; Public Records Office, Admiralty 1/484. The British were aware of the threat for there is a brief reference to Bushnell in an intelligence report from Governor William Tryon. *NDAR*, Vol. 3, 1101,1111. Bushnell received support from the Connecticut Governor and Council of Safety at a meeting on 2 February 1776 and was awarded financial support the next day. In his letter to Jefferson, Washington notes that he lent financial aid as well.

<sup>18</sup> David Bushnell. *Transactions of the American Philosophical Society*, vol. 4, 1798. 303-312.

that the rudder “was made very elastic” so that it might be “used for rowing forward.” Though he declined to elaborate it appears probable that it was an attenuated rudder that could be used for sculling.<sup>19</sup>

Bushnell used his talents to produce both the transport vehicle and its weapon system. The latter consisted of a removable canister made of two conjoined pieces of hollowed out oak containing one hundred and fifty pounds of gunpowder. This powder magazine was attached by a length of line to a wood screw set atop a hand crank apparatus. The crank could be turned from within the hull driving the screw into the bottom of an adjacent ship. The screw could be cast off, though the inventor failed to say how, and left in the planks of the target with the now detached torpedo firmly secured by the line. A preset clockwork device delayed detonation for up to twelve hours at which time it fired an internal flintlock to ignite the powder. The theory behind Bushnell’s bomb parallels that of the limpet mine of World War II, which was held in place by a magnet and placed on its target by a scuba diver.<sup>20</sup>

Three attacks were made on British shipping, all of them unsuccessful. Though brilliant in concept, *Turtle* suffered from a primitive technology that doomed it to failure. Bushnell boasted that when sealed up there was enough air inside for thirty minutes. Considering that the crew was functioning in almost total darkness, at night and submerged, this air must have been exhausted much more quickly when consumed by an anxious man who had to steer with his left hand while cranking the propeller with his right, simultaneously controlling depth with valves, pumps, and another crank and propeller. He had to find his target, place *Turtle* at an appropriate position and depth against the hull so that the wood screw could penetrate the enemy’s planking, and hold the tiny sub in place against the currents and swinging of the ship while affixing the weapon. It was all simply too much to do, with too little air and without adequate light and maneuverability. Bushnell’s invention had much in common with many that

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<sup>19</sup> John S. Barnes. *Submarine Warfare*, 18-19; David Bushnell. *Transactions of the American Philosophical Society*, vol. 4, 303-312.

<sup>20</sup> John S. Barnes. *Submarine Warfare*. 18-22, 25.

followed, for it coupled creative intellect with an incredible lack of knowledge of basic hydrodynamics and seamanship.<sup>21</sup>

*Turtle* failed to harm the British but the experiment was not forgotten and it generated ongoing interest from such figures as Thomas Jefferson and the learned men of Philadelphia's American Philosophical Society. Inventor Robert Fulton, a contemporary of these men, experimented with torpedo craft in the first years of the 19<sup>th</sup> century. He was born in Little Britain, Pennsylvania, in 1765 and moved to Philadelphia in 1782 where he established himself as a painter of miniature portraits. He moved to Britain, ostensibly for health reasons, in 1787 and became involved in canal building. His thoughts may have been on submarines and underwater explosions for some time, for when he traveled to France on business in 1797 he approached the French government with an offer to build a submarine for use against the British. Though initially rejected by Paris, he started with submarine experimentation and by 1800 had finished *Nautilus*, a true submersible powered by a hand-cranked propeller. He then offered his creation to the British who found it wanting but expressed interest in the "submarine bombs" he had fashioned. They awarded him a contract to produce these and though his fascination with submarines never faded, henceforth he concerned himself with torpedo attack by surface craft.<sup>22</sup>

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<sup>21</sup> Ibid. 18.

<sup>22</sup> John S. Barnes. *Submarine Warfare*, 25-26; David Bushnell. *Transactions of the American Philosophical Society*, vol. 4, 1798. 303-312. Jefferson asked George Washington about *Turtle* and Bushnell after the war and Washington replied on 26 September 1785. Bushnell presented his account in writing and orally at a meeting of the American Philosophical Society in 1798. Edwyn Gray, *The Devil's Device: Robert Whitehead and the History of the Torpedo*. (Annapolis: Naval Institute Press, 1991), 68, 69.

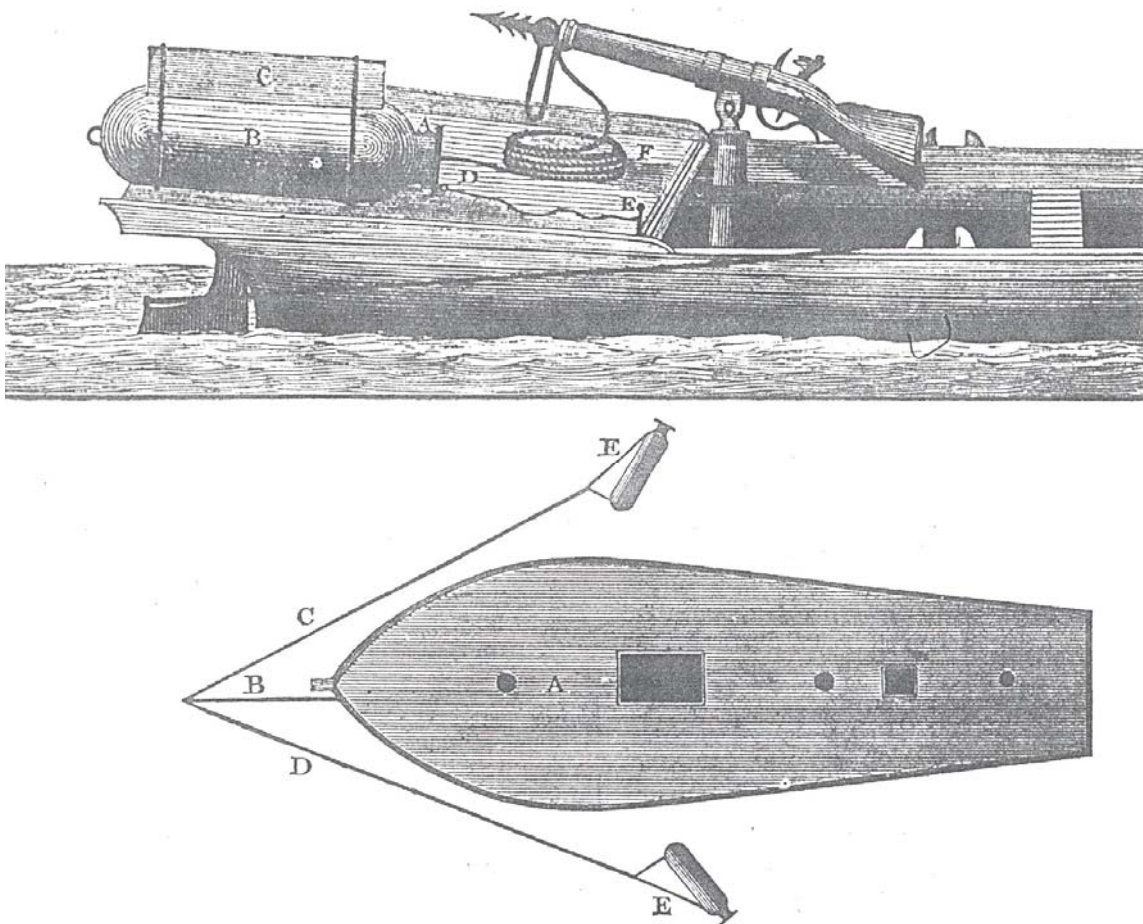


Figure 2. Robert Fulton's torpedoes. Fulton devised two methods of torpedo delivery. One involved harpooning the ship and attaching the bomb with a harpoon and lanyard. Another used tethered canisters to snag the anchor line and have the current pull them into contact with the hull. Both techniques relied upon a timing mechanism and flintlock and neither had much merit<sup>23</sup>

In 1805, he demonstrated a floating explosive device tethered between two small rowboats by 80-foot lengths of line. This torpedo consisted of two separate explosive containers linked by a line and outfitted with a clockwork mechanism set for eighteen minutes. Each torpedo, a floating mine actually, was towed behind a rowed tender. The two launches approached their target, the old brig *Dorothea*, on parallel courses. Upon closing with it, they diverged so that the lines would become taut and as they passed the target ship the canisters were brought up along the hull, exploded on contact, and broke

<sup>23</sup> Robert Fulton, *Torpedo War and Submarine Explosions*, New York: William Elliot, 1810, 15.

the vessel in half. Though exuberant over the result the tactical use of such a contraption remained in doubt. The two launches were rowed well within range of a warship's guns and small arms, and the lengthy fuse setting gave time for a victim to cut the torpedo loose and let it drift away. Still, it was the first time a ship had been sunk by an underwater explosion and had the British not quashed the French naval threat at Trafalgar a week earlier big things might have come of it.<sup>24</sup>

Fulton soon returned to America and conducted further experiments with "catapulting charges" and spar torpedoes on launches. His torpedoes were designed to be towed against a ship, float with the current and snag upon a hull or anchor line, or use a spar-mounted explosive canister. Reluctantly realizing that his towed torpedoes were useful only against ships at anchor and indifferently guarded, he devised a flintlock harpoon gun suitable for rail or deck mounting. A line was secured to the harpoon as if for whaling but with a torpedo at the other end. The bomb could be rigged to float or to be suspended from a buoy at a given depth. The torpedo boat could sail or be rowed near the target ship, the harpoon would be fired into the topsides, and the torpedo jettisoned over the side. With luck and the aid of currents, it might come to rest alongside the hull. If an enemy was lax in his guard it might rest there for some time until detonated. Like Bushnell's invention, and all his other torpedoes, Fulton's systems were dependent upon the negligence of a relaxed and careless enemy. Slow boats had to approach at very close quarters in order to be effective and in so doing their missions became almost suicidal.<sup>25</sup>

Fulton focused his talents on the development of weapons systems and tactics to employ it but there was nothing unique about his surface craft. They were simple launches useful for a variety of purposes and did not lead to advances in naval architecture or engineering. The singular exception may have been a craft known as the "Turtle-Boat" which was developed during the War of 1812. It was characterized by extremely low freeboard, a screw propeller turned by hand, and by the use of towed charges floating astern and detonated by a lanyard. There are no known depictions of this boat but it seems to have been comparable to the Confederate *Dauids* of the Civil War.

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<sup>24</sup> Edwyn Gray, *The Devil's Device*, 70-71.

<sup>25</sup> Robert Fulton, *Torpedo War and Submarine Explosions*. (New York: William Elliot, 1810), 14-15.



This mystery craft was wrecked in a gale and subsequently destroyed by the British before it could be tested in action. Until his untimely death in 1815, Fulton remained confident that the concept of torpedo warfare was sound and that technological advances would make it practical.<sup>26</sup>

Other inventors and mechanics toyed with the notion in the years that followed without making noteworthy progress. Samuel Colt experimented with electrically fired mines and achieved some notoriety, and Prussian Moritz Jacobi crafted marine and terrestrial mines for the Russians in the Crimean War. Rumors of Jacobi's work raised consternation in the British northern squadron and his torpedoes slightly damaged two ships but had only a marginal impact on operations. Meanwhile, unrelated inventions had changed torpedo potential dramatically. The first was the fitting of steam engines in small craft. Boats were no longer at the mercy of wind and tide or limited by the muscle power of their crews. They could reach higher speeds and maintain them for long periods. Second, the use of percussion caps instead of flintlocks as an ignition method made detonation upon contact far more certain. Together with expanding knowledge of chemistry and metallurgy, it would take only the impetus of war to make the torpedo boat a viable warship. The need arose at 0430 on 12 April 1861 when Confederate forces opened fire on Fort Sumter.<sup>27</sup>

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<sup>26</sup> A. C. Davidonis, "Harbor Forcing Operations," 81; Robert Fulton, *Torpedo War and Submarine Explosions*, (New York: William Elliot, 1810), 1-4; Edwyn Gray, *The Devil's Device*, 72-73; Wallace S. Hutcheon, *Robert Fulton: Pioneer of Undersea Warfare*, (Annapolis, MD: Naval Institute Press, 1981), 123; Peter Kemp, *The Oxford Companion to Ships and the Sea*, (London: Oxford University Press, 1976), 898; Larry Smart, "Evolution of the Torpedo Boat." *Military Affairs* 23 (2) (Summer 1959), 97. Most sources credit Fulton with the invention of the "Turtle Boat" but his biographer, Wallace Hutcheon, disputes this by quoting from *Niles Weekly Register*, 6 (17 July 1813), 326-327, which gives credit to "an ingenious gentleman by the name of Berrian."

<sup>27</sup> Robert Anderson to L. Thomas, April 19, 1861, *War of the Rebellion, Official Records of the Union and Confederate Armies*, Series 1, Volume 1, 12, hereinafter referred to as OR.

## CHAPTER 3

### FIRST BLOOD:

#### Torpedo Boats in the American Civil War

##### Captain Francis D. Lee, CSA and the Spar Torpedo

Civil War engineers and inventors made extensive use of spar torpedoes but these were more refined and powerful than the primitive apparatus Fulton had known. They usually consisted of a copper or wooden keg attached to a long wood or metal pole extending from the bow of the attacking vessel. They were triggered by percussion caps or chemical contact fuses. Some Southern officers were especially enthusiastic about torpedo potential and sought to improve both the weapon and the delivery vessel. Confederate Secretary of the Navy Stephen Mallory and some of his senior subordinates often took a position of benign neglect toward this mode of warfare but several of his officers agitated for their use on ironclads and torpedo boats. Surprisingly, some of the most vocal and effective supporters of the idea of a specialized torpedo boat were not in the Navy but were Army officers.<sup>28</sup>

Captain Francis D. Lee was an engineering officer on the staff of General Pierre G. T. Beauregard and he was the first to experiment with spar torpedoes and the craft to deliver them to the enemy. As commander of the Department of South Carolina and Georgia, Beauregard's primary responsibility was the defense of Charleston. He welcomed Lee's local knowledge and engineering expertise. Prior to the war Lee had been a successful architect in Charleston and was familiar with the area and its waterways. He had helped design the fortifications at Port Royal and Fort Wagner on Morris Island on the south side

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<sup>28</sup> P.G. T. Beauregard, "Torpedo Service in the Harbor and Water Defenses of Charleston," Southern Historical Society papers, Vol. 5, April 1878, 145-147; P. G. T. Beauregard to Francis W. Pickens, October 8, 1862, *OR* Ser. 1, Vol. 14, 631-632.

of the Charleston Harbor. He had been present at the Battle of Port Royal Sound and had been commended for his actions there.<sup>29</sup>

By 1862 he had taken an interest in underwater explosions and quickly realized that the need for a reliable detonator was the spar torpedo's greatest weakness. After brief experimentation, Lee produced a chemical fuse that was far superior to anything previously available and integrated it with a copper cylinder capable of holding 50 to 150 pounds of gunpowder, depending upon its size. This chemical fuse consisted of a lead or copper tube approximately three inches long and an inch or so in diameter. A sealed glass vial containing sulfuric acid was placed in the tube and surrounded with a compacted composition of chlorate of potassium, powdered sugar, and finely ground rifle powder. The upper, exposed end of the fuse was sealed with a dome-shaped cap of thin metal. The lower end was threaded so it could be screwed into the head of the torpedo and it was sealed on the interior with oiled paper. When the fuse was put in it was protected against leakage with brass couplings and rubber washers. Unlike the timed mechanisms used in the past this was a contact fuse that would detonate the charge upon impact. When the fuse struck the hull the blow would dent the thin metal cap breaking the vial of sulfuric acid. This would ignite the potassium compound and discharge the torpedo. With two or more of these on the nose of a waterproof, powder-filled metal flask, almost any ship that could be hit could also be sunk. After two centuries of international effort the spar torpedo had at last come of age.<sup>30</sup>

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<sup>29</sup> Beatrice St. Julien Ravenel, *Architects of Charleston*, Charleston, SC: Carolina Art Association, 1964, 221-230; S. W. Ferguson to Francis D. Lee, *OR Ser. 1*, Vol. 1, 266; P.G.T. Beauregard to Leroy Walker, April 27, 1861, *OR Ser. 1*, Vol. 1, 34; Report of Major Francis D. Lee, December 4, 1861, *OR Ser. 1*, Vol. 6, 18-20; Thomas F. Drayton to L. D. Walker, November 24, 1861, 13; John A. Wagener to H. E. Young, November 11, 1861, 16. Much criticism has been heaped upon the designers and builders of these fortifications for fashioning emplacements too small for the armament and neglecting to provide traverses to deflect enfilade fire. In fact, traverses were constructed but the weapons supplied were different from those called for in the original plans. As a result, the traverses had to be dispensed with in order to have room to mount and work the guns. The mismatch between ordnance and engineering doomed the defenders.

<sup>30</sup> P.G. T. Beauregard, "Torpedo Service in the Harbor and Water Defenses of Charleston," 145.

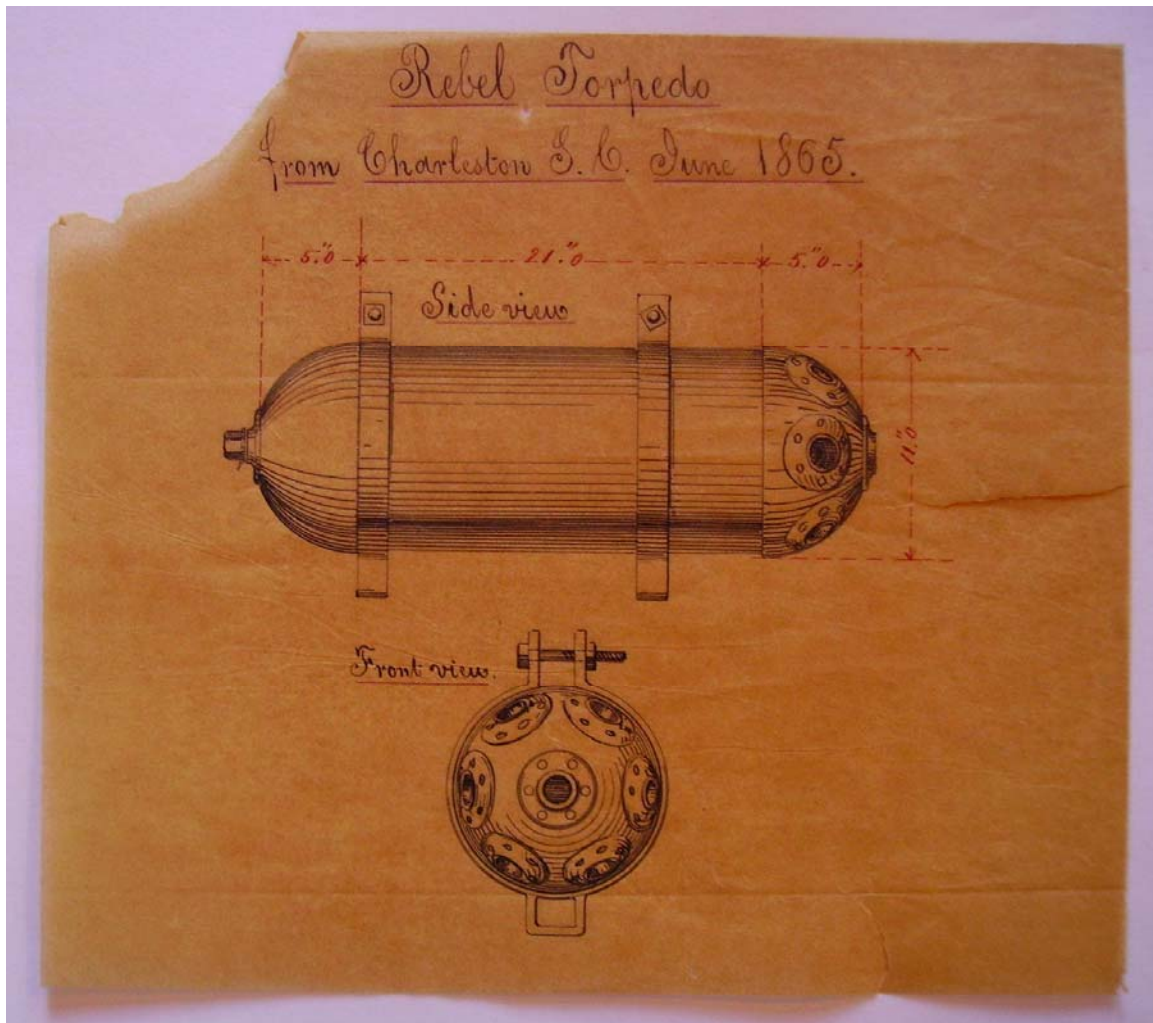


Figure 3. Confederate copper torpedo used on boats and launches. A wooden shaft was inserted in the lower, rectangular aperture of the brackets, and Lee's chemical fuses were screwed into each of the seven threaded openings. (National Archives)

Lee had a weapon and next he designed a warship to carry it. He obtained an unfinished hull from the Navy and converted it for use as a torpedo boat. No plans or construction details survive to describe it. The only clue comes from a rebel deserter who said it was a casemated model like the Confederate ironclads, though much smaller. Later christened *CSS Torch*, it was screw-driven steamer using engines salvaged from a Savannah steamboat. Original plans called for the deck to be armored but lack of iron kept this from happening. The torpedo was attached to the forward end of a long wooden pole mounted on the bow. The aft end of the pole was hinged to the deck. A line was

secured to the pole to raise and lower it by means of a line led to a winch in the cockpit. The torpedo was a unique triple warhead arrangement, reminiscent of a pawnbroker's logo. The tactic proposed was to approach a Union ship at high speed under cover of darkness, lower the spar during the approach, and strike it against the target below the waterline.<sup>31</sup>

There were two major problems with this technique. First, despite its low profile the boat might still be sighted and destroyed well before making contact. It had no armor and no armament save the spar torpedo. Second, it was widely believed that the proximity of the attacking craft to the target would mean that the explosion would destroy them both. Lee held otherwise, arguing that the incompressible nature of water would channel the explosive force upward into the enemy's hull. On 13 March 1863 he proved his point when he sank a hulk that had been procured for the trial. Lee placed a thirty-pound torpedo on the end of a twenty-two foot long spar and lashed the assembly to the underside of a small, unmanned canoe. He used a line run from the bow of the canoe to a block on the hulk and then to a rowboat some distance away. Upon his order, the rowboat sprang forward, the line ran through the block, and the canoe soon slammed into the side of the derelict with an impressive roar. The target ship took less than twenty seconds to sink and the canoe was recovered completely intact.<sup>32</sup>

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<sup>31</sup> P.G. T. Beauregard, "Torpedo Service in the Harbor and Water Defenses of Charleston," 147;

<sup>32</sup> Francis D. Lee to Thomas Jordan, March 13, 1863, *OR* Ser. 1, vol. 14, 820.



Figure 4. Confederate copper warhead. A Confederate spar type torpedo with two fuses screwed into the apertures in the ogive. The hole is of uncertain origin. (West Point Museum Collections, U.S. Military Academy)

An observer from the ironclad *CSS Chicora* reported the results enthusiastically but it was months before the Navy leadership took any interest. Meanwhile, Beauregard, Francis Lee, and other Army officers persisted in their efforts. *CSS Torch* was completed and made a strike on *USS New Ironsides*, the most powerful ship in the Union Navy, off Charleston Harbor on the night of 20-21 August 1863. Trouble with the balky second-hand steam engine caused the attack to fall short and *Torch* was never used in combat again. It did serve as the prototype for several others that became known as the *David* class.<sup>33</sup>

### The *David*-Class Torpedo Boats

Lee's work was well known in Charleston and inspired others to become involved in constructing weaponry to oppose the blockading fleet. Among these were local businessman Theodore Stoney and his friend and partner Dr. Julian Ravenel. They organized a firm to construct low, cylindrical steamboats that came to be known

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<sup>33</sup> James Carlin to P. G. T. Beauregard, August 22, 1863, *Official Records of the Union and Confederate Navies in the War of the Rebellion*, Ser. 1, Vol. 14, 498-499, Hereinafter referred to as *ORN*.

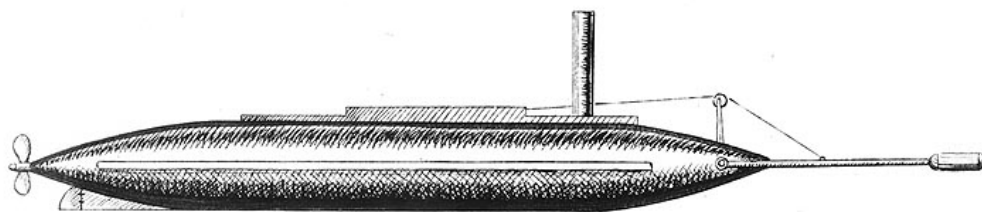
generically as “ *Davids*.” They retained local mechanic David Ebaugh to build the first *David* at Stony’s Landing on the Cooper River about thirty miles above Charleston. Writing after the war, the Ebaugh described the vessel as 48.5 feet long, 5 feet in beam, and cigar shaped. The central portion was a cylindrical section eighteen feet long with each end then tapering to a point. The last few feet of each end of the hull was a conical section turned from a large pine log and rabbeted to receive planking. This consisted of a single layer of 1.5-inch thick, riveted to the frames, with each plank hollowed on the inside to conform to the tubular shape of the frames. These consisted of two sections of 1.5-inch oak riveted together and placed on fifteen-inch centers. The roughed hull was then caulked, heavily ballasted, painted light blue, and shipped downriver to Charleston where machinery was installed.<sup>34</sup>

On the night of 5-6 October 1863, *CSS David*, commanded by Lieutenant William Glassell ventured offshore and made a successful sortie against *New Ironsides*. Glassell was the young officer who had witnessed Lee’s demonstration the previous March and he had become an enthusiastic believer in the engineer’s inventions. The Federal vessel would almost certainly have been sunk had it not been for the fortuitous chance that the torpedo struck only six feet below the waterline and abreast a strong transverse bulkhead that absorbed most of the shock. Still, *New Ironsides* was damaged so extensively that it was later necessary to make significant repairs at the Philadelphia Navy Yard. More importantly, this success spread torpedo fever on both sides of the conflict. The South sought to build more *Davids*, primarily in Charleston but also in Mobile, and to equip common steam launches with Lee’s spar torpedoes.<sup>35</sup>

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<sup>34</sup> David C. Ebaugh, “David C. Ebaugh on the Building of the *David*,” *South Carolina Historical Magazine*, January 1953, 23.

<sup>35</sup> John Dahlgren to Gideon Welles, October 7, 1863, *ORN* Ser. 1, Vol. 15, 10-11; Extract from report of the Secretary of the Navy, November 30, 1863, *ORN* Ser. 1, Vol. 15, 19-20; William T. Glassell, “Reminiscences of Torpedo Service in Charleston Harbor,” *Southern Historical Society Papers*, 1877, vol. 4, 230.



CONFEDERATE ~~DAVID~~  
Civil War Torpedo Boat

Figure 5. Confederate *David* (Naval Historical Center)

The Southern navy soon made use of a small steamboat named *Squib*, of approximately forty feet in length, Lieutenant Hunter Davidson commanding, and armed it with a spar torpedo similar to Lee's. Davidson had spent much of the war operating small vessels and placing torpedoes on the James River and was well acquainted with the waters. He had proven himself in combat as a gun captain aboard CSS *Virginia* during her two-day sortie on 8-9 March 1862, and later as commander of a gunboat stationed at Norfolk.<sup>36</sup>

On 8-9 April 1864 he made an assault on USS *Minnesota* in Hampton Roads. The device exploded but without critical damage to the frigate. *Squib* withdrew with but slight injury, and *Minnesota* was able to remain on station. Other Confederate launches, CSS *Wasp*, CSS *Scorpion*, and CSS *Hornet*, served with the James River flotilla but without distinction. All these craft were restricted in their operations by being small, relatively slow, and often burdened with unreliable propulsion. They were hampered by a lack of seaworthiness, which dictated their employment in near-shore waters in settled weather

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<sup>36</sup> William H. Parker, *Recollections of a Naval Officer*, Annapolis: Naval Institute Press, 1985, 294.



conditions. Further, their slow speed meant they could not operate far from secure bases and still enjoy the cover of darkness that was so vital to their success and survival.<sup>37</sup>

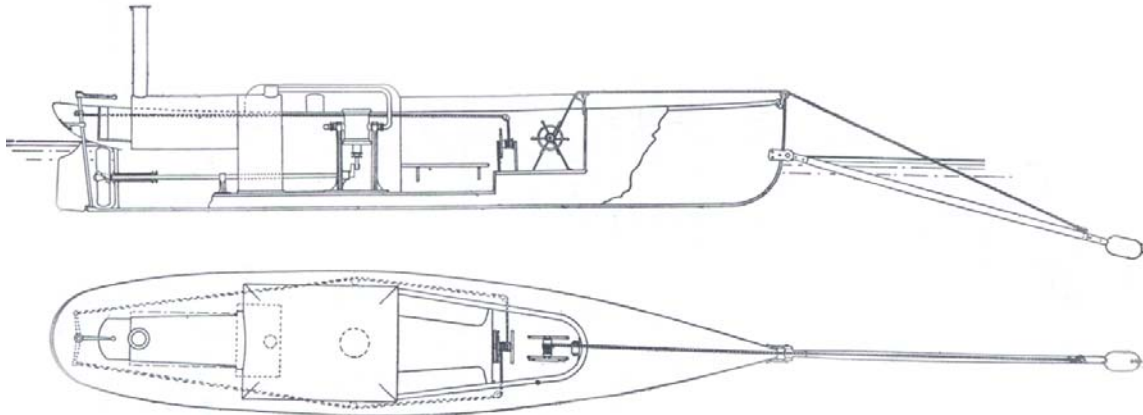


Figure 6. CSS *Squib* (ORN Ser. 1, Vol. 9, 602)

The Confederate Navy, Engineer Bureau, and private syndicates undertook to build a number of boats in the last year of the war. They were laid down at Mobile, Richmond, Savannah, Wilmington, Lynchburg, Texas, and of course, at Charleston. Few became operational and those that did seldom left the dock and inflicted no damage upon their Union opponents. Retreating rebels destroyed many in 1865 but a surprising number survived to satisfy the curiosity of the occupying forces. At least six were recovered at Charleston and three of these were made operational. Five were found incomplete at Savannah but their final disposition is unknown. Two were scuttled at Mobile, and the builders claimed a single craft at Lynchburg.

Much of the South was a wasteland by April 1865. The South's most valuable capital assets, slaves, had walked away from perpetual bondage resulting in a huge financial loss to the old gentry. What little liquid capital had existed before the war had been consumed in its prosecution and many of those who had lived a privileged life in 1861 found

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<sup>37</sup> Smart, "Evolution of the Torpedo Boat", 98; Abstract from log of USS *Minnesota*, April 9, 1864, ORN Ser. I, Vol. 9, 603.

themselves impoverished in 1865. The civilian survivors and returning veterans faced a future of financial depression and legal uncertainty. Their fates as traitors to the Union had as yet to be resolved and many men who had been involved in the torpedo program chose to seek their futures abroad.

Most of the men who had conceived, constructed, and operated the rebel torpedo boats found themselves in strained financial straights at the end of the war. The officers who had formerly served in the United States Navy had lost any chance of retirement and a pension. Most recovered to a degree and went on to full, productive lives. A number of former Confederates took employment with foreign navies. Confederate torpedo and torpedo boat technology had received worldwide recognition and their services were in great demand in Europe and South America.

As the Union armies advanced across the south, fleeing Confederates destroyed or abandoned the boats and ships of their short-lived navy. Many vessels were unfinished at the time and were burned on the stocks to prevent capture. The large and diverse torpedo boat fleet at Charleston seems to have been simply abandoned in its entirety.

At least two of the *David*-class boats were taken north as prizes. The written story of their origins and their demise is incomplete and we can be certain of their existence only thanks to contemporary photographs. One made its way to the United States Naval Academy at Annapolis where it was placed on exhibition ashore. Another was placed in a park at the Brooklyn Navy Yard. It is remembered as “Midge” a name bestowed by Union sailors. The *Official Records* do not mention it. It was broken up in 1877.

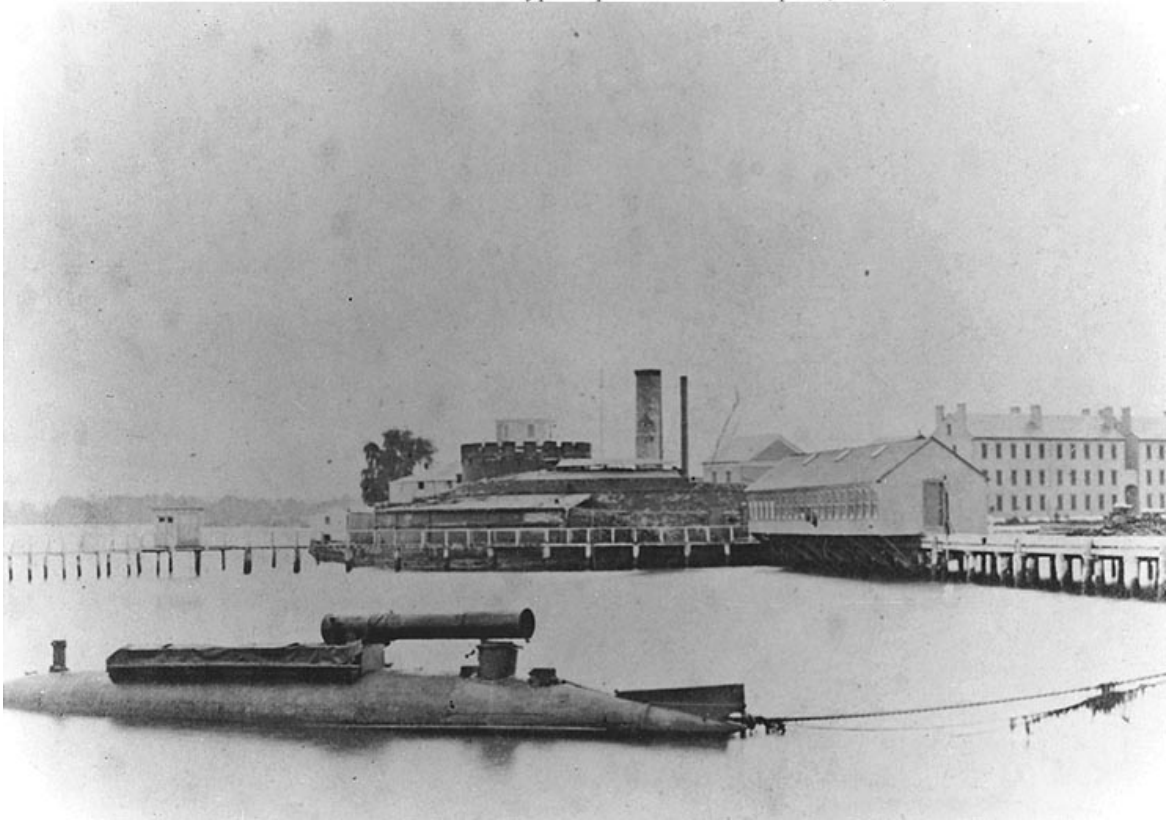


Figure 7. Captured *David* at Annapolis. The smokestack was been lowered. The Union captured several *Davids* after the fall of Charleston but many were rotten, worm-ridden, and unsalvageable. Two were taken north and displayed for several years but their eventual fate is uncertain. (Naval Historical Center)

The fate of CSS *Viper*, built at the Confederate Navy Yard at Columbus, Georgia is well documented thanks to Federal records. The Navy Yard log contains no construction details but *Viper* was most probably an open steam launch built to plans by Naval Constructor William A. Graves and therefore a sistership of *Hornet*, *Scorpion*, and *Wasp*. She was captured on the banks of the Chattahoochee River after being abandoned by the retreating Confederates and taken to Apalachicola. On 25 May 1865, her cockpit was covered with canvas and USS *Yucca* took the little steamer in tow. She was to be delivered to Key West, Florida and then taken on to Norfolk. A few days after departing Apalachicola, the weather deteriorated and *Viper* started taking on water. Rough

conditions overwhelmed the launch, forcing the watch to be taken aboard *Yucca*. *Viper* sank soon thereafter.<sup>38</sup>

### Union Torpedo Boats and Operations

The South was the first and primary user of torpedoes and torpedo boats. This was natural since the Confederate Navy was almost always on the defensive, struggled to safeguard interior lines of communication, lacked the resources of its opponent and was forced to use ingenuity to deflect the powerful Union fleet. The great number of ships employed by both the Union Army and Navy offered numerous targets for torpedo attack and served as a motivating factor. Conversely, there were few Confederate vessels to stimulate Union endeavors. Southern ironclads were usually kept secured well behind the lines beyond the reach of torpedo craft. As a result, the best and most advanced torpedo boats and weapons were devised and built by the hard-pressed Southerners. Yet, the most spectacular torpedo attack of the war was made by Union Lieutenant William B. Cushing commanding picket boat *No. 1*, equipped with an extremely complex spar torpedo, which sank the Confederate ironclad *Albemarle* in 1864.<sup>39</sup>

Cushing had two picket boats constructed in New York, equipped with torpedoes, and then drove them south under their own power. *Picket Boat 2* was lost to enemy guerillas in Virginia, but *Picket Boat 1* made it to the Federal squadron in Albemarle Sound. With a volunteer crew, and muffled engine, Cushing cruised up river past sleepy guards and sank the ironclad CSS *Albemarle* at her moorings. His boat was lost in the process but Cushing and one other man escaped. The rest of the crew was captured. His success returned balance of power in the region to the Union.

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<sup>38</sup> C. K. Stribling to Gideon Welles, May 29, 1865, *ORN* Ser. 1, Vol. 17, 853-854.

<sup>39</sup> William B. Cushing to David D. Porter, October 30, 1864, *ORN* Ser. 1, Vol.10, 611-613.

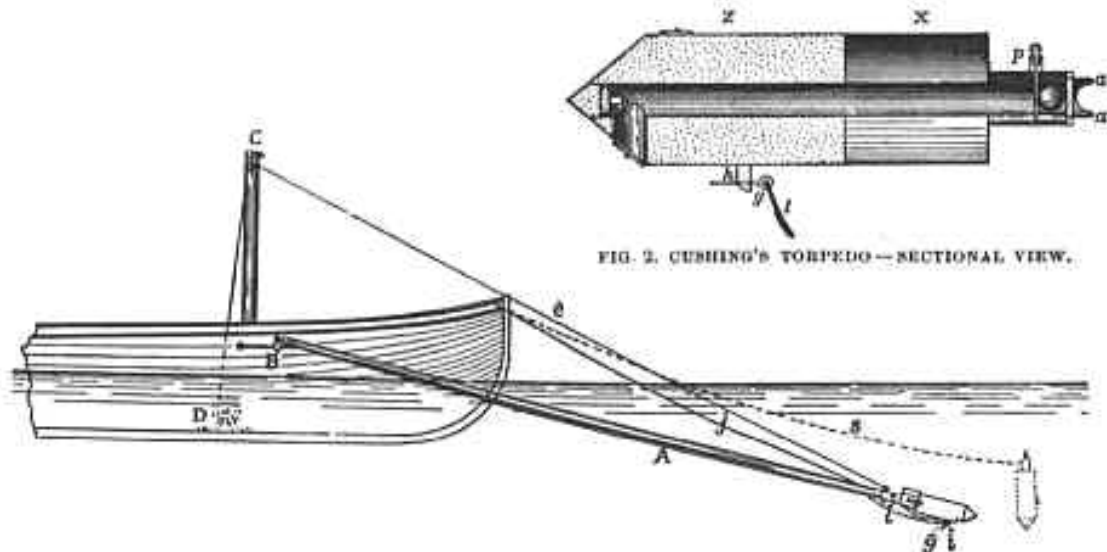


FIG. 1. CUSHING'S LAUNCH AND TORPEDO—SHOWING METHOD OF WORKING.

Figure 8. Wood-Lay torpedo. This weapon used by Lt. William B. Cushing was an overly complex device inferior in every way to the weapons of Captain Francis Lee, yet it scored the most significant torpedo boat victory of the Civil War. There was no contact fuse and Cushing had to place the torpedo under *Albemarle* using two guide ropes, pull a lanyard to release it to float free against the hull, and pull another to detonate the explosive. All this had to be done in darkness and under intense short-range fire. (*ORN* Ser. 1, Vol. 10, 622)

*Picket Boat No. 1* was captured by *Albemarle*'s crew and later placed at the disposal of James Hopkins, a former pilot on the Chesapeake and Albemarle Canal. Hopkins had been in the Confederate Navy for some time, serving as a pilot aboard CSS *Beaufort*. He was pilot/first mate aboard CSS *Albemarle* at the time of her sinking. There were rumors Hopkins might attempt to turn the boat against the Federals but if true, nothing came of it.

Admiral David Porter, commander of the Union's North Atlantic Blockade Squadron, called for volunteers to emulate Cushing's gallantry and established torpedo boat units in North Carolina and the James River. The response was positive but since there were few Southern ships to attack and the Confederate James River Squadron was reluctant to leave Richmond and expose itself to danger there were no practical results. Nevertheless,

the move showed an interest in, and appreciation of, the ship killing power of small craft crewed by brave and determined men.<sup>40</sup>

A study of these incidents reveals three constant themes. First, when success was realized it was due to the bravery and skill of the commander and crew. A torpedo assault in one of these frail craft was a very hazardous undertaking. Only men of exceptional talent and daring were likely to volunteer. Second, these were covert operations that were entirely dependant upon the cover of darkness and often the complacency and confusion of the guard aboard the target. Third, and just as important, luck played a major role. Cushing had so many close calls, met and overcame so many obstacles, that it is a wonder he survived the attack on *Albemarle*, much less sank her. The first two factors would be of great significance in PT operations throughout World War II.

Some Union officers looked upon torpedo carrying vessels as being a deterrent to sorties by Confederate ironclads based in Richmond. At the same time that Cushing's picket boats were being developed, the Navy accepted plans for a vessel to be built from the keel up as a torpedo boat. Originally named *Stromboli*, but later rechristened *Spuyten Duyvil*, it was destined to become the last Union steam warship built during the war. It measured 84 feet overall, with a beam of just under 21 feet, and a draft of seven to nine feet depending upon whether ballast tanks were flooded. These were special sealed compartments intended to reduce freeboard during combat. The craft made eight knots normally or approximately three when heavily ballasted. Oddly, the hull and deck were armored with one inch of iron plate while the pilothouse had twelve inches of armor. *Spuyten Duyvil* was armed with a large spar-mounted torpedo that apparently gave her inventors and crew endless problems and the craft was never proven in action.<sup>41</sup>

Even with these deficiencies, the post-Civil War Navy sustained a role for torpedo boats. Commodore Foxhall A. Parker, writing shortly after the war in his book *Fleet*

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<sup>40</sup> *ORN* Ser. 1, vol. 10, 39-40, 77, 247-248, 340, 441, 463, 539-540, 611-612, 622, 624; series 1, vol. 11, 881; series 2, vol. 1, 177.

<sup>41</sup> Clark G. Reynolds, "Yankee Supership? Sortie of Spuyten Duyvil," *American Neptune* 42(2) (1982), 85-86.

*Tactics*, called for torpedo boats to protect “our long line of seaboard” and said that the function of a torpedo boat was to move “stealthily upon a large vessel at night, in thick weather or amid the smoke of battle.” He was not alone in seeing potential for these small boats. Admiral Porter was enthusiastic about torpedo warfare and in 1869 he established the Newport Torpedo Station to experiment with all types of torpedoes and mines.

In the first two decades after the Civil War the U.S. Navy showed continued interest in torpedo boats, but development was slow. They were primarily regarded as coastal defense craft, although the concept of the torpedo boat as a fleet adjunct had been considered as early as 1873. At that time Commodore Parker had suggested their use as fleet auxiliaries to pick off enemy vessels damaged by the barrage of capital ships and to “proceed stealthily but swiftly to complete the work of devastation inaugurated by the charge.” Parker failed to note that a fleet capable of severely damaging its opponents would also be able to sink them and thus have no need of torpedo boats, but his writings document that American naval theorists realized that in certain circumstances small vessels armed with suitable weapons were capable of inflicting damage far out of proportion to their size and expense.<sup>42</sup>

Union torpedo launches and the Confederate  *Davids*  were arguably little more than primitive manned torpedoes. They were relatively slow, incapable of self-defense, and unseaworthy. Their failures had far outweighed their triumphs and the few victories were usually more attributable to the men involved than to their machines. Nevertheless, in favorable conditions they had shown potential that was understood at home and abroad and coming changes in technology would make them far more effective. When Robert Whitehead tested the first self-propelled torpedo in 1866 he made them a potent force in naval warfare. The Russians used spar torpedoes with excellent results in their 1877 war

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<sup>42</sup> W.I. Goggeshall and J.E. McCarthy, *U.S. Naval Torpedo Station, Newport, R.I. 1658-1920* (Newport: Training Station Press, 1920), 12; Hagan, *This People's Navy*, 182-183; Foxhall A. Parker, *Squadron Tactics Under Steam* (New York: D. Van Nostrand, 1864) and *Fleet Tactics Under Steam* (New York: D. Van Nostrand, 1870), 231. In *Fleet Tactics Under Steam*, Parker maintained that when approaching an enemy battle line “the column designated to pierce the enemy’s center should always be led by a vessel of great artillery or *ramming* (Parker’s italics) power, and should have abreast of it (a little in advance) the most formidable ram or torpedo vessel in the fleet...”

with Turkey and within a few years torpedo boats were a common element in all European navies. American inventors had done much to bring this about.



