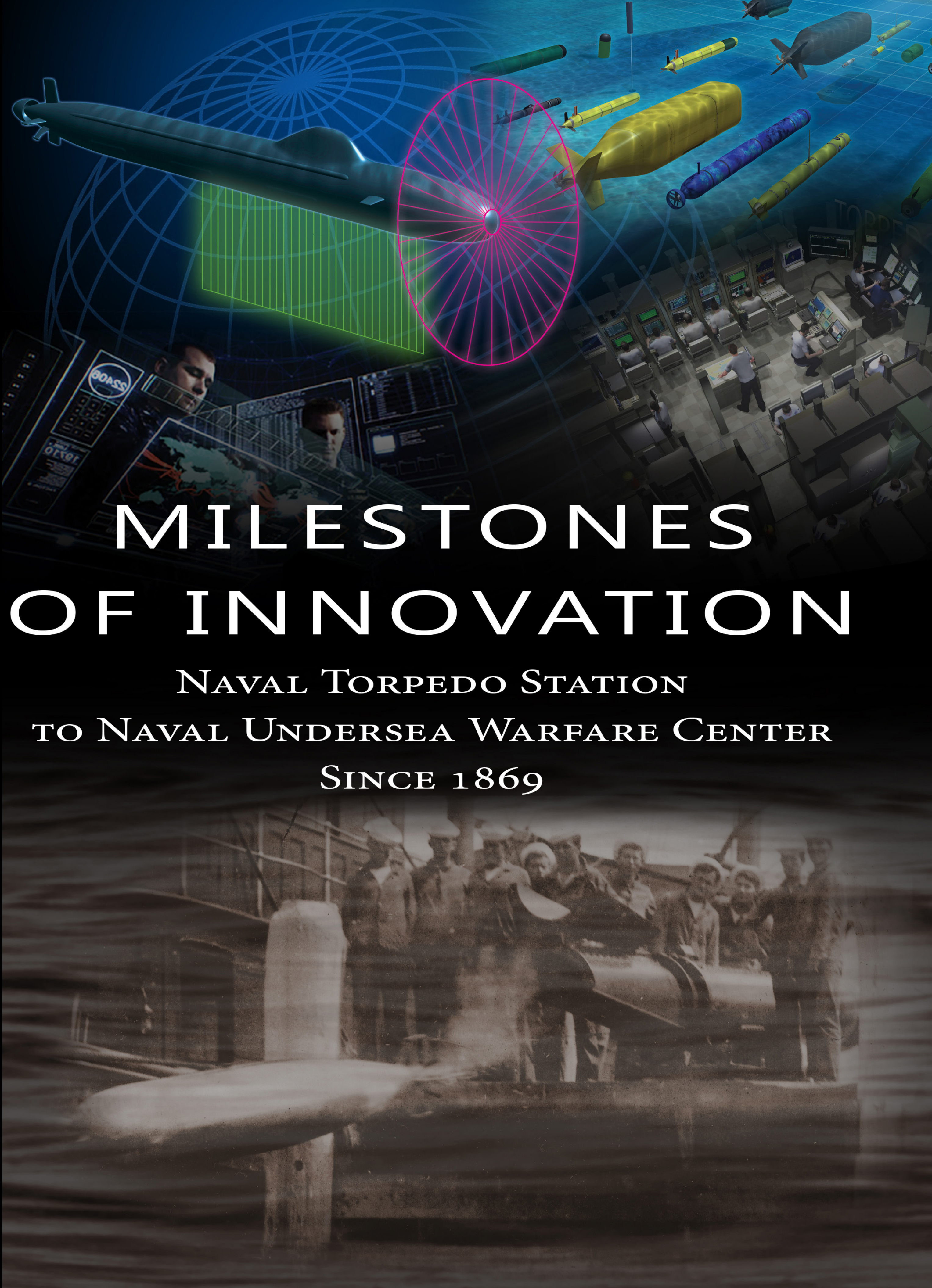

MILESTONES OF INNOVATION

Naval Torpedo Station to Naval Undersea Warfare Center Since 1869

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Bernard J. Myers

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14. ABSTRACT

This illustrated history of the Naval Undersea Warfare Center (NUWC) depicts in photographs and diagrams the Center's evolution from the Naval Torpedo Station, founded in 1869 on Goat Island off Newport, Rhode Island, as the Navy's first experimental ordnance station for torpedoes, to its current incarnation as the Navy's full-spectrum laboratory for undersea warfare, developing underwater technology, weapons, and integrated systems for submarine and surface combatants. A genealogy and timeline capture NUWC's evolution from predecessor organizations over 150 years. The inventions, achievements, and diverse workforce are depicted by decade, beginning with the artisanal weapons and launchers of the post-Civil War years and the industrial era and continuing through heavy production for two world wars, the workforce professionalization with mission changes, the early role of professional women, and the sophisticated integrated systems that met the challenges of the nuclear and Cold War eras—torpedoes, launchers, sonar, periscopes, and antennas—and test facilities from ice camps to anechoic chambers to deep-water test beds. The photographs are accompanied by detailed captions and narrative for historical context. The photographic history continues into the first decades of the 21st century with modern submarines, torpedoes, sonar, unmanned vehicles, stealth vehicles and weapons, and cyber warfare technology.

15. SUBJECT TERMS

Antisubmarine Missiles, Antisubmarine Warfare, Combat Control Systems, Command and Control Systems, Launchers, Mines, Mobile Acoustic Torpedo Targets, Naval Torpedo Station, Naval Undersea Warfare Center, Naval Undersea Warfare Engineering Center, Naval Underwater Ordnance Station, Naval Underwater Systems Center, Naval Weapons, Navy Underwater Sound Laboratory, Pacific Coast Torpedo Station, Periscopes, Sonar Array Handling Systems, Sonar Systems, Submarine Antennas, Submarines, Test Ranges, Torpedoes, Undersea Warfare, Underwater Sound Reference Laboratory, Unmanned Undersea Vehicles

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Overleaf (bottom photo):
Mk 3 Whitehead Torpedo
Naval Torpedo Station, 1894

MILESTONES OF INNOVATION

Naval Torpedo Station to Naval Undersea Warfare Center Since 1869

BERNARD J. MYERS

former Deputy Technical Director of the Naval Undersea Warfare Center

JOSHUA D. ROBINSON

Graphic Designer for the Naval Undersea Warfare Center Division, Newport

Milestones of Innovation
Naval Torpedo Station to Naval Undersea Warfare Center
Since 1869

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Dedication

This book and the wall mural on which it is based are dedicated to the civilian and military personnel of the Naval Undersea Warfare Center (NUWC) and its predecessor organizations whose innovation and technical expertise have contributed heavily to the success of the U.S. Navy's undersea warfare (USW) missions for almost a century and a half. This workforce forms the bedrock of NUWC's leadership role in providing the full spectrum of USW capabilities in each era, in step with changing technologies and USW threats.

The initial workforce of the Naval Torpedo Station (NTS), founded in 1869 on Goat Island off Newport, Rhode Island, as the Navy's first experimental ordnance station for torpedoes, was composed of naval officers, sailors, and civilian scientists and technicians. Their mission was to train officers in torpedo warfare and develop and evaluate torpedo technology. Their research and experiments were based on the science of their time and great inventiveness. Their success was due to recruiting and training talented individuals, with a strong focus on innovators. Since torpedoes and mines were essentially artisanal weapons—from components to delivery systems—through World War II, the NTS apprentice program developed a large corps of artisans trained in all aspects of machine design and manufacturing. This artisan-based workforce became the core of a highly trained scientific and technical organization, even when production was primary in the war years.

When the Navy's mission changed after World War II, the NTS research and development (R&D) core was expanded in successor organizations to take advantage of rapidly developing theory and new technologies. The educational profile of the workforce changed with each era, but recruiting and training the brightest talent and focusing on innovation were still central to the organization's success as it evolved into the full-spectrum USW center for underwater technology, weapons, and systems for submarine and surface combatants that is still headquartered in Newport.

The organization became a leader in introducing women into the workforce and qualifying them for all positions, starting early in World War I. The role of women at NTS continued to expand through World War II. At that time, women were part of the artisan workforce needed to produce and test torpedoes and mines. After World War II ended and the organization reverted to its R&D roots, the hiring of professional women commenced, first as mathematicians and soon after as physicists, scientists, and engineers.

This highly trained and diverse workforce, many with the advanced degrees now needed to explore the latest technologies and to develop new and highly sophisticated systems, continues to demonstrate its innovative abilities and technical skills, as witnessed, for example, by thousands of patents. Its workforce makes NUWC uniquely qualified to advance the capabilities of today's USW systems, as it continues to demonstrate the art of the possible in providing the undersea warfighting capabilities the Navy requires.