## CHAPTER 4

### FROM CONCEPT TO REALITY:

#### An Era of Technological Experimentation and Innovation

In spite of their inclusion in naval tactical planning, the two decades following the Civil War was an era of tight naval budgets, and limited funds restricted torpedo and torpedo boat research and development. The Newport Torpedo Station experimented with the Lay “automobile” torpedo, took notice of related events in Europe, and considered the design of anti-torpedo nets. Clearly, the possibilities were not ignored, but they were not considered a national priority.<sup>43</sup>

While the United States Navy experienced shrinking resources and some intellectual retrenchment in the 1870s, European powers remained actively involved in naval construction, experimentation with ship types and designs, weapons research, and an ever-accelerating arms race. For them, it was a time of technical and tactical progress and growth. Military attaches had studied the events of the Civil War and knew that the Union torpedo launches and the Confederate *Davids* were actually little more than manned torpedoes. They were slow, incapable of self-defense, and not at all seaworthy. Their failures had far outweighed their triumphs and the few victories were usually more attributable to the men involved than to their machines. Nevertheless, in favorable conditions they had shown potential and coming changes in technology would make them far more effective.<sup>44</sup>

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<sup>43</sup> Goggeshall, *U.S. Naval Torpedo Station*, 14-17; Curtis Nelson, *Hunters in the Shallows*, 37-38; Larry Smart, “Evolution of the Torpedo Boat”, 99.

<sup>44</sup> Theodore Ropp, “The Modern Italian Navy,” *Military Affairs* (5) (1) (Spring 1941), 42-45; Edward L. Beach, *The United States Navy, 200 Years* (New York: Henry Holt and Company, 1986), 317; Donald W. Mitchell, *History of the Modern American Navy from 1883 through Pearl Harbor* (New York: Alfred A. Knopf, 1946), 3-18; and Harold and Margaret Sprout, *The Rise of American Naval Power, 1776-1918*, (Princeton, NJ: Princeton University Press, 1967), 177. Naval historians often refer to the two decades following the Civil War as the Doldrums. It was certainly an era of limited defense budgets, lack of focused and directed public policy and debate on the Navy’s role, and of division over political, strategic, and

In 1864, retired Austrian naval officer Giovanni de Luppis met with British engineer Robert Whitehead to discuss the former's concept of a self-propelled, guided, underwater apparatus capable of delivering an explosive charge against a ship's hull. The Luppis device was basically a sealed, self-contained elongated surface vessel guided by ropes from the shore. It ran a screw propeller shafted to a clockwork mechanism and carried a warhead filled with explosives and ignited by a percussion cap. Whitehead expressed great interest and joined in partnership with Luppis. The engineering problems were never resolved and the joint venture soon ended. Whitehead continued working independently though, and produced a radically different model that was tested by the Austrian navy in December 1866. It was almost twelve feet long and either fourteen or sixteen inches in diameter. Speed was slow at eight to ten knots and range was a maximum of 700 feet. It was propelled by compressed air, a jet of which exited a canister at a steady rate, and struck and turned angled blades attached to a propeller shaft.<sup>45</sup>

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technological issues within the service. Most historians find this to be a time in which American naval power reached its nadir intellectually and in combat capability. It is therefore ironic that these were the years that produced Stephen Luce, Alfred Thayer Mahan, and James Soley, saw the creation of the U.S. Naval Institute, and led to an entirely new perception of American sea power. The concept of the 1870s as a decade in which the Navy became intellectually moribund enjoyed widespread acceptance for a century but it has been challenged in the last two decades. Frederick S. Harrod, "New Technology in the Old Navy: The United States Navy during the 1870s," *American Neptune* 53 (1) (1993), 5-19. Harrod has produced a very well conceived and documented argument that it was the spirit of invention and experimentation of the 1870s that made the rebirth of the fleet possible in the following decades. For a well-written view that contests the idea of the Doldrums see Lance C. Buhl, "Maintaining 'An American Navy,' 1865-1889." In *In Peace and War: Interpretations of American Naval History, 1775-1984*, ed. Kenneth J. Hagan,. (Westport, Conn.: Greenwood Press, 1984), 237-262

<sup>45</sup> R.B. Bradford, *Notes on Moveable Torpedoes*, (Newport, R.I.: U.S. Torpedo Station, 1882), 20; Harald Fock, *Fast Fighting Boats, 1870-1945*, Lymington, Hampshire, England: Nautical Publishing Company, 1978), 11; Edwyn Gray, *The Devil's Device: Robert Whitehead and the History of the Torpedo*, (Annapolis: Naval Institute Press, 1991); Frank Johnson, *United States PT-Boats*, 6-7; Nelson, *Hunters in the Shallows*, 33, 34; H.A.V. Von Pflugk, "Torpedo Boats," *U.S. Naval Institute Proceedings* (August 1941), 1115; Smart, "Evolution of the Torpedo Boat", 99. There is an interesting historical debate played out along national lines as to who was truly and primarily responsible for the first workable torpedo. German writer Fock claims that Luppis developed it in 1864-1866 and that Whitehead improved it in 1872.

The Austrians rejected Whitehead's first torpedo because it could not maintain a specified depth. It took the inventor two more years of work to find a solution to this dilemma. By 1868, he had developed a pressure sensitive bellows that maintained a set depth. With such a system, the torpedo boat no longer had to make contact with its opponent but could approach quietly, under cover of darkness, fire without betraying its presence or location, and depart the area before enemy fire could be brought to bear upon it. The Austrians bought rights to manufacture the new weapon that same year. The British followed suit in 1870 and within eight years virtually every nation in Europe had acquired rights and was fitting out ships and torpedo boats to utilize a weapon that had not yet been proven in combat.<sup>46</sup>

The employment of torpedoes was not the only major change in the structure and armament of the major navies in the late 19<sup>th</sup> century. Evolution and experimentation was the order of the day and it showed in the variety of ships and armament. Warship hulls were more and more likely to be made of steel than either iron or wood. A debate raged between proponents of ships with many guns of various calibers versus those who sought

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Gray and Nelson credit Luppis with a related concept but maintain that Whitehead actually designed and built the first workable self-propelled torpedo. Smart writes that Luppis originally created a boat-like weapon. After rejection by the Austrian Navy he sought advice from Whitehead and they began a collaboration that produced the moderately successful 1868 model. Gray has written the most complete study of the topic and acknowledges Luppis's work as Whitehead's inspiration but states that the "automobile torpedo" was the product of Whitehead's mechanical genius and tenacity.

<sup>46</sup> Charles Chabaud Arnault, "The Employment of Torpedoes in Steam Launches Against Men-of-War", *U.S. Naval Institute Proceedings* 6(11), (1880) 87; A. C. Davidonis, "Harbor Forcing Operations", 85; Edwyn Gray, *The Devil's Device*, 113-114; Frank Johnson, *United States PT-Boats*, 7; Curtis Nelson, *Hunters in the Shallows*, 34-36, 44. Von Pflugk, "Torpedo Boats," 1115. Arnault's article describes in detail a number of Russian torpedo attacks on Turkish naval vessels using three torpedo types – a towed explosive container the author calls a "divergent" torpedo, spar torpedoes, and Whitehead's being used in combat for the first time. The towed torpedoes were a dismal failure, the spar and Whitehead torpedoes garnered mixed results, often being deterred by booms or nets. Whitehead's device frequently did not maintain course or failed to explode though they did score a victory when two of them were fired at very close range, eighty yards, and sank a Turkish revenue steamer. The Turks denied the sinking but most Europeans accepted it and this lent new impetus to the torpedo boat rage. Von Pflugk writes that by 1884, "Russia had 115 torpedo boats, France 50, Holland 22, England 19, Italy 18, and Austria 17."

a small number of larger tubes mounted in widely traversing turrets. Ram shaped prows had come into vogue during the American Civil War but they proliferated after the Austrian ironclad *Ferdinand Max* rammed and sank the Italian armored frigate *Re d'Italia* in the battle of Lissa. Though the ramming doctrine dominated battleship design for the rest of the century, none of these ships was ever used to ram another. Lissa had been an aberration and some thought that the use of torpedoes might be another trend doomed to failure. Ironically, as naval historian Kenneth Hagan has noted, the self-propelled torpedo doomed ramming tactics by insuring that “the would-be ramming vessels became vulnerable as they raced toward their targets.”<sup>47</sup>

Despite the questionable and transient nature of some developments and innovations, Europeans engaged in an expensive naval buildup that included the use of Whitehead’s “Devil’s Device” and of specially designed vessels to make use of it. The trend was given impetus by Russian success in the 1877 conflict with Turkey. Based upon repeated encounters between small Russian boats and Ottoman ships, it was widely agreed that the danger to attacking torpedo boats had been “over-estimated.” Studying the operations in detail, French Navy Lieutenant Charles Arnault concluded that torpedo boats could be very effective when used against anchored vessels at night, and that Whitehead torpedoes were especially useful in clear conditions where a spar-equipped launch could be spotted or when the target was protected by booms or other surface obstructions.<sup>48</sup>

How best to employ the new apparatus was a matter of controversy. Eventually, two general classes of torpedo boat evolved. Large boats, small ships actually, were designated as first class torpedo boats. They were generally well in excess of 100 feet long, usually carrying guns as well as torpedoes. They were planned and built for independent offshore work or for operation with a fleet of capital ships. Second class

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<sup>47</sup> Paradoxically, Whitehead designed the engines in *Ferdinand Max*. Edwyn Gray, *The Devil’s Device*, 38-44; Kenneth Hagan, *This People’s Navy*, 187; Frank Johnson, *United States PT-Boats*, 7; Curtis Nelson, *Hunters in the Shallows*, 45; Theodore Ropp, “The Modern Italian Navy,” 36, 41. Ropp notes that the Italian torpedo service was established in the early 1870s and many of its experiments were failures. Navalists were wise to be cautious in this era.

<sup>48</sup> Charles C. Arnault, “The Employment of Torpedoes in Steam Launches Against Men of War.” 97-98.

boats were considerably shorter, anywhere from 30 to 100 feet in length, but generally well under 60 feet overall, and were expected to serve as harbor and near-shore defense craft. The smaller ones, less than 40 feet or so, were intended as shipboard auxiliaries, to be transported in davits and carried into battle aboard larger vessels. They would then be launched to conduct attacks upon the opposing battle fleet or conduct raids. In time, the first class boats would continue to grow in size and weaponry until they became the destroyers of World War I. The idea of carrying second-class boats aboard mother ships soon proved a failure, as it would be in repeated trials by several nations. The notion of halting a fleet on the high seas while closing with an enemy force was outrageous in its own right. Anyone who has attempted to launch and retrieve boats of modest size on the high seas will confirm this idea was a child of armchair admirals devoid of small craft experience. Additionally, there was no need to build a fleet of small coastal craft when larger vessels could be had that possessed equivalent or greater speed, could boast more powerful armament, and whose scope of operations was more flexible because it was not restrained by lack of seaworthiness. The day of the smaller torpedo boat would simply have to await advances in technology and changes in international conditions.<sup>49</sup>

The rush to build the early larger boats was the result of anxiety about the balance of power in Europe and competition for overseas colonies and trade, and was exacerbated by saber rattling from the militant German Kaiser Wilhelm II. With the modest distances between major ports, the constraints of narrow seas, and the restricted size of the European area of operations, short range, inexpensive, quickly built craft like the steam propelled examples of the time had real potential, in spite of their limited seaworthiness. For the first time in naval history, they afforded an opportunity for small vessels to consistently sink large ships. While Great Britain, Austria, France and other major sea powers quickly bought into Whitehead's invention, it was a notion that was especially

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<sup>49</sup> Harald Fock, *Fast Fighting Boats*, 11-14, 17-20, and numerous other references throughout the text; Frank Johnson, *United States PT-Boats*, 7-8; Curtis Nelson, *Hunters in the Shallows*, 43-51; H.A.V. Von Pflugk, "Torpedo Boats," 1116, 117-1118.

attractive to weak navies. In the 1870s Britain, France, Italy, Russia, Austria-Hungary, Germany, The Netherlands, Sweden, and Denmark built torpedo boats.<sup>50</sup>

There was no accepted technique for launching torpedoes and several options were tried. There was stern launching, in which the torpedo was shot backwards out an open port or launching rack with the hope that the mother craft would be fast and maneuverable enough to avoid falling victim to its own spawn. This gained favor among the British during World War I and was retained by the Spanish in their civil war. The Italians, among others, developed boats with side launching racks or longitudinal ports to drop the “fish” over the side parallel to the boat’s direction of travel. Some nations fitted a bow launching tube, most commonly integral to the stem. Side racks were used on a number of boats, where the torpedo was rolled into the water. Tubes mounted off center on deck or within the hull gained favor with some navies. These tube mounts fired torpedoes by a blast of black powder or compressed air – the latter technique still in use today. Whatever launching method the craft used, they all lacked two of the three traits that are an essential characteristic of the modern motor torpedo boat – a self-propelled, guided torpedo, a powerful, lightweight power plant, and a planing hull capable of reaching high speeds. Whitehead had provided the answer to the first problem, but the advent of a suitable hull and engine was decades away. Part of the difficulty obtaining suitable speed in a diminutive hull was attributable to simple laws of hydrodynamics.<sup>51</sup>

The vessels of this era were all displacement types, that is, they moved through the water, pushing it aside as they did so. A displacement hull requires the use of enough force to move the water aside plus overcome the friction of the hull’s surface against the water. As the ship moves through the water, it creates a wave. As speed increases, the wavelength increases proportionally until the crest of one wave is at the bow while the crest of the preceding one is at the stern. Thus, the wavelength produced by the boat comes to equal the waterline or wetted length of the hull. A displacement vessel can then travel no faster, for the stern begins to squat dramatically and the craft can theoretically

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<sup>50</sup> Harald Fock, *Fast Fighting Boats*, 11. Frank Johnson, *United States PT-Boats*, 7.

<sup>51</sup> Harald Fock, *Fast Fighting Boats*, 12-13, 18-19.

be driven under. Regardless of the power available, a displacement hull can only reach a certain speed, determined as a ratio of the length of the hull at the waterline. The generally accepted rule is that the square root of the length or load waterline, expressed as LWL, multiplied by 1.34, equals the theoretical maximum hull speed. Thus, Cushing's *Picket Boat No. 1*, with a length at the waterline of no more than 42 feet, could travel no faster than  $6.48 \times 1.34$ , or 8.68 knots. This speed might be adequate for a stealthy approach but would hardly suffice for a quick exit.<sup>52</sup>

Throughout the late 19<sup>th</sup> century, torpedo boat development was hindered by heavy steam power plants and the physical limitations of the displacement hull. European navies attempted to overcome this by designing long, narrow craft that would reduce friction while increasing the waterline length and hence, the theoretical maximum speed. Additionally, in larger ships a smaller proportion of the hull can be given over to machinery than with smaller ones, and hulls became progressively longer and narrower, meriting names like *Stiletto* and *Lightning*. As they became longer and probably faster, they received heavier armament and larger profiles until they lost one of the major advantages of torpedo boats tactics, a low silhouette with ability to close upon a target while remaining undetected. And though they became longer and faster, they still had a shorter waterline length than the ships they were designed to attack and so had a lower “potential” hull speed. The long, narrow sections meant they were subject to rolling and

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<sup>52</sup> Carl A. Chase, *An Introduction to Nautical Science*. (New York: W.W. Norton, 1991), 54-55; Norman Friedman, *U.S. Small Combatants*, 1; Frank Johnson, *United States PT-Boats*, 9; George Charles Manning, *Manual of Naval Architecture*, (New York: D. Van Nostrand, 1930), 69-77. Manning gives a brief, lucid discussion of resistance affecting a displacement hull; Tad Roberts. “Sailing Cruiser Design: History, Hydrostatics, and Art, Part 1.” *Wooden Boat Magazine*, no. 175, November/December 2003, 59. A knot is the commonly accepted nautical unit of measurement of speed. One knot is one nautical mile per hour, a nautical mile being 6,080 feet. Cushing's boat had a theoretical maximum hull speed of 8.68 knots or 10 miles per hour ( $1.15 \times 8.68$ ); Peter Kemp, ed. *The Oxford Companion to Ships and the Sea.*, 454; Curtis Nelson, *Hunters in the Shallows*, 18. Various sources give different lengths for *Picket Boat No. 1*. They range from 30 to 45 feet. A very famous drawing of the boat at the moment it sank *Albemarle* shows an open launch of approximately 30 feet. Drawings in the *ORN*, vol 10, 622, lack measurements or scale. Nelson uses 45 feet – a figure he received from Dana Wegner, curator of ship models for the U.S. Navy, who constructed the model of *No 1*. now on display at the Smithsonian Institution.

had large turning radiuses with reduced maneuverability. Though many of the first class torpedo boats were capable of very high speeds for the time, they were unsuited to their conceived mission of cheap, small, low outline torpedo boats and were actually the first destroyers. Ironically, they evolved at the same time that the modern torpedo boat became possible.<sup>53</sup>

Instead of stretching hulls until they were no longer suitable for the intended purpose, the real answer was in a radically different hull configuration – one with a planing bottom that would skim across the surface of the water rather than plow through it. This would require a design with moderately flat bottom sections, especially aft, moving across the surface at such a speed that the incompressible nature of the water would support the vessel's weight. There would still be some displacement of water but it would be far less than a comparable displacement hull. Unfortunately, flat hulls can pound viciously in opposing or cross seas and it was always a challenge to the naval architect to balance the need for flat sections to promote speed and lift the boat onto a plane versus the demand for V-shaped sections forward to dampen the pounding.

A further complication was the need to get over the “hump” quickly and efficiently while carrying a combat load. The hump is the point at which the forward speed of a planing hull is sufficient to lift the vessel from displacement mode onto a plane, comparable to an aircraft on its takeoff roll reaching a speed where enough lift is created for flight. The longer the hull, the higher the speed required to get it over the hump and hence, the more power required to do so. Of course, more power means more weight, so there is always a delicate compromise of size, power, and weight to be evaluated and maintained or adjusted to meet conditions.<sup>54</sup>

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<sup>53</sup> Harald Fock, *Fast Fighting Ships*, 11, 20; C. Raymond Teller, “The Quadraconic Hull,” *Motorboating* (1952), a reprint by Huckins Yacht Corporation. Teller defines a displacement boat as “one that continues to displace the same volume and weight of water at any and all speeds as she does at rest.” A planing hull “is one that at some speed arises bodily in the water and then displaces less than her own weight.” Tellers article is an excellent examination of the hydrodynamics of the planing hull.

<sup>54</sup> Harald Fock, *Fast Fighting Boats*, 21; Norman Friedman, *U.S. Small Combatants*, 6-7.



The first reference of the notion of a planing warship is credited to Rev. Charles M. Ramus, who proposed it to the British Admiralty in 1870. Expatriated American W. H. Fauber was a pioneer designer in the field and British shipbuilder Sir John Thornycroft patented a “skimming” boat in 1877. Nevertheless, nothing came of it for the simple reason that the powerful, lightweight propulsion machinery necessary was not yet available. Even given an appropriate and efficient hull form, a vessel cannot plane if the entire craft, including combined weight of hull, engine, equipment, stores, and crew, exceeds thirty-five pounds per horsepower. This was far outside the capabilities of heavy steam machinery.<sup>55</sup>

The advent of the internal combustion engine answered this need. Physicists had been aware of the energy potential of contained, ignited, gases for decades but it was not until 1883 that the German engineer Gottlieb Daimler was able to utilize it in a working motor. Two years later he produced the first automobile and launched a worldwide technological revolution. Within a few years, the new power plant was being claimed for the pleasures of rich boating enthusiasts who harnessed it to hard-chine planing hulls to reach water borne speeds previously regarded as impossible. Naval architects and warship designers did not miss the implications. The major powers were soon producing hulls capable of combat missions and fitted for the internal combustion engine. They widened and flattened the bottom sections aft of amidships and provided additional buoyancy to support added horsepower. The third essential for a successful motor torpedo boat (MTB)

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<sup>55</sup> Gordon Adamson and Douglas Van Patten, “Motor Torpedo Boats: A Technical Study,” *U.S. Naval Institute Proceedings*, (July 1940), 977-978; Fock, *Fast Fighting Boats*, 13, 23.; Nelson, *Hunters in the Shallows*, 53-54. Ramus submitted a proposal to the Admiralty for a stepped planing vessel of 2,500 tons – a notion that seems highly impractical even by current standards. The stepped hull incorporated a cut away section in a relatively flat bottom. After the hull reached planing speed it would be supported at the step and at the stern with very little displacement of water. This could result in high speeds but stepped hulls are efficient only in flat water as evidenced by the fact that even today they are used in protected waters while high speed ocean racing is dominated by V-hulls.

had been found. The only thing required to blend and test these ingredients was the catalyst of war and this would not be long in arriving.<sup>56</sup>

Since the appearance of the self-propelled torpedo, designers, engineers, and naval tacticians had emphasized the need for high speed in torpedo carriers. The record shows there was very little debate on how important this aspect really was. Typically, most successful torpedo attacks had been, and would continue to be, characterized by slow speed, covert approaches, under cover of darkness. The image of the high speed planing motorboat making an attack at forty knots is somewhat a legacy of Hollywood action films that has little basis in reality. Nevertheless, speed continued to be stressed in torpedo boat formulation and in World War II it finally paid off. Speed and maneuverability would be vital in combating air attacks, raids and “barge busting” in the Pacific Theatre, and it would allow MTBs to range far from base during hours of darkness and to make hasty departures after launching weapons.<sup>57</sup>

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<sup>56</sup> Ibid. Irving R. Allen, *Never a Dull Moment*, (Jacksonville, FL: Huckins Yacht Corporation, 1943,est); Frank Johnson, *United States PT-Boats*, 9; Peter Kemp, *Oxford Companion to Ships and the Sea*, 166. Johnson writes that in 1907 American Clinton Crane utilized a planing hull with wide, flat bottom sections aft to support the weight of added horsepower. His boat, *Dixie*, captured the British International Trophy, and inaugurated a healthy competition between the United States and Britain to build faster boats.

Kemp defines chine as “the angle where the bottom strakes of a boat meet the sides. In a hard-chined boat the angle is pronounced; in a soft-chined boat it is rounded off gradually.”

<sup>57</sup> With the submarine *Turtle*, Cushing’s *Picket Boat No. 1*, the Russian torpedo boats of the Turko-Russian War, and most successful torpedo boat attacks in both world wars, the commander tried and often succeeded in remaining undiscovered until torpedoes were fired or contact was made. Sometimes, the MTBs were never sighted and could retire at slow speed as well. Only when spotted and brought under fire was speed an asset, though unquestionably a very valuable one. The significant wake thrown up during such a withdrawal made the enemy’s target acquisition easier but the smoke generators of World War II helped remedy that situation. Speed really became an asset in the Pacific Theatre in World War II when it extended the operating range of the boats and was a defense against air attack. S. A. Peters, “The PT Boat,” *Bureau of Ships Journal* (August 1953), 3. Peters writes “The PTs main defense is high speed and change of pace.” “Change of pace” or maneuverability was found to be critical in World War II in PTs evading air attack. The long, slender displacement hulls of the late 19<sup>th</sup> century must have tracked very well but have had wide turning radiuses. U.S. Navy Bureau of Personnel, *Principles of Naval Engineering*,” 16. “smaller ships are more maneuverable because they have smaller turning radii than larger ships...”; Theodore Ropp,

## CHAPTER 5

### PROVEN UNDER FIRE

#### Domestic and Foreign Development, 1865-1918

While experimentation and development continued in Europe, a change in foreign policy and the national mood in the late 19<sup>th</sup> century had made torpedo boats chiefly irrelevant in the United States. Previously, they had offered a cheap, disposable, potentially deadly form of harbor defense and were attractive so long as the foundation of U.S. naval strategy was the *guerre de course*. Commodore Parker's vision of battleships deployed as a fleet with torpedo boats serving as minor auxiliaries, was a precursor to the big ship philosophy and doctrine of sea power soon to be espoused by Alfred Thayer Mahan, James Soley, and Stephen Luce. It marked the beginning of a major change in U.S. foreign and naval policy that would have a decisive impact on development of all vessel types and would practically eliminate U.S. Navy interest in torpedo boats for a generation.<sup>58</sup>

As noted previously, the concept of cruiser warfare, *guerre de course*, had served the United States well through its first century. American ships had been designed and built to outfight anything in their class and to outrun everything else. They had acquitted themselves well in three declared wars and numerous other engagements, inflicting losses on enemy shipping and forcing the maintenance of expensive blockades and deployments by the British. With the closing of the western frontier in 1890, Americans looked overseas for new fields to contest and this mandated a significant change in the Navy's place in U.S. politics and in the nation's concept of itself and its world role. The rise of American imperialist expansion encouraged the Mahanian scheme of capital ships slugging it out in line of battle for control of the sea lanes, a concept known as *guerre d'escadre*. This doctrine came to dominate U.S. strategic thinking and planning. Large

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"The Modern Italian Navy, Part II," *Military Affairs* 5 (2) (Summer 1941), 111, writing about small craft raids in the Adriatic and English Channel during World War I says, "In the storms of war, unfortunately, speed is the most uncertain of all tactical factors, at the mercy of any chance hit or machinery accident..."

<sup>58</sup> Curtis Nelson, *Hunters in the Shallows*, 37; Foxhall A. Parker, *Fleet Tactics Under Steam*, 8, 231.

steel-hulled battleships and cruisers with a few guns of large caliber, on armored hulls and powered by huge steam engines became every career officer's idea of the real navy. Other vessels existed only as plain, unglamorous workhorse auxiliaries to service and support their imposing sisters.<sup>59</sup>

There were colliers to supply fuel and a few freighters to transport equipment and supplies but plans called for the charter or purchase auxiliaries as needed. The idea of a permanent service support fleet was far in the future. U.S. forces, even when far from home, often relied upon replenishment from shore depots so that the dreadnoughts were not only the heart of the navy – they *were* the navy of their day and they were seen not only as projections of American power but as fulfilling the traditional role of coastal defense as well. By the late 1890s, the battleship was the mainstay of the United States Navy. This being the case, the torpedo boat, which was considered a coastwise and harbor defense craft, was seen as an unnecessary duplication of effort and a drain on funds that could be used to better effect building capital ships capable of both coastal defense and projection of power abroad.<sup>60</sup>

Still, professional naval officers remained interested in torpedo warfare, and studied the nature and course of European testing and discovery. In 1869, Rear Admiral William Radford visited the Whitehead factory at Fiume. Though Radford was impressed by what he saw, the Americans evidently “balked at the asking price” for the new contrivance and returned home without a deal. Rather than purchase Whitehead's product, the U.S. spent years trying to build an indigenous equivalent. One was the brainchild of Commander John A. Howell, USN, and was driven by the inertia of a flywheel that was set spinning at a very rapid rate by a turbine motor attached to the launching tube. When maximum rotational speed was attained, the turbine was removed and the torpedo launched. Howell worked on the project for almost twenty years and in 1889 finally produced a serviceable apparatus that excelled Whitehead's in several respects. Unfortunately, its range was

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<sup>59</sup> Kenneth J. Hagan, *This People's Navy*, xi, 12, 20, 182-184, 190; Curtis Nelson, *Hunters in the Shallows*, 41, 58, 59.

<sup>60</sup> Kenneth J. Hagan, *This People's Navy*, 228; Curtis Nelson, *Hunters in the Shallows*, 58.

limited by its mode of propulsion and it found little acceptance after the Navy bought Whitehead's torpedo in 1890.<sup>61</sup>

During these same decades, the U.S. made moderate trials with torpedo boats. *Intrepid*, *Alarm*, and *Lightning* were experimental spar torpedo boats of extreme length; 179'4", 172', and 58' overall respectively. The last, *Lightning*, was built as late as 1876, at a time when the Russians were still using these methods to sink Turkish ships. All three were one-of-a-kind experiments that were not repeated and the first two were so large they bear hardly any relation to the motor torpedo boat. The first U.S. vessel to carry "automobile" torpedoes was the wooden hulled *Stiletto*, built by the Herreshoff yard in Bristol, Rhode Island. It was acquired by the Navy in 1887 and intended as a testing platform. Not until 1890, did the United States commission its first torpedo boat designed and built as such from the keel up. She was fittingly named *Cushing* and was launched at a time when "there were over 800 torpedo boats in the seven largest navies of the world."<sup>62</sup>

Debate ensued over what type of torpedo boat best suited U.S. strategy. Should small boats be used for harbor protection as originally intended or was it best to build ships

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<sup>61</sup> Norman Friedman, *U.S. Naval Weapons: Every Gun, Missile, Mine and Torpedo Used by the U.S. Navy from 1883 to the Present*. (Annapolis: Naval Institute Press, 1984), 115; Goggeshall, *The Naval Torpedo Station*, 19; Edwyn Gray, *The Devil's Device*, 85; Curtis Nelson, *Hunters in the Shallows*, 36-37, 40-41; Smart, *Evolution of the Torpedo Boat*, 99.

<sup>62</sup> Charles C. Arnault, "The Employment of Torpedoes," 82-87; Norman Friedman, *U. S. Small Combatants*, 98. Friedman quotes a 1908 report from the Office of Naval Intelligence that Russia had the largest torpedo boat fleet at the time; not surprising given their cheaply won successes against the Turks thirty years before. Goggeshall, *The Naval Torpedo Station*, 18, 19, 20; H. E. Rossell, "Types of Naval Ships" In *Historical Transactions 1893-1943 of the Society of Naval Architects and Marine Engineers* (New York, 1945), 282. Smart, "Evolution of the Motor Torpedo Boat," 99, 100; Von Pflugk, "Torpedo Boats," 1116. An audit of the inventory of torpedo boats in foreign navies shows how intense the race to build torpedo boats had become. Von Pflugk reports that in 1890, the year *Cushing* was commissioned, France had 210 torpedo boats, "England, 206; Germany, 180; Italy, 152; Russia, 143; Austria, 61; Greece, 51; Holland, 50; Denmark, 34; China, 32; Norway and Sweden, 31; Turkey, 30; Japan, 24; Spain, 15; and Brazil, 15."

capable of coastal protection and high seas offensive operations? This continued amidst the discussion of whether there was any role for them at all under the new imperialist, sea power oriented foreign policy. Still, more ships followed, including 225-foot long *Stringham*, which was more of a destroyer than a boat. Parker's idea of torpedo boats as fleet auxiliaries was revived but soon discarded as it had been in Europe. In 1908, Assistant Secretary of the Navy, H. L. Satterlee, an avid proponent of small boats for harbor defense, instructed the Board of Construction and Repair to provide a conceptual drawing for a torpedo carrier with a 150-foot long waterline but the project never got beyond the design stage. Canadian inventor, W. Albert Hickman approached the Navy about his "sea sled" design, a hull with an inverted-V form that resembled a "W" in cross section. A prototype was demonstrated off Boston in 1913, to favorable response from the officers in attendance. While these officials expressed little enthusiasm for it as a combatant, they felt it could fill a new role – air-sea rescue craft to pick up downed pilots training at seaside bases like Pensacola and Langley. As a result, two sea sleds were purchased for rescue craft with numerous others procured for that purpose in the following years.<sup>63</sup>

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<sup>63</sup> Adamson, "Motor Torpedo Boats," 983-984; Charles C. Arnault, "The Employment of Torpedoes," 97-98; Harald Fock, *Fast Combatant Boats*, 31; Norman Friedman, *U.S. Small Combatants*, 98-99. Before each of the world wars, naval planners in the United States, Britain, Russia and other nations revisited the idea of davit launched torpedo boats to range ahead as scouts, antisubmarine craft, and torpedo boats. There was a constant dichotomy between the need to make the boats large enough to carry the combat load needed, the endurance desired, the seaworthiness that was absolutely mandatory and the weight limits imposed by the capacity of seaboard davits and cranes. This method was revisited on numerous instances between 1873 and 1939 and was used successfully on at least three occasions. Twice during the Turko-Russian War, the tender *Constantine* had carried torpedo-laden boats to within striking range of Turkish harbors and launched and retrieved them without mishap. In August 1919, British depot ship *Vindictive* transported seven CMBs into the Gulf of Finland where they attacked and torpedoed Soviet ships.

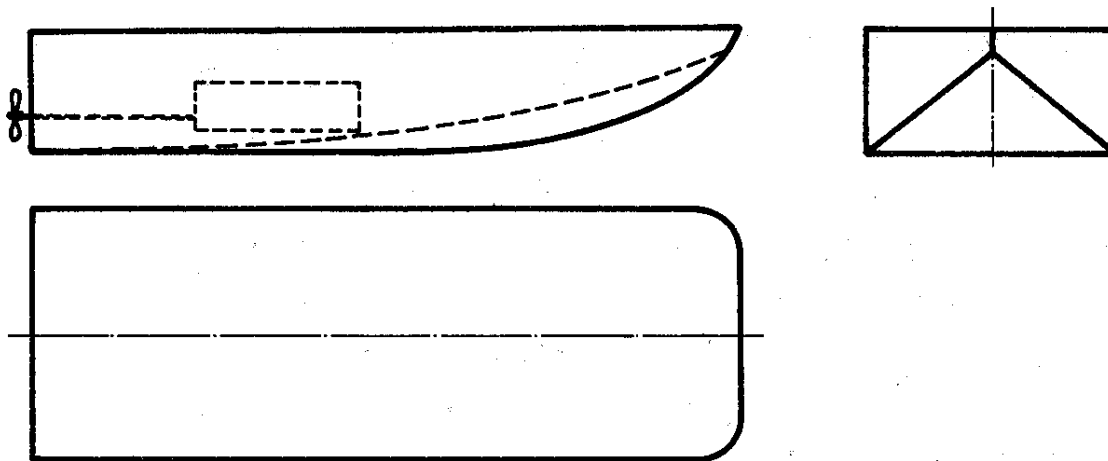


Figure 9. Hickman Sea Sled. The United States Navy toyed with this concept over a span of twenty years but it was found unsuitable as a motor torpedo boat. The structure could not support forward ordnance deck loads concentrated on the centerline over the apex of the inverted “V”. The recreational boating industry would embrace the idea in the early 1960s and it endures in today’s Boston Whaler. (Harald Fock, *Fast Fighting Boats*, 62)

The General Board of the Navy, an advisory body established in 1900, was consistently hostile to the MTB initiative. The prevailing sentiment was that torpedo “boats” might be useful in the limited area of Europe, they had little place in U.S. war planning and were seen as “irrelevant.” U.S. strategy continued to call for sending the fleet offshore en masse to contest enemy forces in waters away from the coast in a realm where short-range boats would have little usefulness. Yet, the fact that changes in technology might cause alterations in strategy could not be totally ignored, and in 1915, the Board established requirements for an MTB “small enough to be hoisted aboard battleships.” Constructed by Greenport Basin Company, the boat was completed in 1917 and failed speed trials but was acquired by the Navy anyway for antisubmarine warfare (ASW). Occasional testing of other types continued through the First World War, including tiny craft that were basically manned torpedoes, but the U.S. Navy was not committed to MTBs. The General Board members found “that labor and material would be better employed turning out destroyers, submarine chasers, submarines, and aircraft.”

Given the nature of the German naval threat, and the U.S. part in the conflict they were unquestionably right.<sup>64</sup>

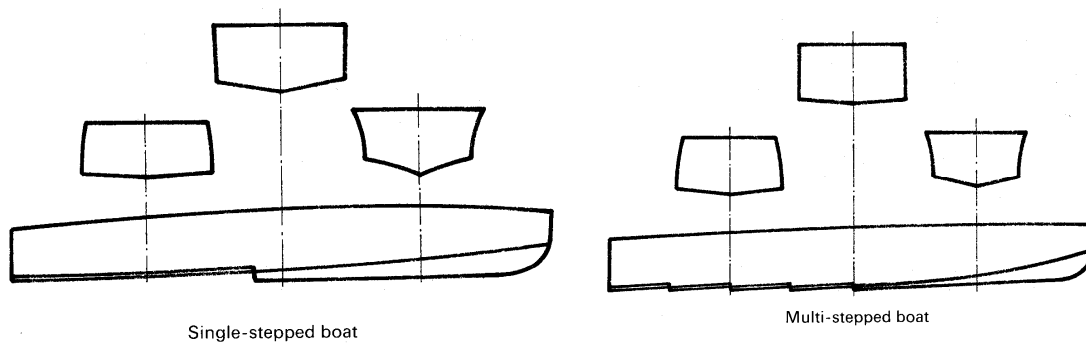


Figure 10. Stepped planning hulls. Stepped bottoms provide very efficient planing surfaces in smooth water but they pound and often became difficult to control in moderate to severe weather conditions. They were adopted for CMBs during World War I but by the early 1930s had given way to the speed, seaworthiness, and easier rough-water ride of the conventional, unstepped V-bottom.<sup>65</sup> (Harald Fock, *Fast Combatant Boats*, 22)

The American viewpoint did not change during World War One despite numerous and successful motor torpedo boat operations, especially by the Italians and British. Early on, both these nations combined the planing hull, internal combustion engine, and self-propelled torpedo to inflict considerable damage upon the Central Powers.<sup>66</sup>

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<sup>64</sup> Norman Friedman, *U.S. Small Combatants*, 99-100. This quote, from the General Board of the Navy, is found in almost every source that discusses U. S. MTBs in the early 20<sup>th</sup> century.

<sup>65</sup> Frank Johnson, *United States PT-Boats*, 10; Von Pflugk, "Torpedo Boats", 1117.

<sup>66</sup> Gordon Adamson, "Motor Torpedo Boats" 979, 982-983; Irving Allen, *Never a Dull Moment*; Harald Fock, *Fast Fighting Boats*, 23-31; Curtis Nelson, *Hunters in the Shallows*, 56-57; A.E. Sokol, "Italian Attempts at Harbor Forcing During the Last War." *U.S. Naval Institute Proceedings* (January 1942), 37-38. Sokol credits the Italian MAS boats with reversing the fortunes of the naval war in the Adriatic.



British craft, designated as Coastal Motor Boats or CMBs, were produced in two sizes, 40 feet and 55 feet. They were of very shallow draft in order to pass over German mines laid in the ports of occupied Belgium. Sir John Thornycroft, a leader in planing hull theory and construction, drew and built several models before his 40-foot, stepped hull version was adopted. It featured a unique stern launcher with one torpedo. As the boat approached its target, the torpedo was rammed tail first down a trough by a piston driven by an explosive charge. After the torpedo hit the water, the boat accelerated and turned away leaving its progeny to continue to the objective. The 40-foot CMB was originally intended for use as an adjunct to light cruisers, being deployed much like the seaplanes used on later capital ships. In practice, however, they were used in coastal operations running from shore bases in England. The CMB was refined steadily, with higher speed and more armament. The later incarnations proved too heavy for launching from ships but much more lethal than the first model.<sup>67</sup>

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<sup>67</sup> Gordon Adamson, 'Motor Torpedo Boats,' 978-979; Robert Bulkley, *At Close Quarters*, 40.; Harald Fock, *Fast Fighting Boats*, 25-27; Frank Johnson, *United States PT-Boats*, 10-11. In chapter 2 of *At Close Quarters*, Captain Bulkley reviews the emergence of the American PT and acknowledges that he has drawn heavily upon an unpublished text by Frank A. Tredinnick, Jr. and Harrison L. Bennett. "An Administrative History of PT's in World War II." U.S. Naval Administration in World War II Series, No. 171. Washington: Office of Naval History, 1946. Rare books collection, Navy Department Library. Naval Historical Center, Washington, D.C. The torpedo was supported in a trough with longitudinal rails about it and trailing astern the transom. It could not be successfully fired if the CMB was traveling at less than 17 knots. The wake produced at that speed must have made detection by the Germans much easier so the covert approach favored by the Italians was nearly impossible. The question remains of whether the CMB was built to fit the launcher or the launcher was designed to suit the CMB. Fock also makes reference to a 45' CMB but provides no additional information. This may be a typographical error.

Main frame of a 55' CMB.