Workforce Over the Years 1869–2017

Late 1800s Guncotton Production

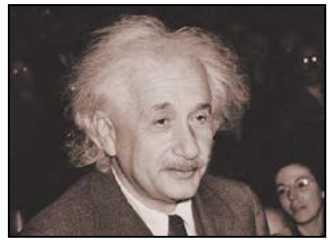
1894 Firing Early Torpedo

1917 Women Workers

1920s Torpedo Team

1920s Keyport Baseball Team

1930 Torpedo Shop Workers



Consultant at $25 Per Day in 1943

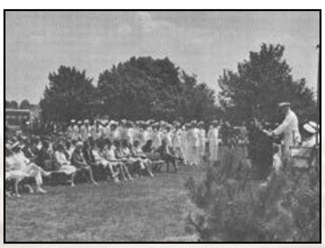
Naval Torpedo Station 1944

1945 Army-Navy E Award Keyport

1950s Central Torpedo Office

Circa 1965 Newport City Fathers Visit

1969 100th Anniversary Ball



1970 NUSC Established

1978 Keyport Prep. 1,000th Mk 48 Torpedo

1984 NUSC's Astronaut

1985 NUSC ICEX Team Removes Ice Core

1990s Lancher Lab Demo

1997 Quiet Wind Tunnel Demo

1997 SECNAV Visits NPT

2009 Some Decibel Award Winners

Foreword

"The Navy has both a tradition and a future—and we look with pride and confidence in both directions."

– Admiral Arleigh Burke, Chief of Naval Operations, Change of Command Address at Annapolis, Maryland, 1 August 1961

Donald McCormack
Executive Director
Naval Surface and Undersea Warfare Centers

This book provides a historical narrative of the Naval Undersea Warfare Center (NUWC) from its origins in 1869 as the experimental Naval Torpedo Station on Goat Island in Newport, Rhode Island, to its present-day incarnation as the Navy's premier undersea laboratory. Still headquartered in Newport, NUWC has undergone many organizational and name changes. One feature remains constant, however: the commitment to facilitating the U.S. Navy's global leadership in undersea warfare today and tomorrow.

NUWC's success over the past century and a half has been made possible by two major factors. First, and foremost, is the vital role of technology innovation, evidenced in the early years by the large number of inventors who made torpedoes and torpedo components and launchers. Later, there were sonar and fire control breakthrough discoveries. These innovations had major impacts not only on the weapons but on the platforms themselves, ensuring that our country's defense goals were met. The continuous development of new technologies and their timely transition to the fleet have been key features of NUWC's tradition of excellence.

Of equal importance to NUWC's accomplishments through the years is the workforce that has achieved them. Highly motivated and extremely capable, the NUWC workforce has constantly evolved, from the early staff of inventive naval and civilian experimenters and artisan workers to today's highly trained scientists, engineers, technicians and business professionals to meet new and greater challenges.

Taking a page out of Admiral Burke's book, NUWC and the Navy are building on their shared past to shape a shared future in which the Navy continues to play a vital role in our nation's dominance at sea, maintaining open lines of communication and commerce and projecting power at sea and ashore anywhere in the world. NUWC will continue to provide value to the Navy and the nation by improving technical expertise, delivering unique capabilities for undersea warfare, and seeking the most cost-effective solutions possible, all while meeting or exceeding fleet and customer expectations.

One can only imagine where this will take us over the next 150 years.

Contents

Acknowledgments

The photos and illustrations in this book were drawn from the wealth of material that was gathered by many contributors for a 14-panel wall mural presenting an illustrated history of the Naval Undersea Warfare Center (NUWC) that was originally developed for installation at NUWC Headquarters.

The author is indebted to the late Arthur E. Burke for his work on the early history of the torpedo in Newport, Phil Tabor for his thorough review of both the wall mural and this book, Dr. John E. Sirmalis for his many helpful suggestions, and Jane Tracy for providing source material on local history available in the files at NUWC Division Newport.

Special thanks are due to Linda Nichols for editing the historical text and for her many insightful comments and helpful suggestions and to Josh Robinson for the graphic design of both the mural and the book.

Thanks also go to the entire NUWC Division Newport Graphic Art and Visual Design group, the many personnel from the Division Newport product lines who provided historical material, many retirees from both the Newport Division and the Underwater Sound Laboratory, and Bob Cembrola of the Naval War College Museum Newport. Great support was also received from NUWC Division Keyport personnel, especially Diane Crocker, Dean Cox, Sara Wineman, Robert White, and Joe "J" Overton.

The support of Pamela J. Lisiewicz, Director, Strategic and Corporate Planning, NUWC, and Donald F. McCormack, Executive Director, Naval Surface and Undersea Warfare Centers, was essential to the creation of this book to document and publish the illustrated history of the Center.

Bernard J. Myers
November 2017

Introduction

With nearly 150 years of leadership and innovation covering a broad range of torpedo, sonar, combat, and many other surface and submarine systems, the Naval Undersea Warfare Center (NUWC) and its predecessor organizations have had a major impact on the full spectrum of 20th and 21st century naval warfare.

Key aspects of this long and impressive institutional history are reflected in a 14-panel wall mural showcased at NUWC Headquarters in Newport, Rhode Island. The mural depicts significant events and trends decade by decade in

this history, from the establishment of the Naval Torpedo Station in 1869 to the present, focusing on the organization's many accomplishments, its development as an entity, and the role it played in contemporaneous events.

A dozen of the panels in the mural each cover roughly a decade at a time, highlighting the organization's technology and people against the backdrop of world events. Each panel provides an overview of the technical progress and innovation at NUWC and its predecessors, the key people involved, and a summary of the events that influenced the organization during that specific period of time.

The penultimate panel depicts some of the advanced technologies and systems developed at NUWC to support the Navy against the challenges posed by the emergence of diverse threats in recent years. The final panel—"The Future"—displays snapshots of many of the scientific and technological breakthroughs being innovatively exploited at NUWC to meet the future undersea warfare mission needs of the Navy.

Certain themes, such as the role of women in the workplace and the co-evolution of naval strategy and advances in technology to meet ever-evolving threats, are reflected across multiple time periods.

After the original 14 panels were displayed at NUWC Headquarters, the mural was also reproduced on the walls of the NUWC Division Newport reception area, with some alterations to highlight key events in the Division's history. Interest in the mural then extended to the Naval War College Museum, where the first 100 years of the illustrated history are displayed, and to NUWC Division Keyport, where selected parts of the mural were used in Division Keyport's 100th anniversay celebration.

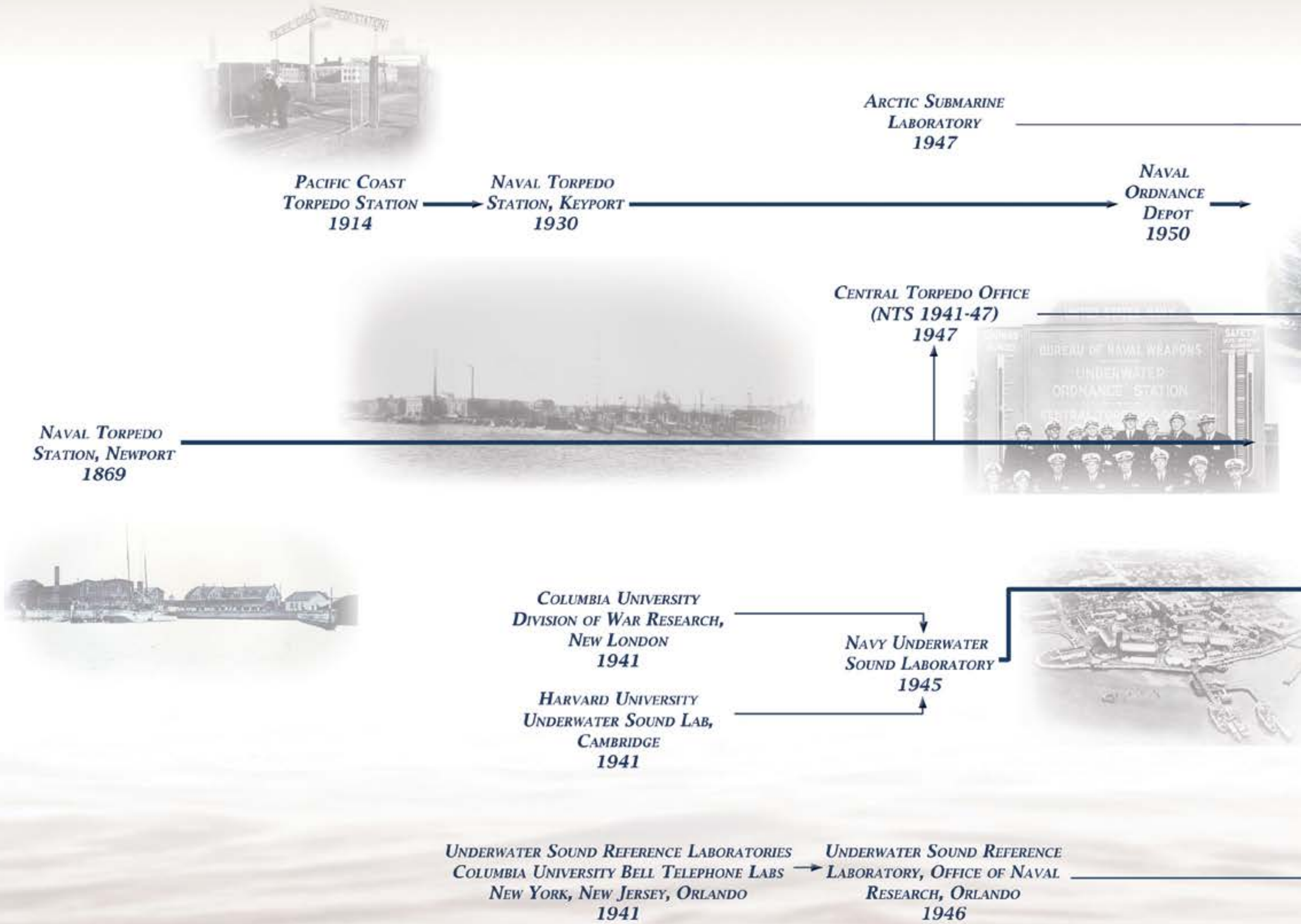
The purpose of this book is to capture the content of the mural in a form that can be made more readily available to a larger audience. Each of the panels is presented in a chapter in which the photos and illustrations from the panel are enlarged and accompanied by fully explanatory captions. Additional photos supplement the history of the naval events in the period, and a short essay puts these events into historical context.

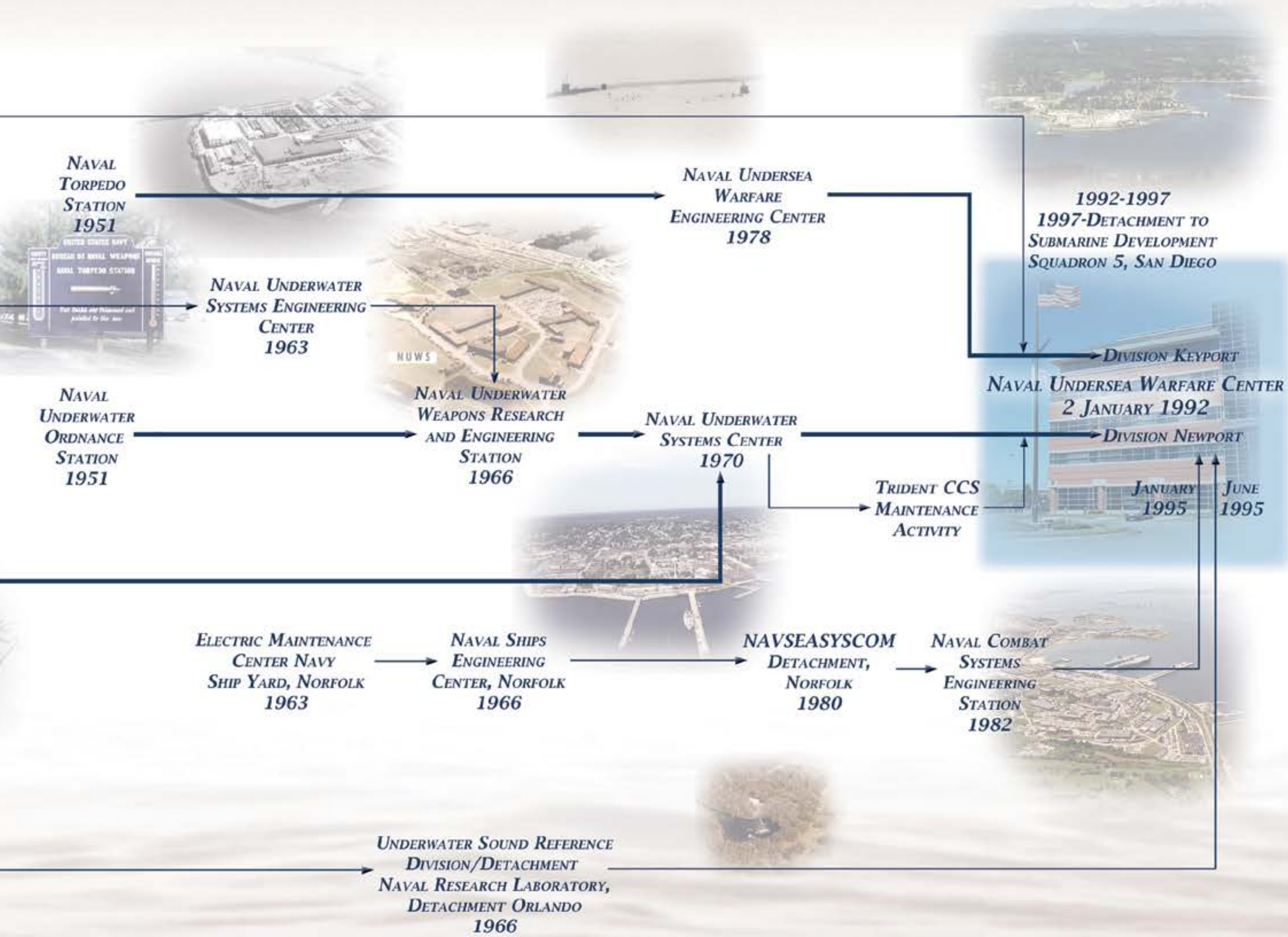
To set the scene for the history presented in the mural, a genealogy panel traces NUWC's timeline from 1869 to the present. This genealogy, also reproduced in this book, follows the organization's evolution through its many administrative and name changes, the addition of complementary organizations as its responsibility broadened, and the consolidations resulting from several Base Realignment and Closure actions. The direct line from the Naval Torpedo Station of 1869 to the Naval Undersea Warfare Center of today is clearly traced.

The history captured in this mural underscores how innovative scientific and engineering responses over the years have proven to be the engine of progress for NUWC and the Navy. This book concludes with a vision of the future of undersea warfare in which NUWC will continue this pattern of innovation—pursuing the newest and broadest range of technologies—to develop the new capabilities needed to meet future threats.

Genealogy

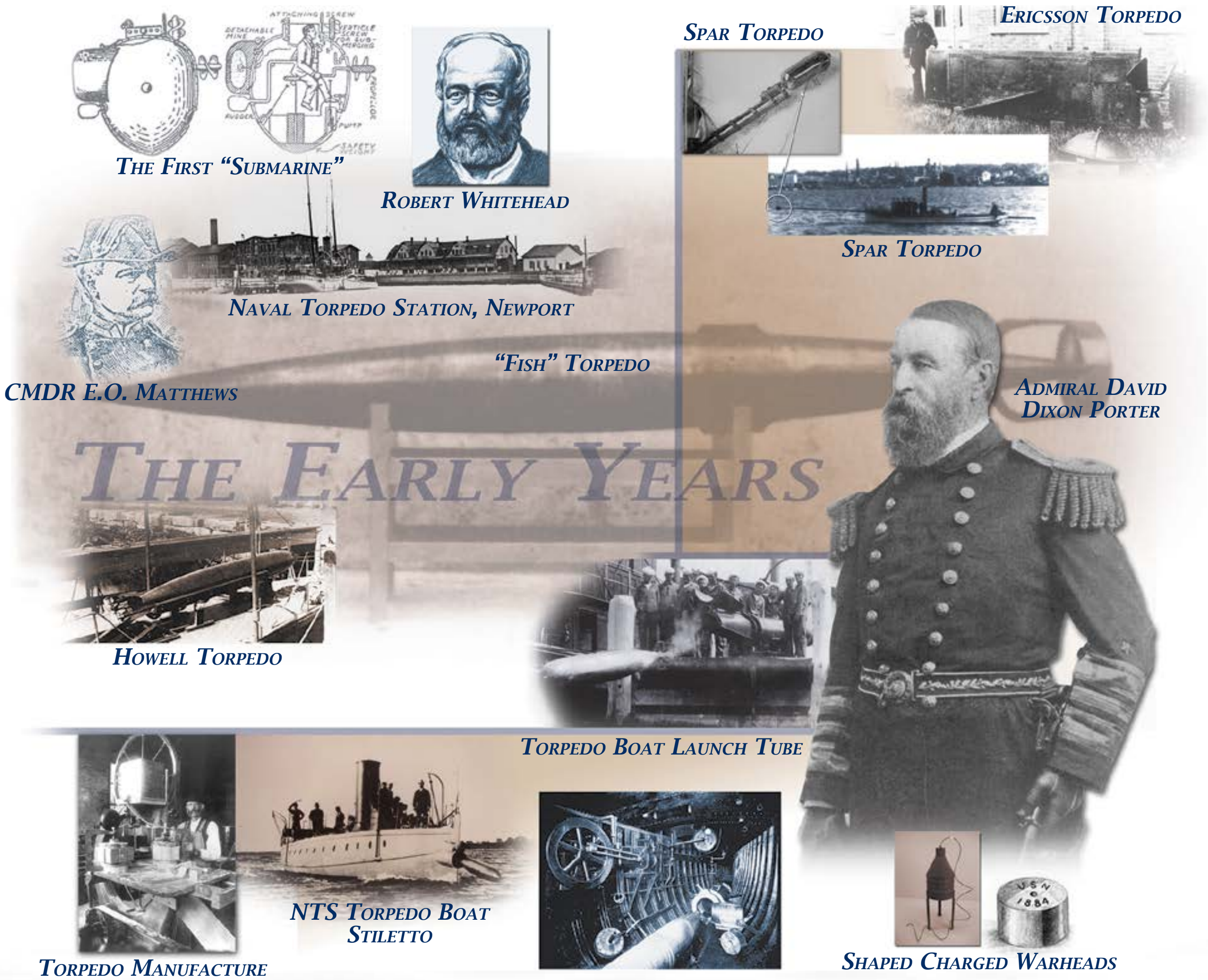
of the Naval Undersea Warfare Center





Naval Torpedo Station 1951
Naval Undersea Warfare Engineering Center 1978
1992-1997
1997-Detachment to Submarine Development Squadron 5, San Diego
Naval Underwater Systems Engineering Center 1963
Division Keyport
Naval Undersea Warfare Center
2 January 1992
Naval Underwater Ordnance Station 1951
Naval Underwater Weapons Research and Engineering Station 1966
Naval Underwater Systems Center 1970
Division Newport
Trident CCS Maintenance Activity
January 1995
June 1995
Electric Maintenance Center Navy Ship Yard, Norfolk 1963
Naval Ships Engineering Center, Norfolk 1966
NAVSEASYSCOM Detachment, Norfolk 1980
Naval Combat Systems Engineering Station 1982
Underwater Sound Reference Division/Detachment
Naval Research Laboratory, Detachment Orlando
1966