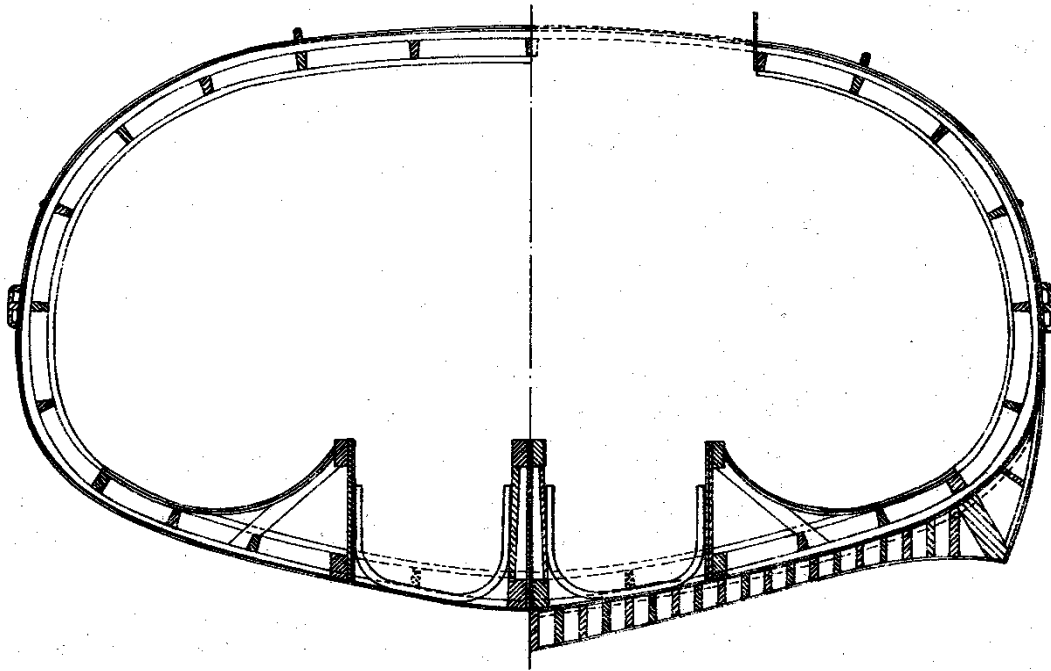


Figure 11. Cross section of CMB. This view shows aeronautical construction techniques employed to make these boats light and fast. The structure is a monocoque component that provides strength and rigidity primarily from the skin instead of an interior framework. It boasts a relatively flat second bottom attached to serve as a planing surface with a peculiar downward turn at the chine. This hull form was developed by British designer S.E. Saunders and was well received in the sports racing fraternity. By using laminated layers of thin, flexible planking as opposed to a single or double layer, it was possible to achieve more radical hull shapes in a technique known as cold-molding. The inward curvature of the hull as it rises and becomes the deck is called tumblehome and has long been a common feature in European small craft design. It has little place in a warship since it significantly reduces deck space available for weapons and equipment, while doing nothing to deflect spray. (Harald Fock, *Fast Fighting Boats*, 29)

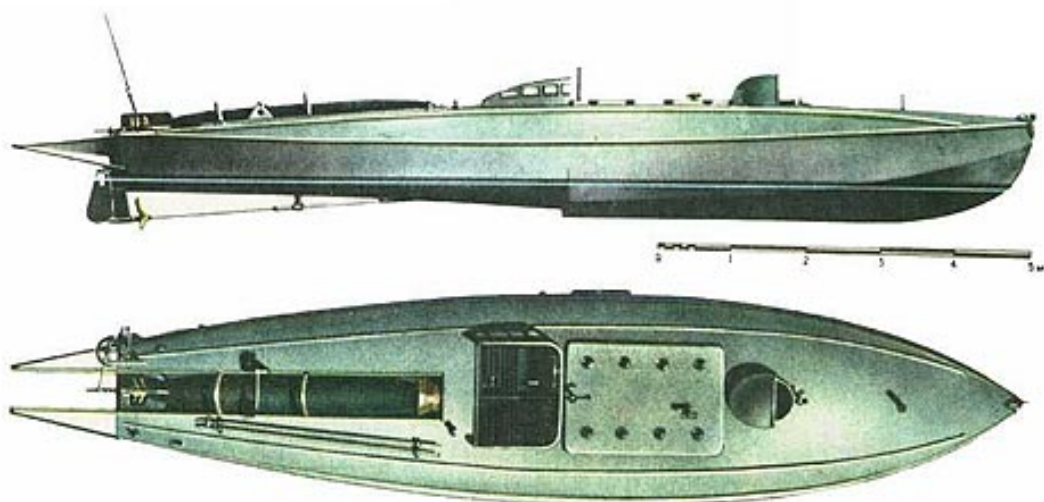


Figure 12. 40' Coastal motor boat. Note the stepped bottom and stern-launched torpedo. Extensions protruding aft are guides and supports to prevent the warhead from hitting the transom as it was rammed aft. ([commi.narod.ru/bmc/ka1.htm](http://commi.narod.ru/bmc/ka1.htm))

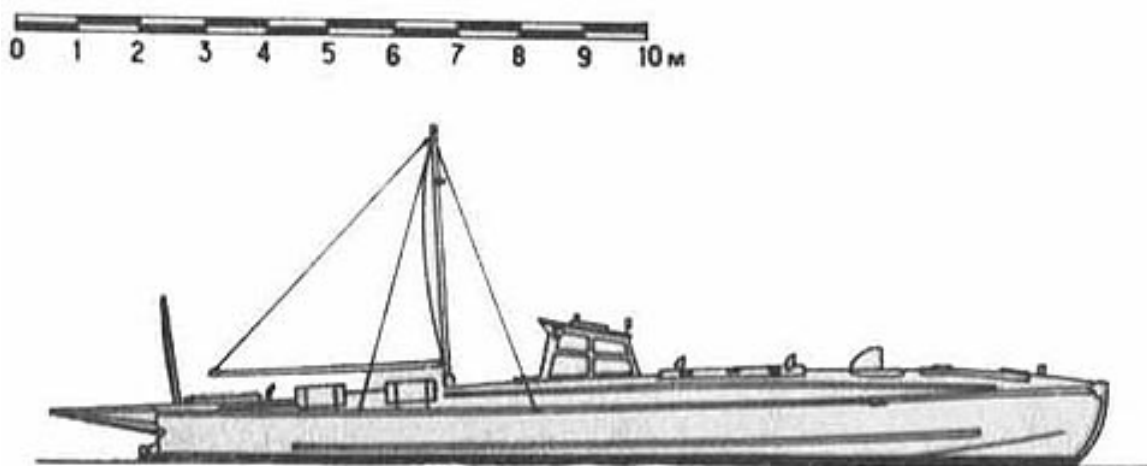


Figure 13. 55' Coastal motor boat. These MTBs carried two torpedoes in parallel racks or a combination of torpedoes and depth charges. The stepped hulls were an adaptation supposedly inspired by the racing hydroplane *Miranda IV*, designed by Thornycroft Company in 1910. Though quick to rise onto plane, and fast over a measured mile, stepped hulls give poor performance at low speeds, have mediocre rough water capabilities, and can be difficult to maneuver. When the world's navies went looking for offshore torpedo boats in the 1930s, stepped hulls were replaced by V-bottoms with hard chines ([commi.narod.ru.uk/bmc/b/55cmb.jpg](http://commi.narod.ru.uk/bmc/b/55cmb.jpg))

In 1917, a 55-foot prototype was launched that featured two stern launched torpedoes, two machine guns, and two depth charges, the latter the result of the U-boat campaign. Some examples carried a reduced armament of only one or no torpedoes, but substituted a larger number of depth charges. Increased engine output and speed was the most notable feature of the 55s, which regularly reached forty knots on their two Thornycroft 375 horsepower gas engines, a phenomenal speed for so large and heavily laden a craft with these engines. Being more lethal, faster, and more seaworthy than their 40-foot predecessors, the 55s came to dominate the CMB campaign on the Belgian coast.<sup>68</sup>

While British CMBs scored few victories during the war, the Italian Navy used a radically different type of boat and tactics to achieve spectacular results against the Austrians. At least one historian credits them with reversing the course of the naval war in the Adriatic. In the first half of the campaign, the Austrian Navy had sailed roughshod over its larger Italian counterpart and Italian ships seldom dared enter the northern regions of the Adriatic. This prevented them from aiding the hard-pressed Italian Army and left the Austrians free to bombard coastal targets almost at will. From May 1915 through December 1916, Italy warship losses amounted to 70,100 tons while their opponents to the north lost a mere 2,900 tons. From January 1917 to the end of the war the Italians lost 8,100 tons while the forces of the dual monarchy suffered losses of 47,800 tons. The newly deployed Italian torpedo boats accounted for this reversal of fortune, accounting for 90 percent of the damage inflicted on the Austrians in this period.<sup>69</sup>

Where the CMBs stressed speed even when it disclosed their presence, the Italian MAS (motobarca armata silurante) boats relied upon low profile vessels, making silent advances under cover of darkness or inclement weather. A number of models measured from approximately forty-five to seventy feet overall, and sported stepless, shallow V-hulls, propelled at twenty to twenty-five knots with very little superstructure protruding above the deck. Almost all had twin engines and a single balanced rudder and on many

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<sup>68</sup> Gordon Adamson, "Motor Torpedo Boats", 979, 982. Harald Fock, *Fast Fighting Boats*, 29-30; Curtis Nelson, *Hunters in the Shallows*, 56-57.

<sup>69</sup> A. E. Sokol, "Italian Attempts at Harbor Forcing During the Last War," 37-38.

the deck was raised or humped to give adequate room in the engine and storage areas. Most muffled their engines by using underwater exhausts. Some had twin electric motors installed. When within a few miles of the target, the gas engines were turned off and the electric motors were utilized to permit near silent running. Using these circumstances, the Italians quickly determined stern launching was unsatisfactory for their tactics and adopted a side launching technique with a rack that was slid sideways until the torpedo was suspended over the water and then dropped.<sup>70</sup>

MAS boats had generally mediocre sea keeping ability but were adequate for the confined waters of the Adriatic where they operated. Because of the protected nature of the area of operations, with a lengthy coastline and a narrow sea dotted with numerous islands, and the limited distance between their bases and those of their enemy, torpedo boats played a larger role here than anywhere else in the war. The Italians built and used more such craft than any other belligerent and probably produced more of them than all the other naval powers combined.<sup>71</sup>

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<sup>70</sup> Gordon Adamson, "Motor Torpedo Boats", 982-983.; A. C. Davidonis, "Harbor Forcing Operations", 89; Harald Fock, *Fast Fighting Boats*, 30, 32-47; Curtis Nelson, *Hunters in the Shallows*, 56-57; Theodore Ropp, "The Modern Italian Navy, Part I," 42-43; Theodore Ropp, "The Modern Italian Navy, Part II," *Military Affairs* 5(2) (Summer 1941), 104, 106, 110; A.E. Sokol, "Italian Attempts at Harbor Forcing During the Last War." *U.S. Naval Institute Proceedings* (January 1942), 36. Fock states that most CMBs did not use silencers in an effort to "mislead their opponents, and simulate aeroplanes." Fock provides an excellent review of the MAS program, details of the boats, and their operations. It appears to be the best available English source on the topic, but Fock acknowledges that he leaned heavily on an Italian source cited only as Ufficio Storico della Marine Militare, *I MAS e le Motosiluranti Italiane*, 1967. There were two general classifications of MAS boats – silurante, or torpedo boats, and cannonieri, which were gunboats and anti-submarine warfare craft. Others were specially modified to be minelayers or convoy escorts. Therefore, while Fock writes that Italy fielded 359 MAS in World War I only a very small proportion were torpedo boats.

<sup>71</sup> Frank Johnson, *United States PT-Boats*, 11; A. E. Sokol, "Italian Attempts at Harbor Forcing During the Last War," 37. Sokol claims that "At the end of the war Italy had about 400 of these handy craft..."

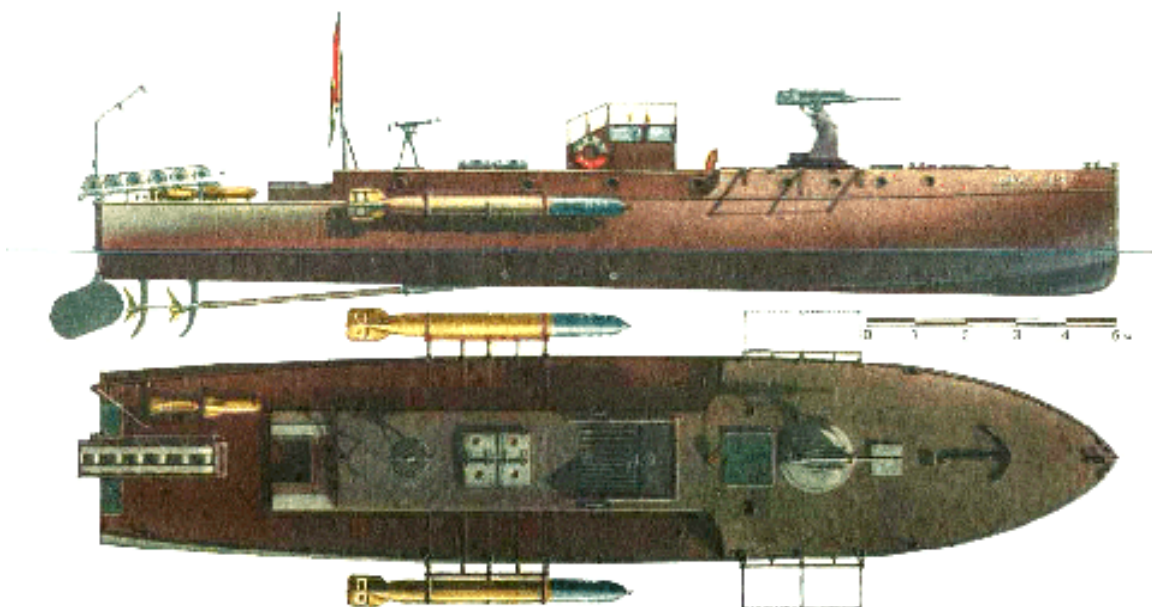


Figure 14. Italian MAS. Armament was two side-dropping torpedoes, automatic weapons, and depth charges. These low-profile, low-budget craft scored the biggest torpedo boat victories in history.(commi.narod.ru/bmc/i/mas397.gif)

In World War I, motor torpedo boats numbered only a few hundred while in World War II there were thousands of them involved in countless battles and skirmishes. Yet, ironically, CMBs and MAS boats won the greatest victories ever achieved by motor torpedo boats anywhere in 1918 and 1919. Capitano di Corvetta (Commander) Luigi Rizzo used two small MAS boats, 9 and 11, to attack the Austrian battleships *Wien* and *Budapest* on the night of 9-10 December 1917. The Italians were towed to within easy range of Trieste and released. They then used hydraulic shears to cut through boom defenses, closed on the enemy using electric motors alone and put two torpedoes into *Wien*, which sank in minutes. Both boats withdrew at slow speed and unobserved. Other attacks followed, but the most notable was on 10 June 1918 when Rizzo used the same covert tactics to engage the Austrian dreadnought *Szent Istvan* and sister ship *Tegethoff*. His companion boat missed its target but Rizzo's *MAS 15* hit and sank *Szent Istvan*. Both

MAS then managed to outrun pursuing destroyers, certainly an indictment of Austrian sea power.<sup>72</sup>

Rizzo could arguably be called the most successful naval officer in history. He used a torpedo boat displacing 12 tons to sink battleships with a combined displacement of over 30,000 tons. Like most MTB skippers in all wars and regardless of nationality, he was a reservist, a merchant marine officer by trade, and was sent to the boats because the regular line officers shunned them.<sup>73</sup>

British CMBs laid mines, performed reconnaissance missions, and made raids along the occupied Belgian coast throughout 1917 and 1918. Yet, their most notable performance came after the war, when Allied contingents were lending aid to the Whites in the Russian civil war. In August 1919, British depot ship *Vindictive* transported seven CMBs into the Gulf of Finland where they attacked and torpedoed two Russian (Red) battleships and sank a depot ship at the cost of four CMBs sunk by gunfire.”<sup>74</sup>

Italy and Great Britain were the only belligerents to develop and deploy torpedo boats on a large scale and with any telling effect. Austria-Hungary, Germany, and Russia had

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<sup>72</sup> Robert Bulkley, *At Close Quarters*, 40; Davidonis, “Harbor Forcing Operations”, 88-91; Harald Fock, *Fast Fighting Boats*, 48. Paul G. Halpern, *A Naval History of World War I*, (Annapolis: Naval Institute Press, 1994), 170, 174-175; Frank Johnson, *United States PT-Boats*, 11; A. E. Sokol, “Italian Attempts at Harbor Forcing,” 38-41. Sokol states that fourteen “harbor forcing” attempts were made and only two of these were successful. Davidonis claims they made seventeen attempts, “nine...against Pola, five against Durazzo”, two at Trieste and one at Buccari. Davidonis provides a highly informative overview of Italian MAS operations and leans heavily upon *The Italian Navy in the World War, 1915-1918*, (Rome, Office of the Chief of Staff of the Royal Italian Navy, 1927). The sinking of *Szent Istvan* was caught on film and can be found online at a number of sites.

<sup>73</sup> Details of Italian MAS boats and *Szent Istvan* are found in *Jane's Fighting Ships of World War I*, London: Jane's Publishing Company, 1919.

<sup>74</sup> Gordon Adamson, “Motor Torpedo Boats,” 979, Adamson claims that the CMBs sank or disabled “two capital ships, a cruiser, two destroyers, and other craft, at a loss of only two boats. Robert Bulkley, *At Close Quarters*, 40; Harald Fock, *Fast Fighting Boats*, 31; Paul Halpern, *A Naval History of World War I*, 443-444.

MTB programs as well, but they had little impact on the war. Austria and Russia were restrained in naval projects by limited industrial capacity. Germany had difficulty divorcing itself from round-bilged hulls in spite of their limitations on speed because North Sea conditions demanded a more seaworthy design than the stepped hulls of the Royal Navy or low freeboard Italian types used in the Mediterranean.<sup>75</sup>

Though the efforts of these three powers, together with those of Italy and Britain, would have little impact upon the future of American motor torpedo boat design their successes would have an impact on later U.S. Navy operations. A cursory study of their hulls shows very little resemblance to the PTs of World War II. But the experience of the CMBs and MAS demonstrated to Americans the potential of small boats in a given context. Though not especially useful on the high seas, MTBs were cheap and lethal when used in restricted or coastal waters and could free larger, more expensive ships for other duties. Furthermore, the Mahanian image of massive battleships contesting the sea lanes that had dominated naval thinking for a generation had not come to pass. The naval war had been characterized by the incredible cost and impotence of the capital ships, by the rising importance of submarines and aircraft, and by the movement of surface conflict from the distant seas to the littoral. Many decision makers would remember and profit by this lesson as crisis loomed two decades later. The PTs of World War II might not owe their design lineage to the CMBs and MAS boats but their creation was somewhat inspired by the victories of their First World War ancestors.<sup>76</sup>

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<sup>75</sup>Harald Fock, *Fast Fighting Boats*, 49-59; A. E. Sokol, "Italian Attempts at Harbor Forcing." 37.

<sup>76</sup>Harald Fock, *Fast Fighting Boats*, 49-59.



## CHAPTER 6

### BEWEEN THE WARS: Retrenchment and Resurrection

The boats of World War I, like those a generation afterwards, were made of wood and had short useable lives. Within a few years after the Armistice, most had been broken up or sold. Several CMBs found new employment slaking the thirst of Prohibition bound Americans. Thornycroft sold a 40' and one 55' CMB to the United States following the war and these were used "sporadically" for trials for a few years before being struck off the active list. Following the Washington Conference on the Limitation of Armaments and in an era when otherwise intelligent men thought they could actually outlaw war, most of the other former belligerents discontinued their develop as well. Only Italy and Germany continued to develop and produce high-speed attack craft.<sup>77</sup>

Fortunately for the former and future Allies, domestic interest in high speed, seaworthy boats remained strong for other reasons. The economics of Prohibition sustained and rewarded private firms that could furnish fast boats capable of carrying heavy loads in a variety of conditions, much like the fallacious drug war of the late 20<sup>th</sup> century. The Royal Air Force and the U.S. Navy were always looking for air-sea rescue boats capable of reaching downed fliers quickly and so both services remained receptive

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<sup>77</sup> Gordon Adamson, "Motor Torpedo Boats," 984-987; Robert Bulkley, *At Close Quarters*, 41; Harald Fock, *Fast Fighting Boats*, 79-80; Frank Johnson, *United States PT-Boats*, 14; Curtis Nelson, *Hunters in the Shallows*, 63, 64. Fock says the Navy bought a 45' and a 55' version. Nelson says they were 40 feet and 55 feet and he cites "Motor Torpedo Boats," dated 14 April 1937, General Board Files, 420-14, 4<sup>th</sup> Endorsement, G.B. Serial No. 1740, p.2, para. 5. Adamson gives a brief synopsis of international MTB development between the wars. Fock's book has been translated from the original German text and though it is the authoritative text on overseas MTB history errors of this nature are not uncommon. Regarding development programs in the 1920s, Adamson writes that only France and Italy continued to work on planing boats, Nelson says that only Italy and Germany continued trials, while Fock notes that Germany, Italy, and the Soviet Union continued their work. One spectacular result was the German E-boat of the Second World War. The Soviets seemed to enjoy little success as they came to lean heavily upon PTs made in the U.S.A. though Adamson reported that they had "around 130 M.T.B.'s" in December, 1939.

to the type of vessel that could easily serve as a prototype for an MTB. The private sector in both Great Britain and the United States provided these craft and continued to build faster boats and more powerful engines for the recreational boating industry. These manufacturers steadily moved away from the stepped hull format because of its limited offshore capabilities, and by the early 1930s had adopted the v-bottom hull with hard chine that continues to dominate the powerboat market seventy years later. The Hickman Sea Sled would reappear, make some inroads in the pleasure craft market, but in 1936 it would lose decisively in sea trials against hard chine boats. This type initially found some support among naval officers but in sea trials that year it showed a tendency to “slew” off course when encountering quartering seas at speed, to yaw badly, and to experience varying degrees of difficulty in maneuvering.<sup>78</sup>

Many of the boats of the interwar era were powered by converted aircraft engines that stressed high power and low weight – important factors in small craft construction. Racing enthusiasts in Britain and the United States not only refined the stepless, V-bottom hull; they also were in the forefront of engine research and experimentation. Boat builder and racer Garfield Wood foresaw lightweight aircraft engines as being suited for high-speed boats as well. He modified World War I vintage Liberty aircraft engines, manufactured by Packard, to tweak more power out of consistently lighter engines while using less fuel. His work was to pay dividends when the Navy went hunting for a suitable PT power plant in 1940. Unfortunately, low demand resulting from the Depression, the

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<sup>78</sup> Gordon Adamson, “Motor Torpedo Boats,” 984; Robert Bulkley, *At Close Quarters*, 41; Harald Fock, *Fast Fighting Boats*, 80-81; Norman Friedman, *U.S. Small Combatants*, 106-107; Curtis Nelson, *Hunters in the Shallows*, 64-65. The sea sled had an unusual hull that was similar to a catamaran forward with a “W” cross section that merged to a flat bottom aft of amidships. In an overhead view it was rectangular and offered considerable deck space – a characteristic of today’s catamarans. But like its modern sisters, the two hulls forward placed tremendous strain on the deck where they joined, the boat had a tendency to pound, and to yaw in a following sea, and was not very responsive to the rudder. The weak deck was a defect that could only be remedied with addition of considerable weight slowing the boat even further. Versions of this design reappeared in the late 1950s and early 1960s as fiberglass boats, with their ability to assume any form, started to enter the marketplace. The first Boston Whalers were of this type and they pounded so badly they were soon abandoned for the cathedral hull that is still produced today.

end of Prohibition, and the weak military market discouraged most industrialists from making the investment of time and capital to improve their products and construct facilities for manufacturing them. The search for a suitable power plant would become critical in the late 1930s as the western democracies started to prepare for war.<sup>79</sup>

The wake up call for rearmament was fast approaching. Despite naval armaments limitations treaties and the hopeful but naïve attempt to outlaw war, events in Europe and Asia were alerting some thoughtful individuals to the dangers of fascist aggression. In 1931, the Japanese Army invaded Manchuria. This was done without even consulting the civilian government. Two years later, Adolph Hitler was elected Chancellor of Germany and began the slow but steady expansion of German military power and territorial expansion. Benito Mussolini embarked upon the road of colonist violence when he invaded Ethiopia in 1935. A year later he and his new German ally were actively involved in supporting the fascist general Francisco Franco in his rebellion to topple the democratic government of Spain. Japanese forces occupied Inner Mongolia and northern China in 1937, continued their conquests to the south and in the process, attacked and sank the gunboat USS *Panay*. Militant fascism was prominent and triumphant on every continent. A few lonely voices in the west warned of the rising danger. Initially ignored by those in power, events continued to support their arguments and reluctantly, begrudgingly, efforts began to plan for the coming crisis. It would prove to be a drama in which every type of vessel would have a significant role. The era of the motor torpedo boat was about to dawn.<sup>80</sup>

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<sup>79</sup> Gordon Adamson, "Motor Torpedo Boats," 983; Frank Johnson, *United States PT-Boats*, 15-17.

Adamson includes an excellent table comparing horsepower, weight, and weight per horsepower of engines available for MTBs in 1940. The three most powerful engines listed, the British Rolls-Royce Merlin, Italy's Isotta-Fraschini, and the American Packard 2500 were all converted aircraft engines. Johnson gives a good review of civilian racing activities before and after World War I and their relevance to U.S. and British MTB development.

<sup>80</sup> A.J.P. Taylor, ed., *The Illustrated History of the World Wars*, (New York: Galahad Books, 1978), 233, 278, 319-320; Hugh Thomas, *The Spanish Civil War*, (New York: Simon and Schuster, 1961), 129-130. and numerous other points throughout the text.

Well into the mid 1930s, the United States continued to observe the endeavors of European powers with building fast attack craft but took no action to produce its own. In 1935, British Power Boat Company under the leadership of the prophetic racing enthusiast Hubert Scott-Paine developed a 60-foot hard-chined hull and offered it to the British Navy. Spurred by Italy's Abyssinian adventure and Axis interest in high speed boats, the Admiralty ordered six of these boats, each equipped with two stern launched torpedoes. They undertook a voyage to Malta and back, and while the armament proved less than satisfactory the boats themselves did well. Reacting to the success of its competitor, British concern Vosper produced and sold a 68-foot model later purchased by Britain and designated MTB 102. Like Scott-Paine's boats, the Vosper was double-planked mahogany but it utilized Italian Isotta-Fraschini engines because they had a better power to weight ratio than those available from domestic manufacturers.<sup>81</sup>

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<sup>81</sup> Gordon Adamson, "Motor Torpedo Boats," 983, presents an excellent table comparing engine weight s and horsepower. Robert Bulkley, *At Close Quarters*, 42; Harald Fock, *Fast Fighting Boats*, 65-71; Bob Ferrell and Al Ross, *Early Elco PT Boats*, (Memphis: PT Boat Museum and Library, 1980), 1; Curtis Nelson, *Hunters in the Shallows*, 94-95. Hubert Scott-Paine(1891-1954) was one of the most remarkable men of the age. He started designing land aircraft in 1910, was concentrating on seaplanes by 1914, helped start Imperial Airways in 1924, and founded the British Power Boat Company in 1927, largely to counteract the intrusion American boat manufacturers into the British market. He designed, built, and successfully raced powerboats, winning the world water speed record in 1933. He went on to supply high speed rescue craft for the Royal Air Force, modernize British MTB design, and to become, arguably, the father of the American PT boat.

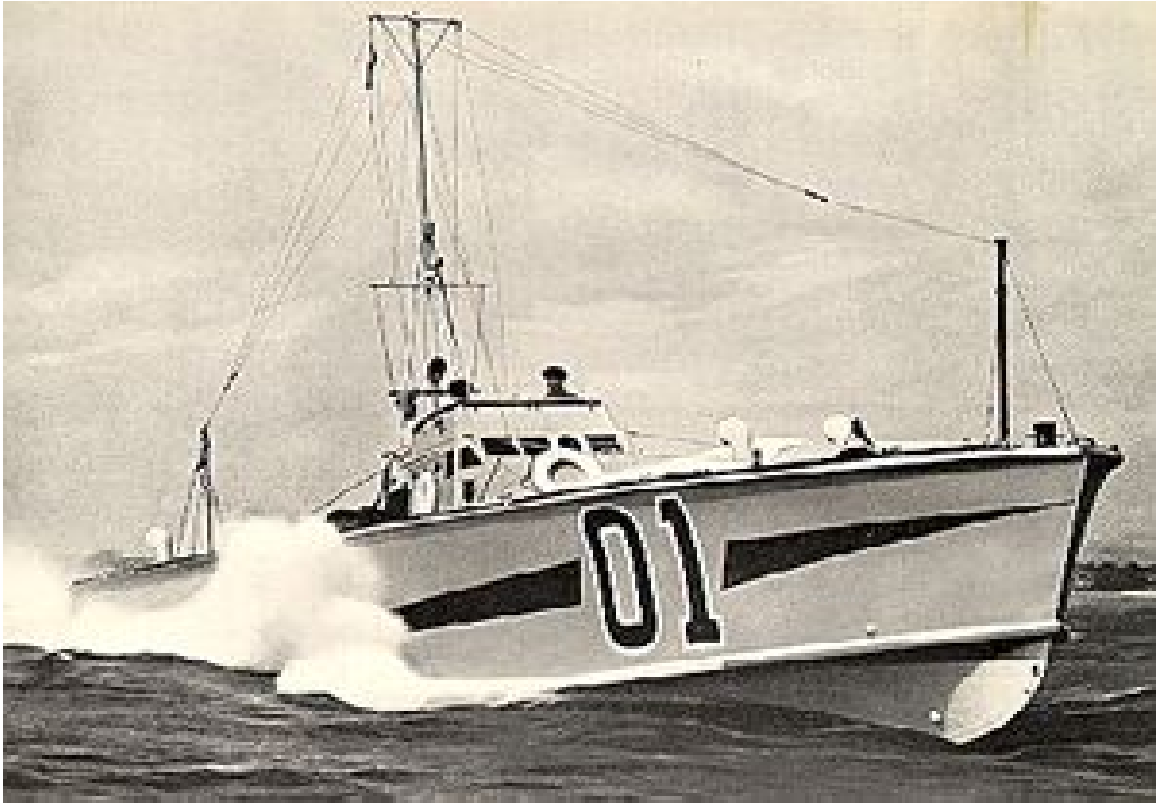


Figure 15. MTB 01. British racing champion and industrialist Hubert Scott-Paine entered the military market with this 60' motor torpedo boat in 1935. Several later saw service in the Far East. It was the predecessor of his 70' model and of all the Elco PTs of World War II. Scott-Paine worked with and incorporated ideas from an amateur designer and high-speed boat driver named T. E. Shaw, better known to history as T. E. Lawrence, of Arabia ([www.ya;umba.co.uk/](http://www.ya;umba.co.uk/))

Changes in geo-politics caused some Americans familiar with British experiments to reconsider the Navy's stance on the need for torpedo boats. Perhaps prodded by the well-publicized success of the new British MTBs and the German *schnellboots*, American interest in torpedo boats was growing. On 19 June 1936 Acting Chief of Naval Operations (CNO) Captain William S. Pye instructed the Bureau of Construction and Repair (C & R) to consider requirements for a CMB for local defense of the U.S. coastline and of island installations in the Pacific. C & R made a preliminary study based upon Pye's guidelines but concluded that the speed demanded could be met only through the use of a flimsy hull unable to withstand routine weather conditions. Then in December, Rear Admiral Emory S. Land, chief of C & R wrote to Pye proposing that a moderate experimental program be established to test private and bureau designed boats.

Observing the pace of naval construction in Europe, in December 1937 he wrote to the Chief of Naval Operations (CNO) suggesting that:

Developments since the War of the motor-torpedo-boat type...have been continuous and marked in most European navies...The results being obtained are such as to indicate that vessels of considerable military effectiveness for the defense of local areas, are being built...It appears very probable...that the type might very well be used to release for offensive service ships otherwise unavoidably assigned to guard important geographic points...If the department concurs, this Bureau suggest the inauguration of an experimental development program of such boats and will endeavor to have included in its appropriations for experimental work, funds for the construction of two such boats each year...<sup>82</sup>

The Bureau of Engineering (BuEng) endorsed the letter with the comment that the power requirements for such craft were already under consideration by its staff. On 5 January 1937 Pye, acting for the new CNO Admiral William D. Leahy, recommended to Secretary of the Navy Claude A. Swanson that the matter be referred to the General Board of the Navy for its consideration. About this same time, support for MTBs arose from a powerful, but unexpected quarter.<sup>83</sup>

In October 1935, General Douglas MacArthur ended his term as U.S. Army Chief of Staff and agreed to become senior military advisor to the government of the Philippines. The Tydings-McDuffie Act of 1934 had authorized complete independence for the commonwealth in 1946 but until that time the U.S. military sought to retain a presence there as a hedge against Japanese aggression. MacArthur was charged with command of U.S. Army and Air Corps assets in the islands as well as the creation and training of an

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<sup>82</sup> Harald Fock, *Fast Fighting Boats*, 80; Norman Friedman, *U.S. Small Combatants*, 109-110; Curtis Nelson, *Hunters in the Shallows*, 71-72. Rear Admiral Land's memo to the Chief of Naval Operations is reproduced in Appendix A.

<sup>83</sup> Robert Bulkley, *At Close Quarters*, 43; Norman Friedman, *U.S. Small Combatants*, 109-110; Frank Johnson, *United States PT-Boats*, 19; Curtis Nelson, *Hunters in the Shallows*, 70-72.

indigenous defense organization. As an island nation with thousands of miles of coastline, coastal defense was a primary concern. Knowing that the Philippines could ill afford a large navy, and rationalizing that a purely defensive force need not project its power beyond its own territory he quickly fastened upon MTBs. They were shoal draft for interisland operations, packed a ship-killing punch in their torpedoes, and could act as a maritime constabulary in peacetime.<sup>84</sup>

MacArthur called upon his naval aid, Sidney Huff, to evaluate the craft available in Europe and report back. Dissatisfied with what he found, Huff made inquiries with the Navy Department and, in a meeting with representatives from Bureau of Engineering (BuEng) and Bureau of Ordnance (BuOrd), submitted a plan he had drawn for a boat with three engines and stern-launched torpedoes. Although nothing came of Huff's design, the Secretary of the Navy subsequently directed C& R to prepare a design for MacArthur. He showed little interest in their aluminum hard-chine submission and eventually contracted with Thornycroft for 65' and 55' patrol craft. Only three of these had been delivered before the Japanese attacked on 8 December 1941.<sup>85</sup>

The impact of MacArthur's interest is open to speculation, as he was no favorite in naval circles, but when the General Board replied to Swanson in April 1937 it was clear that the official view of the usefulness of motor torpedo boats had changed radically. Plan Orange, the Navy's strategy for fighting a war against Japan, called for a push across the Pacific, supposedly to relieve the Philippines and Guam though many had already written them off as being indefensible and almost certain to be lost. It provided for establishment of island bases in the western Pacific regions as the fleet fought its way west and increasingly envisioned operations against the enemy at close quarters. As U.S. forces came to grips with the Japanese "enemy fleets would come closer together and...motor torpedo boats could replace larger craft which would otherwise have to be deployed in defensive missions." Then, with prophetic vision the Board also hit upon the mission that

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<sup>84</sup> Norman Friedman, *U.S. Small Combatants*, 110-113; Frank Johnson, *United States PT-Boats*, 19-20; Curtis Nelson, *Hunters in the Shallows*, 72-75.

<sup>85</sup> Norman Friedman, *U.S. Small Combatants*, 113.

would dominate PT employment in the Pacific; “Moreover, future situations can occur under which it would be possible for such small craft to be used on directly offensive missions...” The General Board then called for “an experimental design program” to develop two types of boats, a small vessel not to exceed twenty tons and capable of being hoisted aboard fleet auxiliaries and another of approximately 80’ for offshore patrols.<sup>86</sup>

The Naval Appropriations Bill of 1938 was passed in August of 1937 without provision for an MTB program. Then, in September, the Japanese made it clear they would no longer be restrained by previous naval limitations agreements. They had just struck at the Soviets along the Korean border and no one could deny the militant threat of Japanese fascism. Cognizant of the danger to U.S. interests, President Franklin Roosevelt submitted a supplemental bill asking for a 20% increase in naval tonnage and including \$15,000,000 for “experimental vessels.” This was later reduced to \$3,000,000 but when it was approved in May 1938, the seed money to create an American MTB was at last in place.<sup>87</sup>

On 11 July 1938, the Navy announced a design contest to produce plans for the boats envisioned by the General Board’s report of 14 April 1937. Strangely, it was open only to firms that held no government contracts thus excluding many experienced builders and naval architects, including the Elco Boat Company of Bayonne, New Jersey. The motivation seems to have been to spread government largesse in a nation still wracked by depression. The Navy called for submissions for several types of vessels; a 165’ steel subchaser, a 110’ wood subchaser, and two MTBs of approximately 70’ and 54’. The specifications of the General Board were to guide the entries but beyond that they could

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<sup>86</sup> Robert Bulkley, *At Close Quarters*, 43; Harald Fock, *Fast Fighting Boats*, 80-81; Curtis Nelson, *Hunters in the Shallows*, 75-77. Nelson includes paragraphs 8-14 of a 14 paragraph report drawn from letter from Chairman of the General Board to Secretary of the Navy, dated 14 April 1937, on “Motor Torpedo Boats,” General Board Files, 420-14, 4<sup>th</sup> Endorsement, G.B. Serial No. 1740, 18 April 1937, reproduced herein as Appendix B.

<sup>87</sup> Gordon Adamson, “Motor Torpedo Boats”, 987; Robert Bulkley, *At Close Quarters*, 43; Frank Johnson, *United States PT-Boats*, 21; Curtis Nelson, *Hunters in the Shallows*, 87-88; Peters, “The PT Boat”, 3; Peters, “The Motor Torpedo Boat”, 943. Peters writes that the appropriation was \$5 million for “an experimental patrol craft program” and that the boats were to be approximately 59 feet and 80 feet long.



exercise great flexibility. The larger MTB was to be 70' to 80' in length, reach 40 knots, and carry at least two .50 caliber machine guns, two 21" torpedoes, and four depth charges. It could be made of any material, be round or V-bottomed, and be propelled by gasoline or diesel engines. The smaller boat could be no more than 60', weigh not more than 20 tons, and have sufficient structural integrity to withstand repeated hoisting in a sling under moderate weather conditions.<sup>88</sup>

The length parameters were somewhat arbitrary but based upon perceived tactical and logistical requirements. The larger boats were to be deployed overseas but the distances involved mandated they be carried as deck freight rather than make the voyages on their own bottoms. 80 feet was considered the maximum practical length for such a move. The smaller boats needed to be light and compact enough to be launched from a ship at sea, hence their smaller size and armament. In World War II, PTs would make a number of long passages to in-theater redeployments in the Mediterranean and Pacific with refueling underway. Yet, they would all be transported to the theater of operations initially as deck cargo.

Twenty-four designs were submitted for the smaller boat and thirteen for the larger one. Only three entries for the smaller boat made it past the preliminaries, while five for the larger boat passed onto the finals. The results were made known on 21 March 1939. Professor George Crouch, a well-known designer of small high-speed civilian craft, won in the smaller class and Sparkman and Stephens, an internationally renowned builder of racing yachts, took top place in the 70-foot category. Crouch was one of the most famous small boat designers of the day and noted for his fast, planing runabouts. Whatever his other attributes and achievements, he showed little innovation with this model. It measured 59-feet overall, the lines were strongly reminiscent of the CMBs of World War I and showed no original thinking. Sparkman and Stephens victory was another big mystery. This firm had long been a widely known and respected designer of racing and cruising sailing yachts and had drawn the lines for more than one America's Cup

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<sup>88</sup> Gordon Adamson, "Motor Torpedo Boats", 987; Robert Bulkley, *At Close Quarters*, 44; Norman Friedman, *U.S. Small Combatants*, 118; Curtis Nelson, *Hunters in the Shallows*, 91; Peters, "The PT Boat", 3.

defender. They had never been substantial powerboat architects and it is strange that they emerged victorious. Both prototypes had stern launched torpedoes that the Navy soon found unsatisfactory prompting the question of how they won the contest. Both designs were extremely conservative and traced their lineage to World War I. It was as though the contest winners and the judges were blind to two decades of progress in engine and small craft design.<sup>89</sup>

Documents in the National Archives may shed some light upon why these firms won. Officers from Bureau of Construction and Repair had been in contact with both Crouch and Sparkman and Stephens well before the contest was held. Crouch had been retained to perform services of an unknown nature and was already on the navy payroll. It is quite possible that he was involved in drawing the parameters for the competition and at any rate was certainly well known within the Bureau. Was the contest rigged? Evidence uncovered so far is inconclusive but shows that the possibility exists.

Contracts to build trial products of the winners were signed in May 1939 with three different civilian yards and one government facility. By this time the Navy had adopted the type designator “PT” and the first contract was awarded to Fogal Boat Yard, later Miami Shipbuilding of Miami, Florida to build PT 1 and PT 2 to Crouch’s specifications. Fisher Boat Works of Detroit built PT 3 and PT 4, also Crouch boats. Higgins Industries of New Orleans, soon to become the major figure in the construction of landing craft as

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<sup>89</sup> Gordon Adamson, “Motor Torpedo Boats”, 987; Robert Bulkley, *At Close Quarters*, 44; Harald Fock, *Fast Fighting Boats*, 81; Norman Friedman, *U. S. Small Combatants*, 118-119; Frank Johnson, *United States PT-Boats*, 21-22; Curtis Nelson, *Hunters in the Shallows*, 91-92; Peters, “The Motor Torpedo Boat”, 943. George Crouch is always referred to as “Professor” although none of the sources consulted for this article say anything about his academic credentials. Nelson says he was associated with “Tams, Inc. a New York designer of racing motorboats.” Adamson, Bulkley, and Friedman write that “The 54-foot winner was Professor George Crouch of Henry B. Nevins” of New York. Fock says he was employed by Hewey B. Nevins, Inc. In fact, Crouch was one of the foremost powerboat designers of the era, produced numerous successful hydroplane designs, served as Vice President of Dodge Boat Works, and helped put that firm on the road to financial success. The company eventually became Chrysler Marine, producer of small boats and outboard motors from the 1950s –1970s. Considerable confusion arises in discussing the smaller boats because they are variously referred to as “second class”, “54-foot”, “58-foot”, “59-foot”, and “under 60” class. The Navy called for a boat under 60 feet in length and Couch’s boats measured just under 59 feet overall. Friedman gives specifications on p. 121.

well as PT boats, was chosen to manufacture PT 5 and PT 6 to Sparkman and Stephens 70-foot entry, now stretched to 81 feet on orders from the Bureau of Construction and Repair. The Philadelphia Navy Yard would undertake production of PT 7 and PT 8 based on in-house Navy designs.<sup>90</sup>

Every one of these boats proved a failure. Since a Navy board selected the winners, several questions arise. How much did the board members know about small boat performance and design parameters? Did the board members have any small boat experience? Most naval officers have very little time in small craft. Were they aware of the hydrodynamic forces at work in a hard-chined vessel driving head on in to steep seas at forty knots? If stern launched torpedoes were so unsuitable, and the Navy soon said as much, why were these designs selected at all? Perhaps, they chose the best of a poor lot, but then again, maybe they chose Crouch and Sparkman and Stephens to suit their own rather conservative, uninformed thinking. Without examining each of the plans submitted, this must remain an intriguing but unanswered question. Whatever the reasoning for the Board's actions, most of the experimental craft would take far longer than projected before being delivered to the Navy and none of them would be found suitable for service as intended.

PT 1 and 2 sat in Miami for a year and a half before receiving their Vimalert 1,200 engines and were not delivered until December 1941. They would eventually be accepted and "downgraded" to small boats. PT 3 and 4, with their 4M2500 Packard engines, were activated in late June 1940 and included in the experimental Squadron 1 the following month. PT 5, built at Higgins New Orleans plant, was also delayed for lack of Vimalert

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<sup>90</sup> Gordon Adamson, "Motor Torpedo Boats", 987; Robert Bulkley, *At Close Quarters*, 44; Harald Fock, *Fast Fighting Boats*, 81-82; Norman Friedman, *U.S. Small Combatants*, 118-119; Frank Johnson, *United States PT-Boats*, 21-22; Curtis Nelson, *Hunters in the Shallows*, 91-92, 102 ; Jerry E. Strahan, *Andrew Jackson Higgins and the Boats that Won World War II*, (Baton Rouge: Louisiana State University Press, 1994), 41-43. In July 1940, the Bureau of Construction and Repair merged with the Bureau of Engineering to form the Bureau of Ships, BuShips.

engines, but was eventually accepted for service, though found “lacking in performance.”<sup>91</sup>

PT 6 became a strange saga in itself. Andrew Jackson Higgins had not entered the design contest but actively sought a building contract. He experienced difficulty getting specifications and an invitation to bid from C & R with whom he had an ongoing feud over landing craft development and fabrication. He eventually bid well below cost for PT 5 and 6 just to get his foot in the door of the PT program. Higgins repeatedly protested to C & R that the boat, as drafted, was doomed to be a failure. He offered changes in form and materials but was told to mind his own business and adhere to the terms of the contract. When PT 6, powered by Packards, was tested in April 1940 it could not pass the Navy acceptance trials. The boat was then offered to the Finnish government that had recently ordered a Scott-Paine designed 81-foot boat from Higgins. At the cost of \$26,000, which the builder absorbed, PT 6 was rebuilt and purchased by the Finns. Changes in the political and military situation in Europe would delay and finally cancel

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<sup>91</sup> Robert Bulkley, *At Close Quarters*, 48; Harald Fock, *Fast Fighting Boats*, 83; Norman Friedman, *U.S. Small Combatants*, 118-119, 134; Frank Johnson, *United States PT-Boats*, 27; Curtis Nelson, *Hunters in the Shallows*, 114.; Peters, “The PT Boat”, 3; Jerry Strahan, *Andrew Jackson Higgins*, 54. Higgins later said the boat had been completed for 446 days before the engines were supplied.

The possibilities of MTBs were largely unknown in the United States Navy and there was much speculation upon how they should be built, armed, manned, and employed. For two fine contemporary, contemplative articles by naval professionals see a tactical evaluation in H.A.V. Von Pflugk, “Torpedo Boats”, *U.S. Naval Institute Proceedings*, (January 1942), 37-41 and the very thorough review by Gordon Adamson and Douglas Van Patten, “Motor Torpedo Boats: A Technical Study”, *U.S. Naval Institute Proceedings*, (July 1940), 976-996. Changes in the geopolitical situation following the fall of the Soviet Union have prompted a reevaluation of the value of large, costly ships versus small ones and there is much talk about putting more combat punch in a smaller, less expensive package. The old problems of design, construction, potential and tactics is explored in William D. O’Neil, “If It Can’t be Big, It Needs to be Novel”, *U.S. Naval Institute Proceedings* 129 (December 2003), 47-51.

the sale and Sparkman and Stephens' castoff would eventually end up transferred to Britain under Lend-Lease.<sup>92</sup>

Higgins then went to work creating a new PT 6 from the keel up. Designated PT 6 *Prime*, it measured 81 feet overall and was "the best of the American designed boats." It incorporated Higgins "ideas on strength, speed, and hull form" and featured a concave bottom aft that served almost like a tunnel to trap air and water. This reduced pounding by providing a cushioning effect and channeled the flow of water to the propeller for added efficiency and reduced cavitation. This second PT 6, powered by Packards, was accepted and served with Squadron 1 before being sent to the Newport Torpedo Station as a training vessel.<sup>93</sup>

PT 7 and 8 were conceived and constructed by the Navy. They measured 81-feet overall and like Crouch's invention they had much in common with the CMB of World War I. PT 7 had a wood hull while its sister ship was to be the only U.S. aluminum PT built only after World War II. Both boats used heavy-duty ship type fittings and weighed too much to attain satisfactory speed. They had two 21" torpedo tubes and looked much like an expanded CMB. PT 7, like most of the first boats, was incorporated into Squadron 1 but eventually went to the British under Lend-Lease along with PTs 3, 4, and 5. PT 8 was retained stateside, stayed tied to the dock for most of the war, and was later sold as

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<sup>92</sup> Robert Bulkley, *At Close Quarters*, 49; Even Bulkley got it wrong and writes that it was sold to Finland in 1941. Norman Friedman, *U.S. Small Combatants*, 119, 121; Jerry Strahan, *Andrew Jackson Higgins*, 42, 43, 44, 45, 54.