The Early Years



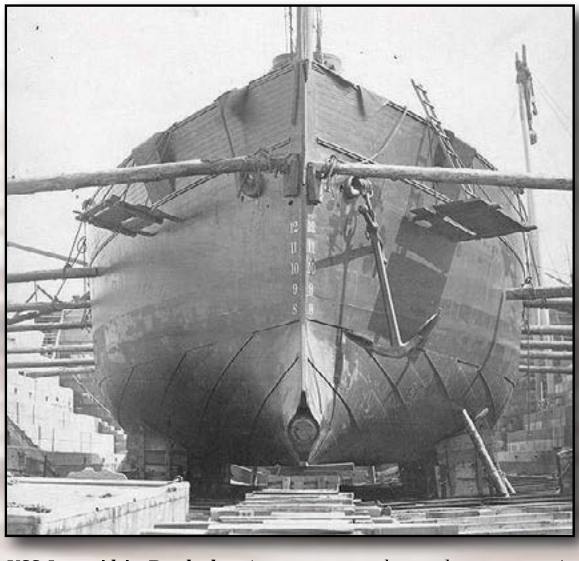
1869 — 1899

Throughout history, ships have played an important role in commerce and war. All early civilizations with access to the sea used ships to enlarge their spheres of influence. Early ships were often fitted with battering rams since it was well known that a hole in an opponent's vessel below the waterline usually sank it. The invention of gunpowder by the Chinese led quickly to the development of cannons and explosive devices such as mines.

Olympias *– A reconstruction of an ancient Athenian trireme with its ram. With trained oarsmen, the ram became an early and effective naval weapon.*

In 1776, David Bushnell's first "submarine" was designed for a stealthy approach in order to attach an explosive charge, or "mine," to the hull of a ship below the waterline. The "spar" torpedoes popular during the Civil War were designed as mobile mine delivery systems.

The "mobile" torpedo invented in the 1860s by Robert Whitehead, an English engineer working in Austria, was initially known as an automobile torpedo and later simply as a torpedo to differentiate it from a mine or mobile mine.



USS Intrepid in Drydock *– A steam-powered torpedo ram commissioned and built in 1874, she had the distinction of being the world's first U.S. Navy ship armed with self-propelled torpedoes. In concept and design, she was roughly comparable to the Royal Navy's HMS Polyphemus.*

In 1869, the Naval Torpedo Station (NTS) on Goat Island near Newport was established as the U.S. Navy's first experimental ordnance station for the development of torpedoes and torpedo equipment, explosives, and electrical equipment.

Shortly after its establishment, the Torpedo Station at Newport was given the task of building a "Fish" torpedo, similar to the Whitehead torpedo. The Fish torpedo was to be designed to meet two requirements:

1. To go underwater for a considerable distance at a fair rate of speed, and

2. To make a straight course and maintain constant immersion, whether started on the surface of the water or below it.

***Royal Navy Ram with Five 14-inch Underwater Tubes** – With one tube housed within the ram itself, she could fire either spar or early 14-inch diameter Whitehead torpedoes. She was launched in 1881.*

The first trials of the Fish torpedo were conducted in Narragansett Bay in 1871 but never led to production.

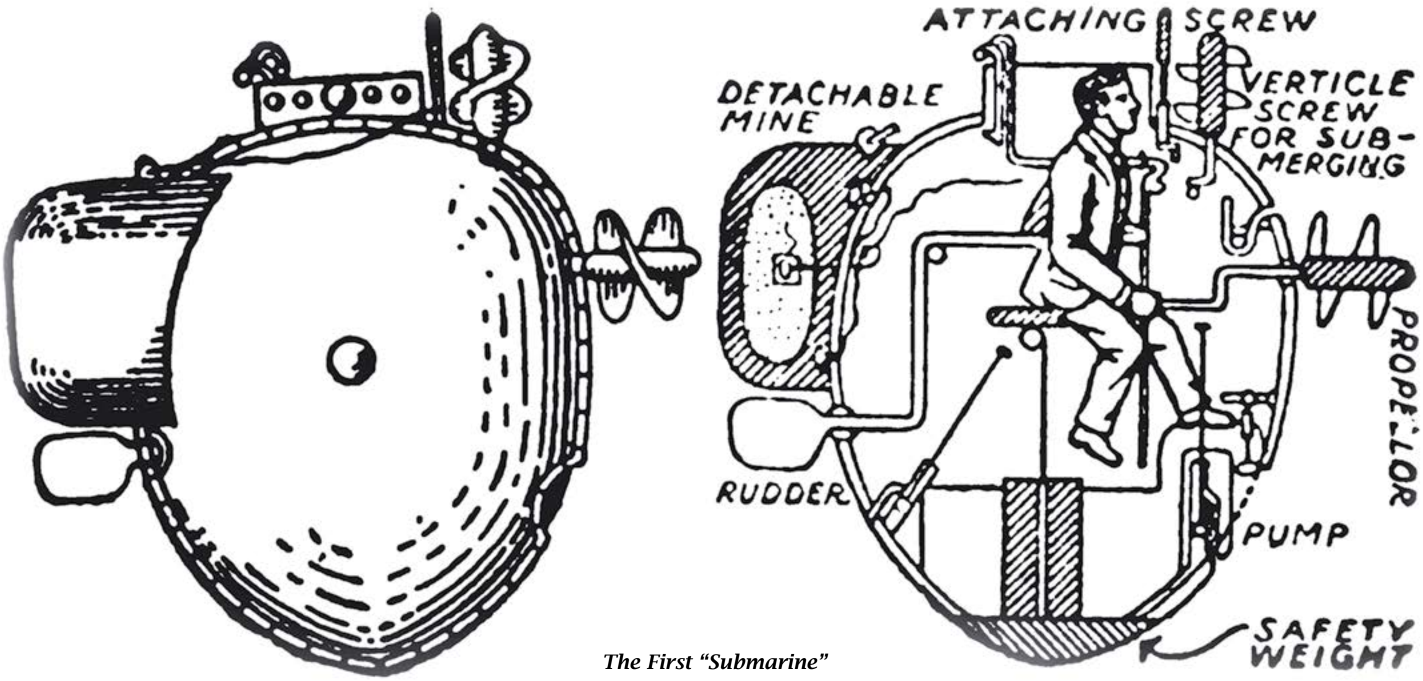
Circa 1880, Lieutenant Commander J. A. Howell (later Rear Admiral Howell) developed the first U.S. torpedo to achieve production status. It was manufactured, starting in 1889, by the Hotchkiss Ordnance Co. of Providence, Rhode Island, and remained in service until 1898.

In 1891, the rights to build a Whitehead torpedo were purchased by the E. W. Bliss Company of Brooklyn, New York, and they, under contract to the U.S. Navy, built an initial 100 Mk 1 Whitehead torpedoes (3.55 meters by 45 centimeters).

An additional 300 Whitehead torpedoes of various types were built by Bliss between 1896 and 1904.

Torpedoes of many designs were invented in this period, and several new designs, including the Ericsson, Lay, Barber, and Cunningham torpedoes, were evaluated in experiments at the Naval Torpedo Station.

Howell Torpedo



The First "Submarine"

David Bushnell's "Turtle," built in 1775 in Old Saybrook, CT, was designed to stealthily attach an explosive charge (a mine) to a ship in harbor.

CMDR E. O. Matthews

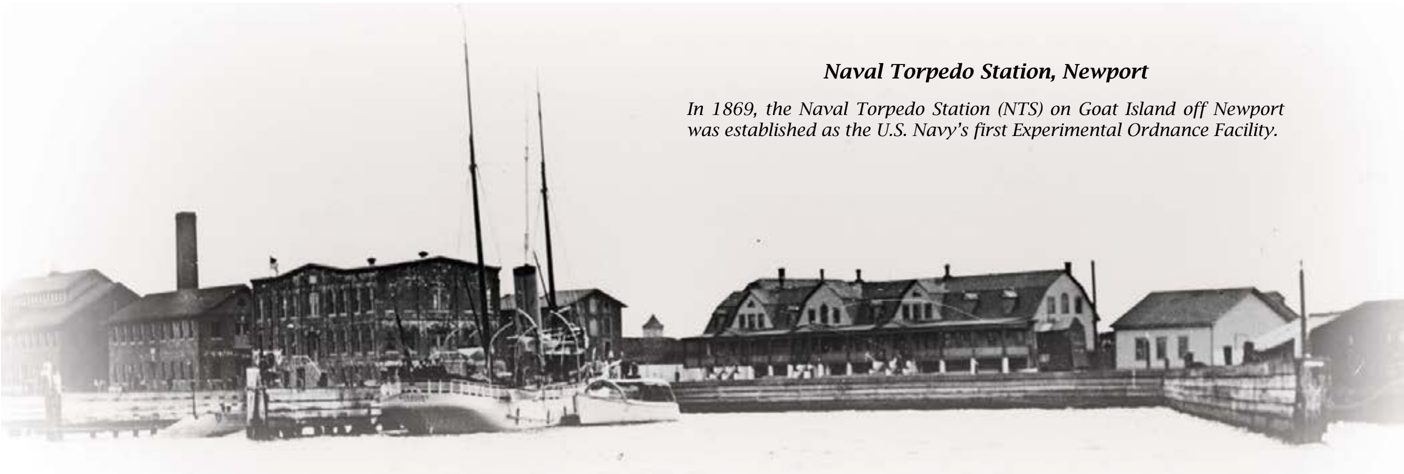
The Naval Torpedo Station's first commanding officer, CMDR Matthews served from 1869 to 1873.

Torpedo Manufacture at NTS Newport

Worker at a band saw is engaged in guncotton (nitro-cellulose) production, which was one step in the manufacture of early torpedo warheads.

Howell Torpedo

Circa 1880, LCDR J. A. Howell (later RADM Howell) developed the first U.S. torpedo to achieve production status. Powered by a 132-pound flywheel, the Howell torpedo was in service from 1890 to 1898. It was manufactured by the Hotchkiss Ordnance Co. of Providence, RI. The photo shows a Mk 1 Howell torpedo on the deck of torpedo boat Stiletto at NTS Newport in 1898.



Naval Torpedo Station, Newport

In 1869, the Naval Torpedo Station (NTS) on Goat Island off Newport was established as the U.S. Navy's first Experimental Ordnance Facility.

NTS Torpedo Boat Stiletto

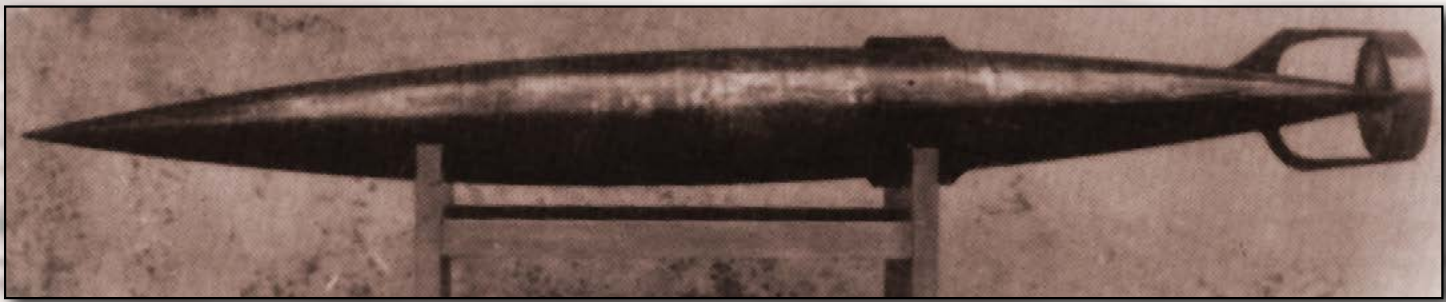
Built by the Herreshoff Company of Bristol, RI, in 1886, the Stiletto was the first of the Navy's wooden torpedo boats. Here, the Stiletto is firing a Howell torpedo from its bow tube.

Robert Whitehead

An English engineer and inventor working in Austria, Whitehead revolutionized naval warfare in the 1860s with the invention of the first "Automobile Torpedo."

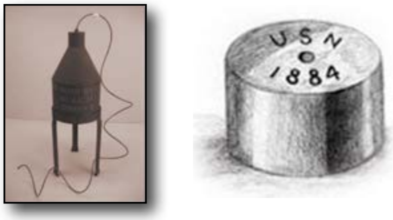
Torpedo Boat Launch Tube

This interior view of the torpedo boat Cushing (TB-1) shows the typical single torpedo tube launch configuration on early torpedo boats.



"Fish" Torpedo

In 1871, Admiral Porter directed NTS Newport to "examine closely into the subject and ascertain if torpedoes of this plan [similar to the early Whitehead designs] cannot be gotten up." The NTS Fish torpedo, the Navy's first self-propelled torpedo, was built by NTS Newport later that year.

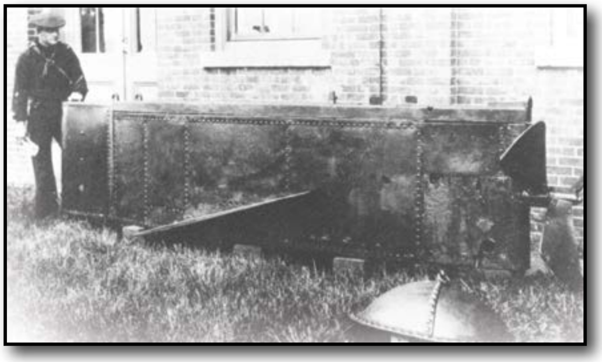


Shaped Charged Warheads

Charles Edward Munroe joined NTS Newport as a chemist in 1886, where he discovered the basis for explosive shaped charges—the Munroe effect. He also discovered smokeless gunpowder. Later, he became the Dean of the Corcoran Scientific School at Columbian University.

Mk 3 Whitehead Torpedo

The Mk 3 Whitehead design was the first torpedo to use a gyro for azimuth control. Here, a Mk 3 Whitehead is being fired from the NTS Newport pier in 1894.



Ericsson Torpedo

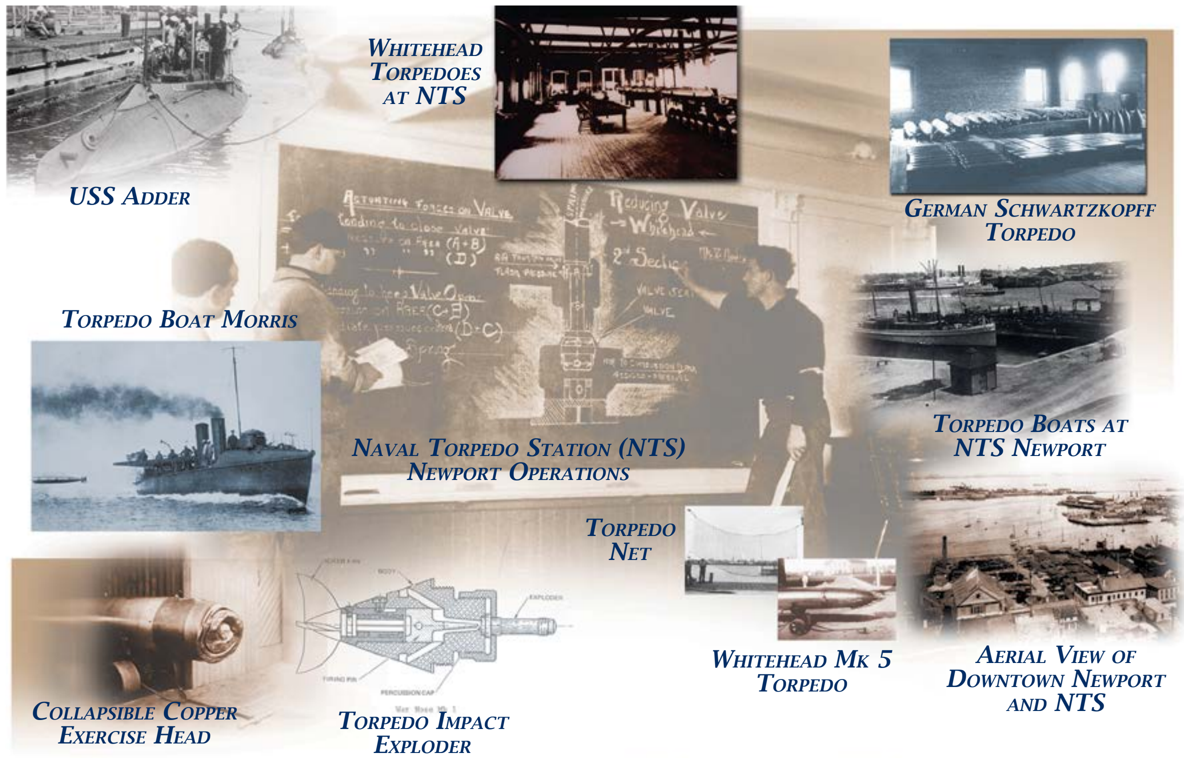
One of the many early "Automobile Torpedo" designs, the Ericsson torpedo underwent NTS trials in Long Island Sound in 1873.

Admiral David Dixon Porter

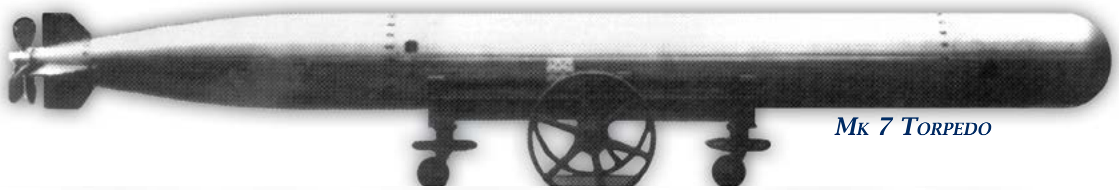
Admiral Porter was one of the early advocates of the "Automobile Torpedo."