<sup>93</sup> Norman Friedman, *U.S. Small Combatants*, 121, 136; John A. Heitmann, "The Man Who Won the War: Andrew Jackson Higgins", *Louisiana History* 34(1) (1993), 40-41; Frank Johnson, *United States PT-Boats*, 32; Curtis Nelson, *Hunters in the Shallows*, 114; Jerry Strahan, *Andrew Jackson Higgins*, 43-44, 53-54. Even among scholars, there continues to be confusion about PT6, PT 6 *Prime*, and the eventual disposition of both. Friedman writes that PT 6 became British MGB 68 and he goes on to give high marks to PT 6 *Prime*. Johnson maintains that it was sold to Finland and confuses PT 6 *Prime* with another Higgins boat, a 76-foot craft of Higgins Industries own design built on speculation and later purchased by the Navy and designated PT 70, but nicknamed "dreamboat." Nelson has also deciphered the true tale but Strahan's account is the most complete as it details the flow of funds in this complex transaction.

surplus. There could be no question of the quality of its construction or materials as it is still in civilian service in Louisiana as of 2009.<sup>94</sup>

The construction and transfers of these trial craft would take place over a period of almost two years. In the meantime, Elco Boat Company, though not a participant in the design contest or a successful bidder for building the first boats, was to make a move that would put it in the forefront of the PT program. Henry R. Sutphen, Elco's executive vice-president, had noticed the Navy's interest in MTBs. Elco had made hundreds of small launches and patrol craft for the British in World War I and Sutphen recognized that whether the United States became an active belligerent or not, there was a lot of business at stake. As a holder of numerous government contracts, Elco was barred from submitting a design. The contracted boats would not be completed for some time and their performance and capabilities were unknown. What was needed was a proven prototype to present to the Navy as ready for mass production and immediate service. If Elco could approach the Navy with a tested and established MTB, they might be able to obtain substantial contracts. The need, the opportunity, and the boat appeared concurrently.<sup>95</sup>

Hubert Scott-Paine, designer and builder of the latest 60-foot British MTBs, completed a new 70-foot version on speculation in 1938. Powered by three Rolls-Royce Merlin engines, with four 18" torpedo tubes, and a great improvement generally over the 60s he confidently approached the Royal Navy about buying it. The boat was rejected in favor of a new Vosper design and the repercussions would dramatically alter the evolution of the American PT program. Suddenly, Scott-Paine had a need to look for new markets. Accounts vary, but according to one story, while Sutphen was in England that year he learned of Scott-Paine's boat, identified as PV-70, and upon his return

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<sup>94</sup> Robert Bulkley, *At Close Quarters*, 49, 51; Harald Fock, *Fast Fighting Boats*, 84; Norman Friedman, *U.S. Small Combatants*, 134; Frank Johnson, *United States PT-Boats*, 25; Curtis Nelson, *Hunters in the Shallows*, 114.

<sup>95</sup> Robert Bulkley, *At Close Quarters*, 45, 51; Harald Fock, *Fast Fighting Boats*, 79; Curtis Nelson, *Hunters in the Shallows*, 93-94. Elco had produced hundreds of boats for the British in World War I and the company was well respected there. This accounts for the warm welcome Sutphen received on his visits in 1938 and 1939.

approached Assistant Secretary of the Navy Charles Edison about buying it through Elco. Edison, who was de facto secretary in place of the terminally ill Swanson, received the endorsement of the General Board to obtain one or two such vessels “as a check on our own development.” Sutphen still had no guarantee that the Navy would accept PV-70 or any sister ships that might be produced but Edison promised that if the boat performed as promised he would approach Congress for funds for the purchase of additional units.<sup>96</sup>

With this unwritten agreement, Sutphen departed for England with his chief designer, Irwin Chase. They inspected offerings from Thornycroft and Vosper but found PV-70 far more to their liking. Its ability to handle rough weather won their approval and a deal was soon signed to acquire PV-70 and the right to manufacture others to the same design at Elco’s Bayonne factory. Elco and the Navy signed a purchase agreement on 1 June and

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<sup>96</sup> Gordon Adamson, “Motor Torpedo Boats,” 991; Robert Bulkley, *At Close Quarters*, 45; Ferrell, *Early Elco PT Boats*, 3, 6; Harald Fock, *Fast Fighting Boats*, 82-83; Norman Freidman, *U.S. Small Combatants*, 122; Frank Johnson, *United States PT-Boats*, 25-26; Curtis Nelson, *Hunters in the Shallows*, 95-96.; Jerry Strahan, *Andrew Jackson Higgins*, 83; John D. Venable, *Out of the Shadow: The Story of Charles Edison*, (East Orange, N.J.: Charles Edison Fund, 1978), 143. Johnson writes that Assistant Secretary of the Navy Charles Edison “cornered” Sutphen to discuss the prospect of Elco building PT boats. He maintains that Edison suggested to the General Board that a British MTB be acquired and the Board concurred stating, “Inasmuch as said design is known to be the result of several years’ development, the General Board considers it highly advisable that such craft be obtained as a check on our own development.” Johnson must sometimes be taken with caution, as when he says that Richmond Kelly Turner was killed in a night battle at Guadalcanal. Fock asserts that Edison approached Sutphen and cites Frank A. Tredinnick, Jr. and Harrison L. Bennett. “An Administrative History of PT’s in World War II.” U.S. Naval Administration in World War II Series, No. 171. Washington: Office of Naval History, 1946. Rare books collection, Navy Department Library. Naval Historical Center, Washington, D.C. Nelson writes that Sutphen contacted Edison after his trip in 1938. Then Edison made recommendations to the General Board and based on the reply, told Sutphen to go ahead with the purchase. Nelson’s account seems the more credible. He has made use of John Venable’s *Out of the Shadow: The Story of Charles Edison*, and has thoroughly footnoted his text. Nelson believes that the Edison-Sutphen machinations were less than ethical, if not outright illegal, and many of Sutphen’s contemporaries in the American boating industry felt the same way. Andrew Higgins later commented on the “cozy” relationship between Elco and the Navy Department in congressional hearings. He found it peculiar that Elco had built a major new facility that was not justified unless they had been assured of large future contracts.

PV-70 was soon being prepared for shipment to her new home. Scott-Paine accompanied his creation as she traveled as deck cargo on board SS *President Roosevelt*, arriving in New York on 5 September 1939, four days after the German army rolled into Poland.<sup>97</sup>

In the weeks to follow, PT 9, as she was now known, was put through her paces for Navy and Coast Guard officials. Edison and the uniformed officers came away suitably impressed, though Scott-Paine's talented boat handling had a lot to do with their endorsement. An official entry from the Office of Naval History reads "Scott-Paine personally did as much to sell the boat to the navy as the boat did itself. From all the evidence, the English designer was an exceptional boat-handler, and he was non-paniel when handling his own design."<sup>98</sup>

PT 9 was now regarded as a proven design and Elco was its licensed U.S. builder. The American boats, PT 1-8, were still under construction, would not be ready for months, and their attributes were completely unknown. Europe was embroiled in war and the Japanese continued to advance in China. Faced with the perceived need to move quickly, Edison made the boldest and most controversial decision of the entire PT program. He resolved to bypass the competitive bidding process and to procure two full squadrons of Scott-Paine boats without waiting for launching and testing of the indigenous designs. He wrote President Roosevelt on 3 October 1939 asking for approval to purchase about twenty boats and received the presidential nod contingent upon price. While PT 9 underwent further trials, Edison negotiated with Elco. Edison wanted twenty-three additional boats since the Navy planned to deploy PTs in squadrons of twelve and this

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<sup>97</sup> Robert Bulkley, *At Close Quarters*, 45; Ferrell, *Early Elco PT Boats*, 6; Harald Fock, *Fast Fighting Boats*, 82-83; Norman Friedman, *U.S. Small Combatants*, 122; Peters, "The Motor Torpedo Boat", 943; Peters, "The PT Boat", 3.

<sup>98</sup> Gordon Adamson, "Motor Torpedo Boats," 992; Robert Bulkley, *At Close Quarters*, 44-47; Ferrell, *Early Elco PT Boats*, 9; Harald Fock, *Fast Fighting Boats*, 83; Norman Friedman, *U.S. Small Combatants*, 122-123; Curtis Nelson, *Hunters in the Shallows*, 97. In chapter 5 of *U.S. Small Combatants*, Friedman provides an impressively detailed account of the Navy's development program to include excerpts from letters and reports, the particulars and conclusions of tank tests conducted at Norfolk, and facts to be found in no other known secondary source.



volume would facilitate tactical and logistical experimentation and improvement. Sutphen initially offered to build only sixteen for the \$5 million the government offered but eventually agreed to Edison's request with the hopes of more lucrative business in the future.<sup>99</sup>

The deal was announced on 7 December 1939 and the American motorboat industry reacted quickly and vigorously. Ironically, Scott-Paine's British Power Boat Company had been established to counter American intrusion into the British market and now he was grabbing a huge domestic contract as well. George Sutton, president of the Marine Trades Association called it "American scandal No. 1 of world war No. 2." Legitimate questions were asked but not fully answered. Since the Navy had already spent money on design and construction of two separate models, why not wait until they were complete and tested before beginning mass production? Why had Elco invested in a huge new facility at Bayonne, one not justified by the current contract, if they were not involved in a sweetheart arrangement with the Navy to build more boats in the future? The combination of going outside the competitive bidding process, adopting a foreign design, and handing the business to a political ally had something to offend everyone.<sup>100</sup>

In spite of vocal industry protests and letters to Congressmen, there was no investigation and construction proceeded. The 70s were to use identical hulls and superstructures but two different armament plans. Twelve PTs, 9-20, with PT 9 already on hand, were to be torpedo boats. They were unique in that they were the only American PTs equipped with an 18-inch torpedo. Another twelve were to be completed as fast antisubmarine warfare vessels, designated PTC 1-12, with depth charges in lieu of

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<sup>99</sup> Robert Bulkley, *At Close Quarters*, 47; Harald Fock, *Fast Fighting Boats*, 83; Norman Friedman, *U.S. Small Combatants*, 122-123; Curtis Nelson, *Hunters in the Shallows*, 98-99; Peters, "The PT Boat," 3; Venable, *Out of the Shadow*, Sutphen later stated that Elco lost \$600,000 on the deal.

<sup>100</sup> Irving Allen, *Never a Dull Moment*; Harald Fock, *Fast Fighting Boats*, 83; Norman Friedman, *U.S. Small Combatants*, 123; Curtis Nelson, *Hunters in the Shallows*, 100; Jerry Strahan, *Andrew Jackson Higgins*, 83-84. Friedman says Elco got the contract on 13 December 1939. One competitor who lauded Elco was Frank Huckins. Irving Allen wrote "Huck accords his big competitor all honor for their foresight and ability."

torpedoes. All would carry two twin .50 cal machineguns in plastic turrets and would be powered by three 1200 HP Packard gasoline engines driving a combination of straight shafts or V-drives.<sup>101</sup>

The first Elco 70s were delivered in November 1940 just as some of the Navy's experimental craft were being completed. The Chief of Naval Operations organized the latter into Squadron 1 to include PTs 3, 4, 7, and 8. PT 5 did not arrive until March 17, 1941 and it was found unsatisfactory. As noted previously, the original PT 6 was never activated. PT 10-19, all Elco 70s, became Squadron 2. Over the next few months, the strengths and weaknesses of each design became apparent. Both units headed south in January 1941 to conduct sea trials and maneuvers. Ron 2 made the trip to Miami without problems but Squadron 1 had to contend with chronic engineering problems. The design contest boats proved so poor that they were left in Miami where they were soon joined by the Higgins-built PT 5 and PT 6 *Prime*. Ron 2 continued to Cuba but was recalled in March 1941 and the 70s were transferred to Britain under Lend-Lease while most of the Squadron 1 boats were found unacceptable for service as PTs.<sup>102</sup>

Already, the 70s were considered obsolete. In July 1940, while construction was in progress, the General Board had decided to switch to a more powerful 21-inch torpedo instead of the 18-inch type originally installed. This meant the boats would have to be longer to accommodate the increased size of the launching tubes. Elco soon drew plans for a 77-foot model and on 17 September 1940, before the first "70" was completed, the Bayonne firm received an order for twenty-four of the new PTs. PT 20, already under contract but not yet under construction, was to become the first "77". The test run to Cuba had shown major structural problems in Scott-Paine's progeny with bottom planking springing loss from the frames, fasteners failing, seams opening at the gunwale where the deck joined the hull, and cracked bulkheads among other defects. The boat was

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<sup>101</sup> Robert Bulkley, *At Close Quarters*, 47-48; Ferrell, *Early Elco PT Boats*, 7; Harald Fock, *Fast Fighting Boats*, 83-85; Norman Friedman, *U.S. Small Combatants*, 123, 125, 134.

<sup>102</sup> Robert Bulkley, *At Close Quarters*, 48-51; Ferrell, *Early Elco PT Boats*, 16, 22. Harald Fock, *Fast Fighting Boats*, 83. By July 1941, PTs 3, 4, 5, and 7 along with most of the PTCs and PTs 9-19 had been transferred to Britain.

simply using scantlings that could not take the pounding of a forty-knot cruise. Some of these problems would be remedied in the “77” but not all of them.<sup>103</sup>

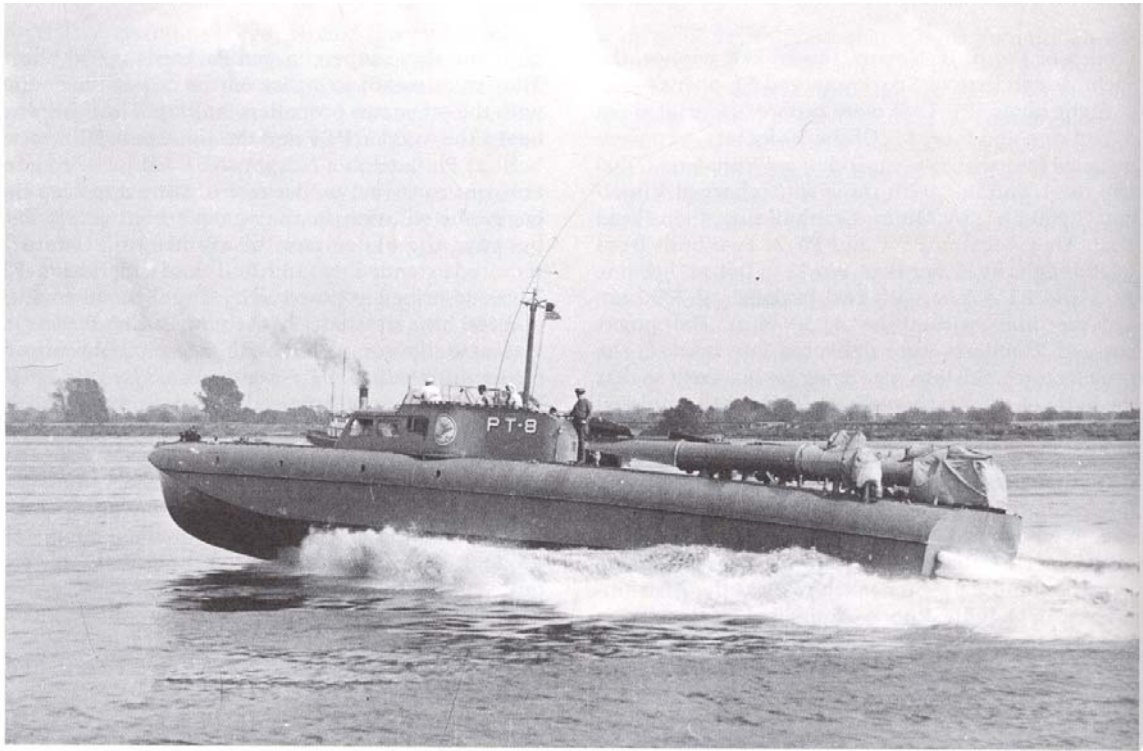
Lessons learned from the winter cruise and activities in the private sector provoked a reassessment of the PT program. CNO Admiral Harold R. Stark had pushed for a standard PT boat months earlier and demanded the “conduct of comparative service tests without further delay.” He renewed the request in May writing “It is apparent that a considerable divergence exists among the various offices of the Navy Department and among the officers of Motor Torpedo Boat Squadrons as to the suitability of the various types of Motor Torpedo Boats which have been acquired...it is desired that the Board of Inspection and Survey conduct comparative tests.”<sup>104</sup> On 19 May 1941 the former commanders of Squadrons 1 and 2 met with representatives from the Chief of Naval Operations, Bureau of Ships, Bureau of Inspection and Survey, and Interior Control Board to discuss future actions. All the boats produced thus far had been found highly unsatisfactory. The design contest winners were failures in every respect and the Elco 70 was too weak and too small to carry the new armament. The new Elco 77, PT 20, had not yet been tested. Thus, three years after funds had been appropriated for “a moderate experimental program” the U.S. Navy still had no operational motor torpedo boats.<sup>105</sup>

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<sup>103</sup> Robert Bulkley, *At Close Quarters*, 50-51; Ferrell, *Early Elco PT Boats*, 28; Harald Fock, *Fast Fighting Boats*, 84; Norman Friedman, *U.S. Small Combatants*, 134-136; Frank Johnson, *United States PT Boats in World War II*, 27.

<sup>104</sup> Chief of Naval Operations restricted letter. Op-23D-KM Serial 150323 dated 31 May 1941.

<sup>105</sup> Robert Bulkley, *At Close Quarters*, 52; Bob Ferrell, *Early Elco PT Boats*, 28; Harald Fock, *Fast Fighting Boats*, 83-85, 87; Norman Friedman, *U.S. Small Combatants*, 136; Frank Johnson, *United States PT Boats in World War II*, 32; Curtis Nelson, *Hunters in the Shallows*, 106-107. Bureau of Construction and Repair and Bureau of Engineering had merged in July 1940 to form Bureau of Ships (BuShips).



PT 8, cruising at about 40 knots near Philadelphia on 29 June 1941, was significant for its aluminum hull, the success of which inspired the use of aluminum in the four postwar PTs. Note the two massive conventional torpedo tubes aft.

Figure 16. PT 8. The legacy of British CMBs is obvious in PT 8, designed and built by Bureau of Ships at the Philadelphia Navy Yard. Heavy scantlings and ship fittings made the hull exceptionally strong, but expensive. There would be no more aluminum MTBs constructed until after the war. The boat is still operational. As of December 2008, it was on a huge trailer in Louisiana with an asking price of \$1,000,000 (Norman Friedman, *U.S. Small Combatants*, 120)

## CHAPTER 7

### THE PLYWOOD DERBIES:

#### Testing the PT Prototypes in 1941

There was cause for optimism in spite of the abysmal failure of the design contest and the experimental boats. PT 20 would clearly be a refinement of Scott-Paine's 70-foot model, now structurally reinforced and lengthened, and two new offerings from the private sector widened the service's options. Andrew Higgins had decided that the best way to create a suitable MTB was to do the designing and construction on his own without Navy involvement. The result was a 76-foot hard-chine planing hull promptly nicknamed "dreamboat." PT historian Frank Johnson notes that during acceptance trials "the boat drew an enthusiastic response from virtually everyone who had an opportunity to go aboard. The boat handled well, was almost as fast as the Elcos and – of particular delight to the crews – did not pound as hard as the Elcos in a seaway."<sup>106</sup> The competition in Bayonne would take note of this and profit from it. Higgins built it at his own expense without a contract but with assurance from Bureau of Ships that the Navy would buy the boat if it "proved successful." Under the same premise, Frank Huckins, built a 72-foot boat to his own design incorporating his "quadraconic" hull form and offered it to BuShips. Huckins was President of Huckins Yacht Corporation of Jacksonville, Florida and was a respected builder of small motor yachts who emphasized light weight in hull construction.<sup>107</sup>

In addition to his "dreamboat", Higgins had designed and built a prototype MTB for the British with the caveat that the Royal Navy would not interfere in the process. In

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<sup>106</sup> Frank Johnson, *United States PT Boats of World War II*, 32

<sup>107</sup> Irving Allen, *Never a Dull Moment*; Norman Friedman, *U.S. Small Combatants*, 136; Frank Johnson, *United States PT Boats in World War II*, 32; Peters, "The PT Boat," 4; Jerry Strahan, *Andrew Jackson Higgins*, 42; *Time*. "Shipbuilding: Huck's New Boat," 1 December 1941. Huckins had initially designed a smaller boat but when finally presented with data concerning the military load he realized that his design was too small. He went back to the drawing boards and produced a 72-foot model with four Packard engines accepted by the Navy as PT 69.

return, he promised to sell the completed craft at cost plus 10 percent. The resulting boats were far less expensive than the U.S. PTs. Trials for PT 5, the second PT 6, thereafter designated PT 6', and the 70-foot British MTB were held on Lake Pontchartrain in late November before members of the Board of Inspection and Survey. PT 5 failed to meet Navy standards, and PT 6 *Prime* experienced engine problems, but the members were highly impressed by the British 70. The Board found that the Higgins MTB was about half the cost of comparable boats from Elco and still possessed "military characteristics comparable to those of our own 70-foot boats that cost about twice as much. Its maneuverability is superior and its access and arrangement are excellent."<sup>108</sup>

Both Higgins and Huckins complained that it was very difficult to get Bureau of Construction and Repair to supply specifications for speed, size, load, or other requirements, a fact that Higgins made known in an appearance before a Congressional investigating committee. Higgins's biographer, Jerry Strahan, wrote that he "had considerable difficulty in 1939 securing from the navy the specifications for the 81-foot PT boats. He found it even harder to get an invitation to bid." Throughout the war, Higgins Industries of New Orleans consistently built PT boats for far less than Elco but the latter received the majority of the contracts. Labor was cheaper in Louisiana than at Elco's Bayonne facility, and Higgins used his close ties to South American timber interests to secure mahogany at favorable prices. He later proclaimed he could build them even cheaper if the Navy would stop changing specifications and causing him to redesign and retool.<sup>109</sup>

These developments and disappointments perplexed the participants at the May 1941 meeting. The war in Europe was almost two years old, Germany was triumphant on all fronts, attempts to reach an accommodation with Japan were stalemated, and the Navy desperately needed conclusive solutions in its PT program. With Admiral Stark's mandate in hand, the conference recommended that sea trials and tests be conducted by

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<sup>108</sup> "Memorandum for the Secretary of the Navy, PT6 –Preliminary Acceptance Trials," November 26, 1940, in Office of the Secretary, General Correspondence, 1940-42, Box 1003, Folder "PT 6," Record Group 80, National Archives. This entry cited in Strahan, *Andrew Jackson Higgins*, 54.

<sup>109</sup> Irving Allen, *Never a Dull Moment*; Jerry Strahan, *Andrew Jackson Higgins*, 42, 54, 83.

the Board of Inspection and Survey to rate the various boats on strength, speed, facilities, habitability, maneuverability, and seaworthiness. Board President Rear Admiral J. W. Wilcox complied promptly, establishing a panel headed by himself with Commanders R.E. Jennings, W.M. Downes, N.O. Schwien, Lieutenant Commanders R.K. Wells, J.M. Will, and Lieutenant W.C. Winn sitting as members. In July, the Board acted in accordance with Stark's directive by sponsoring a series of events that would be known ever after as "The Plywood Derbies".

There were eight entries in the Navy competition including Higgins' PT 6 *Prime*, his new 76-foot boat "dream boat," now accepted as PT 70, the Higgins' British 70-footer, Huckins 72-footer soon to be PT 69, the Philadelphia Navy Yard's PT 8, and several Elco 77s (PT 20, 26, 30, 31, and 33). The Navy had purchased PT 70 several months before. Likewise, Huckins' boat had been accepted a few weeks before the trials and designated PT 69.<sup>110</sup>

The trials began on 21 July 1941 off New London, Connecticut.<sup>111</sup> Participants included:

PT 6' – 81-foot built by Higgins Industries of New Orleans and very loosely based upon the contest winning Sparkman and Stephens design stretched from 70-feet, and powered with three Packard 4M 1200hp direct drive engines. The original PT 6 had been a failure and Higgins had designed and built this one at his own expense.<sup>112</sup>

Length overall – 81'3"      Length water line – 75'7"      Beam – 16'8"

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<sup>110</sup> Robert Bulkley, *At Close Quarters*, 52-53; Norman Friedman, *U.S. Small Combatants*, 136-137; Frank Johnson, *United States PT Boats of World War II*, 32; Curtis Nelson, *Hunters in the Shallows*, 52-53.

<sup>111</sup> Data on boats, performance, and many other matters relating to the Plywood Derbies is drawn from United States Navy. Board of Inspection and Survey. *Report of Comparative Service Tests of Motor Torpedo Boats*. 14 August 1941, in National Archives Record Group 80, Records of the General Board, file 420-14, unless otherwise noted.

<sup>112</sup> Jerry Strahan, *Andrew Jackson Higgins*, 42-43.

Fuel capacity – 3700 gallons      Fresh water capacity – 200 gallons  
Designed ordnance load – 2 x 21” stern launching torpedo tubes with  
torpedoes (Mark VIIIs?), 1 depth charge rack, 4 depth charges (Mark 4 or 6),<sup>113</sup>  
or one smoke generator, 2 x .50 caliber machine guns.

PT 8 - An 81-foot aluminum hull, built by Philadelphia Navy Yard to a Bureau of  
Ships design, two Allison 2000hp engines, and one Hall-Scott 550hp engine, all  
three engines using geared drives for a total of 4500 horsepower. PT 8 was the  
only U.S. aluminum PT hull built during World War II and was probably the  
only aluminum MTB hull in existence anywhere prior to late 1945.

Length overall – 80’8”      Length water line – 75’      Beam – 16’8”  
Fuel capacity – 3000 gallons      Fresh water capacity – 400 gallons  
Designed ordnance installation – 2 x 21” torpedo tubes with torpedoes, 1  
depth charge rack with 4 depth charges, 1 smoke generator, 2 x 50. caliber  
machine guns.

PT 20 – 77-foot Elco (Electric Boat Company. Bayonne, New Jersey), based upon  
the Hubert Scott-Paine design, three Packard 4M 1200hp engines, equipped with  
special propellers and with additional strengthening members on hull and deck.

The three engine arrangement was to become standard in U.S. PTs and in  
Elco boats the center engine was a direct drive while the outer or wing  
engines were actually installed backwards but their thrust was reversed by  
using a V drive. Only in this manner could the engine space accommodate all  
three power plants, plus generator, batteries, and other equipment.<sup>114</sup>

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<sup>113</sup> *Report of Comparative Service Tests* does not designate a model number of any of the weapons carried  
so it is not possible to determine the load the boats were expected to carry. This is an important factor  
because weight and performance of torpedoes and depth charges varied significantly and strongly impacted  
vessel performance. The *Report* indicates that PT 6’ was to carry depth charges weighing 300 pounds each  
but depth charges in the U.S. Navy inventory at the time weighed 420 pounds (Mark 2, 3, and 6), while the  
Mark 4 was a hefty 745 pounds. Mark 2, 3, and 6 each held 300 pounds of explosive and this might have  
been misinterpreted as the total weapon weight. Depth charge data from, Norman Friedman, *U.S. Naval  
Weapons: Every Gun, Missile, Mine, and Torpedo Used by the U.S. Navy from 1883 to the Present*.  
Annapolis: Naval Institute Press, 1984, 272.



Length overall – 77’      Length water line – Not given      Beam – 19’  
Fuel capacity – 3000 gallons      Fresh water capacity – 180 gallons  
Designed ordnance installation – 4 x 21” torpedo tubes with torpedoes, 1  
smoke generator, 2 x dual .50 caliber machine gun mounts in power driven  
Dewandre type turrets.<sup>115</sup>

PT 26, 30, 31, 33 – 77-foot Elco models with standard propellers and without added stiffeners.

PT 69 – 72-foot built by Huckins Yacht Corporation, a small Jacksonville, Florida firm and powered by four Packard 1200hp engines (the only four engine PT)<sup>116</sup>

Length overall – 72’      Length water line – 70’      Beam – 16’5”  
Fuel capacity – 3430 gallons      Fresh water capacity – 250 gallons  
Designed ordnance installation – 2 x 21” torpedo tubes with 2 x 21”  
torpedoes, 1 depth charge rack with 7 depth charges or 1 smoke generator, 2  
x dual .50 caliber machine guns mounted in gun tubs/turrets adjacent to the  
cockpit.

PT 70- 76-foot Higgins “dreamboat,” three Packard 4M 1200hp direct drive engines. This vessel had recently been purchased by the Navy and designated PT 70.

Length overall – 76’3”      Length water line – 70’1”      Beam – 20’10”  
Fuel capacity – 4500 gallons      Fresh water capacity – 250 gallons

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<sup>114</sup> PT 20, 26, 31, and 33 were all built to the same design and designated the PT 20-44 series.

<sup>115</sup> These turrets were very similar to those found in the B-17 bomber but they were abject failures when used in the boats. They had a tendency to fog over, could only be accessed from below deck, and were hydraulically driven. Hence, without the engines running to build hydraulic pressure they could not be traversed. This proved important on 7 December 1941 when six PTs (26, 27, 28, 29, 30) loaded aboard freighters at Pearl Harbor attempted to fire upon Japanese aircraft. Crewmen then cut away the hydraulic lines and rotated the turrets by hand. See Robert J. Bulkley, Jr. *At Close Quarters*, 3.

<sup>116</sup> Letter from President, Board of Inspection and Survey to Secretary of the Navy, subject: 72’ Motor Torpedo Boat built by the Huckins Yacht Corporation, Jacksonville, Florida – Purchase of; recommendation for., 3 July 1941, General Board of the Navy Files, 420-14.

Designed ordnance installation – 4 x 21” torpedo tubes with 4 x 21”  
torpedoes, 2 depth charge racks with 10 depth charges, 3 x dual .50 caliber  
machine guns

70-foot boat without designation, built for Royal Navy by Higgins, three Hall-Scott  
900hp direct drive engines.

Length overall – 70’                      Length water line – 64’                      Beam – 17’8”  
Fuel capacity – 2400 gallons                      Fresh water capacity – 200 gallons  
Designed ordnance load – 2 x 21” torpedo tubes with 2 x 21” torpedoes, 1 x  
42mm gun, 2 x .50 caliber machine guns.

Each boat would be tested using several criteria - speed over an open course,  
maneuverability as assessed by turning radius, ease of handling in attack, internal  
communication below deck, livability for crew, cost to build, fuel consumption, and  
sea keeping abilities. The main event was an open water run of 190 miles at full  
throttle.<sup>117</sup>

Habitability is an important consideration in a small boat but holding the trials at New  
London produced skewed conclusions. Weather on Long Island Sound in July is  
splendidly moderate, with temperatures in the mid 70s, relatively little rainfall, and the  
gentlest winds of the year. In short, it was nothing like what the boats would actually  
experience. Squadrons deployed to the Pacific would operate in conditions where  
humidity was routinely near 100%, daytime temperatures hovered in the 90s for months  
at a time, and where little breeze and poor ventilation meant conditions below deck were  
stifling. Hence, crews took to sleeping on deck whenever the absence of mosquitoes  
made it possible. Otherwise, they were restricted to trying to grab a few hours of fitful  
sleep while rolling about in their own sweat. Two squadrons were sent to purgatory in the  
Aleutian Islands where the men froze and the boats were beaten apart while making no  
contribution to the war effort. All this occurred because weather conditions had been so  
optimal as to hide shortcomings.

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<sup>117</sup> Report of Comparative Service Tests, I-2.

Later, the changing role from torpedo boat to gunboat would exacerbate the situation. The boats were designed for a crew of two officers and nine enlisted personnel and quarters were fitted accordingly. Addition of multiple crew-served automatic weapons meant a commensurate increase in personnel so that later in the war, there could be as many as eighteen men assigned to a single boat but with no increase in accommodations. The greatly expanded combat ammunition load made room even more of a premium.

There were important engineering and administrative matters to attend to before the competition started, however. For unknown reasons, the Navy had made armament available only to Elco. Therefore, their boats weighed more than the others and the tests would be measuring their boats loaded but the others light. To compensate, metal ingots were placed on the Higgins, Huckins, and BuShips boats. Unfortunately, these ingots were not distributed as the ordnance would have been, and they were not properly secured. Every time a boat plowed through a wave crest the ballast would rise off the deck and slam back down with tremendous force. “Twenty thousand pounds of copper, ingots, piled in the turrets as ballast, left the deck on the crest of every wave threatening to go through to Davy Jones Locker.”<sup>118</sup> This use of loose ballast instead of well secured and distributed armament severely handicapped every boat but the Elcos, producing a significant impact upon the test results.<sup>119</sup>

The matter of ballast versus actual armament was not the only factor working for Elco and against the other entrants. Elco’s Bayonne, New Jersey plant was less than a day’s cruise from New London, but Huckins had to run PT 69 over a thousand miles on her own bottom from Jacksonville up the east coast with commensurate expense,

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<sup>118</sup> Irving R. Allen, *Never a Dull Moment: Metamorphosis of the Huckins Motor Torpedo Boat*. (Jacksonville: Huckins Yacht Corporation, 1944). Allen’s work is actually a short, well-illustrated review written for Frank Huckins. The pages are unnumbered and hence not cited along with the author’s name. There is a contradiction in the sources as to whether the ballast was iron or copper. Strahan writes that the Higgins boats used iron but Allen writes that PT 69 was ballasted with copper ingots piled in the gun tubs.

<sup>119</sup> Report of Comparative Service Tests, IV-2; Robert Bulkley, *At Close Quarters*, 52-55; Norman Friedman, *U.S. Small Combatants*, 136-138, Peters, “The PT Boat”, 4; Jerry Strahan, *Andrew Jackson Higgins*, 91-92.

accumulation of bottom growth, plus wear-and-tear. Higgins had it even worse because he had to move three boats over a much longer distance. The risk to both firms was significant, as a bent shaft or other problem could have put either out of the running, far from home. The Higgins boats ran all the way from New Orleans and PT 70 and the British 70-footer did not reach Newport until 23 July. Nevertheless, all entries were on station for the tests that ran from 21-24 July.<sup>120</sup>

The nagging question remains as to why Rear Admiral Wilcox decided to hold the tests at Newport at all and place this unequal and unwarranted burden upon the two smaller contractors. The benefit to Elco was obvious since that firm's parent corporation, Electric Boat Company, had a huge construction facility at nearby Groton, Connecticut. The official report of the sea trials states that it was "because it was desired to conduct a run in the open sea as part of these tests and also to take advantage of the logistic facilities afforded by the Submarine Base, New London." Yet, far more extensive facilities existed at Hampton Roads, Virginia which had much larger naval and civilian shipbuilding establishments and support services than Newport. The harbor at Norfolk offered protected waters only twenty miles from the open Atlantic and Chesapeake Bay afforded a wide range of semi-protected and shallow waters for testing in diverse conditions. Norfolk was a two-day run for Huckins from their Jacksonville plant and could be reached from Elco's Bayonne facility in a single daylight run in the long days of July. The Board's report in this regard lacks logic and it was neither the first nor the last occurrence of evidence of favoritism in evaluation and contracting in the PT program. The influence of Charles Edison and other New Jersey politicians was not to be underestimated.<sup>121</sup>

The main sea trial was an open water run from Sarah Ledge, around Block Island, then around the Fire Island Lightship, and on to the finish at the whistling buoy off Montauk Point. The weather was favorable with "moderate swells and a cross-surface chop." PT 26 (77' Elco) did not take part because of deck cracks that developed during previous

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<sup>120</sup> Report of Comparative Service Tests, IV-1-2.

<sup>121</sup> Report of Comparative Service Tests, I-1.

exercises. The Higgins-built British 70-foot boat was the first casualty, developing engine problems within five minutes of the start and dropping out. PT 33 (77' Elco) soon withdrew when deck cracks similar to those on PT 26 appeared off Block Island on the first leg. PT 70 (76' Higgins) dropped out on the second leg when unsecured ballast caused damage to the deck and frames. PT 30 (77' Elco) “suffered structural damage” near the end of the race and was disqualified by the trial board. Thus, of the ten boats that showed up in New London, only half finished the entire evaluation series.

Designator	Model	Average Speed in Knots
PT 20	77' Elco	39.72
PT 31	77' Elco	37.01
PT 69	72' Huckins	33.83
PT 6'	81' Higgins	31.40
PT 8	81' BuShips	30.73

Figure 17. Results of 1<sup>st</sup> Open Water Competition<sup>122</sup>

Designator	Model	Light Load	Full Load
PT 20	77' Elco	45.3	44.1
PT 69	72' Huckins	43.8	41.5
PT 70	76' Higgins	41.2	40.9
PT 6'	81' Higgins	35.0	34.3
PT 8	81' BuShips	31.9	31.1

Figure 18. Speed Over Measured Mile<sup>123</sup>

<sup>122</sup> Ibid, IV-3; Peter Kemp, *Oxford Companion to Ships and the Sea*, (London: Oxford University Press, 1976), 454. A knot is one nautical mile (6,080 feet) per hour.

<sup>123</sup> Report of Comparative Service Tests, III-2.

The tables above indicate that Elco was the winner in the speed evaluation but Higgins contested this, stating that the pig iron used as compensatory ballast had been concentrated and had damaged the boats. The trial board agreed with Higgins and stated that ballast had not been properly placed to “give horizontal and vertical moments equal to the simulated loads.” With both parties in agreement that the validity of the trials had been compromised, the trial board ordered another series scheduled for 11-12 August to allow time to make repairs.<sup>124</sup>

Speed was not the only factor studied. The Elco boats often were deficient in other categories. Despite having the actual armament in place, with less strain placed on the hulls by a shorter run from the factory, and enjoying the nearby support of Electric Boat’s Groton facility, only two out of their five boats survived without damage – a lower average than Higgins (50% completion) and much lower than Huckins (100% completion). It appeared that superior speed had been gained at the cost of structural integrity and later 77s used long deck stiffeners to avoid cracking. The Elco was found least maneuverable and gave the roughest ride in the type of conditions encountered. Both these qualities were extremely important because the boats depended upon speed and maneuverability for avoiding air attack while a rough ride led to crew exhaustion. The Board noted that Elco’s had a “tendency to pound heavily in a seaway” and concluded that it was the endurance of the crew, rather than of the boat, that limited its ability to operate in rough water. The Higgins and Huckins boats were rated intermediate in these categories with PT 8 giving the smoothest ride, though the heavy aluminum hull was notably difficult to maneuver.<sup>125</sup>

On strength alone, the board found that while PT 8 was clearly the strongest boat its integrity had been gained by using heavy-duty ship fittings that greatly increased weight. Furthermore, it was very hot, with poor habitability. PT 6 (81’ Higgins) was judged second strongest, followed by the 70-foot British boat, Huckins PT 69, and the 77-foot Elco. Ironically, Higgins also placed last on strength with PT 70 being the weakest

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<sup>124</sup> Ibid, IV-2; Jerry Strahan, *Andrew Jackson Higgins*, 91.

<sup>125</sup> Report of Comparative Service Tests, II-1-4, III-2, IV-1-2.

structurally though it rated first in habitability, followed by PT 6', Huckins, PT 8, Elco, and the 70-foot British Higgins. When all facets of the survey were considered, the Elco 77 left much to be desired, Higgins had a worthwhile entry with PT 6', though PT 70 was apparently a failure, and the Huckins PT 69 placed consistently in the middle or upper half in every category.<sup>126</sup>

Andy Higgins protested that the loose ingots used to simulate ordnance loads had been improperly distributed and secured, thus damaging his boat and making the test results invalid. The Board agreed noting "Ballast could not, in general, be so disposed as to give horizontal and vertical moments equal to the loads simulated" and scheduled a repeat series for 11 and 12 August.<sup>127</sup> By then the field had shrunk from eight boats to six. PT 8, PT 69, and PT 70 returned, as did Higgins' 70-foot MTB on loan from the British. The previous Elco entries were withdrawn entirely and replaced by two new 77-footers - PT 21 and PT29 – demonstrating one of the advantages of being well capitalized and close to home. PT 6' had been transferred to the Royal Navy under Lend-Lease.

In the weeks since the first tests, ordnance had been installed on every boat except the British Higgins and only it required ballasting. Elco's PT 29 would be along to take accelerometer readings to measure the pounding of PT 8, but it was not considered to be competing. Additionally, the destroyer USS *Wilkes* would run the course with the boats at maximum speed possible under the prevailing conditions. The comparative speeds would give a better assessment of the PT's ability to operate in difficult sea conditions.<sup>128</sup>

The starting lineup had changed somewhat by the time of the second Derby. PT 6' had left the field, being transferred to Britain under Lend Lease and most of the Elco 77s were left in the shed. This time only five boats would make the run – the 70-foot British Higgins, BuShip's PT 8, the Huckins PT 69, Higgins PT 70, and a single Elco 77, PT 21. Elco's PT 29 would be along to take accelerometer readings to measure the pounding of

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<sup>126</sup> Ibid.

<sup>127</sup> Report of Comparative Service Tests, IV-2.

<sup>128</sup> Report of Comparative Service Tests, IV 5-7; Irving Allen, *Never a Dull Moment*; Robert Bulkley, *At Close Quarters*, 54; Harald Fock, *Fast Fighting Boats*, 87-89; Jerry Strahan, *Andrew Jackson Higgins*, 91.

PT 8, but it was not considered to be competing. Additionally, the destroyer USS *Wilkes* would run the course with the boats at maximum speed possible under the prevailing conditions. The comparative speeds would give a better assessment of the PT's ability to operate in difficult sea conditions.<sup>129</sup>

The course was only five miles shorter than before but the weather conditions had deteriorated drastically. Instead of moderate seas, the boats had to confront “heavy cross swells” of six to eight feet “with occasional waves of ten to twelve feet” and very restricted visibility. Between Block Island and Montauk Point there was a confused sea running with swells from several directions colliding to create short, steep waves up to fifteen feet high.<sup>130</sup>

Designator	Model	Average Speed in Knots
PT 21	77' Elco	27.5
PT 70	76' Higgins	27.2
PT 8	81' BuShips	25.1
PT 29	77' Elco	25.1
PT 69	72' Huckins	Withdrew
British	70' Higgins	24.8

Figure 19. Results of 2<sup>nd</sup> Open Water Competition<sup>131</sup>

There were casualties on this run, too, even among the winners. PT 69 sustained “several fractured bilge stringers”, PT 70 had planking pull loose, and PT 21 developed more deck cracks, though not as extreme as before. PT 8 finished without damage but

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<sup>129</sup> Ibid, IV-5-7.

<sup>130</sup> Ibid, IV-5

<sup>131</sup> Ibid.



gave a very uncomfortable ride in these harsher seas. It was soon declared unsuitable for use as a motor torpedo boat and served as a yard boat in Philadelphia for the duration of World War II. It was the only aluminum PT produced until the Navy renewed MTB experimentation after the war. Ironically, it is the only one of the early boats to survive and is currently afloat and in operating condition in Louisiana.<sup>132</sup>

Notably, USS *Wilkes* finished only twenty-five minutes ahead of PT 21 though the bigger ship was a “destroyer of modern type...given advance notice that full power would be required and directed to be as nearly as possible at full power upon crossing the starting line.”<sup>133</sup> The trial board was suitably impressed by the ability of the little wooden PTs to follow so closely behind the much larger and more powerfully propelled steel hulled destroyer. They concluded that for the role PTs were intended to play “modern destroyers possess no sensible advantage over the motor boats even under sea conditions highly unfavorable for the latter, and that in areas where limited visibility is not unusual the motor boats might readily prove much more adaptable than the larger vessels within the limitations of their operating ranges.”<sup>134</sup>

The Board’s conclusions were confirmed by experience in action in the years that followed. They found the reliable performance of the 12-cylinder supercharged Packard 4M “highly satisfactory” and thus ended experimentations with Hall-Scott and Allison engines as well as the cursed Vimalerts that had dogged PTs 1-4. They determined that “the hulls of these boats have in general demonstrated their ability to withstand operations in a heavy sea to the limits of their crews”, concluding that in these high speed assault craft the human factor would fail before the boat did. Further, that the boats should operate from shore bases, were “suited only for operations in protected water and in such operations are superior to destroyers.” The definition of what constituted

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<sup>132</sup> Ibid, IV-5-6.

<sup>133</sup> Report of Comparative Service Tests, IV-6.

<sup>134</sup> Ibid, IV-5-6.

“protected water” would be stretched considerably between 1941 and 1945 as the PTs operated far afield and at the forward edge of the battle area.<sup>135</sup>

Additional recommendations followed. First, that future ordnance loads be standardized to consist of two torpedo tubes, machine guns, and depth charges. Second, that the Huckins 72', PY 69, be accepted for immediate construction as presently designed and built – the only entry to be found acceptable in its current condition and without modifications. Third, that the Higgins boat, PT 6', be accepted after being slightly reduced in length. No cogent reason was given for this directive. And last, that the Elco 77' be accepted only after design changes were made to reduce pounding and strengthen the hull and deck.<sup>136</sup>

Armed with the trial board's recommendations and usable data in hand, the Navy stood ready to make decisions about the place of torpedo boats in its inventory, decisions that would be crucial in the coming conflict. By October funding was available for more boats. The Plywood Derbies had led to further revision of the Navy's requirements and these were conveyed to the three yards in September. First, it was agreed that the length of the hulls would be not less than 75 feet or more than 82. The additional length would permit use of four 21-inch torpedo tubes instead of two as recommended by the trial board. Overall length was restricted because it was “the largest that could be transported easily” although why the limit of 82 feet was so important was not explained. The use of three Packards in each boat was standardized as was the requirement that each engine exhaust be muffled. Each boat was to carry two twin 0.50-caliber machine guns and a smoke generator. Time would show that this armament was woefully inadequate. Trial speed had to reach 40 knots or more, be maintained for one hour, and the vessel had to cover 500 miles at cruising speed. The hull designs would remain basically unchanged. They would be stepless, planing hulls, of hard chine, and stress light weight commensurate with necessary stiffness and strength.<sup>137</sup>

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<sup>135</sup> Report of Comparative Service Tests, VI-1.