Spar Torpedo

Spar torpedoes were used with some success during the Civil War (1861—1865). In 1873, NTS Newport conducted a series of experiments on these weapons in an effort to increase their combat effectiveness.

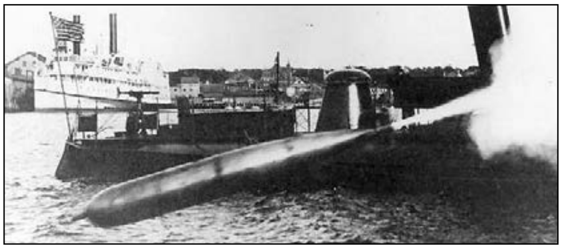


Industrial Era Begins



1900—1909

During the later years of the 19th century, navies of the world began to face significant changes in the way wars at sea were conducted. Bow rams, spar torpedoes, and especially the potential capabilities offered by the new Whitehead self-propelled torpedo threatened the large battleship fleets. Although many highly placed advocates throughout the world continued to view large battleship forces as the backbone of their fleets for many years to come, others began to look to the potential of the mobile torpedo, which was still in its early development.



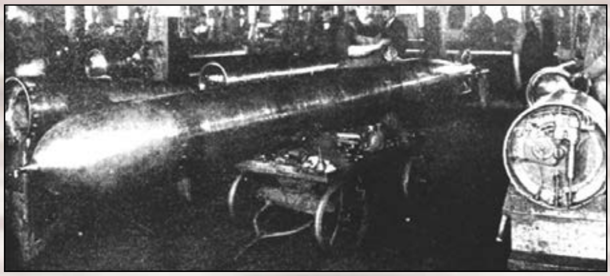
Whitehead Torpedo Being Fired at NTS

Many navies built a number of transitional ship designs incorporating the ram and spar torpedoes and the new mobile torpedo. In the U.S., such ships were usually assigned to the Naval Torpedo Station in Newport for experimentation and at-sea evaluation. Most designs did not pan out and showed only limited promise at best. Attempts to incorporate the new automobile torpedo also met with limited success, both in launching the torpedoes and in capabilities such as torpedo speed and azimuth/depth control. It was quite common for the launch vessel to overrun the torpedo because of the torpedo's limited speed.

A major advantage, however, soon became apparent within just a few years as torpedo development achieved technical advances in depth, range, speed, and warhead size. Some of these improvements were:

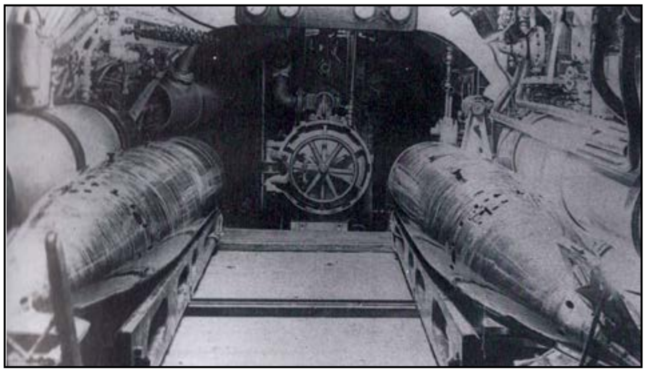
- A pendulum for improved depth control,
- A gyro for azimuth control,
- Venting exhaust gas through the drive shaft,
- A single-stage turbine followed by a two-stage turbine with counter rotating propellers (provided improved efficiency and removed unbalanced torque),
- A hot gas system for increased energy availability for higher speed and longer range, and
- Improved warhead size and fusing.

Whitehead torpedoes were licensed for production in the U.S. by the E. W. Bliss Company in 1892. The motivation, after 25 years, for the U.S. Navy to finally accept the Whitehead torpedo was probably its successful wartime use by the Chilean navy to sink an insurgent battleship during the Chilean civil war of 1891.



***A Completed 21-inch Bliss-Leavitt Torpedo** – The small propeller at the head, by revolving, releases the exploder firing pin as soon as the torpedo enters the water. To the right is the principal valve group.*

In 1901, the Whitehead Mk 5 torpedo was designed as a "hot running" torpedo. The increased efficiency of this unit allowed it to run at 27 knots for 4,000 yards—an increase in range by a factor of five. Such an advance, with constant incremental improvements, went a long way toward cementing the role of the torpedo as a major force in future naval capabilities, tactics, deployment of forces, and ship design.

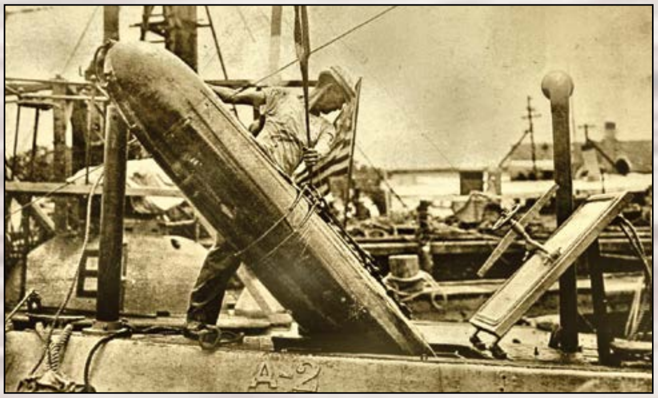


***Torpedo Room of USS Moccasin (SS-5, later A-4)** – A 1912 view of the torpedo tube and two reloads are shown.*

E. W. Bliss built the "cold running" Whitehead torpedoes (Mk 1 to Mk 4) for the U.S. Navy. In 1908, the "hot running" Whitehead Mk 5 was the first torpedo built by the Naval Torpedo Station in Newport, not by Bliss. Meanwhile, the new Bliss-Leavitt designs improved rapidly on the Mk 1 (1904). In 1911, the Newport torpedo plant began producing the new turbine-powered Bliss-Leavitt Mk 7. Bliss cooperated with NTS on designs through the last in the series—the Mk 9.

The torpedo was initially deployed on submarine platforms on *Holland*-class boats and on the follow-on *Plunger* class starting in the early 1900s. These submarines had a single tube and carried two additional torpedoes.

One of the great advantages that torpedo development enjoyed on the threshold of the Industrial Age was the availability of highly skilled and extremely talented artisans. These innovators relied largely on trial and error in the absence of theoretical foundations, and a great deal of in-water testing was needed to support torpedo development and rapid increases in capability. The necessary infrastructure was in place at the Naval Torpedo Station in Newport and formed an early basis for providing the tremendous lethal capability that the torpedo provided the Navy during these early decades of development and production.



USS Adder Loading a Mk 7 Torpedo

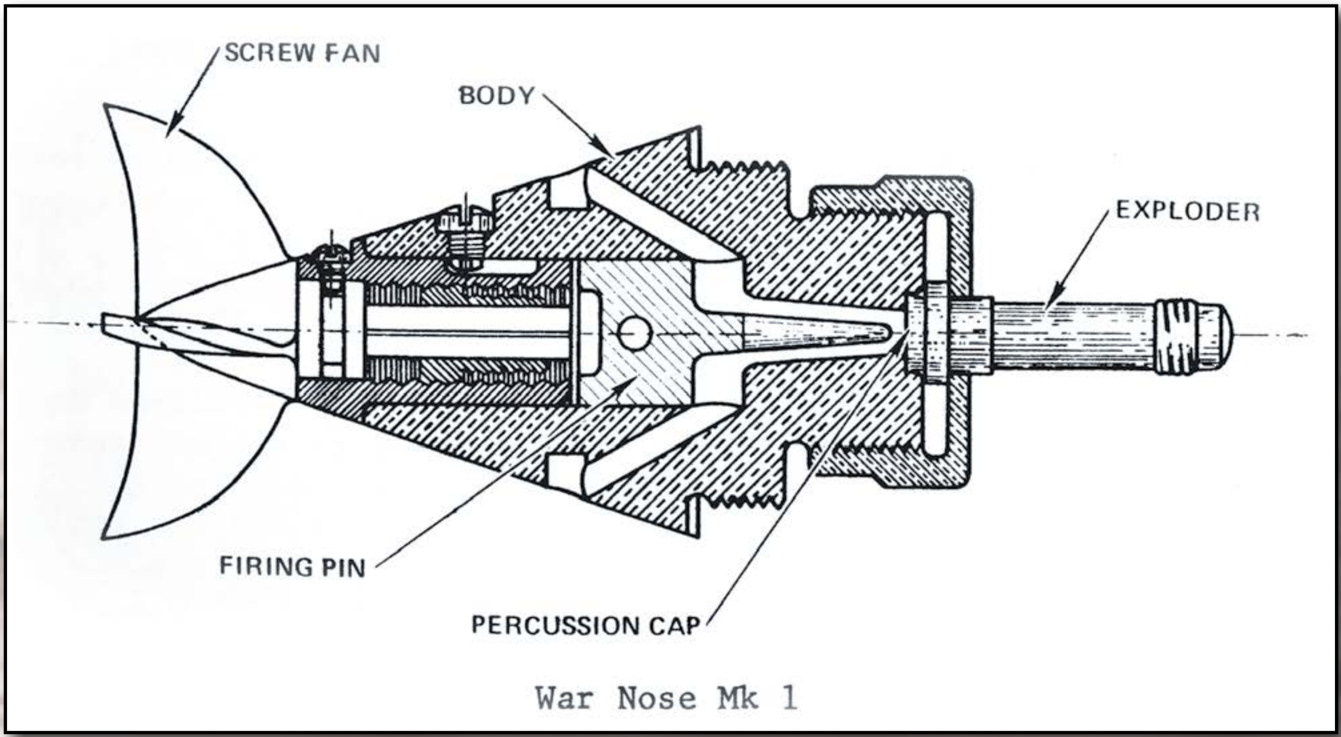
USS Adder (1903–1922)

USS Adder (SS-3) was one of the earliest submarines used by the U.S. Navy. Built by the Crescent Shipyard in Elizabethport, NJ, her first assignment was for experimental duty at NTS Newport.

Collapsible Copper Exercise Head (1904)

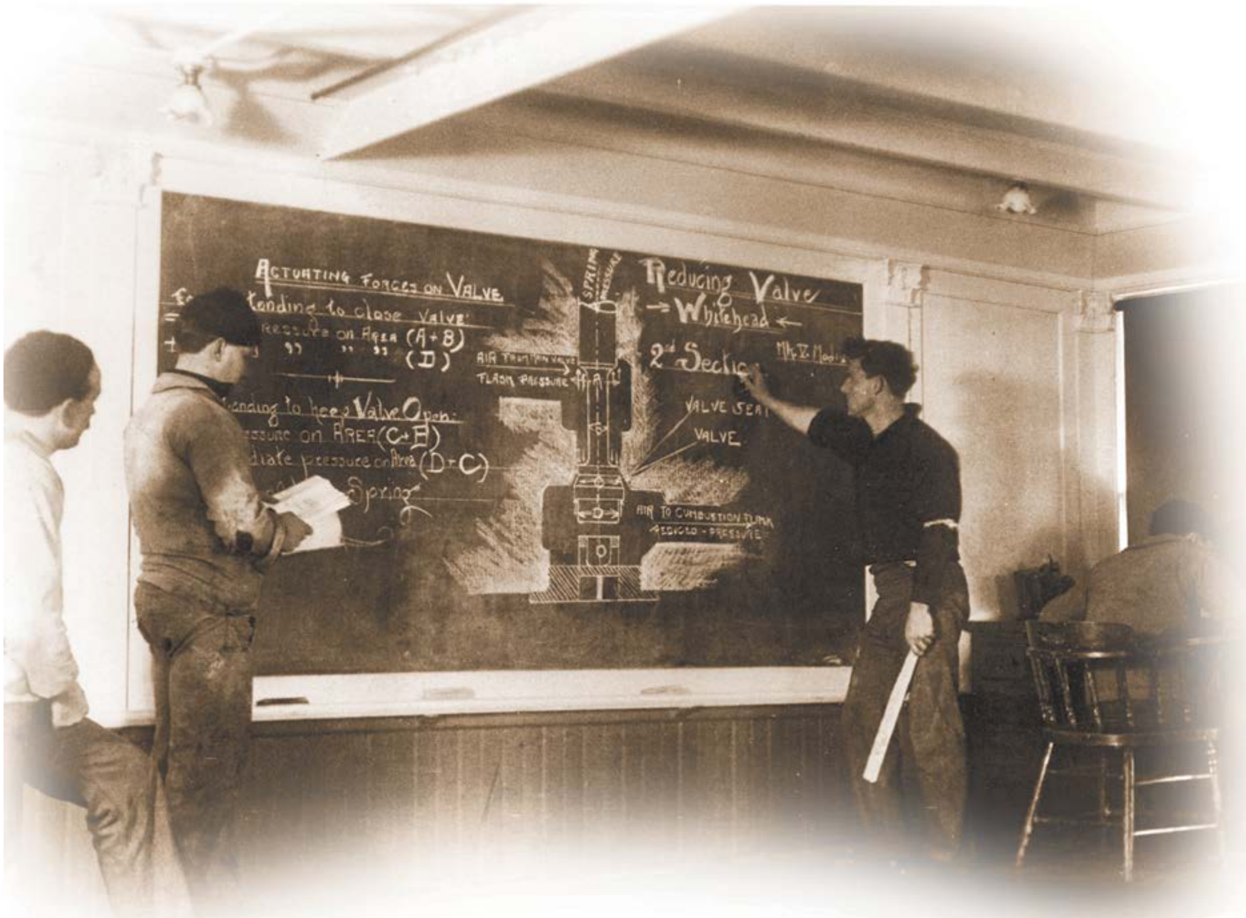
Torpedo Boat Morris

The torpedo boat Morris (TB-14) was designed and built by the Herreshoff Company of Bristol, RI. Here, at NTS Newport in 1906, she is firing a Whitehead torpedo.



Drawing of an Early Torpedo "Impact" Exploder

The drawing shows the "screw fan" (propeller) safety arming feature. The propeller had to rotate some 20 times (equivalent to 70 yards of torpedo travel) before the firing pin was allowed to move.



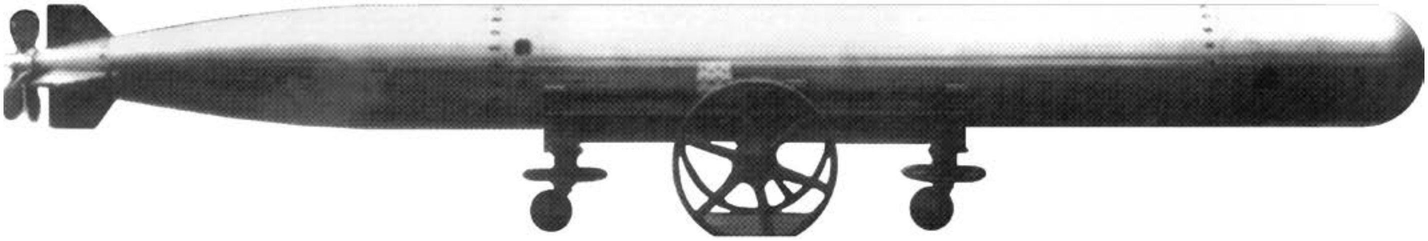
Naval Torpedo Station (NTS) Newport Operations Circa 1900

NTS Storage Building for Whitehead Torpedoes (1909)

A Net Pierced by a Net-Cutting Torpedo During an NTS Test (1908)

Mk 5 Whitehead Torpedo

Whitehead Mk 5 torpedo fitted with a net cutter. It was the first torpedo to have incrementally variable low, medium, and high speed.



Mk 7 Torpedo

The Bliss-Leavitt Mk 7 torpedo was the U.S. Navy's first steam torpedo. It was jointly developed by the E. W. Bliss Company and NTS Newport between 1909 and 1911. It remained in the fleet for 33 years.

German Schwartzkopff Torpedo

These torpedoes were acquired from enemy ships after the Spanish American War and underwent evaluation at NTS Newport.