<sup>136</sup> Ibid, VII-1.

<sup>137</sup> Ibid, VII-1; See Appendix E. Robert Bulkley, *At Close Quarters*, 56-58.

All three contractors modified their boats accordingly. On 6 October 1941 BuShips met with representatives from each firm to review and approve the plans. Contracts were awarded on 19 November 1941. Frank Huckins had strengthened and lengthened his hull to 78 feet and installed a wide exterior timber at the chine called a “belly band” that substantially stiffened the hull. He received an initial contract for eight boats. There would be other contracts for a total production of eighteen boats that served in Hawaii, Midway, and at the Melville, Rhode Island training center though none ever saw combat. Andrew Higgins, who narrowed his hull and made it “stronger...steeper...heavier,” received a contract for twenty-four PTs and went on to build hundreds of PTs and become a major wartime supplier of a variety of small boats. Elco went back to the drawing board as well. It raised the forward part of the chine to give a deeper V-section forward to reduce pounding, lengthened the boat three feet, stiffened the hull, and produced the classic 80-foot model that typifies the American PT. The flared topsides so apparent in the Scott-Paine 70-footer and the 77-foot model were retained to deflect spray and cushion the ride and the Elco, with its flared hull and central superstructure, was widely appreciated for being drier than the Higgins’ boats. No more 77s would be built but Elco received its first order for 80s in January 1942. The first ones, PT 103-114, were commissioned as MTB Squadron 3 on 16 June 1942.<sup>138</sup>

To this day much controversy continues over the genesis of the 80-foot boat. Partisans of both Higgins and Huckins strongly suggest that the people at Elco got their inspiration and maybe the actual lines, from either PT 69 or PT 70. Both these builders incorporated lengthy concave sections in the bottom of their production boats and Elco incorporated concave sections forward in the 80-foot boat. Ted Sprague, Higgins’s team leader at the Derbies, and Frank Huckins both noted that the redesigned Elco had lines strikingly like their own boats. Sprague said that “You’d swear somebody must have gone in there and taken the lines off the (Higgins) boat,” and Huckins always felt that Elco had drawn the

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<sup>138</sup> Irving Allen, *Never a Dull Moment*; Robert Bulkley, *At Close Quarters*, 56-58; Harald Fock, *Fast Fighting Boats*, 89-90; Norman Friedman, *U.S. Small Combatants*, 139-141; Jerry Strahan, *Andrew Jackson Higgins*, 92.

“80” from the chine to the keel based upon his “Quadraconic hull.” It should not go unnoticed that Hubert Scott-Paine’s influence was very much in evidence in PT 103 and her sisters. Whatever the source, Elco went on to become the biggest builder of PT boats and to supply them to Britain, the Soviet Union, and the United States.<sup>139</sup>

The 78-foot Higgins and the 80-foot Elco became service standard for the Navy and despite changes of armament and experimentation with other hull forms they would remain structurally and architecturally unchanged for the duration of World War II. After three years of experimentation, the United States had finally produced the boat that would help hold the line against Japan in the early days of the war, and later help sever Axis supply lines and hasten the march to victory.

The Plywood Derbies of 1941 showed the Navy and the General Board at its creative and administrative best. After five long, frustrating years of experimentation and false starts the United States finally had produced serviceable MTB designs. Indeed, the 80-foot Elco would not be surpassed for a decade after the war. The myth persists, probably because of the attack on Pearl Harbor and bureaucratic obtuseness in other areas, that the Navy failed to anticipate the demands of the coming war. The PT experience belies that notion. Most of the officers concerned exhibited flexibility in doctrine and demonstrated foresight in their ability to anticipate a previously unexpected dimension of and mode of naval warfare alien to the U.S. naval establishment. Above all, they deserve praise for the concept of harnessing the recreational marine industry to both design and build the boats that helped hold the line in the early days of the war in the Pacific and went on to perform vital services in every theatre for the duration of the conflict. The precedent they set would lead to widespread use of modified recreational vessels in Vietnam and has continued to impact small war craft design worldwide.

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<sup>139</sup> Irving Allen, *Never a Dull Moment*; Jerry Strahan, *Andrew Jackson Higgins*, 92.

## CHAPTER 8

### DEPLOYMENT AND EVOLUTION

#### Metamorphosis of MTB Mission, Design and Armament, 1941-1945

The American PT boats of World War II lived and fought in a dynamic environment. Changes in tactics, strategy, and the battlefield situation forced the Navy and the PT crews to adapt to new combat challenges. When Lt. John Bulkeley and the men of Motor Torpedo Squadron Three (Ron 3) took on the Imperial Japanese Navy in early 1942, they did so with lightly armed craft equipped for torpedo attack rather than close quarters gunnery. Bulkeley's PT 41, like her sisters, was a 77-foot Elco carrying four antiquated, unreliable Mark VIII torpedoes in heavy steel tubes and four 0.50 caliber machine guns in two dual mounts. In less than two years the old Mark VIIIs had been replaced with more reliable Mark XIIIs but the torpedoes had become largely irrelevant. The winds of war had rendered a revolution in PT armament.<sup>140</sup>

The typical 80-foot Elco of 1945 carried its original 0.50 machine guns plus a 40mm Bofors gun on the aft deck, a 37mm automatic gun on the bow, one or more 20mm Oerlikon automatics, and numerous 0.50 machine guns on pedestal mounts on the bridge and along each side deck. There might also be twin rocket launcher pedestals carrying eight 5-inch spin-stabilized rockets in pods on either side of the bridge. Some carried depth charges in racks along the side or in a special mount on the stern. The American PT boat had become more of a gunboat than a torpedo boat.

The amount of ordnance placed aboard U.S. PTs far exceeded their original design load. The 80' Elco was to have displaced 38 tons but by the end of the war many carried so much firepower that they weighed 50 tons or more. By 1944, most PTs in the Pacific

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<sup>140</sup> Bruce M. Bachman, *An Honorable Profession: The Life and Times of One of America's Most Able Seamen: Rear Admiral John Duncan Bulkeley, USN*. (New York: Vantage Press, 1985), 28-29; and William B. Breur, *Sea Wolf: The Daring Exploits of Navy Legend John D. Bulkeley*. (Novato, CA: Presidio Press, 1989), 25.

had been armed in this or a similar fashion. The ordnance accounted for 25% of their displacement making them, pound for pound, the most heavily armed vessels in the U.S. Navy.

The first main battery of U.S. torpedo boats was the Mark VIII torpedo, a relic of the First World War that had become operational in 1911. It had been designed for use in deck-mounted tubes aboard destroyers where weight and size were less of a factor than on smaller vessels like PTs. It was 21 inches in diameter, this being the standard mode of measurement for torpedoes, and almost 21 feet long. This extreme length had forced the original PTs to be lengthened from 70 feet to 77 feet to accommodate four Mk VIIIs and their launching tubes and later boats manufactured by Elco Boat Company were lengthened to 80 feet. The torpedo weighed 3,050 pounds and was shot out of a Mk XVIII tube that weighed an additional 1,450 pounds. Elco was the sole wartime proprietor for the Mk XVIII although all the actual manufacturing was subcontracted. Each tube was constructed of welded steel and bolted to a base pad placed on deck during construction. They were built surprisingly well considering the demands of wartime – so well in fact, that it was the finding of one of these well preserved tubes after five decades under water that enabled Robert Ballard to identify the wreckage of PT 109. These were usually mounted two on each side of the deckhouse with the forward tube directly in front of the aft one. On some of the early boats the aft tube was replaced by depth charges mounted singly or in racks.<sup>141</sup>

Tubes were placed as close as possible to parallel with the centerline of the hull on the Elco boats. This made it mandatory to devise a scheme to face them away from the boat so as to clear the hull and each other upon firing. Elco PTs had a worm screw affixed on a mounting base at the forward end of each tube. When action was anticipated these were turned outward to obtain the necessary clearance – 8.5 degrees for the forward tube, 12.5

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<sup>141</sup> Bob Ferrell and Al Ross, *Early Elco PT Boats* (Memphis, TN: PT Boat Museum and Library, 1980), 32, 49; Norman Friedman, *U.S. Naval Weapons: Every Gun, Missile, Mine, and Torpedo Used by the U.S. Navy from 1883 to the Present*. (Annapolis: Naval Institute Press, 1984), 116; and Norman Polmar and Samuel Loring Morison. *PT Boats at War: World War II to Vietnam*. (MBI Publishing Company, 1999), 35.

degrees for the aft – while the aft end of each tube pivoted on a ring. Higgins Industries of New Orleans, the other major wartime PT builder, mounted the tubes at a permanent angle of 12 degrees off center and farther inboard. This was made possible by erecting the cockpit farther forward than on the Elcos and by eliminating all superstructure aft of it. A raised trunk cabin extended well aft from the control station on all Elco boats and made this skewed installation problematic since it made passage along the side decks difficult. The angled firing position had no impact upon aiming the torpedo because an internal gyrocompass compensated for the angle of deflection and allowed the weapon to acquire the proper heading after launch.<sup>142</sup>

There were also differences in how the torpedoes were fired. Elco used a black powder charge in a canister atop the trailing end of each tube. This could be activated electrically from a control panel in the cockpit. In case of failure, there was a striker knob on each canister that could be hit with a mallet to ignite the charge and fire the torpedo at a speed of 40 feet per second. There were several problems with this method of firing. Most notably, the black powder created a sizable flash and cloud of smoke. Since successful torpedo boat attacks were usually made at night using stealth instead of speed for survival, the flare up disclosed the presence and position of the attacker at the crucial moment when he was closest to the enemy.

The torpedoes and the interior of the tubes were covered with grease to keep out water and provide lubrication. This grease had an unfortunate tendency to ignite upon firing so that an orange flare up would accompany the smoke cloud. Furthermore, the powder itself was just one more fire hazard aboard a wooden boat and the power of the black powder and its ability to thrust the torpedo clear of the hull could be degraded by moisture. The torpedo cleared the deck by a mere six inches and operational records show several instances of torpedoes not clearing the boat and striking their fins or propellers on deck after firing. Maintenance was made more difficult by the black powder residue that had to be removed after firing.

Former torpedoman Robert Dunphy has stated that as a slight young man of only 110 pounds, he was charged with the unenviable task of “diving the tubes.” This process meant donning oilskins for some protection, being pushed into the tube from one end and

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<sup>142</sup> Ibid.

cleaning the interior with Varsol. Then, using a slurry of grease and oil “you get a bucket of this stuff and a brush that looks like you would hang paper with it, and you would have to work your way in” coating the interior of the tube as you went.<sup>143</sup> Higgins avoided these drawbacks by installing canisters of compressed air on the Mk XVIII tubes in lieu of black powder. They produced no flash and there was no explosive or fire hazard. With so much in its favor it remains a mystery why the Navy did not adopt this technique as standard.<sup>144</sup>

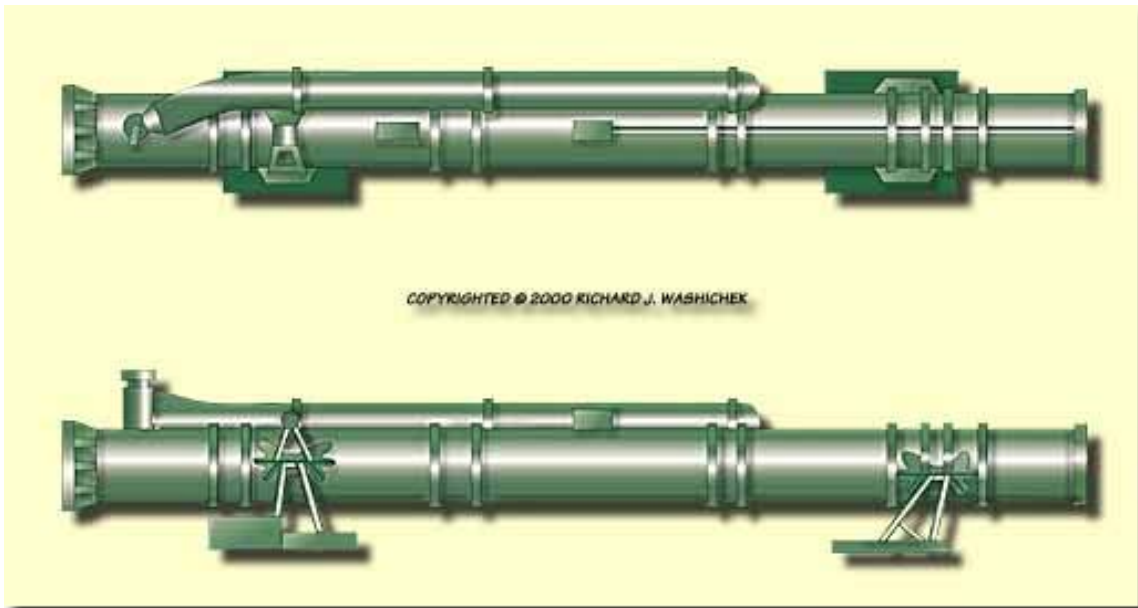


Figure 20. Torpedo tube used on Higgins' PTs. Long canister atop the tube was a compressed air flask used to eject the torpedo (PT Boats, Inc.)

<sup>143</sup> Interview with Robert Dunphy, Tallahassee, Florida, 18 March 2004.

<sup>144</sup> Robert Bulkley, *At Close Quarters*, 34; Robert Dunphy, former Torpedoman First Class (TM1c) Squadron 17 and 39 in an interview with the author on 18 March 2004. Bob said that as the smallest man in the crew it was his job to be shoved into the tube to clean it. Bob Ferrell, *Early Elco PT Boats*, 32; Norman Friedman, *U.S. Small Combatants*, 157; and Norman Polmar, *PT Boats at War*, 35. The Soviets had many torpedo boats built at U.S. facilities and they usually employed the Higgins designed Mk 19 launcher that used compressed air.



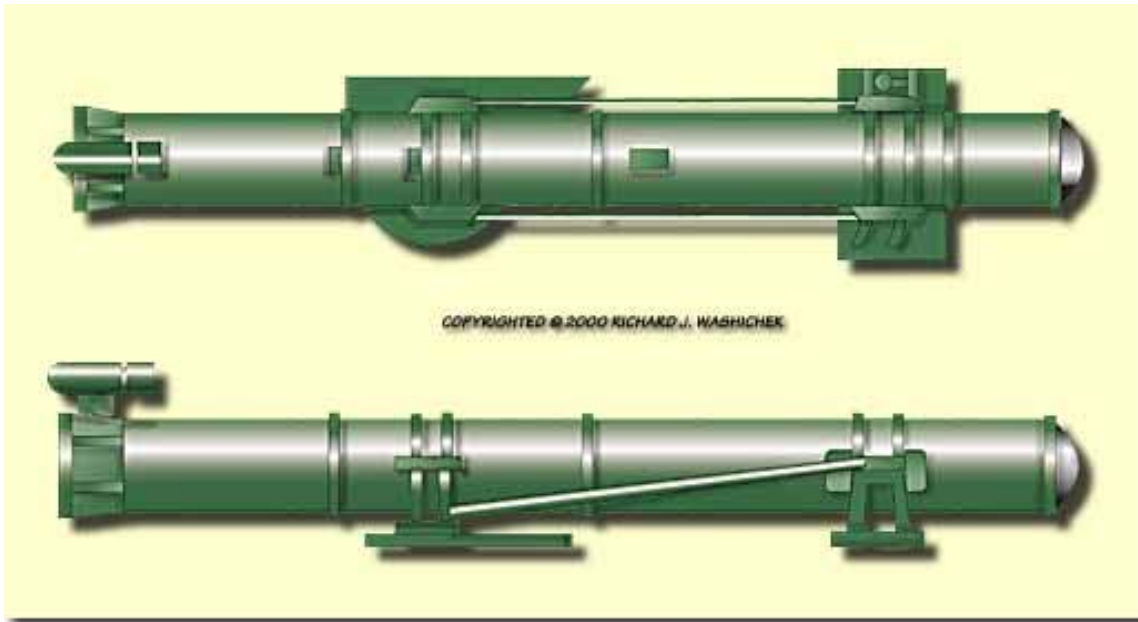


Figure 21. The 21" torpedo tube used on Elco PTs. The upper view shows the two pads the tube rested upon. The circular pad to the left was a swivel mount, the one on the right held a worm screw gear so that the tube could be traversed for firing. The lower view shows the tube in profile. The raised canister on the left held the black powder charge at the rear of the tube that ejected the Mark VIII torpedo (PT Boats, Inc.)

Most of the Mk VIIIs used on the PTs had been built in the early 1920s at the Naval Torpedo Station at Newport, Rhode Island. Their steam turbines could propel them at a speed of thirty-six knots, useful against slow merchant ships but of less value against Japanese destroyers and cruisers which were capable of more than thirty knots. They were delicate weapons requiring constant maintenance and even then were prone to failure in action. There are numerous accounts of torpedoes running too deep, taking erratic courses, or failing to detonate upon contact with a target. Not all torpedo problems were mechanical in nature, however. PT crews seldom fired practice rounds because in the first year of the war torpedoes were expensive and in short supply. Realistic training exercises were rare and few Pacific crews became proficient torpedo marksmen.<sup>145</sup>

<sup>145</sup> Robert J. Bulkley, Jr. *At Close Quarters*, 34, 295-296, 297, 300; Dunphy, interview with author; Bob Ferrell, *Early Elco PT Boats*, 49; Norman Friedman, *U.S. Small Combatants*; Norman Friedman, *U.S. Naval Weapons*, 268; Dick Keresey, *PT 105*, (Annapolis, Naval Institute Press, 1996), 23 and Norman Polmar, *PT Boats at War*, 36. The sources differ substantially in the specifications they give for the Mk

The heavy weight, large size, and erratic behavior were enough to condemn the Mk VIII as an unreliable weapon but there were numerous other problems as well. The warhead contained 466 pounds of high explosive, a relatively light charge and half as much as that found in the Japanese Long Lance torpedo. Although it had a range of 16,000 yards, this was of little value in a torpedo boat since most PT attacks were made at close range. The boats were less stable firing platforms than destroyers and submarines and lacked the mechanical torpedo computational equipment to make accurate long distance shots. Furthermore, the Mk VIII was meant to be used against deep draft vessels and was designed to run well below the surface. It may have been armed with the highly secret Mk VI magnetic exploder (the evidence is unclear) that was meant to detonate when tripped by the target's magnetic field. The intent was to have the torpedo pass under the target and to explode directly underneath it. The incompressible nature of water would force the destructive power upward breaking the back of the enemy vessel. It was an insightful concept but never achieved reliability during the war. Besides, many of the PTs targets were shoal draft coastal lighters operating in shallow seas so depth settings had to be set for running just below the surface. Unfortunately, the bellows system that maintained depth was unreliable at these settings and the torpedo might either porpoise out of the water or dive well below the target.<sup>146</sup>

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VIII torpedo. Bob Ferrell and Al Ross give a weight of 3,050 pounds, range of 10,000 yards, and speed of 27 knots. Dick Keresey writes that the Mk VIII ran at 27 knots. Norman Polmar gives it 36 knots, a range of 16,000 yards, and a weight of "2,600 pounds with a warhead of 466 pounds of TNT." It is unclear if the figure "2,600" includes the warhead. Norman Friedman is a respected naval scholar noted for attention to detail. Yet, two of his books were consulted here and they contradict each other. In *U.S. Small Combatants* he gives the following data for the Mk VIII: Range 10,000 yards, speed, 27 knots, warhead 300 pounds. In *U.S. Naval Weapons* he gives 16,000 yards at 36 knots, a weight of 2,600 pounds with a 466 pound warhead. Again, there is some confusion whether 2,600 pounds includes the warhead. Robert Dunphy recalls that at the torpedo school in Norfolk he was taught that the Mk VIII had a range of 8 miles or over 14,000 yards and that the internal flask that held air for the steam turbine power plant was pressurized to 2800 pounds per square inch and occupied almost half the length of the torpedo.

<sup>146</sup> Robert Bulkley, Jr. *At Close Quarters*, 34, 295-296; Bob Ferrell, *Early Elco PT Boats*, 49; Norman Friedman, *U.S. Naval Weapons*, 268; Dick Keresey, *PT 105*, 23; and Norman Polmar, *PT Boats at War*, 35.

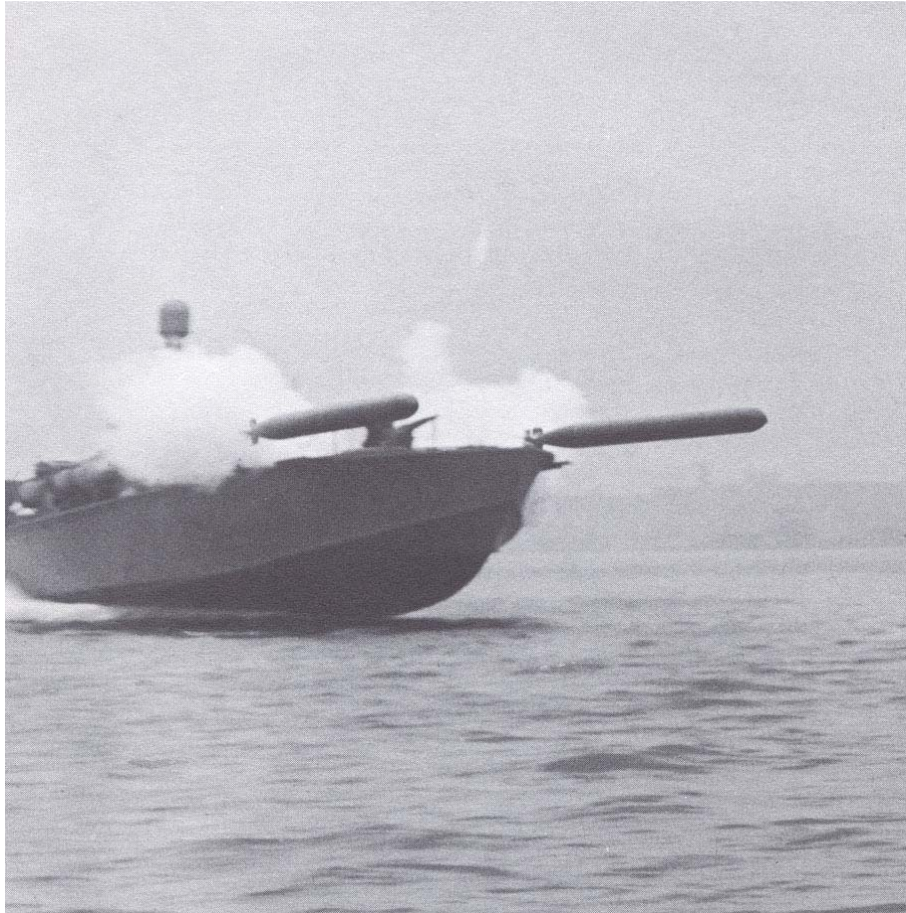


Figure 22. ELCO 80' firing torpedoes. This is why PT sailors hated the ELCO torpedo tubes. The flash is impressive in daylight training but revealed position in nighttime attacks. The boat is an early series ELCO 80. Size and shape of radar dome indicate the photo was taken in late 1943 or early 1944 (US Navy)

This situation prevailed until the Mk VIII was replaced in late 1943 by the lighter, more powerful, more reliable Mk XIII. This smaller weapon was designed for use as an aerial torpedo, therefore weight was a significant factor in its construction. Though slightly broader than the Mk VIII at 22.5 inches it was only 13.5 feet long, and weighed 2,216 pounds. Though lighter than its predecessor, the Mk XIII carried a heavier charge

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Friedman and Polmar give the range as 16,000 yards at 36 knots. Ferrell and Keresey list it as 10,000 yards and 27 knots. Bulkley uses 10,000 yards at 27 knots with a 300-pound warhead.

of 600 pounds of Torpex in its warhead. It delivered a speed of 33.5 (46?) knots with a reduction in range to 6,300 yards. The shorter range was not significant in torpedo boat warfare for reasons already discussed – successful PT attacks were conducted at short range since they lacked sophisticated targeting equipment and the boats were often unstable launch platforms.<sup>147</sup>

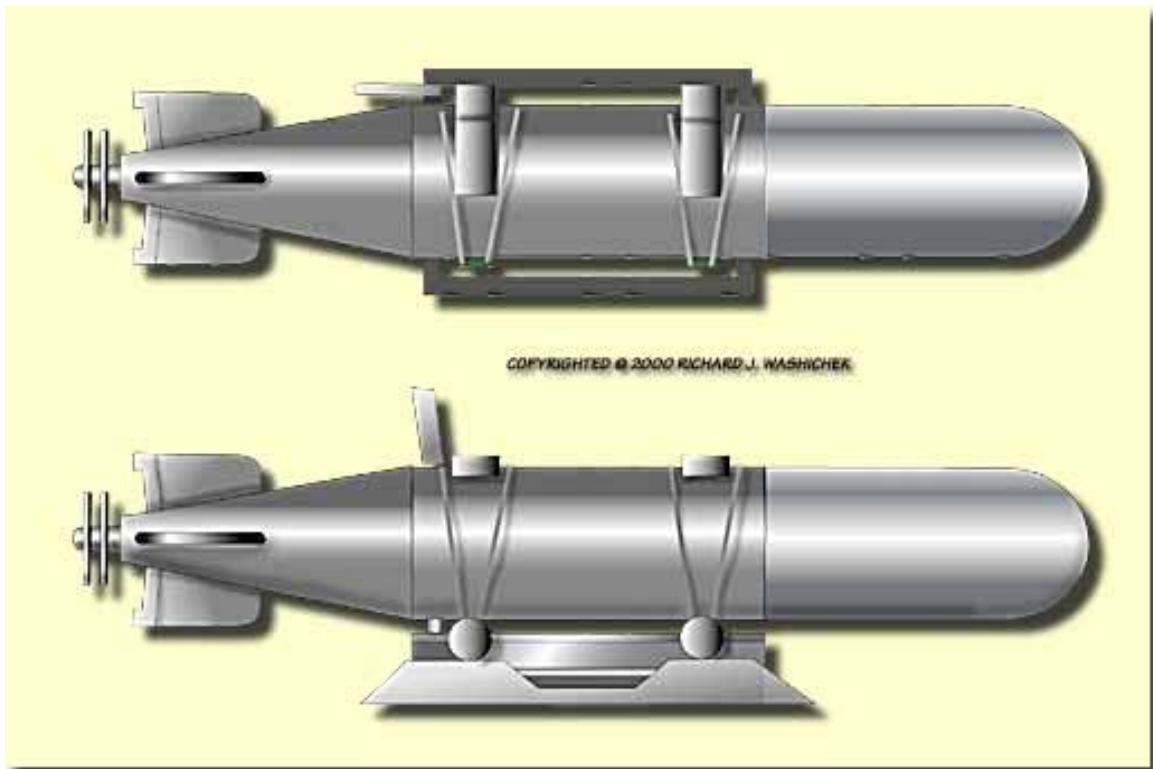


Figure 23. Mark XIII aerial torpedo in side launching rack (PT Boats, Inc.)

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<sup>147</sup> Norman Friedman, *U.S. Naval Weapons*, 117, 268; Norman Friedman, *U.S. Small Combatants* 121. In *U.S. Naval Weapons* Friedman writes that the Mk XIII ran at 33.5 knots but in *U.S. Small Combatants* he credits it with a speed of 46 knots, a range of 6,000 yards and a warhead of 813 pounds. The lethality of the Mk XIII warhead was more than a matter of weight. The Mk VIII carried 446 pounds of TNT while the MK XIII held 600 pounds of Torpex, a TNT derivative. Since 1 pound of Torpex has the explosive power of 2 pounds of TNT the new warhead was almost three times as powerful as the old one.

Arguably, the greatest advantage of the Mk XIII was the weight reduction and the use of the new launching technique that accompanied it to the field – the side launching rack. The legend persists that Lieutenant George Sprugel and Lieutenant (j.g.) James Costigan of PT 188 invented this device one evening in February 1943 in a New York bar. It was a relatively lightweight mount of 540 pounds similar to a depth charge rack. The torpedo rested in two semicircular arms instead of a 1,450-pound tube. To fire, a lanyard was pulled that started the motor and triggered a blast of compressed air to start the gyrocompass. Then a pin was pulled and the torpedo rolled off the side into the water with its propellers turning at full speed. A model was made at the New York Navy Yard and successfully tested for Bureau of Ordnance officials at the Newport Torpedo Station. By August 1943 it had been adopted as standard for U.S. PTs and was used with the Mk VIII and Mk XIII although the latter soon became more common.<sup>148</sup>

Yet the new torpedo was not without fault. In at least one case, a torpedo circled back on the boat that had fired it and hit an adjacent PT in the stern. The “fish” lay half in and half out of the transom and fortunately had not traveled far enough to arm the exploder in the warhead. Problems with course and depth keeping, contact and magnetic detonators, and premature explosions would continue to a declining degree throughout the conflict.<sup>149</sup>

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<sup>148</sup> Norman Friedman, *U.S. Small Combatants*, 157. Thanks to Bob Dunphy for explaining the mechanism of this mount.

<sup>149</sup> Robert Bulkley, *At Close Quarters*, 311-312; Robert Dunphy, interview with the author, 13 April 2004; and Russ Hamachek, *Hot, Straight and True: An Anecdotal View of PT Boats in World War II*, (Portland, OR: Self Published, 2001), 78-79. This was evidently a problem with both models of torpedoes. Hamachek relays a story told to him by Rumsey Ewing, skipper of PT 191 where a coral reef was misidentified as a surfaced Japanese submarine. PT 191 launched two torpedoes. One hit the reef but the other, a Mk VIII circa 1925, circled back fully armed and passed under the bow of the boat. The year of production was known because torpedoes were issued with logbooks detailing their history. Many had been used repeatedly over the years with practice warheads. The practice warhead was loaded with water to approximate the weight of the actual live warhead. It was then fired and as it moved through the water the air flask that spun the turbine gradually emptied. At a certain point, this reduction in pressure in the flask triggered a valve to blow the water out of the warhead causing the expended torpedo to rise to the surface and float vertically with its nose in the air. A torpedo retriever would then pick it up by a pad eye mounted in the nose in lieu of the detonator and recover the torpedo to be used again after overhaul.

Still, the new torpedo and its mounting racks brought a new measure of reliability to torpedo boat warfare and it wrought a tremendous savings in weight on a very weight-sensitive vessel. If bogged down with too much heavy gear the boats could not obtain the speed they needed to reach their patrol areas in darkness and to elude their adversaries. The Mk VIII with its Mk XVIII tube weighed 4,500 pounds. The Mk XIII in its rack weighed approximately 2,700 pounds. When four torpedoes were carried this gave a savings of 7,200 pounds. This weight reduction came at a crucial time for the character of the war in the Pacific and the role of the American motor torpedo boat was about to be altered dramatically.<sup>150</sup>

Changes in the nature of the Pacific war mandated that gun armament be increased. The motor torpedo boats, or MTBs, had originally been intended to make either a high speed or covert approach on an enemy vessel, launch torpedoes, and withdraw quickly under cover of darkness. In the first two years of the war, the MTBs had fulfilled this role in holding actions in the Philippines and in combating Japanese cruisers, destroyers, and transports in the Solomon Islands. As the tide of battle turned against Japan, the Imperial Navy was forced to abandon the use of large vessels to supply and reinforce its garrisons in the battle zone and came to rely upon self-propelled barges, small lighters, and shallow draft coastal freighters to keep its forces from starving. In this case, the term barge is somewhat of a misnomer. Although comparatively slow, they were difficult to detect at night and many were heavily armed and armored. With these craft, the action moved from the confined, but deep-water channels and sounds to shallower water close to the littoral. Here the enemy could seek to blend with the shoreline while operating at night and could seek refuge from prowling U.S. aircraft during the day. This was an arena where torpedoes had little value but rapid and voluminous firepower was essential. It was under these circumstances that the American PT boat was transformed from torpedo launcher into a hard-hitting, high-speed gunboat.<sup>151</sup>

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<sup>150</sup> The actual weight savings is difficult to assess precisely due to the varying figures previously noted.

<sup>151</sup> Robert Bulkley, *At Close Quarters*, 131-132; Dick Keresey, *PT 105*, 51.

The early armament of two dual mounted 0.50 machine guns soon proved unequal to the new mission. These were air-cooled weapons mounted in pairs in two gun tubs, often erroneously called turrets. The gun tubs were located on opposite sides of the deck – one on each side of the cockpit in the 77-foot Elco and the Higgins boats but later staggered in echelon in the 80 foot Elco. This latter arrangement allowed all guns to bear on a surface target off the beam simultaneously. The previous alignment on the “77” had meant that only one set of guns could bear on a surface target at any one moment. On the Higgins’ boats this problem was never resolved and for the duration of the war the forward “50s” could not be brought to aim at a surface target within thirty degrees of the bow. This was a significant shortcoming since it meant that a boat charging into attack could not bring its machine guns to bear at the crucial time when suppressive fire was most important. As the war progressed and field modifications were put in place, “50s” sometimes appeared as a dual barrel mount on the bow, as in Elco 77s PT 45-68. Throughout the war in the Pacific they were often found as single free-swinging weapons variously mounted on the bow, cockpit rails, and on pedestal mounts on the side decks.<sup>152</sup>

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<sup>152</sup>Bob Ferrell, *Early Elco PT Boats*, 48.

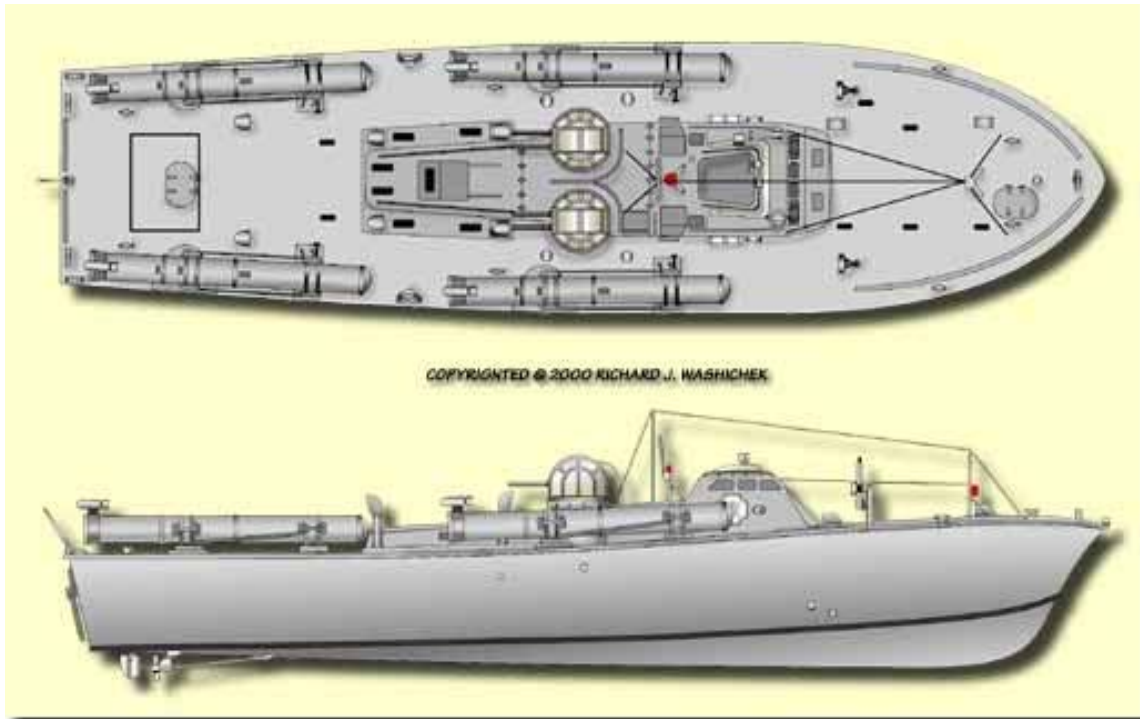


Figure 24. PT 20. This was the first of the 77' Elco boats. It carried four torpedoes in tubes and two 0.50 caliber machine guns in each of its bubble turrets. The plexiglas had a tendency to fog in use and this type of installation was soon discontinued. The gun tubs remained open for the rest of the war (PT Boats, Inc.)

The “50” was a modification of the Browning M2 which was then standard in the U.S. Army and continues in service world-wide. It had a muzzle velocity of approximately 2900 feet per second with a rate of fire of 500 rounds per minute. Projectiles were fed through a disintegrating link belt and housed in special arc shaped, open top ammunition boxes that conformed to the shape of the gun tub. The M2 and its derivatives were made before and during the war by Frigidaire, AC Spark Plug, Saginaw Steering Gear, Colt, and numerous other firms. It was so rugged and deployed in such numbers that it is a common artifact on Pacific battlefields and wreck sites.<sup>153</sup>

While they had a rapid rate of fire, battlefield reports show the Navy’s 0.50 machine guns were prone to jamming after a few rounds and had limited range. They were excellent anti-personnel weapons but their limited range meant that in the anti-aircraft role by the time an attacking airplane was close enough to be fired upon effectively, it would

<sup>153</sup> Joseph E. Smith, ed. *Small Arms of the World*, (Harrisburg, PA: Stackpole Books, 1969), 713.



have already dropped its bomb or torpedo. The “50s” might ensure the pilot did not live to fly another day but they could not prevent his aircraft from destroying the boat, too.<sup>154</sup>

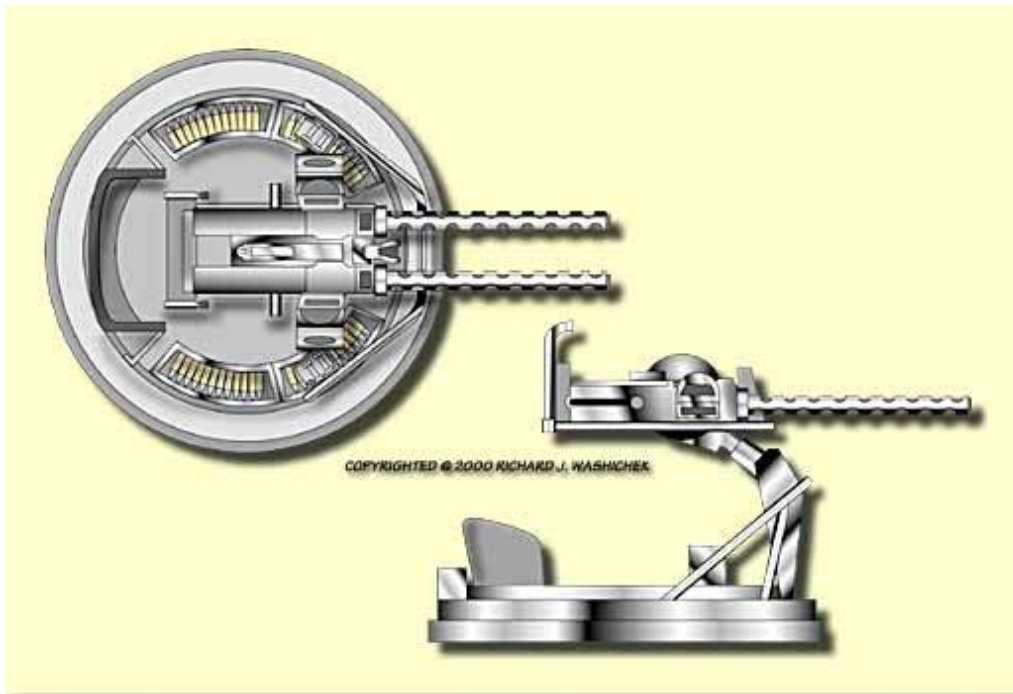


Figure 25. .50 Caliber Browning machine gun on swivel ring (PT Boats, Inc.)

Beginning with the second series of Elco 77s (PT 45- 48 and 59-68), a 20mm Oerlikon was mounted on the aft deck to increase anti-aircraft protection. This gun was of Swiss origin and had given credible service in the Spanish Civil War. The Model 1934 then in use had a low rate of fire of 265 rounds per minute. Nevertheless, the Japanese Navy had adopted it as service standard and the infusion of funds from that deal had allowed the Oerlikon Company to continue to refine the design and increase its rate of fire. The British accepted it after several years of testing, primarily for anti-aircraft defense, and successfully lobbied the U.S. Navy to adopt it in 1940. It became “the most widely used

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<sup>154</sup> Ibid.

naval automatic weapon of World War Two” and was notable because it was the first time in decades that the United States Navy had adopted a foreign weapon.<sup>155</sup>

The Oerlikon, labeled Mk 1 through Mk 4, was an adaptable weapon. It had a 70-caliber barrel, a rate of fire of 450 rounds per minute, firing a .27-pound projectile with a muzzle velocity of 2770 feet per second. With a weight of 150 pounds it could be moved by two men and was fed via a tangential drum magazine. The 20mm was found in single, twin, and quadruple mounts. While the last two incarnations were powered, the single mount was free-swinging and allowed the operator to bring it to bear very quickly. This was the way it was used in the boats. Initially, the Mk 4 mount was used. This was a heavy, wide, cone-shaped pedestal made of cast metal that was incorporated on ships where weight was a less critical factor. Most 20mm guns installed on the aft deck used this configuration but as tactical challenges changed, squadrons sought ways to avoid the weight penalty and its effect upon vessel performance. Lightweight PT boats needed another option and developed the lighter tripod mount that became standard for Oerlikons mounted on the bow. Still, armed with a single 20mm Oerlikon and an array of 0.50 caliber machine guns it was quickly realized that the American PT was too lightly armed to fulfill its new role of interdicting armed and armored coastal supply vessels.<sup>156</sup>

By late August 1943 the PTs barge-busting patrols were showing the shortcomings of the standard equipment. Lieutenant Commander Robert Kelly, commanding the boats at Lever Harbor, New Georgia wrote:

Heavily armored large barges with 40mm. and machineguns escort the medium barges that carry only machineguns and /or 20mm. In order to sink a barge, the range must be closed well within 100 yards and more than 1,000 rounds of .50 caliber and 500 rounds of 20mm. are required...This requires laying to at

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<sup>155</sup> Norman Friedman, *U.S. Naval Weapons*, 76. In naval parlance caliber refers to the length of the barrel, not the diameter. A 70 caliber weapon has a barrel seventy times the diameter of its bore.

<sup>156</sup> There is a functional 20mm Oerlikon mounted on the bow of a partially restored Higgins PT at Battleship Cove Museum, Fall River, Massachusetts. The gun is made of heavy stampings and machined turnings.

point blank range of shore batteries and barges for approximately 10 minutes which is tantamount to sacrificing the PT boat.<sup>157</sup>

It was clear that if the boats were going to accomplish their mission or even survive, much heavier weaponry was needed. Operating at a time and in a theatre when supplies were scarce, creative crews used numerous field expedients to increase their boats' firepower. One of the first experiments was mounting a single shot Army model 37mm antitank gun on the bow. Squadron 5 did this in some of their boats in the summer of 1943 but the cumbersome weapon with its slow rate of fire was a stopgap measure. Much more successful was the introduction of an Army aircraft gun modified for shipboard use. This was the Army 37mm automatic originally designed for and installed in the P-39

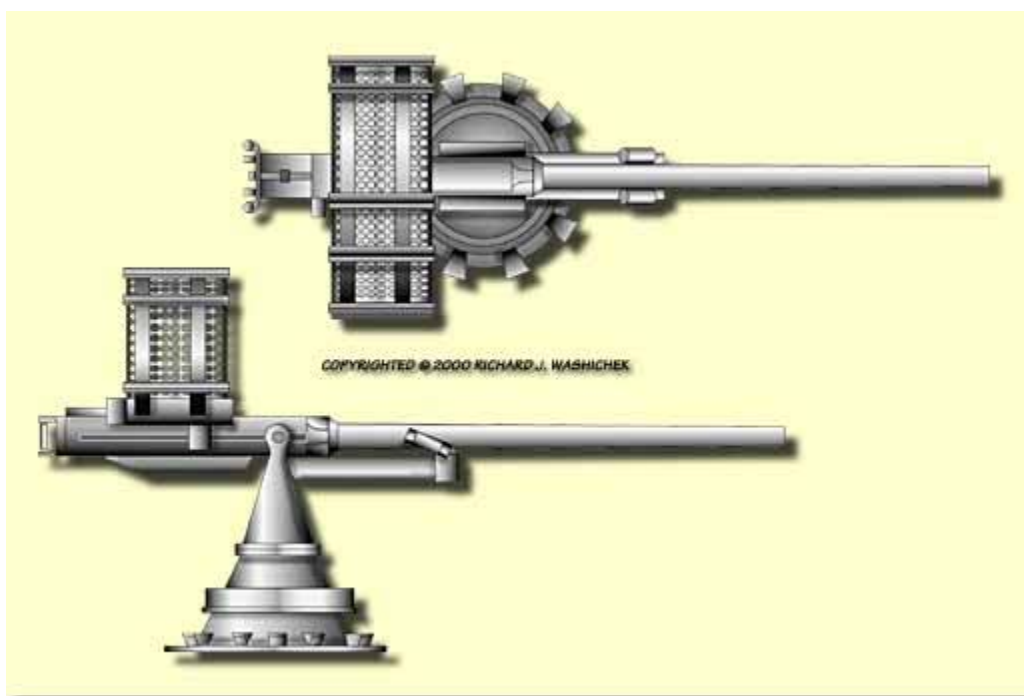


Figure 26. 37mm automatic on factory mount (PT Boats, Inc.)

<sup>157</sup> Robert Bulkley, *At Close Quarters*, 131.

Airacobra fighter. The aircraft itself was considered a failure, lacking speed and ceiling, but much about it was highly creative including placing the engine behind the pilot with a long shaft passing through the cockpit to drive the propeller via gears. By having the engine out of the way, designers were able to install guns in the nose instead of the wings for a no-deflection shot. In aircraft service, the 37mm actually fired through the hub of the propeller and utilized a unique curved magazine arched to fit the shape of the fuselage. This feature was retained when creative PT ordnance personnel adapted the gun for surface fire. Their work was so successful that the 37mm was retained throughout the war. Also designated as Mk 4(M9 in Army nomenclature), the 37mm was designed and built by Browning, weighed a paltry 213 pounds, and fired 150 rounds per minute with a muzzle velocity of 2,000 feet per second. Its 56-caliber barrel gave it an effective range of 4,000 feet.<sup>158</sup>

The most important gun aboard was the multipurpose, rapid firing 40mm Bofors, another import, usually mounted on the aft deck in lieu of the 20mm Oerlikon that was then moved to the foredeck. This weapon had been developed by a Swedish firm and adopted for anti-aircraft use, specifically against dive-bombers. It replaced the old 1.1-inch gun so common in the pre-war U.S. Navy inventory and packed much greater firepower than its predecessor. The Bofors used armor-piercing, high explosive, and incendiary rounds that weighed slightly under 2 lbs, twice that of the 1.1" and boasted a rate of fire of 160 rounds per minute with a muzzle velocity of 2,890 feet per second. While the Oerlikon could punch a hole of about 1 inch in a barge, and the 37mm left a three-inch hole, the Bofors gun smashed a foot wide hole in its target. It was loaded from the top using a four-round clip and these artifacts can still be found on numerous warship wreck sites.<sup>159</sup>

Army-model 40mm guns were initially installed on PT boats in August 1943. John F. Kennedy's PT 59, an old Elco 77' he commanded after the loss of PT 109, was one of the first to receive the new armament. No account of the boats would be complete without mention of John F. Kennedy and PT-109. A debate has been carried on for decades about

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<sup>158</sup> Norman Friedman. *U.S. Naval Weapons*. 233, 237.

<sup>159</sup> Norman Friedman, *U.S. Naval Weapons*, 78.

his culpability in the loss of the boat in the collision with Japanese destroyer *Amagiri*. A definitive discussion is beyond the scope of this paper but this writer's conclusion, based upon study of several secondary accounts, a review of Lt. Byron White's incident report, and study of the technical details of the operation of an 80-foot Elco, finds that throughout his tour of duty JFK performed in a highly professional, responsible, and brave manner. There appears to be nothing he could have done to avoid the collision as he had less than 20 seconds to assess the situation, convey appropriate orders to the engine room, and have those orders executed. PT-109 was running on its amidships engine at idle speed with the muffler engaged as ordered to reduce noise and wake. There was not enough time between recognition of *Amagiri* and the collision to start the other two engines, disengage the muffler, and accelerate out of the way. It appears that Kennedy did attempt to maneuver out of harms way since the recent discovery of the wreckage shows that the boat was not cut in half but instead the starboard quarter was sheared off.<sup>160</sup>

PT 59, along with PT 60 and PT 61, was stripped of torpedoes and then mounted an Army-style Bofors on the fore and aft decks. These were air-cooled, manually aimed weapons, as opposed to the water-cooled, hydraulically trained guns found on larger vessels. The Bofors made its appearance at a propitious moment – barge busting had become the primary PT mission in the Pacific, and squadrons deployed in the Mediterranean were encountering heavily armed coastal lighters and German E-boats in Italy and needed its firepower. It became increasingly valuable in an anti-aircraft role since the range and power of the 20mm was inadequate for this purpose. While a 20mm might kill an enemy it could not do so before he had dropped his bombs or torpedo, whereas the Bofors could knock a plane out of the sky before it was able to hit its target. When fitted with variable-timed proximity fuses, VT, the 40mm did not even have to hit the incoming aircraft. The VT fuse had radar in its nose and when the round passed close by an aircraft it would cause the shell to detonate. This was often close enough so that the concussion and shrapnel might bring the plane down. At a minimum, it made it tougher

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<sup>160</sup> Nelson addresses this issue thoroughly in *Hunters in the Shallows*. Curtis L. Nelson, "Did JFK's Order Sink PT-109?" *Naval History* 17(1), 2003:24-27; Rich Petroncelli, "JFK: A PT Skipper Remembers." *Naval History* 13(6) 1999: 24-27.

for the pilot to maintain control and his aim. These characteristics became ever more important as the Japanese resorted to kamikaze techniques late in 1944. The Oerlikons quickly lost favor and the demand from the Fleet was for more 40mms.

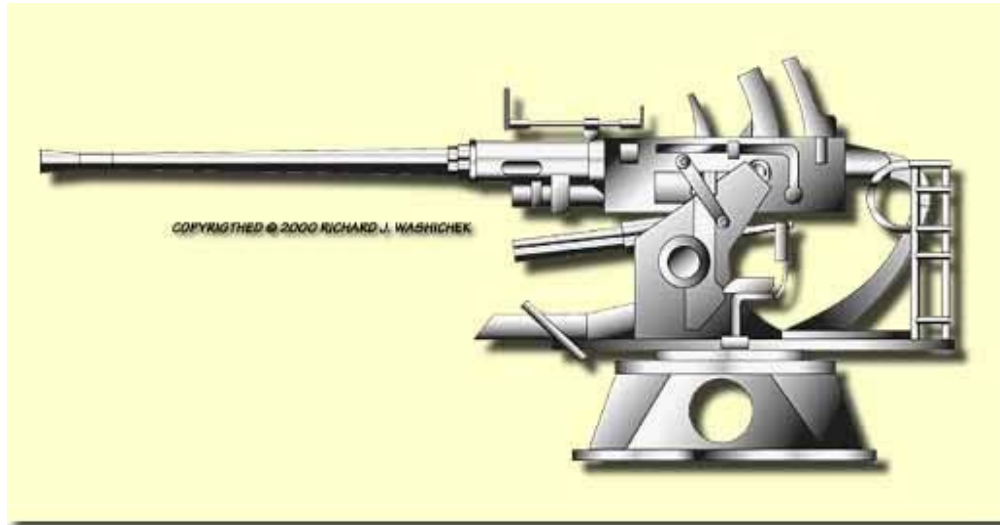


Figure 27. Army style 40mm Bofors as used on PT boats (PT Boats, Inc.)

A common trait of all gun systems found on the boats was their ruggedness, relative ease of maintenance, and reliability under combat conditions in the tropics. They had to be exceptionally robust because of the nature of the vessel and its combat role. High-speed operation meant lots of salt spray covered every surface. Operations in forward areas at the end of a long logistics pipeline meant that maintenance materials were often difficult to obtain or nonexistent, crews had to be show enterprise in both techniques and materials to keep the PTs combat ready.

The year 1944 saw other changes in weapons, mission, and techniques. Torpedoes steadily lost favor in the Pacific as suitable targets became rare. While the Mark XIII was a tremendous improvement over the Mark VIII, U.S. torpedoes still had limited range, could not be controlled after launch, and were limited to use against sizable shipping targets in a conflict where the boats were increasingly fighting shore targets and craft too small and shallow draft to be suitable for torpedo warfare. Still, there was a desire to maintain a ship-killing weapon. Barrage rockets were one of the alternatives considered. They were cheap and readily available since they were used in copious quantities by specially equipped landing craft converted to amphibious support craft by the installation

of hundreds of rocket launchers. The rockets were less than optimal since they set off a flare-up upon firing that revealed the PTs position. Nevertheless, by war's end some officers were arguing that this weapon should replace the torpedo as main battery armament. As early as October 1944, no less an authority than Captain (later Rear Admiral) Selman S. Bowling, former commander of Squadron 21 and Commander, Motor Torpedo Boat Squadrons, Seventh Fleet, wrote: "Rockets are generally regarded in the Task Group as the greatest potential PT weapon of the war...Rockets of sufficient size, power, and range are now available or under development to make replacement of the torpedoes and heavy automatic weapons seem entirely feasible."<sup>161</sup>

Bowling prophetically foresaw the development of the fast missile patrol boats of the Osa and Komar classes the Soviet Union designed shortly after the war. Though these boats are now obsolete this type of low profile, high-speed patrol craft equipped with medium range ship-to-ship missiles are still the mainstay of many smaller navies and are direct descendants of the American and British PTs of World War Two. The first rockets mounted in the MTB squadrons were converted from other uses, like most PT weapons. Rockets offered the advantages of relatively lightweight and heavy firepower for limited periods of time. The Navy experimented with multiple tubes for firing the Army's 2.36-inch bazooka round but range was too short and a better answer was found in-house.

The 4.5-inch rocket was originally deployed en masse aboard converted launching craft to provide fire support during amphibious operations. This was a fin stabilized weapon of limited accuracy (not a critical factor in shore barrage) and in the boats it was used in angled launchers mounted forward of the torpedoes. It weighed twenty pounds and carried a 6.5-pound payload of TNT to a maximum range of 1,000 yards. They were used at Rendova in the Solomon Islands as early as March 1944. The fins complicated loading and by August 1944 California Tech had designed and tested a 5-inch spin stabilized rocket that was accepted and employed aboard boats in the Philippines by March and April 1945. These were mounted in a Mark 50 launcher that had eight tubes with rifling to impart a spin to the projectile, which had a range of 10,000 yards. This

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<sup>161</sup> Robert Bulkley, *At Close Quarters*, 305.

weapons system came into widespread use during the last months of the war in the Pacific.<sup>162</sup>

There had been discussion of an antisubmarine role for some or all PTs prior to U.S. entry into the war. Twelve of the original 70-foot Elco craft were designated PTC 1-12 and were almost identical to the first PTs except for the absence of torpedo tubes and the proliferation of depth charges in their place. They were equipped with simple sonar devices that detracted from performance underway and at rest. When experiments were conducted at Key West in 1941, it was decided that the underwater noise generated by the hull and running gear placed antisubmarine warfare beyond PT capabilities. Nevertheless, throughout much of the war depth charges were installed in limited quantities and the ever-resourceful crews found unique uses for them. Depth charges were used in barge busting attacks in the Pacific where it was learned that the concussion of this weapon could sink a ship or even break its back if it could be set to explode close alongside an enemy vessel. Depth charges could be dropped in the path of an oncoming adversary and the subsequent detonation often caused enough damage or fear to stop pursuit of a fleeing PT.<sup>163</sup>

Not every weapon aboard was offensive in nature. Each boat had a smoke generator mounted well aft and the squadron records are filled with reports of smoke screens laid by PTs that saved themselves, shielded landing craft, or protected larger U.S. ships. The smoke generators were sometimes hazardous as they had a tendency to go off uncontrollably when struck by enemy small arms fire. The mount was designed to permit rapid change of the chemical canister but it was still a dicey proposition to access the release mechanism when enveloped in a cloud of thick, noxious smoke.

With the exception of the quadruple barrel, 20mm mount Thunderbolt, PT weapons were adapted from other sources and not originally intended for service in the boats. Nevertheless, as the mission of the boats evolved from one of torpedo attack to that of

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<sup>162</sup> Captain Richard Sharpe, ed. *Jane's Fighting Ships. 1992-93*. Jane's Information Group Limited, Surrey, United Kingdom. 1992. Numerous entries to include 171, 172, 306, 307, 527-529, 629, and 630; Norman Friedman, *U.S. Naval Weapons*, 232-233.

<sup>163</sup> Bob Ferrell and Al Ross, *Early Elco PT Boats*, 23-25; Norman Friedman, *U.S. Small Combatants*, 125.



gunboat and close support, weapons systems successfully changed with it. By November 1944, standard PT armament included two or four Mark XIII torpedoes in Mk 1, Mod. 1 side launching racks, a 40MM Bofors on the aft deck, and both a 20mm Oerlikon, and a 37mm cannon on the foredeck. The 37mm was usually mounted well forward on the centerline while the 20mm was offset and abaft of it on the port side. A number of .50 caliber machine guns were scattered about the vessel – four could be found mounted as twins in the two gun tubs, and other free-swinging guns were mounted on “pipe stem” mounts adjacent to the torpedoes. The smoke generator was retained as far aft as possible. The American PT boat had become, for its displacement, the most heavily armed warship in the world.

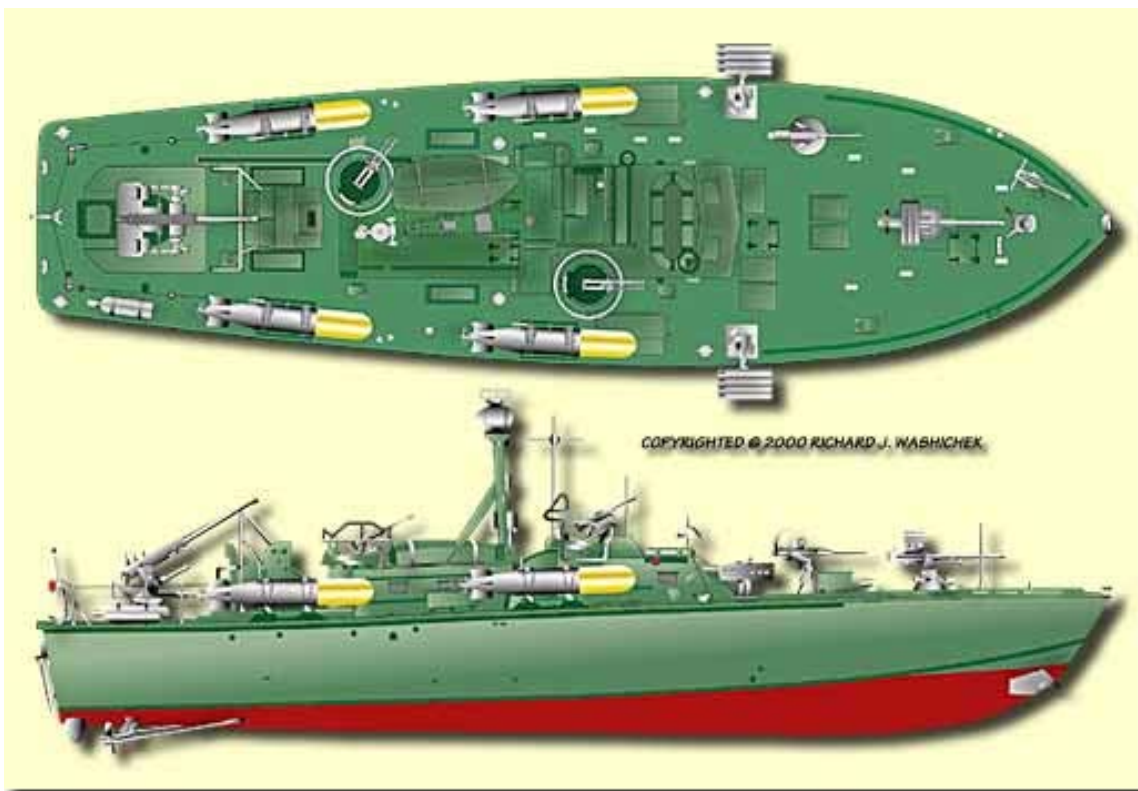


Figure 28. PT 426. This was the final product. PT 426 was completed late in 1944 and was typical of the late-war boats. For its displacement, it was the most heavily armed warship in the United States Navy (PT Boats, Inc.)

## CHAPTER 9

### A NEW MISSION FOR AN OLD WARRIOR<sup>164</sup>

We cannot sit out in the deep blue, waiting for the enemy to come to us. He will not. We must go to him. We need a green water capability and a brown water capability....I want the ability to go close in and stay there. I believe our Navy is missing a great opportunity to influence events by not having a riverine force. We're going to have one.

Admiral Michael G. Mullen<sup>165</sup>

The Japanese surrender came as a welcome surprise to the MTB forces spread across the globe. Veterans would and still do proclaim they felt reprieved from a death sentence. August 1945 found squadrons from Europe and the Mediterranean either preparing to return to the United States, already aboard ship and underway, or in various domestic yards undergoing refit in preparation for redeployment to the Pacific for the invasion of Japan. New boat construction had started to decline in May as the Navy felt that the returning boats and those already under construction and in the Pacific gave it an adequate coastal force for the home island invasions. The presence of PTs was considered vital for this effort since intelligence revealed that the kamikaze culture was not confined to aircraft. Thousands of small boats packed with explosives had been constructed and horded in Japan in readiness for the invasions that seemed inevitable. These craft of from 20'-40' were secreted in the vicinity of likely landing sites and were to be launched in mass waves similar to their airborne cousins. Fortunately, the bomb meant that hundreds of thousand of soldiers, sailors, and marines would not be exposed to this deadly danger and in the weeks and months following the Japanese surrender these boats were disarmed or destroyed. They had gone from being a terrible menace to objects of curiosity.

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<sup>164</sup> Most of this chapter was previously published as "Bring Back the Boats," *United States Naval Institute Proceedings*, February 2006. Reprinted with permission.

<sup>165</sup> Admiral Michael G. Mullen, US Navy, Chief of Naval Operations, to students and faculty of the Naval War College, Newport, Rhode Island, 31 August 2005.

As for the American MTB squadrons, the Navy brass declared them surplus almost immediately. In fact, the speed with which the squadrons were decommissioned, boats disposed of, and personnel reassigned or discharged shows that the plans for demobilization of the PT force must have been worked out well in advance. Some were loaned or given outright to foreign governments. Hulls under construction, being refitted for service in the Pacific, in Squadron Four at Melville, or otherwise deployed stateside were usually sold as salvage. Some of these found new post-war careers as yachts or commercial fishing or ferry vessels.

The Motorboat Act of 1940 placed rather lax manning and equipment requirements on commercial hulls of 65 feet or less so many of the boats suffered the humiliation of being cut down to 65 feet over all. PT 48, veteran of gallant service in the Solomon's and later in Squadron 4, had her length reduced and freeboard cut dramatically low. The new owners removed the gas guzzling Packard V 12 engines, replaced them with surplus General Motors 6-71s, installed a high deckhouse and renamed her *Pioneer Maid*. PT 40 lost her three Packards, received two inadequate 6-cylinder Lathrops and moved to Gloucester, Virginia as *Folly*. PT 709, a 70-foot Vosper designed and built for the Royal Navy, became *Kalon I*, but retained the Packard power plants. PT 695, another Vosper built for the Royal Navy by Annapolis Yacht, was still powered by Packards and operational in Long Beach, California as late as 1974. These boats retained their original hull forms though superstructures were modified. The ones that were cut down were often classed as motorboats and registered in the homeport state instead of being documented by the Coast Guard. Hence, the paper trail soon runs cold and they disappear from the official records.<sup>166</sup>

The saddest chapter in the decommissioning saga was the burning of the boats at Samar. Few veterans can speak of it, even decades later, without fighting back tears. The United States Navy saw little use for the boats in a Cold War world and quickly removed them from the fleet. Within a year after V-J Day all but one experimental squadron had been decommissioned. Many were stripped of their gear, run aground on a

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<sup>166</sup> Lloyd's Register of Shipping, *Lloyds Register of American Yachts, 1955*, New York, 197, 270; *Lloyds Register of American Yachts, 1974*, 480.

shoal at the Philippine island of Samar, and burned. Others were loaned or given to Allied navies around the world. One of the Elco 80s that went to South Korea has since been returned and restored and is on display at Battleship Cove, Fall River, Massachusetts. Many were found to be beyond repair and were sold off. Of the boats deployed overseas, a handful made it back home. Most of these were craft from Europe sent home for a refit before being reassigned to the Pacific. V-J Day found them in yards stateside. Without need for their services, the Navy sold them. Several were converted to yachts, fishing or tour boats, or other commercial uses.

From 1946 until the late 1950s, there were fewer than a dozen MTB-type boats in the U.S. inventory. About two dozen Patrol Torpedo, Fast (PTF) boats were procured in the early 1960s and saw service in Vietnam under South Vietnamese colors but often with US crews. They were designed around lessons learned in the war and took to heart some observations from PT veteran Dick Keresey and his colleagues. Dick Keresey wrote in *PT 105*, his memoir of service in the boats, that PT organization and leadership in action often left much to be desired. It was not unusual for divisions of three boats, the norm, to go on night patrol without the boat captains and the division commander knowing each other. They might meet at the briefing but go into combat without a clear understanding of their objective and often unable to operate as a team. This had unfortunate consequences for their combat effectiveness.<sup>167</sup>

The value of a low profile was appreciated not only for escaping detection by enemy traffic but for also for avoiding being shot. This was clearly shown in a night engagement in which Ron 5's George Cookman was lost in New Georgia. Cookman was leading a division that fell in with Japanese barge traffic in Blackett Strait. Sighting the "half a dozen" barges on radar he accelerated and moved to intercept, leaving his division racing to keep up. He stood upon a step at the instant the Japanese opened fire and in elevating himself to get a clear sight of the action was cut down in the first burst. The lesson was

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<sup>167</sup> Dick Keresey. *PT 105*. Annapolis: Naval Institute Press, 1996, 107.

not lost on Keresey, a tall man who thereafter consciously sought to keep as low as practical commensurate with his duties.<sup>168</sup>

A few experimental aluminum boats were built and tested in the years that followed although none were ever equipped with torpedoes. The first U.S. Navy actions in Vietnam saw the last of the PTs. The PTF, or Nasty class, was a joint NATO project with Norway, the U.S., and the U.K. Several of these wooden boats were used in covert operations against North Vietnam in 1963 and 1964 and it has been speculated that their activities played an indirect role in the Tonkin Gulf incident. The difficulty of maintaining wooden hulls in the tropics was as real then as it had been for a previous generation and the PTFs did not become a significant presence there. Yet, the mission that they and the original PTs had been designed to fulfill persisted, as it does today.<sup>169</sup>

It was only with the advent of the Vietnam War and with the Navy's desire to find a new and relevant role that shallow water warships returned to the spotlight. Over the next few years the Navy and Coast Guard built and deployed hundreds of small craft in their riverine and coastal campaigns. Like the Elcos, Higgins, and Huckins boats, most of these were the product of civilian drawing boards and the commercial and recreational boating industries. They were disposed of after 1973 and the concept of coastal craft again lost its appeal. Fortunately, some of the lessons of the Vietnam era "brown water navy" have not been forgotten.

Ironically, the events of the past several years have concentrated attention on border security, harbor patrol, and the Navy's need to find a relevant role in current foreign policy. No less a figure than former Chief of Naval Operations, Admiral Vern Clark, has recently called for a turn away from large, costly, obsolete ships designed for Cold War missions and a renewed focus on the use of small, inexpensive, hard-hitting boats to meet

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<sup>168</sup> Dick Keresey. *PT 105*. 95-96, 104. George Cookman was the squadron executive officer, Yale 1937, and evidently admired by Keresey and the other officers. He had voluntarily gone on patrol the night he was killed.

<sup>169</sup> Six of these PTFs have been in dry storage in Norfolk since the early 1960s. They are in advanced states of decay and beyond the point of restoration. The boats sat next to the Chesapeake and Albemarle Canal at Great Bridge for decades before being purchased on speculation and moved to Chesapeake Marine. They sit there today, neglected, vandalized, stripped of most equipment, and falling apart from rot.

the demands of counter terrorist operations. For those who forget its lessons, history does repeat itself.<sup>170</sup>

The modern United States Navy consists of three major constituencies – the surface warfare fleet, aviation, and the submarine fleet. There is no support and lobby group for small combatants. The foreseeable result is that the roles of coastal defense, patrol, and riverine warfare have been habitually shunted aside. The PTs of World War Two were dismissed as soon as the conflict ended – an action repeated after Vietnam leaving the United States with no riverine or littoral force. The recent attention given counter terror and narcotics interception missions have forced the military services to reevaluate their neglect of small combatants. The large, expensive weapons platforms of all the services have little relevance to troops combating covert forces engaged in asymmetrical warfare. The United States Navy in the 21<sup>st</sup> century is by far the world's largest, most powerful, and clearly the most expensive. Ironically though, it lacks the simple capability of sending a gunboat up a river. That may be about to change.

In a recent letter from the Director, Navy Staff, implementing directives from the Chief of Naval Operations (CNO), the essence of which was reported in the *Navy Times* issue of 18 July 2005, the Office of the Chief of Naval Operations was directed to provide a plan not later than 24 August 2005 for establish of an active component riverine squadron in Fiscal Year 2005/2006 followed by the establishment of two reserve riverine squadrons in Fiscal Year 2007/2008.<sup>171</sup> For the third time in 70 years, the U.S. Navy finds itself scrambling to build a riverine/coastal warfare capability and doctrine, quickly and from scratch.

The Navy has faced this challenge before. During World War II, the torpedo patrol (PT) boats were originally built to combat larger ships along the littoral or in confined waters. Within a year after the battle of Midway, however, the PTs cast off this mission.

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<sup>170</sup> Tim Weiner, "The Navy's Fleet of Tomorrow is Mired in Politics of Yesterday," *New York Times*, Tuesday, April 19, 2005. C1-3. Weiner writes, "The Navy says it can make due with fever big ships patrolling the oceans. It wants more fast boats and aircraft to fight offshore and upriver, a speedier force to counter terror."

<sup>171</sup> "Surging still deeper into war on terrorism." *Navy Times*. 18 July 2005, p. 12.

Instead, they became a key element in providing direct fire support to ground troops and transporting small landing forces, especially in raids that destroyed Japanese shore installations and decimated enemy supply craft. These missions should sound familiar to the veterans of river and coastal warfare in Vietnam. The hard and costly lessons learned were largely forgotten after both conflicts as the Navy's leadership rushed to return to a world of large and expensive high seas ships and relegate the brown-water Navy to the archives. The end of the Cold War made the utility of the billion-dollar weapons platforms more questionable than ever. Meanwhile efforts to interdict hostile parties and secure domestic and foreign coastal areas suffered because of the institutional fixation on ships incapable of operating on inshore and inland waters.

The reasons for these recurring lapses of institutional memory are arguable, but two factors seem to prevail. First, the evidence from Vietnam is that involvement in riverine operations is not only very hazardous but is usually detrimental to an officer's career. Brown water operations are seen as taking a surface warfare officer off the preferred career track, and it is held against him at promotion time. Second, few multimillionaires are produced by the small craft industry. The firms that produce boats for this type of warfare are tiny compared to major defense contractors like Northrop-Grumman, Raytheon, and General Dynamics with their facilities employing thousands. The small players lack the political war chests and corporate-funded political action committees that command attention at all levels of government.

In short, the inability of small-craft firms to financially reward political allies condemns them to remain on the periphery of government contracting. Small craft construction is a risky, highly competitive, relatively low-margin business. This means that only the smart and the strong survive. But their very efficiency makes them invisible to politicians, bureaucrats, and officers in search of juicy contracts to hand out to political bedfellows. Former CNO Admiral Vern Clark said as much in April 2005 when he tactfully chided Congress for funding ships the Navy does not want, while ignoring very real needs.<sup>172</sup>

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<sup>172</sup> "The Navy's Fleet of Tomorrow Is Mired in Politics of Yesterday." *New York Times*. 19 April 2005. pp. C-1, C-3; Norman Polmar, *The Naval Institute Guide to the Ships and Aircraft of the U.S. Fleet*, 214-215.

Whatever the reasons for this deficiency in armament, the need for fast, heavily armed shallow-draft gunboats recurs often enough so that it should become a permanent part of the naval establishment. In Vietnam, the Navy was forced to go on a boat-buying mission and had to rapidly acquire and adapt civilian hulls. The result was conversion of an offshore oil supply vessel into the high profile, relatively slow Swift boat, the unarmored river patrol boat (PBR) of moderate seaworthiness, and numerous makeshift landing craft conversions. These performed their missions well but could have done even better had there been time and interest to tailor them to combat conditions.

A generation after the fall of Saigon the United States finds itself relearning the lessons of the past. This time the effort need not be as lengthy, painful, or expensive as it was for generations past. Records show how civilian designers and manufacturers were enlisted to develop the PT boats and landing craft of World War II and the numerous coastal and river gunboats, recon vessels, and transports used in Vietnam.

It might be wise to call on civilian small-craft experts, designers, builders, and operators, from the very beginning. To learn how a boat is going to perform, it would be wise to inquire of the civilian captains who drive them every day. Talk to the men who design and build them by the thousands can avoid costly mistakes. It is time to recall the lessons of prior conflicts and tap this wealth of knowledge and expertise to adapt civilian hulls for military needs.

The historical record shows how these vessels should be configured. Unlike the Navy's current pet projects, they must be of shallow draft; no more than two meters and less if practical. Supported transoceanic capability should not be a feature since these boats will normally not make such passages on their own bottoms. Therefore, they should be short enough to be readily shipped aboard a variety of transports. This suggests a length over all of not more than 90 feet. Selection of hull type should be the simplest question of all. The hard-chined planing hull of the 80-foot Elco and 78-foot Higgins PTs proved themselves in World War II. They shared basic characteristics with the fast river patrol vessels of Vietnam and those qualities continue to dominate the commercial and recreational market today. It is a hull form that incorporates speed, seaworthiness, and simplicity of construction. With a suitably deep V section forward, it can pierce the seas and avoid excessive pounding. The hull should feature considerable flair from the



waterline to the gunwale along its entire length. This will deflect spray for a drier, more cushioned ride and expand the usable deck space. The latter feature would be especially welcome not only for combat, but for routine maintenance as well. In short, many of the traits so desirable in a coastal/riverine gunboat are already found in excellent hulls readily at hand in a number of civilian designs and products. The Navy's Mark V also shows potential for being a starting point in the development process.

Materials such as Kevlar should be incorporated into the laminate for armor protection. Experience in the Pacific and Vietnam shows that the higher personnel are off the water the better their chances of being shot, so a low profile commensurate with seaworthiness is desirable. Modern armament systems make it possible to install a variety of direct and area fire area weapons that would be effective and of comparatively light weight.

These boats would probably be deployed in squadrons or divisions and operate from shore bases. They need not operate independently for more than a day or two so living facilities could be kept to a minimum. The space and weight saved could accommodate bigger engines, more electronic detection and communication equipment, and more ammunition. Using turbocharged diesel engines already in mass production would reduce costs, insure a reliable power plant and make for easy acquisition of parts, support, and training. These should drive well-protected conventional propellers or water jets, avoiding the fragility and complexity of exotic systems. Engines should be rigged to offer a choice of unrestricted exhaust for high speed or being well muffled to facilitate stealthy operations. This function should be readily controlled from the helm. Strength, simplicity, and efficiency should be the motto of this program.

It is unfortunate, but in both ship and small craft development the Navy often repeats past mistakes and makes errors in judgment that are easily avoidable. The design, construction, and purchase of the new *Sea Fighter* catamaran is a case in point. Though it is supposedly intended for shallow water operations, it carries a draft of more than 12 feet. The rule of thumb for retaining stability in loaded blue water catamarans calls for a length to beam ratio of 2:1, although carefully loaded multihulls used in moderate seas can be narrower. With a relatively slender beam of 72 feet and a length overall of 262 feet just how stable will this ship be, especially after being loaded with armament, crew,

munitions, and supplies and with much of this being carried high as a deck load? Its height, length, and draft make it useless for riverine ops and of limited utility for coastwise patrol.

Though supposedly fast, it is actually a large, slab sided target – a juicy invitation to the rocket systems so readily available in most of Asia and Africa. The ship must be tall of necessity since a lowered profile means a concurrent reduction in the clearance between the surface of the water and the bottom of the bridge deck spanning the hulls. If this clearance is inadequate, the underside of the deck crashes into waves instead of passing over them and the bone-jarring ride that results will exhaust the best of crews and destroy fragile electronic equipment.<sup>173</sup>

Ironically, the final product is a ship that is too large to operate effectively in shoal, confined waters and yet it is only in calm to moderate seas that its virtues of large deck area and stability can be utilized. Catamaran performance, both in maneuverability and speed, is severely impacted by weight. A useful combat load will inevitably reduce the performance of this vessel. Though the Navy and the contractor, Titan Corp of San Diego, boast that the ship will top out at 50 knots in *calm* water, it remains doubtful if such speed will be possible when carrying a full load and rigged for sea. Why should this particular speed be lauded as so magical anyway? After all, the 70-foot Higgins Hellcat torpedo boat routinely achieved similar speeds as long ago as 1943 with more inshore utility and at far lower cost.<sup>174</sup>

It can hardly be intelligently argued that this is the Navy's answer for the Global War on Terror, yet in an era of unprecedented national debt, certain elements in the naval hierarchy want to fork over \$80 million each for these high profile boxes. An entire squadron of fast, efficient gunboats could have been fielded for the same amount thus far squandered on this project. To make this situation even more deplorable, Titan received a

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<sup>173</sup> Robert J. Bulkley, Jr. *At Close Quarters: PT Boats in the United States Navy*, 76. Even higher speeds are quoted by some sources. For a better understanding of the pros and cons of catamarans see William D. O'Neill. "If it Can't be Big, It Needs to be Novel." U.S. Naval Institute *Proceedings*, December 2003, pp. 47-51.

<sup>174</sup> "Sleek, Agile *Sea Fighter* Launches Debate Over Future of Navy Ships," *Virginian Pilot*, 7 August 2005, p. A20.

non-competitive bid contract to build the prototype and has been officially recognized as the sole-source contractor. The Navy says that the need for this ship is so urgent that there was no time for the competitive bidding process.

The cost of a coastal/riverine gunboat program is miniscule, especially compared to many wasteful programs of dubious utility. Yet its potential for effective combat and interdiction in the war on terror is far greater than that of our megalithic weapons platforms. In the December 2005 issue of *Proceedings*, Captain James Pelkofski observed that “speedboats are emerging as the weapon of choice” for maritime terrorist operations. Speedboat can be defined in this context as a fast (over 40 knots), low profile, shallow-draft, fiberglass craft with an extremely small radar signature.

Unfortunately, a review of vessels in the current inventory and the developmental pipeline shows that the Navy possesses nothing capably of intercepting, meeting, and defeating these craft in the estuaries and along the littoral where they are bound to proliferate. The current generation of patrol craft is far too slow to be considered as interceptors and their numbers are too few at any rate. The open rigid-bottom inflatable boats (RHIB) of which the Navy and Coast Guard are so fond are in fact rough riding, wet open boats of use only in settled conditions. They can carry a lot of weight but their speeds are ridiculously slow compared to that of a fiberglass, gas-engined high-speed powerboat. These boats are stable in settled conditions but in a seaway they bounce, rock, and roll (but generally do not flip) in such a manner that the ability to use weapons is almost totally compromised. Thus, a boarding party is dependent upon supporting cover and fire from another vessel and is denied its own close firepower at the time it needs it most. Additionally, these boats are full of air. It does not take many bullets to render one hors-d-combat. The continued reliance upon RHIBs simply serves to underscore the absence of suitable high-speed patrol vessels.

Of course, building and equipping the boats is only part of the task. It is necessary to develop a doctrine for tactical employment identifying suitable missions and how the boats will be organized and employed. Training, logistical support, and difficulties in transoceanic transport are all factors to be examined. The officers charged with fulfilling the CNO’s directives and writing the draft Riverine Force plan could save time, money, and grief by dusting off Frank A. Tredennick and Harrison L. Bennett’s *An*

*Administrative History of PTs in World War II*, Robert Bulkley's *At Close Quarters*, and *Brown Water, Black Berets*, Tom Cutler's account of shallow water warfare in Vietnam, to avoid repeating past mistakes and learn what has worked for their predecessors.

Lessons can be learned from the Coast Guard as well. When it tried to produce in-house designs in the past they were often too heavy and cursed with a high center of gravity. In obtaining its new Response Boat – Medium (RBM), the Guard outlined its needs in a publicly issued request for proposals from private contractors. Eight firms responded with design proposals and of these, three firms, Kvichak of Seattle, Textron of New Orleans, and Ocean Technical Services of Harvey, Louisiana responded by each building a 45-foot prototype and providing it to the Coast Guard for testing. The builders were compensated for their design and construction work and were motivated to be both effective and efficient by the opportunity to land a contract to build 180 of these boats.

The Coast Guard comes out as the big winner, though, since it can tap into decades of boat-building expertise garnered in a highly competitive, low-margin industry and do so at minimal expense. The Coast Guard gets to test each boat extensively, gain on-the-water experience with each, and further refine its requirements. The hopeful boat builders take the results of the comparative sea trials and surveys and reengineer their entrees to better meet Coast Guard requirements and reduce construction expenditures.<sup>175</sup>

The Navy's institutional amnesia need not be a permanent disability. The frequency with which the United States has sought a brown water combat capability demonstrates that coastal and riverine forces should be permanently integrated into the fleet. There are some who might claim otherwise – insisting that shallow water combatants can be procured as the tactical situation demands. Yet, there is no substitute for the years of specialized training, systems development, and experience that make these forces so cost effective.

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<sup>175</sup> Dan Spurr. "Kvichak." *Professional Boatbuilder*, No. 96. (August/September 2005), pp. 52-71. Phone conversation with Keith Whittemore of Kvichak Marine Industries, 15 August 2005. The Response Boat – Medium (RB-M) will replace the 41-foot utility boat that has been a Coast Guard mainstay since the early 1970s. The 41' is a Coast Guard design that many Coasties have long considered to be too top heavy for its intended mission. It's big sister, the 82-footer, has an extremely high profile that may be suitable for law-enforcement missions but is an invitation to hostile fire in combat.

Past leaders have failed to learn that there is an ongoing need for the ability to penetrate inland and on coastal waterways to interdict our enemies and deliver close fires in support of our troops. Government must curb the impulse to hand out big ship contracts for vessels of dubious utility. Bigger, more complex vessels are *always* more expensive, but they are not always more effective for a given mission. Sometimes, a small inexpensive vessel is more appropriate and successful. To secure the littoral and afford an inland combat capability, bring the boats back now, and employ the workboat and recreational boating industries to provide them.

## CHAPTER 10

### CONCLUSION

Although Americans were early pioneers in the construction and use of torpedo launches, the true origins of the American motor torpedo boats of World War II were largely derived from British experimentation, competitive racing and combat experience, coupled with civilian development in the American pleasure craft industry. When war became almost inevitable, indigenous designs were sought. The Navy's 1938 design competition produced poor results that were highly conservative and revealed problems in construction, seaworthiness, and power plants. As a result, Secretary of the Navy Edison and the Electric Boat Company looked to Great Britain's Hubert Scott-Paine and his British Powerboat Company to secure a place in the PT program.

Meanwhile, more advanced designs appeared from Andrew Higgins and Frank Huckins who used their boating experience and boat building expertise to turn out promising hulls. It was the influence of these three firms, Elco, Higgins, and Huckins that overcame conservative, unimaginative thinking and lack of small boat experience within certain sectors of BuShips to give birth to the modern motor torpedo boat. They insured that despite the foreign influence, the 80' Elco and 78' Higgins, and 78' Huckins were distinctly American products. This integration and harnessing of the energy and capital of the private sector to achieve public policy objectives showed the American spirit at its finest. The main weaponry they employed may have been problematic but the boats themselves were superbly suited for their mission.

Movies like *They Were Expendable* and *Crash Dive*, and the honestly written, but inflated damage reports of the early skippers created an aura that the boats might be fragile but they were certainly indispensable. The image of gallant young men charging the steel destroyers and cruisers of the Imperial Japanese Navy from the decks of flimsy plywood speedboats was a galvanizing vision that led them to acquire such sobriquets as Devil Boats, the Green Dragons of New Guinea, and Knights of the Sea. In actuality, the boats in the Pacific were largely ineffectual as MTBs. Like their comrades in the "silent service," they were cursed with poor torpedoes that ran too slow, were often erratic in

course and depth, and carried too small a charge. The black charge launch technique was cumbersome, antiquated and dangerous, communications equipment was marginal, charts were inadequate, and until late 1943, they had no radar to pierce the black nights of the reef-infested island waters where they operated.

Yet, even in the difficult days of 1942 and 1943, they made substantial contributions to the war effort. Their presence in the Solomon's, together with forays by U.S. destroyers and cruisers, gave the Japanese pause. The enemy knew how dangerous his torpedoes were and apparently made the logical assumption that a technologically advanced society like the United States had produced a weapon just as potent as the deadly Long Lance. In truth, the ancient, unreliable Mark VIII torpedo was terribly inadequate. It ran deeper than set, was too slow, and often failed to explode upon contact. Though the boats inflicted few losses with this weapon, in more than one instance, Japanese operations were modified, broken off or otherwise curtailed because of the actual or feared appearance of the PTs.

It was only after attrition forced the Admirals of the Japanese Navy to give up on using warships and transports to reprovision and reinforce their far-flung outposts that the PTs really started fulfilling a role for which no other vessel was fitted. The increase of U.S. air and naval power in the South Pacific and the resultant impact on Japanese supply lines forced the enemy to adopt the use of coastal lighters and armored barges to support his troops. These vessels were primarily shallow draft, operated at night and close inshore where they could seek refuge and avoid discovery. To ferret them out, the Navy called on the fast moving, hard-hitting PT squadrons. The resultant clashes were not ones of large fleets in action that made headlines in the States. Instead, it involved hundreds, perhaps thousands of ferocious, but long-forgotten gunfights at very close quarters. These were direct fire engagements in which the antagonists were often within spitting distance of each other. No other craft so consistently engaged the enemy at such short range. With their shallow draft, the boats could project U.S. naval force into remote coves and isolated beachheads no other vessel could reach.

By severing Japanese supply lines, the boats starved enemy troops, and deprived them of ammunition, reinforcement, and medical support. They weakened the opposition that the "grunts" had to overcome and in so doing saved thousands, arguably, tens of

thousands of American lives. As western nations have learned and relearned over the past five decades, despite an advanced technological and industrial base, victory is still measured by the foot – the foot of the combat infantryman. The other branches exist primarily to support him and in this role the investment in PTs paid huge dividends.

The motor torpedo boat was born, lived, and died at the hand of advancing technology. It was made possible through the development of the planing hull and the relatively lightweight, high horsepower internal combustion engine, was given punch by the self-propelled torpedo and automatic weapons, and achieved relevance by the shallow water and coastwise nature of areas of operations in the Pacific and Europe. Likewise, wartime technological advances in radar, fire control and defensive ordnance made torpedoes delivered by surface craft of any size largely outdated by the end of the conflict. In 1944, MTB squadrons began experimenting with rockets and by 1945 it could be said that the torpedo was obsolete armament for the fast gunboats. During the Cold War U.S. strategic doctrine came to be dominated by the Soviet threat and research, funds, and bright minds were concentrated on carriers, submarines, and aircraft. Coastal craft received little attention and were rightly considered a dead end career-wise, a fact that still serves to send funds and personnel to the blue water fleet at the expense of brown water capabilities.

With the demise of the Soviet Union and the evaporation of any threat from an opposing naval power, the Navy's mission is no longer one of contesting the sea lanes in an effort to project power on to the seas. It is now one where naval forces must be tailored to a new role of projecting the U.S. presence from the sea and on to the land. Arguably, even this concept is secondary to the role of border security, littoral patrol, and counter terrorism operations. To fulfill this mission, the United States Navy once again has turned to research and experimentation with novel, faster, less expensive, more lethal war craft designed to dominate the littoral. The PTs may be outmoded but their mission remains.

As for the Elco's, the Higgins's, the Huckins's boats and the brave men who sailed them, most are gone now and those who remain are taking their leave all too quickly. As Jimmy Buffett says "we only have the memories or great books by James Jones" but they have left a glorious legacy and for generations to come, whenever men speak of gallantry



and brilliance in action against the odds they will recall these expendable mahogany boats and the superb sailors who strode their decks.



Figure 29. PT 117. This is what George Gershwin dreamed about when he wrote “Rhapsody in Blue.” PT 117 on sea trials with open throttles in the Hudson River – Summer of 1942. With all three Packards wide open, superchargers screaming like tortured jet engines, and running at 40 knots or better these boats grabbed lots of attention on the New York/Bayonne waterfront. Note lack of spray, clean efficient ride, and chines sweeping higher than on the 77’. Stern drags slightly due to too much weight aft – the Navy disregarded FDR’s instructions to keep the load light. (Author’s collection)

## APPENDIX A

5 December 1936

From: The Bureau of Construction and Repair

To: The Chief of Naval Operations

1. Developments since the War of the motor-torpedo-boat type, then known as Coastal Motor Boats, have been continuous and marked in most European Navies. There has been considerable interest in the fundamentals of the type among the small boat designers and builders in this country based upon patriotic desire to develop pleasure boats that may be of value for naval use in the event of mobilization.

2. The results being obtained in the foreign services are such as to indicate that vessels of considerable military effectiveness for the defense of local areas, are being built, the possibilities of which should not be allowed to go unexplored in our service. It is, of course, recognized that the general strategic situation in this country is entirely different from that in Europe, so that motor torpedo boats could not in all probability be used offensively by us. It appears very probable, however, that the type might very well be used to release for offensive service ships otherwise unavoidably assigned to guard important geographic points such as an advanced base, itself.

3. If the department concurs, this Bureau suggests the inauguration of an experimental development program of such boats and will endeavor to have included in its appropriations for experimental work, funds for the construction of two such boats each year, preferably one by contract on designs of private naval architects and one from Departmental designs.

4. To permit such designs to be prepared or at least outlined, the Bureau requests to be furnished with the military characteristics which are considered desirable in such a type.

E. S. Land, Chief of Bureau<sup>176</sup>

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<sup>176</sup> General Board of the Navy Files, 420-14, G.B. Serial No. 1740, 18 April 1937.

## APPENDIX B

Excerpt from Chairman of the General Board to Secretary of the Navy, dated 14 April 1937, on "Motor Torpedo Boats," General Board Files, 420-14, 4<sup>th</sup> Endorsement, G.B. Serial No. 1740, 18 April 1937

8. For torpedo carrying motor boats it is clearly evident that because of our strategic situation the type is of much less initial value to our Navy than to most, if not all, of the others. In the early stages of war it is unlikely that small torpedo carrying craft would be useful to us. However, the developments of a prolonged war could easily change this situation in that operating areas of our own and of enemy fleets would come closer together and, as mentioned in the basic letter, motor torpedo boats could replace larger craft which would otherwise have to be deployed in defensive missions. Moreover, future situations can occur under which it would be possible for such small craft to be used on directly offensive missions, - as is no doubt contemplated in certain foreign navies...

9. In the initial stages of a war our greatest necessity in the way of small craft, to reinforce our present provision for local defenses, will not necessarily include the ability to carry and launch torpedoes. The essential equipment will include depth charges, machine guns, and listening gear; moderate speeds combined with fair sea endurance will be satisfactory. The conversion of many of the smaller motor pleasure boats to meet such purposes will be relatively easy and require less than will be the case if the general run of such craft are fitted also to carry and launch torpedoes.<sup>177</sup>

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<sup>177</sup> The author had a great uncle whose boat served in this fashion. He fished from the Eastern Shore of Virginia and in 1942 he and his boat were inducted. He was made a Chief Petty Officer, his boat was painted gray, and for the next four years he patrolled his home waters of the Chesapeake Bay and the Atlantic barrier islands. At the end of the war his boat was extensively refurbished at government expense and he received a pension for life. Ernest Hemingway's hero, Tom Hudson, in *Islands in the Stream* was employed in a similar manner off Cuba.

10. As far as concerns small craft to be constructed by or for the Navy during peace, the Board believes that we should not go farther than a sufficient expenditure to develop the types. In this field two types are visualized: the one, a comparatively small type with limiting size such as will permit overseas transportation by auxiliaries or cargo vessels; the second type should be larger with better endurance for of-shore work.

11. The Navy Department is at the present time assisting the Philippine Government in the development of motor torpedo boats for its own program for defense. These plans at present time call for vessels approximately 80 feet in length and easily capable of off-shore patrols. From this work the U.S. Navy should benefit sufficiently to warrant no development work of its own at the present time in this particular type.

12. For the smaller type the stripped weight cannot exceed 20 tons which is the maximum boom capacity of fleet auxiliaries, or that likely to be available in other ships. The comparatively high speed of about 40 knots should be sought for and in order to obtain proper rough weather performance, the hull should be built on the displacement rather than on the step principle. The design should meet the most difficult requirement in this type – ability to carry and launch torpedoes, the number of which, (one or more), will have to be worked out in developing the design. Depth charges as equipment alternative to torpedo armament should be provided for. In so far as is practicable machine gun armaments and listening gear equipment should be included. Radio equipment is also essential.

13. In view of the prospective value to the United States of the smaller type of motor torpedo boats, The Board believes that there should be available a satisfactory design, and therefore recommends the inauguration of an experimental program on a moderate scale. It is also recommended that at least a part of the development and building be accomplished under contract. Moreover, small boat designers and builders in this country should be kept in touch with our development in order to utilize the very general desire of owners of such craft to have use of them in an emergency.

14. Based on the above considerations, the Board recommends the following characteristics:

*Hoisting weight:* Not to exceed 20 tons.

*Length:* Approximately 60 ft.

*Speed:* In excess of 40 knots.

*Armament:* Torpedoes, depth charges alternative, machine guns, .50 caliber.

Smoke devices.

*Crew:* Approximately 2 officers and 8 men (standard accommodations not required)

*Provisions:* Self-sustaining for 5 days.

*Communications:* Fitted with radio and listening devices.

## APPENDIX C

<p>Subject: Report of Comparative Service Tests of Motor Torpedo Boats held July 2--22, 1941 and August 11-12, 1941 at New London, Connecticut, by the Board of Inspection and Survey, USN, Restricted -- excerpt from:</p> <p>There follows an exact copy of Page VII-1 of the above report :</p> <p>MSH PT Boats Comparative Tests RESTRICTED</p> <p style="text-align: center;"><u>VII - RECOMMENDATIONS</u></p> <ol style="list-style-type: none"><li>1. The Board makes the following recommendations :</li><li>1. That the Packard power plant having been found highly satisfactory be adopted as standard for future construction.</li><li>2. That the ordnance installation of future motor torpedo boats consist of two torpedo tubes, machine guns and depth charges.</li><li>3. That the Huckins 72' ( PT 69 ) design be considered acceptable for immediate construction.</li><li>4. That the Higgins 81' ( PT 6 ) design suitably reduced in size to carry such ordnance loads as are required by our Navy be considered acceptable for immediate construction.</li><li>5. That the Elco 77' design be considered acceptable for future construction provided changes in the lines are made to reduce the tendency to pound in a seaway, and the structure is strengthened in a manner acceptable to the Bureau of Ships.</li><li>6. That the Philadelphia 81' boat ( PT 8 ) be stripped of excess weight and be re-engined with three Packard engines.</li></ol> <p style="text-align: center;">VII - 1</p> <p>( End of copy )</p> <p style="text-align: center;">RESTRICTED</p>	<p style="text-align: right;">July 4, 1944.</p>
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### The Final Results of the Plywood Derbies.

This letter is a photocopy from the original report and was sent to Huckins Yacht Corporation three years after the tests. Item I shows that in the 1200 HP Packard the Navy had finally found its powerplant. This engine was later modified to produce 1500 HP. Item 2 would be honored largely in the breach as four torpedo tubes soon became standard and remained so well into 1944. Regarding Item 3, Huckins was the only boat found ready for immediate production yet they only built eighteen boats – none of which saw combat. (Report of Comparative Service Tests)

## APPENDIX D

### Maneuverability of Participating Boats<sup>178</sup>

#### Tactical Diameter (Yds)

Designator	Model	Turn to Port	Turn to Starboard
PT 69	72' Huckins	336	274
PT 6'	81' Higgins	368	256
PT 8	81' BuShips	443	340
PT 20	77' Elco	432	382

#### Cost of Participating Boats

Boat	Model	Hull	Machinery	Total
PT 6'	81' Higgins	61,000	70,500	131,600
PT 70	76' Higgins	120,000	70,500	190,500
PT 69	72' Huckins	118,000	94,000 <sup>179</sup>	212,000
PT 20	77' Elco	157,600	70,500	228,100
PT 8	81' BuShips	268,200	413,000	681,400

<sup>178</sup> United States Navy. Board of Inspection and Survey. *Report of Comparative Service Tests of Motor Torpedo Boats*. 14 August 1941, in Record Group 80, Records of the General Board, file 420-14. The Huckins design experienced significant rudder problems. It was a high-speed horizontal airfoil that was transom mounted instead of being on a rudder post going through the bottom of the boat. With helm full over the rudder was being dragged sideways and caused the boat to lose speed and fall off plane and heel to the outward side of the turn. Other boats lost speed and heeled inward. This design defect was corrected in later Huckins boats, which used inboard mounted rudders. The sudden and radical hard over turn is known as a J-turn and is often used in combat and high-stress law enforcement operations. Recent experience with high-speed Coast Guard and naval small craft shows the technique is extremely hard on any part of the running gear located below the waterline – propellers, struts, and shafts, but especially rudders and the lower units of outboard motors. The life cycle for outboard motors involved in drug interdiction is very short as a result. Modern research has demonstrated that a wedge-shaped, balanced rudder with the tapered edge pointing forward works well in these situations where high speed maneuvers place extreme lateral loads on the rudders.

<sup>179</sup> PT 69 was the only PT with four engines, hence the higher cost of machinery.

### Ease of Control During Attack

Place	Designator	Model
1st	PT 70	76' Higgins
2nd	PT 69	72' Huckins
3rd	PT 6'	81' Higgins
4th	PT 20	77' Elco
5th	British	70' Higgins

### Internal Communication

Place	Designator	Model
1st	PT 20	77' Elco
2nd	British	70' Higgins
3rd	PT 70	76' Higgins
4th	PT 8	81' BuShips
5th	PT 6'	81' Higgins



## A Note on the Sources

I have given priority to primary sources unless the preponderance of secondary material discredits it. In those rare instances, both viewpoints are examined either in the text or in the notes. This is especially true regarding domestic proceedings. The efforts of David Bushnell and Robert Fulton are well documented in their own words although *Turtle's* operational record is still open to debate. *Naval Documents of the American Revolution*, a multivolume work of the Naval Historical Center, is an indispensable source for students of the Continental Navy. Currently at eleven volumes covering 1774 and into 1778, it is an ongoing project and volume 12 is in progress.

The *Official Records of the Union and Confederate Navies in the War of the Rebellion* and *War of the Rebellion: A Compilation of the Official Records of the Union and Confederate Armies* remain the single most valuable published source for students of the Civil War. They are now available via CD or electronically through Cornell Library and this accessibility makes them more helpful than ever. Researchers must use them with caution, however. Errors are not unknown and the editors of the *Official Records, Armies* had an agenda when deciding which documents to include or disregard.

From a naval viewpoint, the nineteenth century was a technologically dynamic era. The latter portion, 1875-1900, was a time of great experimentation and inventiveness. Fortunately, many of the men involved in development of ships, engines, systems, weapons, and materials were highly literate and penned detailed accounts of their activities. The United States Naval Institute, founded in 1873 to foster professionalism, progress and an exchange of views within the U.S. Navy, captured many of these records in its periodical *Proceedings*. The editors not only included articles from American military personnel and civilians, but also frequently translated and reprinted excerpts from foreign military journals. These writings from French, German, Italian, and Russian sources open a window into European naval developments that would otherwise be difficult to access for anyone not gifted with multilingual abilities. *Proceedings* is available on microfilm and is an invaluable source for insight into the evolution from sail to steam, and wood to steel.

Over half a century after it was written, Captain Robert Bulkley's *At Close Quarters* remains the best single source for information on American PT operations in the Second World War. It was finished in 1946, the author having remained on active duty to complete this one final mission. Written at the behest of the Navy Department, it is a "thorough and objective account" and a relatively complete overview of the deployment and operations of U.S. motor torpedo boats before and during the war. Bulkley served in the boats, and "knew and loved these small, fast craft with hornet sting." He was an excellent writer and, most importantly for historians, he had access to first hand accounts, after action reports, and numerous other primary sources that have since been lost or destroyed. He was on duty in Washington as PT officers were returning from active deployment and conducted extensive interviews with them, which are often quoted in his text. He made full use of his access to the sources, and carefully recorded and cited them much to the thanks of later scholars.

*At Close Quarters* was initially intended as an official in-house history for Navy Department use and for fifteen years was not readily available to scholars. The election of a former PT skipper as President in 1960 renewed public and private interest in the boats and led to the book's publication in 1962. Sadly, Captain Bulkley passed on just his book was being edited. He was "a gallant sailor, a true gentleman, and a fine American" and an accomplished scholar to whom all who follow in his wake owe a debt of gratitude. This said, it needs to be confessed that Bulkley's very intimacy with his topic had detrimental effects. He shows a consistent reluctance to critically analyze the PT program, its leaders, the Navy, and his fellow MTB veterans. This makes his book less valuable than it might otherwise have been to historians and to a naval establishment currently scrambling to create a riverine/coastal warfare component. *At Close Quarters* remains an important guide but a detailed, scholarly, and objective history of World War II PT operations is long overdue.<sup>180</sup>

There were wartime books about PT exploits but they are generally of little worth to the student of fast attack craft except that they show how easy it is to overstate damage estimates. William L. White's *They Were Expendable* is the classic case. White was a

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<sup>180</sup> Robert Bulkley, *At Close Quarters*, ix-xi. Quotes are from Introduction by Rear Admiral Ernest M. Eller, Director of Naval History.

journalist who interviewed veterans of Ron 3's exploits in the Philippines after they returned stateside for temporary duty at the Motor Torpedo Boat Training Center in Melville, Rhode Island. At the time, many of the feats of Ron 3 had not been verified and the destruction inflicted upon the Japanese was vastly overstated. This is no reflection upon the officers interviewed or the author. They reported what they thought had happened. It was only after the war, when enemy records could be examined, that it was found how seriously and consistently damage reports were exaggerated.

Several historical works of a technical nature have been written that go far toward explaining the difficulties of producing an effective PT boat and using it in combat. A noteworthy effort that covers all the major powers is *Fast Fighting Boats: 1870-1945 Their Design, Construction, and Use* by Harald Fock. First published in German in 1973, at a time when Fock was an instructor at the Naval School at Murwik, West Germany, *Fast Fighting Boats* examines the development programs of each nation individually and chronologically. Major sections cover the boats before and during World War I, between the wars, and during World War II. Although gunboats and missile boats are discussed, the bulk of the book is concerned with torpedo boats. It is the single best resource for motor torpedo boat development outside the United States.

Of special value for studies of the American torpedo boat is Norman Friedman's *U.S. Small Combatants*. Friedman is a well-known naval scholar with a penchant for technical and administrative detail and he devotes four chapters to the history, design, and operation of U.S. MTBs and gunboat derivatives from 1900 through the "Nasty" class of Vietnam. It is very well illustrated, but sources are poorly cited. *U.S. Small Combatants* is the best source this writer has found for postwar American PT development.

Curtis Nelson's *Hunters in the Shallows* is valuable and unusual in that the author explores the political machinations between Elco and the Department of the Navy more fully than any other source consulted. Nelson's passion is the development of the boats rather than their operations and he raises legitimate questions about the legality and ethics of Charles Edison's actions. In his book and a recent article in *Naval History*, he examines the loss of PT 109 and finds that John Kennedy was the victim of poor equipment, surprisingly poor leadership from his superiors, and very poor communications. As Dick Keresey confessed in *PT 105*, the real failure in this incident

was that Kennedy and his crew were abandoned by their comrades and their leaders. There should have been a search but the boat and the crew were written off without an attempt at investigation and rescue.

*Andrew Jackson Higgins and the Boats that Won World War II* by Jerry Strahan is a sympathetic and relatively complete biography of this remarkable inventor, innovator, and industrialist. It is the only work on Higgins and is done so well that it is likely to remain so. Strahan has concentrated more on Higgins' conflicts with the Navy's BuShips and his development of landing craft and less on PT boats but this gives insight into and support of Curtis Nelson's thesis about the relationship between the service and Elco.

To date, there has been no work done on Frank Huckins and his involvement in the PT program. Huckins Yacht Corporation is still a family owned and operated enterprise and continues to build and repair high-quality motor yachts. Huckins granddaughter, Cindy Purcell, presides at the helm and reveres "Huck" and his part in the PT program as is clearly shown by the numerous PT pictures that adorn corporate offices. The Jacksonville, Florida firm is the only PT builder still in business and the original drawings for PT 69, PT 95, and subsequent boats lie untouched in a drawer in the yard office awaiting the attention of an enthusiastic scholar.

*Early Elco PT Boats* by Bob Ferrell and Al Ross contains a wealth of photos of the 70s and 77s from the files of PT Boats, Inc. It is a brief but very helpful aid to visual identification of the boats and their equipment.

Of great assistance to any PT aficionado is PT Boats, Inc, a veteran's organization run by Alyce Guthrie whose father "Boats" Newberry was a Chief Boatswain's Mate in several squadrons. PT Boats, Inc and the associated PT Boat Museum at Battleship Cove, Fall River, Massachusetts are repositories for documents, photos, letters and artifacts concerning the boats and the men who sailed them. PT Boats, Inc has detailed plans for all the boats available to include construction drawings as well as plumbing, electrical, ordnance, and power plant sheets. They maintain a website with a "message board" and the contacts made there were of special value in contacting PT veterans and learning the fates of the individual boats.

## BIBLIOGRAPHY

### Primary Sources

*Atlas of Pilot Charts, Central American Waters*. Publication 106, Defense Mapping Agency Stock No. NVPUB 106. Washington: Defense Mapping Agency Hydrographic/Topographic Center, 1982.

Beauregard, Pierre. G. T. "Torpedo Service in the Harbor and Water Defenses of Charleston." *Southern Historical Society Papers*, vol. 5, no. 4 (April 1878): 145-161.

Brown, R. William. "They Called Her Carole Baby." *Naval History* 15, no. 5 (2001): 23-25.

Bushnell, David. Letter to Thomas Jefferson, October 1787. Washington: Manuscript Division, Library of Congress.

\_\_\_\_\_. "General Principles and Construction of a Submarine Vessel." *Transactions of the American Philosophical Society* 4 (1799): 303-312.

Carney, Commander Robert B. Letter to Secretary of the Navy, 2 November 1939. In Records of the General Board, file 420-14.

Carney, Robert B. Memorandum to Mr. Edison. Subject: Rough-water Trials of PT-9 (Scott-Paine). 2 November 1939. Record Group 80, Secretary of the Navy, General Board of the Navy Files 420-14, National Archives, Washington, D.C.

Crowley, R.O. "Making the Infernal Machines: A Memoir of the Confederate Torpedo Service." *Civil War Times Illustrated* 12 (June 1973): 24-35.

\_\_\_\_\_. "The Confederate Torpedo Service." *Century Magazine* 56, no. 2 (June 1898): 290-300.

Cushing, William B. "The Destruction of the 'Albemarle'." *The Century Magazine* 36, no. 3 (July 1888): 432-439.

Davidson, Hunter. "Electrical Torpedoes as a System of Defense." *Southern Historical Society Papers* 2, no. 1 (July 1876): 1-6.

\_\_\_\_\_. "Torpedoes in Our War." *United States Naval Institute Proceedings* 24, no. 2 (86) (June 1898): 349-354.

*Dictionary of American Naval Fighting Ships*. 8 vols. Washington: Government Printing Office, 1968.

- Ebaugh, David C. "David C. Ebaugh on the Building of the *David*." *South Carolina Historical Magazine* 54 (January 1953): 32-35.
- Fulton, Robert. *Torpedo War and Submarine Explosions*. New York: William Elliot, 1810.
- Glassell, William T. "Reminiscences of Torpedo Service in Charleston Harbor." *Southern Historical Society Papers*, vol. 4 (1877): 225-235.
- Goldsborough, Louis M. Letter to Secretary Welles, 17 October 1861. National Archives, Record Group 45, entry 81.
- Hoagland, Edgar D. "PT Boats Raid Bongao Island." *Naval History* 13, no. 3 (1999): 42-45.
- \_\_\_\_\_. *The Seahawks: With The PT Boats at War*. Novato, CA: Presidio Press, 1999.
- Huff, Sidney. *My Fifteen Years with General MacArthur*. 1951. Reprint. New York: Paperback Library, 1964.
- Keresey, Dick. *PT-105*. Annapolis: Naval Institute Press, 1996.
- King, Ernest B. *U.S. Navy at War 1941-1945: Official Reports to the Secretary of the Navy*. Washington: U.S. Navy Department, 1946.
- Knapp, H.S. "Results of Some Special Researches at the Torpedo Station." *United States Naval Institute Proceedings* 19, no. 67 (September 1893): 249-266.
- Leahy, William D. *I Was There*. New York: Whittlesey House, 1950.
- Lloyd's Register of American Yachts*. New York: Lloyds Register of Shipping, yearly editions, 1955- 1974.
- MacArthur, Douglas. *Reminiscences*. New York: McGraw-Hill, 1964.
- Mallory, Stephen R. Appointment of James H. Tomb as Chief Engineer, CSN. Eleanor S. Brockenbrough Library. Museum of the Confederacy. Richmond, VA.
- Maury, Betty H. Personal Diary. 2 vols. Maury Papers. Manuscript Division, Library of Congress. Washington: D.C.
- Maury, Matthew Fontaine. "On the Navigation of Cape Horn", *American Journal of Science and Arts* 26 (July 1834): 56, 59, 60, 61, and 62

- \_\_\_\_\_. *A New Theoretical and Practical Treatise on Navigation*, 3<sup>rd</sup> edition, 1845
- \_\_\_\_\_. "On the Winds and Currents of the Ocean", *Proceedings of American Association for the Advancement of Science*, (1848): 64-68.
- \_\_\_\_\_. *Explanations and Sailing Directions to Accompany the Wind and Current Charts*, 4<sup>th</sup> edition, 1852
- \_\_\_\_\_. *Annual Address delivered before the Maryland Institute*, October 25, 1855.
- Maury Papers. Manuscript Division. Library of Congress. Washington, D.C.
- \_\_\_\_\_. 50 items. Eleanor Brockenbrough Library. Museum of the Confederacy. Richmond, VA.
- \_\_\_\_\_. Virginia Historical Society. Richmond, VA.
- Morgan, William James, ed. *Naval Documents of the American Revolution*, 10 vols. Washington: Government Printing Office, 1972.
- Naval Records, Bureau of Navigation, Record of Officers, September 1825-December 1831, Vol. G, 361, 433, National Archives.
- Norberg, Carl A. "In the Southwest Pacific with the Army's Navy." *Aerospace Historian* 27, no. 3 (1980): 163-168.
- \_\_\_\_\_. *Official Records of the Union and Confederate Navies in the War of the Rebellion*. 31 vols. Washington, D.C.: Government Printing Office, 1894-1922.
- Parker, William H. *Recollections of a Naval Officer*. Annapolis: Naval Institute Press, 1985.
- Petroncelli, Rich. "JFK: A PT Skipper Remembers." *Naval History* 13(6) (1999): 24-27.
- Rains, Gabriel J. "Torpedoes." *Southern Historical Society Papers* 3 (1877): 255-260.
- \_\_\_\_\_. *Torpedo Book*. Eleanor S. Brockenbrough Library. Museum of the Confederacy, Richmond, VA.
- Read, Charles W. "Reminiscences of the Confederate States Navy." *Southern Historical Society Papers* 1, no. 5 (May 1876): 331-363.
- Record Group 1, Military Advisory Records. MacArthur Archives, MacArthur Memorial Museum, Norfolk, VA.

- Record Group 19. Bureau of Construction and Repair. Bureau of Engineering.  
Bureau of Ships. National Archives, Washington, D.C.
- Record Group 80. Secretary of the Navy. General Board of the Navy Files, 407, 420-14 and 429-09. National Archives, Washington, D.C.
- Romulo, Carlos P. *I Saw the Fall of the Philippines*. New York: Doubleday, Doran, 1943.
- Scott-Paine, Hubert. "Development of High Speed Craft." *United States Naval Institute Proceedings* 66, no. 444 (1940): 277-280.
- Secretary of the Navy. *Letter to House of Representatives Transmitting Sundry Documents Exhibiting Certain Preliminary Experiments Trying the Practical Use of The Torpedo*. Washington: A and G. Way, 1811.
- Stiles, Ezra. *The Literary Diary of Ezra Stiles, D.D., LL.D.* Franklin Bowditch Dexter, ed. 3 vols. New York: Charles Scribner's Sons, 1901.
- Tomb, James H. "The First Steam Torpedo Boat." *Confederate Veteran* 12 (1904): 106.
- \_\_\_\_\_. "Submarines and Torpedo Boats, CSN." *Confederate Veteran* 22 (April 1914): 168-169.
- \_\_\_\_\_. "Confederate Torpedo Boats." *Confederate Veteran* 31 (March 1923): 93-94.
- United States Coast Guard. Office of Boat Forces (G-OCS). Boats of the United States Coast Guard. Undated.
- United States Navy. Board of Inspection and Survey. *Report of Comparative Service Tests of Motor Torpedo Boats*. 14 August 1941, in Record Group 80, Records of the General Board, file 420-14.
- United States Navy. Board on Ships' Boats. F.E. Chadwick. As printed in *United States Naval Institute Proceedings* 20, no. 70 (June 1894): 359-397.
- United States Navy. Bureau of Naval Personnel. *Principles of Naval Engineering, NavPers 10788-B*. Washington: Government Printing Office, 1970.
- United States Navy. Bureau of Navigation. Office of Naval Intelligence. *Notes on Naval Progress: April 1898*. Washington: Government Printing Office, 1898.
- United States Navy. Bureau of Navigation. Office of Naval Intelligence. *Papers on Naval Operations During the Year Ending July 1885*. Washington: Government Printing Office. 1885. USNA Library, Annapolis. MD



Library. Naval Historical Center, Washington, D.C.

United States Navy. Bureau of Ships. Boat and Small Craft Design, Hull Design Division. *Boats of the United States Navy*. NavShips 250-452. Washington: 1 July 1955.

United States Navy. Hydrographic Office. *American Practical Navigator*. Washington: Government Printing Office, 1938.

United States Navy. Naval Sea Systems Command. *Boats and Small Craft*. Navy Ships' Technical Manual Chapter 583. S9086-TX-STM-010/CH-583R3.

United States Navy. Naval Ships Systems Command. *Twin-Screw Aluminum 50-Foot Patrol Craft, Fast (PCF), Mark 2*. NavShips 0900-031-7010. Undated.

United States Navy. Office of the Chief of Naval Operations, Naval History Division. *Dictionary of American Naval Fighting Ships*. 8 vols. Washington: Government Printing Office, 1959-1968.

United States Navy. Office of the Chief of Naval Operations. Vice Admiral A. T. Church, Director, Navy Staff. Memorandum for Distribution. Subject: Implementation of Chief of Naval Operations (CNO) Guidance – Global War on Terrorism (GWOT) Capabilities. 6 July 2005.

United States Navy. *Ships Data U.S. Naval Vessels, 1941-49*. Washington: Government Printing Office, 1941-49.

Very, Edward Wilson. *Report on Torpedo Boats for Coast Defense*. Washington: Government Printing Office, 1884.

*War of the Rebellion: A Compilation of the Official Records of the Union and Confederate Armies*. Washington, D.C.: Government Printing Office, 1880-1900.

## Secondary Sources

### Books and pamphlets

Armstrong, George Elliot. *Torpedoes and Torpedo Vessels*. London: G. Bell, 1896 (1901).

Bachman, Bruce M. *An Honorable Profession*. New York: Vantage Press, 1985.

Baer, George W. *One Hundred Years of Sea Power: The U.S. Navy, 1890-1990*. Stanford: Stanford University Press, 1994.

- Ballard, Robert D. *Collision with History: The Search for John F. Kennedy's PT 109*. Washington: National Geographic, 2002.
- Barnes, John Sanford. *Submarine Warfare: Offensive and Defensive*. New York: D. Van Nostrand, 1869.
- Barrett, J. Lee. *Speedboat Kings: 25 Years of International Speedboating*.
- Beach, Edward L. *The United States Navy: 200 Years*. New York: Henry Holt & Company, 1986.
- Beaver, Paul. *E-Boats and Coastal Craft: A Selection of Wartime Photographs from the Bundesarchiv, Koblenz*. Tucson, AZ: Aztex Corp, 1981.
- Bennett, Geoffrey. *Cowan's War: The Story of British Naval Operations in the Baltic, 1918-1920*. London, 1964.
- Blackford, Charles Minor. *Torpedoboat Sailor*. Annapolis, MD: Naval Institute Press, 1968.
- Bragadin, Marc Antonio. *The Italian Navy in World War II*. Annapolis, MD.: Naval Institute, 1957.
- Breur, William. *Devil Boats: The PT War Against Japan*. Novato, CA: Presidio Press, 1987.
- \_\_\_\_\_. *Sea Wolf: The Daring Exploits of Navy Legend John D. Bulkeley*. Novato, CA: Presidio Press, 1989.
- Bulkley, Robert J. *At Close Quarters: PT Boats in the United States Navy*. Annapolis, MD: Naval Institute Press, 2003.
- Burton, E. Milby. *The Siege of Charleston 1861-1865*. Columbia: University of South Carolina Press, 1970.
- Canney, Donald L. *The Old Steam Navy, vol. 1, Frigates, Sloops, Gunboats, 1815-1885*. Annapolis: Naval Institute Press, 1990.
- \_\_\_\_\_. *The Old Steam Navy, vol. 2, The Ironclads, 1842-1885*. Annapolis: Naval Institute Press, 1993.
- Cassells, Ken R. *The Fairmile Flotillas of the Royal New Zealand Navy*. Wellington: New Zealand Ship and Marine Society, 1993.

- Chapman, Charles F. *Piloting, Seamanship, and Small Boat Handling*. New York: Motor Boating, 1954.
- Chant, Christopher. *Small Craft Navies*. London: Arms and Armour Press, 1992.
- Chase, Carl A. *An Introduction to Nautical Science*. New York: W.W. Norton, 1991.
- Coggeshall, W.I. and J.E. McCarthy. *U.S. Naval Torpedo Station, Newport, R.I. 1658-1925*. Newport: Remington Ward. 1944.
- Coggins, Jack. *Arms and Equipment of the Civil War*. New York: Doubleday and Company, 1962.
- Coletta, Paolo E. *American Secretaries of the Navy*. 2 vols. Annapolis: Naval Institute Press, 1980.
- Conway's *All the World's Fighting Ships, 1860-1905*. New York: Mayflower Books, 1979.
- Conway's *All the World's Fighting Ships, 1906-1921*. New York: Mayflower Books, 1979.
- Cooling, Benjamin Franklin. *Gray Steel and Blue Water Navy: The Formative Years of America's Military-Industrial Complex, 1881-1917*. Hamden, CT: Archon Books, 1979.
- Cooper, Bryan. *PT Boats*. New York: Ballantine, 1970
- \_\_\_\_\_. *The Battle of the Torpedo Boats*. New York: Stein and Day, 1970.
- Corbett, Julian S. *Maritime Operations in the Russo-Japanese War, 1904-1905*. Annapolis: Naval Institute Press, 1994.
- Corbin, Diana Fontain. *A Life of Matthew Fontaine Maury*. London: S. Low, Marston, Searle, & Rivington, 1888.
- Coski, John M. *Capital Navy*. New York: Savas Beattie, 2005.
- Crowley, R. O. "The Confederate Torpedo Service." In *Secret Missions of the Civil War*, ed. Philip Van Doren Stern, 207-218. New York: Rand McNally, 1959.
- Current, Richard N. *Encyclopedia of the Confederacy*. 4 vols. New York: Simon & Schuster, 1993.
- Cutler, Thomas J. *Brown Water, Black Berets*. Annapolis: Naval Institute Press, 1988.

Davis, Kenneth S. *FDR: The Beckoning of Destiny, 1882-1928*. New York: Random House, 1971.

\_\_\_\_\_. *FDR: Into the Storm, 1937-1940*. New York: Random House, 1993.

Dear, I. C. B., ed. *The Oxford Companion to World War II*. Oxford, U.K.: Oxford University Press, 1995.

Desloge, Rick. *Hell on Keels: The Saga of Motor Torpedo Boat Squadron 12*. Kirkwood, MO.: Rick Desloge, 2001.

*Dictionary of American Naval Fighting Ships*. 8 vols. Washington: Government Printing Office, 1968.

Donovan, Robert J. *PT 109: John F. Kennedy in World War II*. New York: McGraw-Hill, 1961.

Dorling, Henry Taprell. *Endless Story: Being an Account of the Work of the Destroyers, Flotilla Leaders, Torpedo Boats and Patrol Boats in the Great War*. London: Hodder and Stoughton, 1932.

Dudley, William S. *Going South: U.S. Navy Officer Resignations & Dismissals on the Eve of the Civil War*. Washington: Naval Historical Foundation, 1981.

Dunnavent, R. Blake. *Brown Water Warfare*. Gainesville, FL: University Press of Florida,

Durkin, Joseph T. *Confederate Navy Chief: Stephen R. Mallory*. Columbia, South Carolina: University of South Carolina Press, 1987. (First published by University of North Carolina Press, 1954.)

Electric Boat Company, eds. *Elco PTs in Action: The Story of the U.S. Navy's Motor Torpedo Boats*. Bayonne, NJ: Electric Boat Company, 1943.

Elliott, Robert G. *Ironclad of the Roanoke*. Shippensburg, PA: White Mane, 1994.

Evans, David C. and Mark R. Peattie. *Kaigun: Strategy, Tactics, and Technology in The Imperial Japanese Navy, 1887-1941*. Annapolis: Naval Institute Press, 1997.

Farley, Edward I. *PT Patrol: Wartime Adventures in the Pacific and the Story of the PTs in World War II*. New York: Exposition Press, 1957.

Fay, Paul B. *The Pleasure of his Company*. New York: Harper and Row, 1963.

Ferrell, Bob, and Al Ross. *Early Elco PT Boats*. Memphis: PT Boat Museum and Library, 1980.

- Fock, Harald. *Fast Fighting Boats, 1870-1945. Their Design, Construction, and Use*. Lymington, Hampshire, England: Nautical Publishing Company, 1978.
- Fowler, William M. Jr. *Under Two Flags: The American Navy in the Civil War*. New York: W.W. Norton, 1990.
- Frank, Richard B. *Guadalcanal*. New York: Random House, 1990.
- Friedman, Norman. *U.S. Naval Weapons: Every Gun, Missile, Mine, and Torpedo Used by the U.S. Navy from 1883 to the Present*. Annapolis: Naval Institute Press, 1984.
- \_\_\_\_\_. *U.S. Small Combatants: Including PT-Boats, Subchasers, and the Brown-Water Navy*. Annapolis: Naval Institute Press, 1987.
- Fulton, William B. *Riverine Operations, 1966-1969*. Washington: Department of the Army, Government Printing Office, 1973.
- Gannon, Robert. *Hellions of the Deep: The Development of American Torpedoes in World War II*. University Park, PA: Pennsylvania State University Press, 1996.
- Gilbert, Martin. *The Second World War: A Complete History*. New York: Henry Holt, 1989.
- Gray, Edwyn. *The Devil's Device: Robert Whitehead and the History of the Torpedo*. Annapolis: Naval Institute Press, 1991.
- \_\_\_\_\_. *19<sup>th</sup> Century Torpedoes and Their Inventors*. Annapolis, MD.: Naval Institute Press, 2004.
- Gregory, Barry. *Vietnam Coastal and Riverine Forces Handbook*. Sterling, 1988.
- Hagan, Kenneth, ed. *In Peace and War: Interpretations of American Naval History, 1775-1978*. Westport, CN: Greenwood Press, 1984.
- \_\_\_\_\_. *This People's Navy: The Making of American Sea Power*. New York: Free Press, 1991.
- Halpern, Paul G. *A Naval History of World War I*. Annapolis: Naval Institute Press, 1994.
- Hamachek, Russ. *Hot, Straight and True: An Anecdotal View of PT Boats in WWII*. Portland, OR: Russ Hamachek, 2001.
- Hamilton, Nigel. *JFK, Reckless Youth*. New York: Random House, 1992.

- Holiday, James. *PT Boats at War*. New York: Carlton Press, 1995.
- Howarth, Stephen. *To Shining Sea: A History of the United States Navy*. New York: Random House, 1991.
- Huchthausen, Peter A. *Echoes of the Mekong*. Nautical & Aviation Publishing Co., 1988.
- Hutcheon, Wallace. *Robert Fulton: Pioneer of Undersea Warfare*. Annapolis, MD: Naval Institute Press, 1981.
- Ireland, Bernard. *Jane's Naval History of World War II*. New York: HarperCollins, 1998.
- Ienaga, Saburo. *The Pacific War: World War II and the Japanese, 1931-1945*. New York: Pantheon, 1978.
- Isenberg, Michael T. *Shield of the Republic: The United States Navy in an Era of Cold War and Violent Peace. Vol. 1, 1945-1962*. New York: St Martin's Press, 1993.
- The Italian Navy in the World War, 1915-1918*, (Rome: Office of the Chief of Staff of the Royal Italian Navy, 1927).
- James, D. Clayton. *The Years of MacArthur. Vol 1, 1880-1941*. Boston: Houghton Mifflin, 1970. *Vol. 2, 1941-1945*. Boston: Houghton Mifflin, 1975.
- Jane, Fred T. *The Torpedo in Peace and War*. London: W. Thacker and Company, 1904.
- Jane's Fighting Ships of World War I*. London: Jane's Publishing Company, 1919. Reprint. London: Studio Editions, 1990.
- Jane's Fighting Ships of World War II*. New York: Military Press, 1989.
- Jefferson, David. *Coastal Forces at War*. Sparkford, UK: Patrick Stephens, 1996.
- Jones, Virgil C. *The Civil War at Sea*. 3 vols. New York: Holt, Rinehart, and Winston, 1960-1962.
- Johnson, Frank D. *United States PT Boats of World War II in Action*. Poole, Dorset, UK: Blandford Press, 1980.
- Johnson, John. *The Defense of Charleston Harbor*. Charleston: Walker, Evans, & Cogswell, 1890.
- Johnson, Robert Underwood, and Clarence C. Buel, eds. *Retreat with Honor. Vol. 4*

- of *Battles and Leaders of the Civil War*. 4 vols. Reprint. Secaucus, NJ: Castle, 1983.
- Karnow, Stanley. *In Our Image: America's Empire in the Philippines*. New York: Random House, 1989.
- Keating, Bern. *The Mosquito Fleet*. New York: Putnam, 1963.
- Keegan, John. *The Second World War*. New York: Viking, 1989.
- Kemp, Peter. *Oxford Companion to Ships and the Sea*. London: Oxford University, 1976.
- \_\_\_\_\_. *The History of Ships*. Stamford, CN: Longmeadow Press, 1988.
- King, James Wilson. *The War-ships and Navies of the World: Containing a Complete and Concise Description of the Construction, Motive Power, and Armaments of the Modern War-ships of all the Navies of the World*. Boston: A. Williams, 1882.
- Konstam, Angus. *British Motor Torpedo Boat 1939-45*. Oxford, UK: Osprey, 2003.
- \_\_\_\_\_. *Confederate Submarines and Torpedo Vessels, 1861-65*. Oxford, UK: Osprey, 2004.
- Lambert, John. *Allied Coastal Forces of World War II*. Vol. 2. London: Conway Maritime Press, 1990.
- \_\_\_\_\_. *The Fairmile "D" Motor Torpedo Boat*. Annapolis: Naval Institute Press, 1985.
- Larzelere, Alex. *The Coast Guard at War. Vietnam, 1965-1975*. Annapolis. MD: Naval Institute Press, 1997.
- Leckie, Robert. *The Wars of America*, Vol. 2. New York: Harper and Row, 1968.
- Lee, Clark. *They Call it Pacific*. New York: Viking, 1943.
- Le Masson, Henri. *Histoire du Torpilleur en France*. Paris: Academe de Marine, 1996.
- Lord, Walter. *Lonely Vigil*. New York: Viking, 1977.
- Love, Robert William, Jr. *The Chiefs of Naval Operations*, ed. Annapolis: Naval Institute Press, 1980.
- Lundeberg, Philip K. *Samuel Colt's Submarine Battery: The Secret and the Enigma*. Washington: Smithsonian Institution Press, 1974.

- Luraghi, Raimondo. *A History of the Confederate Navy*. Annapolis: Naval Institute Press, 1996.
- Machiavelli, Niccolo. *Arte della Guerra*. Albany, NY: Henry C. Southwick, 1815.
- Macksey, Kenneth. *The Penguin Encyclopedia of Weapons and Military Technology*. London: Penguin, 1993.
- Mahan, Alfred Thayer. *The Influence of Sea Power upon History, 1660-1783*. Boston: Little, Brown, 1918.
- Manchester, William. *American Caesar: Douglas MacArthur, 1880-1964*. Boston: Little, Brown, 1978.
- Manning, George Charles. *Manual of Naval Architecture*. New York: D. Van Nostrand, 1930.
- Marolda, Edward J. *By Sea, Air, and Land: An Illustrated History of the U.S. Navy and the War in Southeast Asia*. Washington: Naval Historical Center, 1994.
- \_\_\_\_\_. *The U.S. Navy in Vietnam*. Brassey's
- \_\_\_\_\_. *From Military Assistance to Combat*.
- Maury, Richard L. *Matthew Fontaine Maury During The War 1861-1865*. Richmond, VA: Whittet and Shepperson, 1915.
- McLeavy, Ron. *Naval Fast Strike Craft and Patrol Boats*. Poole, Dorset, UK: Blandford Press, 1979.
- Melia, Tamara Moser. "Damn the Torpedoes": *A Short History of U.S. Naval Mine Countermeasures, 1777-1991*. Washington: Department of the Navy, Naval Historical Center, 1991.
- Mesko, Jim. *Riverine: A Pictorial History of the Brown Water War in Vietnam*. Squadron/Signal Publications, 1985.
- Miller, Nathan. *Sea of Glory: A Naval History of the American Revolution*. Charleston, SC: Nautical and Aviation Publishing Co., 1974.
- Mitchell, Donald W. *History of the Modern American Navy from 1883 through Pearl Harbor*. New York: Alfred A. Knopf, 1946.
- \_\_\_\_\_. *A History of Russian and Soviet Sea Power*. New York: MacMillan and Company, 1974.



- Moeb, T.T. *Confederate States Navy Research Guide*. Williamsburg, VA: Moeb's Publishing Company, 1991.
- Morison, Samuel Eliot. *History of United States Naval Operations in World War II*. 15 vols. Boston: Little, Brown, 1947-1962. Volumes consulted: vol. 2, *Operations in North African Waters*; vol. 3, *The Rising Sun in the Pacific*; vol. 5, *The Struggle for Guadalcanal*; vol.6, *Breaking the Bismarck's Barrier*; vol. 8, *New Guinea and the Marianas*; vol. 9, *Sicily-Salerno-Anzio*; vol. 12, *Leyte*.
- \_\_\_\_\_. *The Two-Ocean War: A Short History of the United States Navy in the Second World War*. Boston: Little, Brown, 1963.
- Moy, Timothy. *War Machines: Transforming Technologies in the U.S. Military, 1920-1940*. College Station, TX: Texas A & M University Press, 2001.
- Nelson, Curtis L. *Hunters in the Shallows: A History of the PT Boat*. Washington: Brassey's, 1998.
- North, Arthur J.D. *Royal Naval Coastal Forces: 1939-1945. MTBs, MGBs, MA/SBs, MLs, HDMLs*. London: Almark Publishing, 1972.
- Overy, Richard. *Why the Allies Won*. New York: W. W. Norton and Company, 1995.
- Paine, Lincoln. P. *Warships of the World to 1900*. Boston: Houghton-Mifflin Company, 2000.
- Paloczi-Horvath, George. *From Monitor to Missile Boat: Coast Defense Ships and Coastal Defense Since 1860*. Annapolis: Naval Institute Press, 1996.
- Parker, Foxhall A. *Squadron Tactics Under Steam*. New York: D. Van Nostrand, 1864
- \_\_\_\_\_. *Fleet Tactics Under Steam*. New York: D. Van Nostrand, 1870.
- Perry, Milton F. *Infernal Machines: The Story of Confederate Submarine and Mine Warfare*. Baton Rouge, LA: Louisiana State University Press, 1965.
- Phelan, Keiran and Martin H. Brice. *Fast Attack Craft*. London: MacDonald and Jane's Ltd. 1977.
- Philip, Cynthia Owen. *Robert Fulton*. New York: Franklin Watts, 1985.
- Piekalkiewicz, Janusz. *Sea War, 1939-1945*. Harrisburg, PA: Historical Times, 1987. Translated from German by Peter Spurgeon.
- Pollina, Paolo M. *Le Torpediniere Italiane, 1881-1964*. Roma: Marina di Italia. Stato Maggiore. Ufficio Storico., 1964.

- Polmar, Norman and Samuel Loring Morison. *PT Boats at War: World War II to Vietnam*. Osceola, WI.: MBI Publishing Co., 1999.
- Polmar, Norman. *The Naval Institute Guide to the Ships and Aircraft of the U.S. Fleet*. Annapolis: Naval Institute Press, 2005.
- Potter, E. B. *Sea Power: A Naval History*. 2<sup>nd</sup> ed. Annapolis, MD: Naval Institute Press, 1981.
- Prange, Gordon. *At Dawn We Slept: The Untold Story of Pearl Harbor*. New York: Viking, 1991.
- Preston, Anthony. *Strike Craft*. Greenwich, CN: Bison Books, 1982.
- Ragan, Mark K. *Submarine Warfare in the Civil War*. Cambridge, MA: Da Capo Press, 2002.
- Rance, Adrian. *Fast Boats and Flying Boats: A Biography of Hubert Scott-Paine*. Southampton, UK: Ensign, 1969.
- Rastelli, Achille. *Caproni e il Mare: Progetti e Realizzazioni per la Guerra Navale di un Grande Gruppo Industriale Milanese*. Traduzione inglese di Gregory Aegi. Italy: Museo Aeronautico Gianni e Timina Caproni di Taliedo, 1999.
- Reynolds, L. C. and H. F. Cooper. *Mediterranean MTBs at War, Short MTB Flotilla Operations*. Gloucestershire, UK: Sutton Publishing, 1999.
- Roberts, John. *British Warships of the Second World War*.
- Roland, Alex. *Underwater Warfare in the Age of Sail*. Bloomington, IN: Indiana University Press, 1978.
- Ropp, Theodore. *The Development of a Modern Navy: French Naval Policy, 1871-1904*. Ed. Stephen S. Roberts. Annapolis: Naval Institute Press, 1987.
- Rosen, Robert N. *Confederate Charleston*. Columbia: University of South Carolina Press, 1994.
- Roske, Ralph J. and Charles Van Doren. *Lincoln's Commando: The Biography of Commander William Barker Cushing, U.S.N.* New York: Harper and Brothers, 1957.
- Ross, Al. *Allied Coastal Forces Volume II: Vosper MTB and U.S. Elco Designs*. London: Conway Maritime Press, 2002.

- Rottman, Gordon L. *The Vietnam Brown Water Navy: Riverine and Coastal Warfare, 1965-69*. Hong Kong: Concord, 1997.
- Saville, Allison W. "Charles Edison, 2 January 1940-24 June 1940." In *American Secretaries of the Navy*, vol. 2, 1913-1972, ed. Paolo E. Coletta. Annapolis, MD: Naval Institute Press, 1980.
- Scott, Peter. *The Battle of the Narrow Seas: A History of the Light Coastal Forces in the Channel and the North Sea, 1939-1945*. New York: Charles Scribner's Sons, 1946.
- Scotti, Paul. *Coast Guard Action in Vietnam*.
- Schaffer, Louis S. *Confederate Underwater Warfare*. Jefferson, McFarland & Co., 1996.
- Scharf, Thomas J. *History of the Confederate States Navy*. New York: Fairfax Press, 1977.
- Schubert, Hans-Joachim. *German E-Boats of World War II – History, Design, and Operation*. New York: Society of Naval Architects and Marine Engineers, 1962.
- Schuster, Russell E. *Motor Torpedo Boat Squadron 34*.
- Sheppard, Don. *Riverine: A Brown-Water Sailor in the Delta, 1967*. Novato, CA: Presidio Press, 1992.
- Shreadley, R.L. *From the Rivers to the Sea: The United States Navy in Vietnam*. Annapolis: Naval Institute Press, 1992.
- Shulman, Mark Russell. *Navalism and the Emergence of American Sea Power, 1882-1893*. Annapolis, MD: Naval Institute Press, 1995.
- Silverstone, Paul H. *Civil War Navies, 1855-1883*. Annapolis: Naval Institute Press, 2001.
- Simpson, Richard V. *Building the Mosquito Fleet*. Charleston, SC: Arcadia, 2001.
- Sleeman, Charles W. *Torpedoes and Torpedo Warfare*. Portsmouth, UK: Griffin, 1880.
- Smith, Joseph E. ed., *Small Arms of the World*, (9<sup>th</sup> ed.), Harrisburg, PA: Stackpole Books, 1969.
- Sondhaus, Lawrence. *Naval Warfare, 1815-1914*. London: Routledge, 2001.
- Spector, Ronald H. *Eagle Against the Sun*. New York: Free Press, 1985.

- Spencer, William F. *The Confederate Navy in Europe*. Tuscaloosa: University of Alabama Press, 1983.
- Sprout, Harold and Margaret. *The Rise of American Naval Power, 1776-1918*. Princeton, NJ: Princeton University Press, 1967.
- Steensen, Robert Steen. *Vore Torpedobaade Gennem 75 Aar*. Koenhavn: Marinehistorisk Selskab, 1953.(MM)
- Still, William N. Jr. ed. *The Confederate Navy, the Ships, Men and Organization, 1861-1865*. Annapolis: Naval Institute Press, 1997.
- \_\_\_\_\_. *Confederate Shipbuilding*. Columbia: University of South Carolina Press, 1987.
- Strahan, Jerry E. *Andrew Jackson Higgins and the Boats That Won World War II*. Baton Rouge: Louisiana State University Press, 1994.
- Sueter, Murray Fraser. *The Evolution of the Submarine Boat, Mine, and Torpedo from the Sixteenth Century to the Present Time*. Portsmouth, UK: J. Griffin and Company, 1907.
- Taylor, A.J.P., ed. *The Illustrated History of the World Wars*. New York: Galahad Books, 1978.
- Tent, James Foster. *E-Boat Alert: Defending the Normandy Invasion Fleet*. Annapolis: Naval Institute Press, 1996.
- Thornycroft, John I. *A Short History of the Revival of the Small Torpedo Boat (C.M.B.s) During the Great War and Subsequently in the Kronstadt, Archangel, and Caspian Sea Expeditions of 1919*. London: John I. Thornycroft and Company, 1929. MM
- Tregaskis, Richard. *John F. Kennedy: War Hero*. New York: Dell, 1962.
- Tucker, Spencer C. *Handbook of 19<sup>th</sup> Century Naval Warfare*. Annapolis: Naval Institute Press, 2000.
- Turner, Maxine. *Navy Gray*. Tuscaloosa: University of Alabama Press, 1988.
- Underwood, Rodman L. *Stephen Russell Mallory, A Biography of the Confederate Navy Secretary and United States Senator*. Jefferson, North Carolina: McFarland & Company, 2005.
- United States Navy. Office of the Chief of Naval Operations. Naval History Division.

- Civil War Naval Chronology 1861-1865*. Washington: Government Printing Office. 1961-1964.
- Vego, Milan N. *Naval Strategy and Operations in Narrow Seas*. London: Frank Cass, 1999.
- Venable, John D. *Out of the Shadow: The Story of Charles Edison*. East Orange, N.J.: Charles Edison Fund, 1978.
- Von Scheliha, Victor E.R. *A Treatise on Coast Defense*. London: 1868.
- Wagner, Frederick. *Submarine Fighter of the American Revolution*. New York: Dodd, Mead, 1963.
- Warner, Denis and Peggy. *The Tide at Sunrise: A History of the Russo-Japanese War, 1904-1905*. London: Frank Cass, 2002.
- Weinberg, Gerhard L. *A World at Arms: A Global History of World War II*. New York: Cambridge University Press, 1994.
- Wells, Tom Henderson. *The Confederate Navy, a Study in Organization*. Tuscaloosa: University of Alabama Press, 1971.
- Whipple, Chandler. *Lt. John F. Kennedy-Expendable!* New York: Nova Books, 1964.
- White, W.L. *They Were Expendable*. New York: Harcourt, Brace and Company, 1942.
- Wideman, John C. *The Sinking of the USS Cairo*. Jackson, MS: University Press of Mississippi, 1993.
- Williams, Frances Leigh. *Matthew Fontaine Maury, Scientist of the Sea*. New Brunswick, New Jersey: Rutgers University press, 1963.
- Wolfert, Ira. *American Guerilla in the Philippines*. New York: Simon & Schuster, 1945.
- Woodward, David. *The Russians at Sea: A History of the Russian Navy*. New York: 1996.
- Zalinski, E. L. *The Pneumatic Dynamite Torpedo Gun*. New York: Military Service Institution, 1887.

## Articles

- Adamson, Gordon, and Douglas Van Patten. "Motor Torpedo Boats: A Technical Study." *U.S. Naval Institute Proceedings* 66, no. 7 (449) (July 1940): 976-996.
- Alger, Philip R. "Concerning the Tactical Employment of Torpedo Boats." *U.S. Naval Institute Proceedings* 36, no. 136 (December 1910): 1101-1140.
- Allest, Jules d'. "Liquid Fuel for Torpedo Boat Boilers." *United States Naval Institute Proceedings* 14, no. 45 (April 1888): 454-465. Reprinted from *Ravista Marittima*. Translated by John B. Briggs.
- Anderson, Bern. "The Naval Strategy of the Civil War." *Military Affairs* 26, no. 1 (Spring 1962): 11-21.
- Anonymous. "Aluminum Boats for the Navy." *United States Naval Institute Proceedings* 20, no. 69 (March 1894): 211.
- \_\_\_\_\_. "The Development of the Motor Boat." *United States Naval Institute Proceedings* 33, no. 124 (December 1907): 1557-1559. Reprinted from *Engineering Magazine*.
- \_\_\_\_\_. "The Evolution of the Torpedo-Boat." *United Service* 2 (1889): 549-572. Reprinted from *Revue du Cercle Militaire*, translated by Edward Shippen.
- \_\_\_\_\_. "Fiat Motor Boats." *United States Naval Institute Proceedings* 32, no. 120 (December 1906): 1600. Reprinted from *Engineering*.
- \_\_\_\_\_. "Gas Engines for War Vessels of the Future." *United States Naval Institute Proceedings* 33, no. 122 (June 1907): 881-882. Reprinted from *Nautical Gazette*.
- \_\_\_\_\_. "German Torpedo Boat Construction." *United States Naval Institute Proceedings* 33, no. 124 (December 1907): 1517-1519. Reprinted from *Engineer*.
- \_\_\_\_\_. "The Mile-High Submariner." *Colorado Heritage* (Autumn 1993): 19-21.
- \_\_\_\_\_. "Mosquito Boats." *United States Naval Institute Proceedings* 66, no. 9 (September 1940): 1371.
- \_\_\_\_\_. "Motor-Boats." *United States Naval Institute Proceedings* 31, no. 116 (December 1905): 1032-1033.
- \_\_\_\_\_. "Motor-Propelled Launches for Warships." *United States Naval Institute Proceedings* 31, no. 116 (December 1905): 998. Reprinted from *Nautical Gazette*.
- \_\_\_\_\_. "Motor Torpedo Boats." *United States Naval Institute Proceedings* 32, no. 120

(December 1906): 1614. Reprinted from *Page's Weekly*.

\_\_\_\_ "Motor Torpedo-Boats." *United States Naval Institute Proceedings* 33, no. 123 (September 1907): 1292. Reprinted from *Nautical Gazette*.

\_\_\_\_ "Nasty Boats Bought by Navies" *United States Naval Institute Proceedings* 93, no. 773 (July 1967): 153. reprint from *Shipbuilding and Shipbuilding Record*, 12 January 1967.

\_\_\_\_ "The Passing of Ships' Boats." *United States Naval Institute Proceedings* 33, no. 121 (March 1907): 438-439. Reprinted from *United Service Gazette*.

\_\_\_\_ "Patrol Torpedo Boats: New Punch for the PTs." *United States Naval Institute Proceedings* 77, no. 581 (July 1951): 774-775. Reprinted from New York Times, 7 May 1951.

\_\_\_\_ "Seamless Steel Boats." *United States Naval Institute Proceedings* 19, no. 67 (September 1893): 320-321. Reprinted from *Engineering*.

\_\_\_\_ "Sir Alfred Fernandez Yarrow, 1842-1932." *Obituary Notices of Fellows of the Royal Society* 1, no. 1 (December 1932): 7-11.

\_\_\_\_ "Statistics of the American Navy." *Publications of the American Statistical Association* 1, no. 5 (March 1889): 238-240.

\_\_\_\_ "Submarine Boats: Spar Torpedoes for Destroying Them." *United States Naval Institute Proceedings* 27, no. 4 (100) (December 1901): 786-787.

\_\_\_\_ "Torpedo Attack." *United States Naval Institute Proceedings* 31, no. 111 (September 1904): 669-672. Reprinted from *Engineering*.

\_\_\_\_ "A Tory Governor's View of David Bushnell's Submarine." *United States Naval Institute Proceedings* 64, no. 9 (no. 427) (September 1938): 1279.

\_\_\_\_ "Types of French Torpedo-Boats." *United States Naval Institute Proceedings* 32, no. 120 (December 1906): 1576-1578.

\_\_\_\_ "Watt and Fulton Relics in the Possession of the Society." *Proceedings of the American Society of Mechanical Engineers* 30, no. 2 (February 1908): 116-122.

\_\_\_\_ "The Yarrow Motor Torpedo Boat." *United States Naval Institute Proceedings* 32, no. 119 (September 1906): 1149.

\_\_\_\_ "Yarrow 60-Foot Torpedo Launch." *United States Naval Institute Proceedings* 33, no. 122 (June 1907): 881. Reprinted from *Iron Age*.

- \_\_\_\_\_. "The Yarrow-Napier Motor-Boat." *United States Naval Institute Proceedings* 31, no. 114 (June 1905): 535-538. Reprinted from *Engineering*.
- Arnault, Charles Chabaud. "The Employment of Torpedoes in Steam Launches Against Men-of-War." *United States Naval Institute Proceedings* 6, no. 11 (1880): 79-98.
- Badger, Oscar Charles. "History Repeats: The Applications of the Lessons of History on a National Problem of Today." *United States Naval Institute Proceedings* 51, no. 267 (May 1925): 707-721.
- Baldwin, Hanson W. "Fulton and Decatur: An Unpublished Document." *United States Naval Institute Proceedings* 62, no. 396 (February 1936): 231-235.
- Bartsch, William H. "Philippine Air Debacle." *Air Power History* (Summer 1997): 46-63.
- Beach, Edward L. "Our Torpedo Boat Flotilla: The Training Needed to Insure its Efficiency." *United States Naval Institute Proceedings* 29, no. 105 (1903): 117-159 and 29, no. 106 (1903): 441-443.
- Beard, William E. "The Log of the C.S. Submarine." *United States Naval Institute Proceedings* 42, no. 165 (October 1916): 1545-1557.
- Beardow, Keith. "Out of the Desert." *Journal of the T.E. Lawrence Society* 9, no. 1 (Autumn 2001): 65-82.
- Bolander, Louis H. "The C.M.B.'s and the Attack on Kronstadt." *United States Naval Institute Proceedings* 66, no. 451 (September 1940): 1324-1325.
- Bond, Charles W. "The Small Craft Gap – Not Again." *United States Naval Institute Proceedings* 98, no. 833 (July 1972): 94-97.
- Bowers, Everett P. "Terror in the Dark: Torpedo Boat Night Actions at Leyte Gulf." *Sea Classics* 11 (Nov. 1993): 14-24, 64.
- Brassey, Thomas. "On Torpedo Boat Tactics." *United States Naval Institute Proceedings* 6, no. 14 (1880): 400-406. Reprinted from *Mittheilungen aus dem Gibiete Seewesen* 7, no. 4.
- Briggs, Mark. "Innovation and the Mid-Victorian Royal Navy: The Case of the Whitehead Torpedo." *Mariner's Mirror* 88, no. 4 (2002): 447-455.
- Brown, Allan D. "Torpedoes and Torpedo Boats." *Harper's New Monthly Magazine* 65, no. 385 (June 1882): 36-47.



Brown, Robert M. "The USS Alarm." *United States Naval Institute Proceedings* 5, no. 10 (1879): 499-512.

Buhl, Lance C. "Maintaining 'An American Navy,' 1865-1889." In *In Peace and War: Interpretations of American Naval History, 1775-1978*, ed. Kenneth J. Hagan, 237-262. Westport, Conn.: Greenwood Press, 1984.

Chandler, L.H. "The Automobile Torpedo and its Uses." *United States Naval Institute Proceedings* 26, no. 1 (93) (March 1900): 47-104.

Cox, Frederick J. "The American Naval Mission in Egypt." *Journal of Modern History* 26, no. 2 (June 1954): 173-178.

Crowley, R.O. "The Confederate Torpedo Service." *Century Magazine* 56, no. 2 (June 1898): 290-300.

\_\_\_\_\_. "Making the Infernal Machines: A Memoir of the Confederate Torpedo Service." *Civil War Times Illustrated* 12, (June 1973): 24-35.

Davidonis, A.C. "Harbor Forcing Operations." *Military Affairs* 8, no. 2 (Summer 1994): 81-94.

Demetry, James S. and Wayne J. Smith. "Defense Against PT-Boat Attack" *United States Naval Institute Proceedings* 95, no. 800 (October 1969): 148-150.

Dewar, A.C. "The Value of Speed in Tactics and Strategy." *United States Naval Institute Proceedings* 33, no. 124 (December 1907): 1367-1384.

Donnelly, Ralph W. "A Confederate Navy Forlorn Hope." *Military Affairs* (Summer 1964): 73-78.

Dorfman, Joseph. "Fulton and the Economics of Invention." *Political Science Quarterly* 59, no. 4 (December 1944): 578-593.

Dozer, Donald Marquand "Matthew Fontaine Maury's Letter of Instruction to William Lewis Herndon" *Hispanic American Historical Review* 28, no. 2 (May 1948): 212-228.

Drake, Franklyn J. "Automobile Torpedoes." *United States Naval Institute Proceedings* 19, no. 65 (March 1893): 1-52.

Drashpil, Boris V. "Surface Torpedo Craft of the Imperial Russian Navy, Part 1: *Minonoski*." *Warship International* 19, no. 3 (1982): 236-266.

\_\_\_\_\_. "Surface Torpedo Craft of the Imperial Russian Navy, Part 2: *Vzryv*." *Warship International* 22, no. 1 (1985): 90-94.

- \_\_\_\_\_. "The Fate of the Four Chinese Torpedo Boat Destroyers." *Warship International* 24, no. 2 (1987): 193-198.
- Emery, Clark. "A Further Note on Drebbel's Submarine." *Modern Language Notes* 57, no. 6 (June 1942): 451-455.
- Epkenhans, Michael. "Krupp and the Imperial German Navy, 1898-1914: A Reassessment." *Journal of Military History* 64, no. 2 (April 2000): 335-369.
- Falvey, Kevin. "Lessons from the Last PT Boat: American Know-How." *Boating* 74, no. 12 (December 2001): 80-84.
- Ferguson, James D. Commenting on "Are Coast Guard Small Boats Small Enough?" *United States Naval Institute Proceedings* 102, no. 886 (December 1976): 89.
- Fogerty, William K. Commenting on "Skimmer Ops." *United States Naval Institute Proceedings* 100, no. 862 (December 1974): 88.
- Foley, Paul. "The Torpedo Service of Today and Tomorrow." *United States Naval Institute Proceedings* 35, no. 130 (1909): 513-529.
- Frear, Hugo P. *Torpedo Boats and Destroyers*. Society of Naval Architects and Marine Engineers, 1943.(MM)
- Furber, Holden. "Fulton and Napoleon in 1800: New Light on the Submarine Nautilus." *American Historical Review* 39, no. 3 (April 1934): 489-494.
- Georgescu, Mihai. "The Romanian Navy's Torpedo Boat *Rindunica*." *Warship International* 24, no. 2 (no. 4?) (1987): 350-355.
- Gleaves, Albert. "The Howell Torpedo: An Elementary Description." *United States Naval Institute Proceedings* 21, no. 73 (March 1895): 125-129.
- \_\_\_\_\_. "The Problem of Torpedo Discharge." *United States Naval Institute Proceedings* 21, no. 74 (June 1895): 337-347.
- Goodrich, C.F. "Our National Defense." *Century Magazine* 30, no. 1 (May 1885): 172-174.
- Halsey, Ashley, Jr. "Did They Forget to Dare?" *United States Naval Institute Proceedings* 70, no. 492 (1944): 169-174.
- Hanks, Carlos C. "The Gallant Fight of the Winslow at Cardenas." *United States Naval Institute Proceedings* 56, no. 333 (November 1930): 1009-1011.

- Harrod, Frederick S. "New Technology in the Old Navy: The United States Navy During the 1870s." *American Neptune* 53(1) (1993), 5-19.
- Hedgpeth, Joel W. "That Mysterious Torpedo Boat: Did the Japanese Send Naval Vessels to the North Sea in 1904?" *United States Naval Institute Proceedings* 70, no. 496 (June 1944): 700-701.
- Heitman, John A. "The Man Who Won the War: Andrew Jackson Higgins." *Louisiana History* 34(1) (1993): 35-50.
- Hersey, John. "Survival." *The New Yorker*. 17 June 1944.
- Holcombe, Robert "Types of Ships." *The Confederate Navy: the Ships, Men, and Organization, 1861-65*. Annapolis: Naval Institute Press, 1997.
- Holden, Edgar. "The 'Albemarle' and the 'Sassacus'." *The Century Magazine* 36, no. 3 (July 1888): 427-432.
- Hone, Thomas C. "Spending Patterns of the United States Navy." *Armed Forces and Society*, Spring 1982, 443-462.
- Jackson, Chester V. "Mission to Murmansk." *U.S. Naval Institute Proceedings* 95(2) (1969): 82-89.
- Jackson, Richard Harrison. "Torpedo Craft: Types and Employment." *United States Naval Institute Proceedings* 26, nos. 93 and 94 (1900): 1-45, 72-104, and 359-361.
- Johnson, Dallas A. Commenting on "Some Thoughts on Ships' Boats in the Navy." *United States Naval Institute Proceedings* 100, no. 860 (October 1974): 83-84.
- Jones, Colin. "The Purchase of the Australian Colonial Gunboats." *Mariner's Mirror* 81(2) (1995): 182-194.
- Keresey, Dick. "Farthest Forward." *American Heritage* 49, no. 4 (July/August 1998): 60-73.
- Keuthe, J. Louis. "Mechanical Features of a Seventeenth Century Submarine." *Modern Language Notes* 56, no. 3 (March 1941): 202-204.
- Kimball, William Wirt. "Torpedo Boat Organization and Service: Atlantic Coast of the U.S." *United States Naval Institute Proceedings* 27, no. 100 (December 1901): 713-723.
- Koester, Oscar W. "The Torpedo Boat Destroyer and Depot." *United States Naval Institute Proceedings* 25, no. 92 (1899): 851-855.

- Kuethe, J. Louis "Mechanical Features of a Seventeenth Century Submarine" *Modern Language Notes* 56, no. 3 (March 1941): 202-204.
- Lambert, Nicholas A. "Admiral Sir John Fisher and the Concept of Flotilla Defense, 1904-1909." *Journal of Military History* 59, no. 4 (October 1995): 639-660.
- \_\_\_\_\_. "British Naval Policy, 1913-1914: Financial Limitation and Strategic Revolution." *Journal of Modern History* 67, no. 3 (September 1995): 595-626.
- Lautenschlager, Karl. "Technology and the Evolution of Naval Warfare." *International Security* 8, no. 2 (Autumn 1983): 3-51.
- Liscombe, Rhodri Windsor. "Charleston Antebellum Architecture and Civic Destiny" *Journal of the Society of Architectural Historians* 49, no. 1 (March 1990): 115-116.
- Lossing, Benson J. "Scenes in the War of 1812." *Harper's New Monthly Magazine* 28, no. 163 (December 1863): 3-17.
- Lyman, John. "The Centennial of Pressure-Pattern Navigation." *United States Naval Institute Proceedings* 74, no. 3, (March 1948):
- MacGregor, David. "The Use, Misuse, and Non-Use of History: The Royal Navy and the Operational Lessons of the First World War." *Journal of Military History* 56, no. 4 (October 1992): 603-616.
- Major, John. "The Navy Plans for War, 1937-1941." In *In Peace and War: Interpretation of American Naval History, 1775-1984*, ed. Kenneth J. Hagan, 237-262. Westport, CN: Greenwood Press, 1984.
- \_\_\_\_\_. "William Daniel Leahy, 2 January 1937-1 August 1939." In *The Chiefs of Naval Operations*, ed. Robert William Love, Jr. Annapolis, MD: Naval Institute Press, 1980.
- Martin, John L. "Confederate Torpedo Boats." *Confederate Veteran*, no. 31 (1923): 93-94.
- Mason, Victor Louis. "New Weapons of the United States Army." *The Century Magazine* 49, no. 4 (February 1895): 570-583.
- Maury, Matthew Fontaine. "On the Navigation of Cape Horn." *American Journal of Science* 26 (July 1834): 60-61
- \_\_\_\_\_. "Scraps from the Lucky Bag." *Southern Literary Messenger* 7 (December 1840):
- Maury, Richard L. "The First Marine Torpedoes." *Southern Historical Society Papers* vol. 31 (1904): 326-333.

- Maxim, Hudson. "The Warfare of the Future." *Science*, New Series 28, no. 728 (11 December 1908): 820-831.
- McCalip, Dana L. "H.M. Torpedo Boat No. 80." *Model Shipwright* 75 (March 1991): 22-29.
- McGiffin, Philo N. "The Battle of the Yalu." *The Century Magazine* 50, no. 4 (August 1895): 585-604.
- Melvin, Philip. "Stephen Russell Mallory, Southern Naval Statesman" *Journal of Southern History* 10, no. 2 (May 1944): 137-160.
- Morison, Samuel Eliot. "Elba Interlude, June 1944." *Military Affairs* 21, no. 4 (Winter 1957): 182-187.
- Morton, Louis. "The Philippine Army, 1935-39. Eisenhower's Memorandum to Quezon." *Military Affairs* 12, no. 2 (Summer 1948): 103-107.
- Nelson, Curtis L. "They Were Commendable." *Naval History* (April 2002).
- \_\_\_\_\_. "Did JFK's Order Sink PT-109?" *Naval History* 17, no. 1 (February 2003): 24-27.
- Niblack, Albert Parker. "Tactical Considerations Involved in the Design of the Torpedo Boat." *United States Naval Institute Proceedings* 26, no. 93 (January 1900): 167-178.
- \_\_\_\_\_. "Lieutenant Dewar's Papers on 'Speed in Naval Tactics' and 'Speed in Battleship Strategy'," *United States Naval Institute Proceedings* 33, no. 124 (December 1907): 1385-1390.
- O'Neil, William D. "If it Can't be Big, It Needs to be Novel." *U.S. Naval Institute Proceedings* 129, no. 12 (December 2003): 47-51.
- Palen, Lewis Stanton. "Davids of the Sea." *United States Naval Institute Proceedings* 54, no. 12 (No. 310) (December 1928): 1035-1046.
- Palmstierna, C. "Swedish Torpedo Boats and Destroyers: Torpedo Boats." *Warship International* 8, no. 4 (1971): 367-386.
- Parks, E. Taylor. "Robert Fulton and Submarine Warfare." *Military Affairs* 25, no. 4 (Winter 1961-1962): 177-182.
- Patterson, George W. "Britain's Secret Weapon Against the Bolsheviks." *United States Naval Institute Proceedings* 77, no. 575 (January 1951): 39-45.

- Percival, Franklin G. "Future Naval War." *United States Naval Institute Proceedings* 66, no. 454 (December 1940): 1699-1712.
- Peters, Sidney A. "The PT Boat." *Bureau of Ships Journal*. (August 1953). 2-8.
- \_\_\_\_\_. "The Motor Torpedo Boat." *Ordnance*. (May-June 1954). 943-946.
- Petroncelli, Rich. "Does the History Channel Have an Agenda?" *Naval History* 17(1) (February 2003): 28-30.
- Pflugk, H.A.V. von. "Torpedo Boats." *United States Naval Institute Proceedings* 67, no. 462 (1941): 1115-1120.
- Plotkin, Stephen. "Sixty Years Later, The Story of PT-109 Still Captivates." *Prologue: Quarterly of the National Archives and Records Administration* 35, no. 2 (2003): 22-26.
- Poe, Edgar Allen. *Southern Literary Messenger* 2, no. 7 (June 1836): 454-455
- Pollard, S. "The Decline of Shipbuilding on the Thames." *The Economic History Review*, New Series 3, no. 1 (1950): 72-89.
- Poole, Francis. "The T.B. 3 and the Savage Sea." *U.S. Naval Institute Proceedings* 100, no. 11 (November 1974): 40-44.
- Pratt, Fletcher. "Destroyer Grows Up." *United States Naval Institute Proceedings* 61, no. 387, 389, 393 (1935): 683-691, 1007-1009, 1687-1690.
- Radford, Cyrus S. "The Halpine Dirigible Torpedo." *United States Naval Institute Proceedings* 20, no. 71 (September 1894): 606-609.
- Rance, Adrian. "T.E. Shaw and the British Power Boat Company." *Journal of the T.E. Lawrence Society* 2, no. 1 (Summer 1992): 49-68.
- Rankin, Robert .H. "USS *Alarm*: An Experiment." *United States Naval Institute Proceedings* 91, no. 748 (June 1965): 176-178.
- Rey di Villarey, Captain. "The Italian Navy", *Brassey's Naval Annual*, 1919.
- Reynolds, Clark G. "Yankee Supership? Sortie of *Spuyten Duyvil*." *American Neptune* 42, no. 2 (1982): 85-100.
- Reynolds, L.C. "Breakout from Encirclement: The 2<sup>nd</sup> Motor Torpedo Boat Flotilla in the Far East, 1938-1942." *Imperial War Museum Review* 11 (1997): 99-107.
- Roberts, Tad. "Sailing Cruiser Design: History, Hydrostatics, and Art, Part 1." *Wooden*

- Boat Magazine*, no. 175, (November/December 2003): 56-64.
- Robertson, H.T. "Motor Torpedo Boats." *United States Naval Institute Proceedings* 66, no. 451 (1940): 1289-1290.
- Roche, James Jeffrey. "Albemarle Cushing." *The Century Magazine* 36, no. 3 (September 1889): 730-731.
- Rodgers, Frederick. "The Extent to Which the Navy of the United States Should be Increased." *Annals of the American Academy of Political and Social Science* 26, The United States as a World Power (July 1905): 139-145.
- Roland, Alex. "Bushnell's Submarine: American Original or European Import?" *Technology and Culture* 18, no. 2 (April 1977): 157-174.
- Ropp, Theodore. "The Modern Italian Navy, Part I." *Military Affairs* 5, no. 1 (Spring 1941): 32-48.
- \_\_\_\_\_. "The Modern Italian Navy, Part II." *Military Affairs* 5, no. 2 (Summer 1941): 104-116.
- Rossell, H.E. "Types of Naval Ships." In *Historical Transactions 1893-1943 of the Society of Naval Architects and Marine Engineers*. New York, 1945.
- Rosen, Philip. "The Treaty Navy, 1919-1937." In *In Peace and War: Interpretations of American Naval History, 1775-1984*, ed. Kenneth J. Hagan, 221-236. Westport, CN: Greenwood Press, 1984.
- Roudman, Hyman. "The Evolution of New Fleet Tactics." *Military Affairs* 7, no. 4 (Winter 1943): 197-201.
- Rowbotham, W.B. "Robert Fulton's Turtle Boat." *United States Naval Institute Proceedings* 62, no. 406 (December 1936): 1746-1749.
- Rowland, Buford. "Revolution in Nets: An Unglamorous But Essential Phase of Naval Warfare." *Military Affairs* 11, no. 3 (Autumn 1947): 149-158.
- Sanders, Harry. "The First American Submarine." *United States Naval Institute Proceedings* 62, no. 406 (December 1936): 1743-1745.
- Schratz, Paul R. "A Commentary on the Pueblo Affair." *Military Affairs* 35, no. 3 (October 1971): 93-95.
- Scientific American. June 15, 1918.
- Searle, W.F. Jr. "The Case for Inshore Warfare." In *Naval Review 1966*. Frank Uhlig, ed.

- Annapolis: Naval Institute Press, 1965.
- Schroeder, Seaton. "The U.S.S. *Vesuvius*, with Special Reference to her Pneumatic Battery." *United States Naval Institute Proceedings* 20, no. 69 (March 1894): 1-65.
- Sears, W.J. "A General Description of the Whitehead Torpedo." *United States Naval Institute Proceedings* 24, no. 1 (85) (March 1898): 89-110.
- Shanks, W.F.G. "The Brooklyn Navy-Yard." *Harper's New Monthly Magazine* 42, no. 247 (December 1870): 1-13.
- Shugg, Wallace. "The Cigar Boat: Ross Winan's Maritime Wonder." *Maryland Historical Magazine* 93, no. 4 (1998): 428-442.
- Sieche, Erwin F. "Sink the Austrians." *Sea Classics* 11, (Nov. 1993): 34-39, 57-63.
- Simpson, Lloyd P. "The Last of a Type." *Warship International* 10, no. 2 (1973): 165-169.
- Sleeman, Charles W. "Torpedoes." In *The Naval Annual*. 1887 ed. Portsmouth, UK: Griffin, 1888.
- Smart, Larry R. "Evolution of the Torpedo Boat." *Military Affairs* 23, no. 2 (Summer 1959): 97-101.
- Smith, Ralph Harland. "The Mosquito Stings." *United States Naval Institute Proceedings* 66, no. 454 (December 1940): 1693-1698.
- Smith, Roy Campbell. "Torpedo Boat Policy." *United States Naval Institute Proceedings* 23, no. 81 (1897): 1-67, 153-158.
- Snyder, Dean. "Torpedoes for the Confederacy." *Civil War Times Illustrated* 24, no. 1 (March 1985): 40-45.
- Soejima, Lieutenant. "Attack by torpedo boat No. 35 in the battle of the sea of Japan." Extracts from a letter of Lieutenant Soejima. Translated from *Tokyo Asahi*, 3 July 1905. *United States Naval Institute Proceedings* 31, no. 116 (1905): 1045-1046.
- Sokol, Anthony Eugene. "Italian Attempts at Harbor Forcing During the Last War." *U.S. Naval Institute Proceedings* 68, no. 1 (no. 467) (January 1942): 37-41.
- \_\_\_\_\_. "Torpedo Boat Carriers." *United States Naval Institute Proceedings* 68, no. 477 (November 1942): 1586-1590.
- Sondhaus, Lawrence. "Strategy, Tactics, and the Politics of Penury: The Austro-Hungarian Navy and the Jeune Ecole." *Journal of Military History* 56, no. 4



(October 1992): 587-602.

Spaulding, Kenneth P. "Fiber Glass for Boats of the U.S. Navy." *United States Naval Institute Proceedings* 95, no. 793 (March 1969): 141-143.

Spencer, John Curtis. "Squib vs. Minnesota." *United States Naval Institute Proceedings* 86, no. 687 (May 1960): 154-155.

Stanton, C.L. "Submarines and Torpedo Boats." *Confederate Veteran* 22 (September 1914): 398-399.

Stephens, William O. and C. Alphonso Smith. "Two Early Proposals for Naval Education." *United States Naval Institute Proceedings* 39, no. 1 (145) (March 1913):

Stewart, Charles W. "William Barker Cushing" *United States Naval Institute Proceedings* 38, nos. 142 and 143 (June and September 1912): 425-491, 913-939.

Stern, Ed. "'There Will Always be an Elco': The Demise of the Electric Launch Company." *Log of Mystic Seaport* 55, no. 1-2 (2004): 6-17.

Stickle, Warren E. "The Republican Campaign of 1940." *New Jersey History*

Still, William N. Jr. "Facilities for the Construction of War Vessels in the Confederacy." *Journal of Southern History* 31, no. 3 (August 1965): 285-304.

Sutcliffe, Alice Crary. "The Early Life of Robert Fulton." *Century Magazine*. (Sept. 1908): 780-794.

\_\_\_\_\_ "Robert Fulton in France." *Century Magazine* (Oct. 1908): 931-945.

Tamura, Toshio. "The Miscellaneous Ships *Yamsemi* (ex-Chinese Destroyer *Chien Kang*) and *Kawasemi* (ex-Chinese Torpedo Boat *Hu E*)." *Warship International* 23, no. 1 (1986): 86-92.

\_\_\_\_\_ "The Fate of the Chinese Torpedo Boat *Fei Ting*." *Warship International* 24, no. 2 (1987): 190-192.

Taussig, Joseph. K. Commenting on "Some Thoughts on Ships Boats in the Navy." *United States Naval Institute Proceedings* 100, no. 859 (September 1974): 100-102.

Taylor, Roger C. "Some Thoughts on Ships' Boats in the Navy." *United States Naval Institute Proceedings* 100, no. 855 (May 1974): 233-241.

Teller, C. Raymond. "The Quadraconic Hull: Its Form, Structure, Characteristics, Fittings, and Mechanisms." *Motor Boating* (1952):

- Thomson, David W. "David Bushnell and the First American Submarine" *United States Naval Institute Proceedings* 68, no. 468 (February 1942): 176-186.
- Thomson, David Whittet. "Robert Fulton and the French Invasion of England." *Military Affairs* 18, no. 2 (Summer 1954): 57-63.
- Thornycroft, John Isaac. "On Torpedo Boats and Light Yachts for High Speed Steam Navigation." *Proceedings of the Institute of Civil Engineers* 66 Great Britain (1881).
- Toy, Ernest W. "A Farmer's Son Goes to Sea: The Naval Career of Alan Everett Hudson." *Mariner's Mirror* 85, no. 2 : 182-195.
- Trimingham, Derisley. "27 Knotters: The Royal Navy's Early Destroyers." *Warship International* 4, no. 2 (1967): 96-103 and 127-128.
- Turk, Richard W. "Defending the New Empire, 1900-1914." In *In Peace and War: Interpretations of American Naval History, 1775-1984*, ed. Kenneth J. Hagan, 186-204. Westport, CN: Greenwood Press, 1984.
- Tyner, Paul. "Boat to Beat the Lusitania." *Technical World Magazine* (May 1908): 277-282.
- Vannutelli, L. "Concerning the Tactical Employment of Torpedo Boats." *United States Naval Institute Proceedings* 36, no. 136 (1910): 1101-1140.
- \_\_\_\_\_. "On the Employment of Torpedo Vessels in Night Search." *United States Naval Institute Proceedings* 41, no. 155 (1915): 89-105. Reprinted from Rivista Maritima. Translated by W.N. Jeffers.
- Von Pflugk, Captain H.A.V. "Torpedo Boats." *U.S. Naval Institute Proceedings* 67, no. 8, (462) (August 1941), 1115-20.
- Warley, A.F. "Note of the Destruction of the 'Albemarle'." *The Century Magazine* 36, no.3 (July 1888): 439-440.
- Watkins, John. "Action Against 'Elbings,' April 1944." *Mariner's Mirror* 81, no. 2 (1995): 195-206.
- Wicks, Daniel H. "The First Cruise of the Squadron of Evolution." *Military Affairs* 44, no. 2 (April 1980): 64-69.
- Wiren, Alexis R. "The Lesson of Port Arthur." *Russian Review* 1, no. 2 (April 1942): 40-43.
- Yarrow, Alfred Fernandez. "Fast Torpedo Boats." *Cassier's Magazine* 12 (August 1897): 293-318.

Yerxa, Donald A. "The United States Navy in Caribbean Waters During World War I." *Military Affairs* 51, no. 4 (October 1987): 182-187.

#### Unpublished Sources

Allen, Irving. *Never a Dull Moment: Metamorphosis of the Huckins Motor Torpedo Boat*. Jacksonville, Florida: Huckins Yacht Corporation, 1943(est.)

Dunnavent, R. Blake. *Sealords: the Riverine Interdiction Campaign in Vietnam*. Master's Thesis, Texas Tech University, 1992.

Freitas, Mark and Braddock W. Treadway. *Stygian Myth: U.S. Riverine Operations Against the Guerilla*. Master's Thesis, Monterey, CA: Naval Postgraduate School, 1994.

Humphrey, W.S. and W.C. Specht. "The Motor Torpedo Boat-Past, Present and Future: History, Development, Employment and Tactics; Accomplishments to 1 February 1943." Paper first delivered to the Naval War College 17 March 1943. Administrative Histories Appendices. Box 13, Motor Torpedo Boat Materials. Operational Archives. Naval Historical Center, Washington, D.C.

Spangler, David J. *What Lessons Can be Drawn from U.S. Riverine Operations During the Vietnam War as the Navy Moves into the Twenty-First Century?* Thesis. (M.M.A.S.) U.S. Army Command and General Staff College, 1995.

Tredinnick, Frank A. Jr. and Harrison L. Bennett. *An Administrative History of PT's in World War II*. U.S. Naval Administration in World War II Series, No. 171. Washington: Office of Naval History, 1946. Rare books collection, Navy Department Library. Naval Historical Center, Washington, D.C.

Walker, Samuel Bruce. *The Birth of the Motor Torpedo Boat, 1915-19*. Microfilm. USNA Library, Annapolis, MD.

Werth, James R. *The Confederate States Navy: The First Electrical Torpedo*. Lecture presented to Women's Club, March 4, 1905.

Williams, Vernon Leon. *The U.S. Navy in the Philippine Insurrection and Subsequent Native Unrest, 1898-1906*. Ph.D. diss., Texas A & M University, 1985.

#### Periodicals

Haygood, Will. "3 Men and the JFK Legend: Survivor Recalls Night of Tragedy, Heroism." *The Boston Globe*, 21 June 1989.

Hettena, Seth. "Sleek, agile Sea Fighter launches debate over future of Navy ships." *The Virginian Pilot*, 7 August 2005, A-20.

Poulnot, W.P. "Rebel Ram." *Charleston News and Courier* (20 December 1895).

*Look*. "The Man JFK Picked to Play His Wartime Role." 18 June 1963, 48-54.

Scutro, Andrew. "Surging still deeper into war on terrorism." *Navy Times* 18 July 2005, 12.

\_\_\_\_\_. "A Riverine Force." *Navy Times*, April 10, 2006. 14-15

\_\_\_\_\_. "Vietnam Vets Harbor Wealth of Information." *Navy Times*, April 10, 2006, 16.

*Time*. "Shipbuilding: Huck's New Boat." 1 December 1941.

*Washington Daily News*, 9 June 1938, 16.

Weiner, Tim. "The Navy's Fleet of Tomorrow is Mired in the Politics of Yesterday." *New York Times*, 19 April 2005.

#### Electronic Sources

Sea Fighter (FSF 1) Specifications.

<http://www.globalsecurity.org/military/systems/ship/x-craft-specs.htm>. Accessed on 15 August 2005.

X-Craft/Littoral Surface Craft-Experimental (LSC(X)). Fast Sea Frame/Sea Fighter).

<http://www.globalsecurity.org/military/systems/ship/x-craft.htm> Accessed on 15 August 2005.

#### Interviews

Dunphy, Robert. Former Torpedoman First Class (TM1c) Squadron 17 and 39. Interview by author, 18 March and 13 April 2004. Tallahassee, Florida

## BIOGRAPHICAL SKETCH

Ed Wiser was born and raised in Norfolk, Virginia and at a tender age became infected with a terminal love for ships, the sea, and all things nautical. Despite numerous attempts, he has never found a cure for the affliction. After graduating with a degree in Business Administration in 1974, he was commissioned a Second Lieutenant of Field Artillery and spent three years in Germany and the Netherlands playing with nuclear warheads, patrolling the Fulda Gap, and holding back the Communist menace. This was followed by reserve assignments with the 7/9<sup>th</sup> Field Artillery (8-inch) and the 20<sup>th</sup> Special Forces Group, FLARNG (1978-1982).

He returned to the “world” in late September 1978, resolved not to be cold or under someone else’s thumb ever again. Ed obtained a Masters degree in Business Administration from Embry-Riddle Aeronautical University thanks to the generous contributions of the American taxpayers, who were also kind enough to get him a commercial pilot’s license with instrument rating. In 1982, he left aviation to pursue his first love, boats, and since then has been a yacht broker, yacht captain, manager of a charter fleet, and service technician.

Captain Ed is licensed by the Coast Guard as a Master of steam, motor, or auxiliary sail vessels up to 200 tons. As a delivery captain he has operated motor and sail vessels up to 110 feet in length as far north as Massachusetts and as far south as Panama, and made an Atlantic crossing from Livorno, Italy to Fort Lauderdale via Martinique. Somehow he found time to fit in a second master’s degree - this time in history from Florida Atlantic University.

He is an adjunct professor of strategy and policy for the Naval War College, frequently lectures on military and nautical topics and writes about civilian and military small craft. When not busting knuckles in a boatyard, Ed can be found eating oysters at Hurricane Patty’s, sailing on his 28’ Morgan sloop, taking a kid fishing, or diving on shipwrecks.