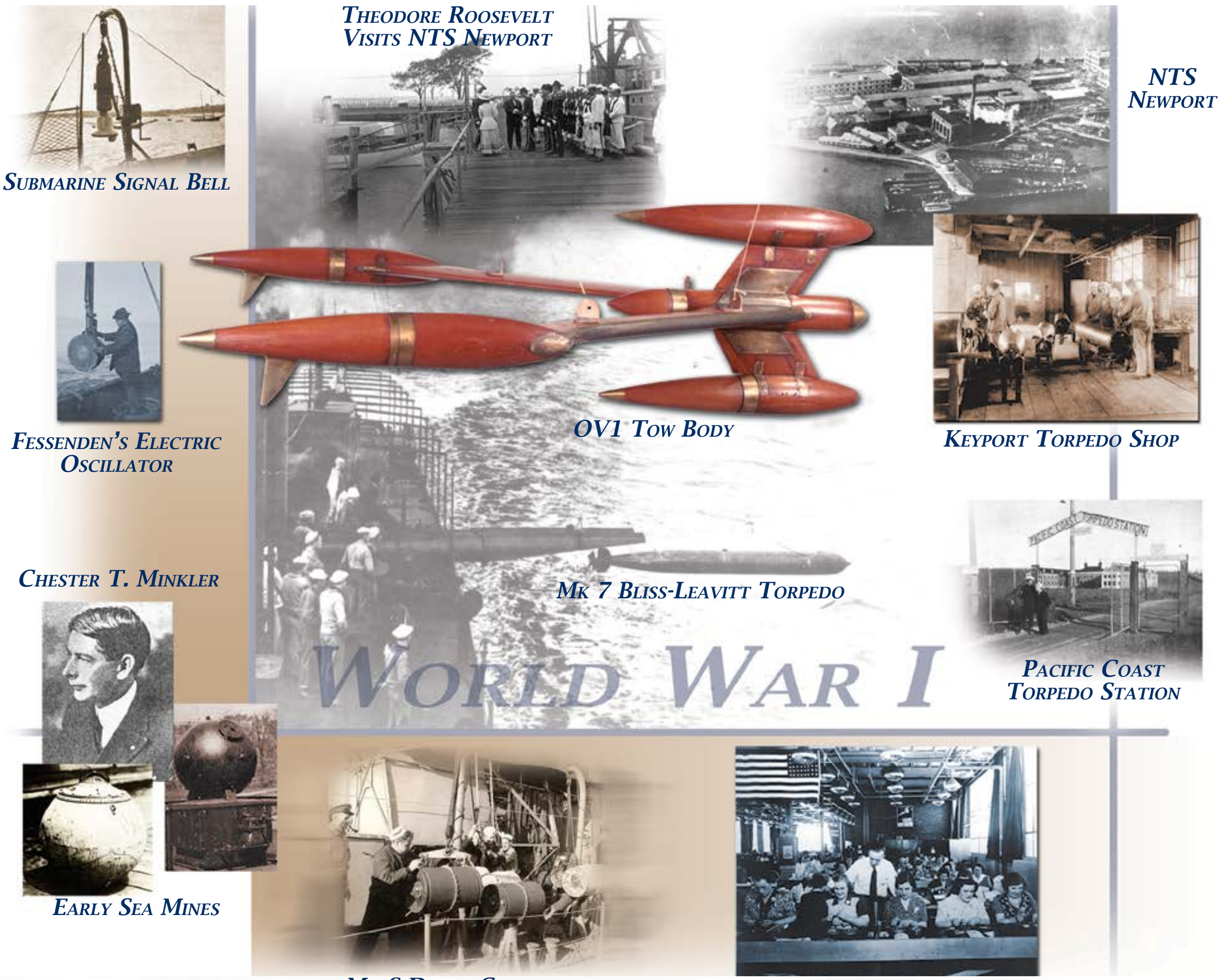
Torpedo Boats at NTS Newport

By the start of the Spanish-American War in 1898, the U.S. Navy had 12 operational torpedo boats.

Downtown Newport in 1909

Aerial view shows the Naval Torpedo Station in the background.

World War I

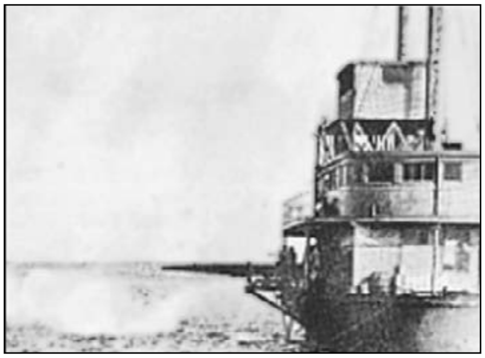


1910—1919

The decade that began in 1910 saw a major expansion of the role of the torpedo, which in turn led to major changes in tactics and ship design as the navies of the world learned how to deploy the new weapon and how to protect their fleets against its use by their enemies.

The United States entered World War I in 1917. By then, the German submarine threat had become so great that it overshadowed all others. Torpedo attacks by destroyers and submarines were prevailing against the more traditional naval tactics of surface fleet engagements by capital ships with large guns and close blockades of enemy ports. Destroyer screens became a necessity.

Torpedo research and development was almost discontinued in favor of development and manufacture of depth charges and sea mines—the anti-ship and antisubmarine warfare (ASW) weapons of the era. The resources of NTS Newport were redirected to these tasks and played a role in wartime developments, particularly that of the U.S. depth bomb. Its actual use by the Allies in World War I was extremely limited. The Germans, however, were credited with torpedoing and sinking 5,408 ships for a total of 11,189 tons during the war years as the battle for control of the Atlantic raged.



***Torpedo Barge** – Added to the NTS floating equipment in 1913, the barge was equipped with above-water torpedo tubes, a training room, machine shop, and berthing space for seaman gunners.*

The losses of merchant shipping to German U-boat operations in the North Atlantic, in the North Sea, and the waters around the United Kingdom were devastating to the Allied war effort. A major breakthrough in the Atlantic was finally achieved when the Allies started using convoys. The first small protected convoy sailed in May 1917. It was quickly followed by others, and the use of larger convoys was in full swing by November of that year. Merchant shipping losses fell sharply, and U-boat sinkings rose. It was later shown that the larger the convoy, the smaller the percentage of ships lost.

The fact that the workforce at Newport was able to pivot so quickly and effectively from torpedo production to the development, testing, and production of other types of naval war ordnance was seen at the time as a very significant contribution to the overall war effort.

The torpedoes available to the U.S. Navy in this wartime period, all developed either at NTS Newport or jointly with the E. W. Bliss Company, were:

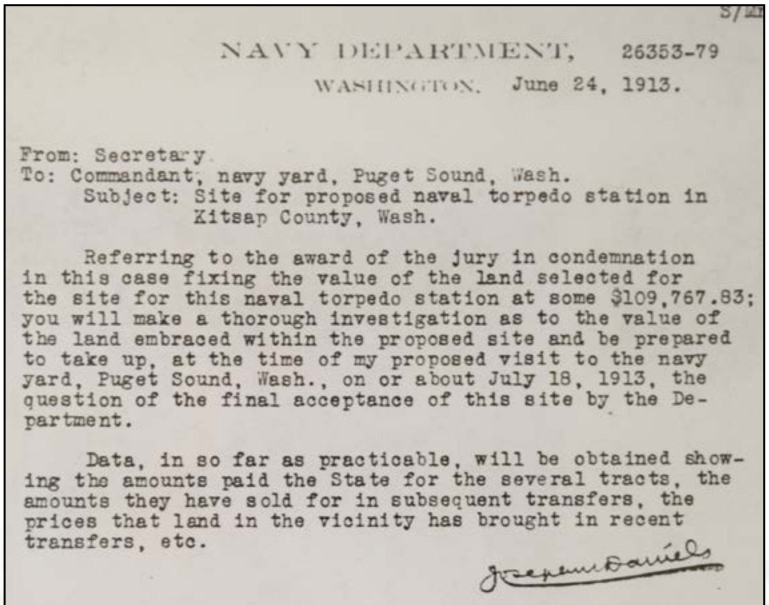
- Mk 7 – 18-inch diameter, launched from destroyers and submarines;
- Mk 8 – 21-inch diameter, launched from destroyers;
- Mk 9 – 18-inch diameter, converted for use in 21-inch submarine tubes;
- Mk 10 – 21-inch diameter, launched from submarines.

NTS Newport focused on developing and producing sea mines and depth charges. The Mk 6 depth charge (or "ash can") developed at NTS Newport was used during the war to sink U-boats. Thousands of the Mk 6 mine, an "antenna" mine, were used in the massive North Sea mine barrage in 1918.

In 1914, the Navy established the Pacific Coast Torpedo Station at Keyport, Washington, for the repair and ranging of torpedoes, to avoid shipping them from the west coast to Newport. Keyport's role expanded to become a depot and an engineering center. From 1978 to 1992, when it became a division of NUWC, it was the Naval Undersea Systems Engineering Center (NUWEC).

***LCDR Henry N. Jenson, First Officer-in-Charge of the Pacific Coast Torpedo Station** – A graduate of the U.S. Naval Academy, he arrived on site in November 1915.*

The rise of women in the NTS workforce was a significant development in this decade. With so many men enlisting in the armed services, there were many more opportunities for women to fill positions at NTS. Of particular note was the sizable number of women hired to prepare the large number of primers needed for mines, depth charges, and a few torpedo warheads during the war.



NAVY DEPARTMENT, 26353-79

WASHINGTON. June 24, 1913.

From: Secretary.
To: Commandant, navy yard, Puget Sound, Wash.
Subject: Site for proposed naval torpedo station in Kitsap County, Wash.

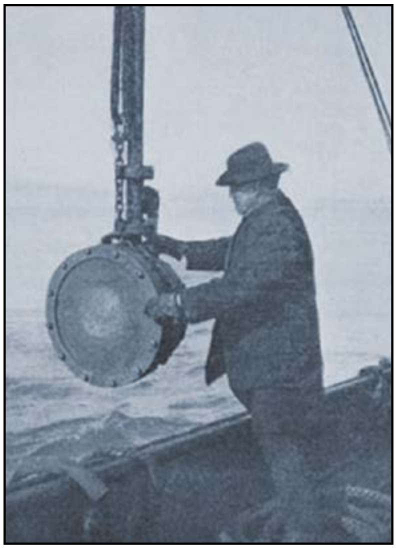
Referring to the award of the jury in condemnation in this case fixing the value of the land selected for the site for this naval torpedo station at some $109,767.83; you will make a thorough investigation as to the value of the land embraced within the proposed site and be prepared to take up, at the time of my proposed visit to the navy yard, Puget Sound, Wash., on or about July 18, 1913, the question of the final acceptance of this site by the Department.

Data, in so far as practicable, will be obtained showing the amounts paid the State for the several tracts, the amounts they have sold for in subsequent transfers, the prices that land in the vicinity has brought in recent transfers, etc.

Josephus Daniels

-o-

In July 1913, Joseph Daniels, Secretary of the Navy, made a special effort to view the controversial property at Keyport while on a trip to Puget Sound. He wanted to make a determination for himself as to whether this peninsula of land was worth all the fuss and expense. He left Puget Sound area convinced that Keyport had great potential and was worth fighting for.



Fessenden's Electric Oscillator

Reginald Fessenden's oscillator, shown being deployed here in 1915, was the first device to receive sonar echoes from the bottom, as well as from an underwater obstruction.

Chester T. Minkler

Mr. Minkler was one of the U.S. Navy's leading experts in explosives. He served for 44 years at NTS Newport and established a solid reputation as "the father of the depth charge."

Submarine Signal Bell

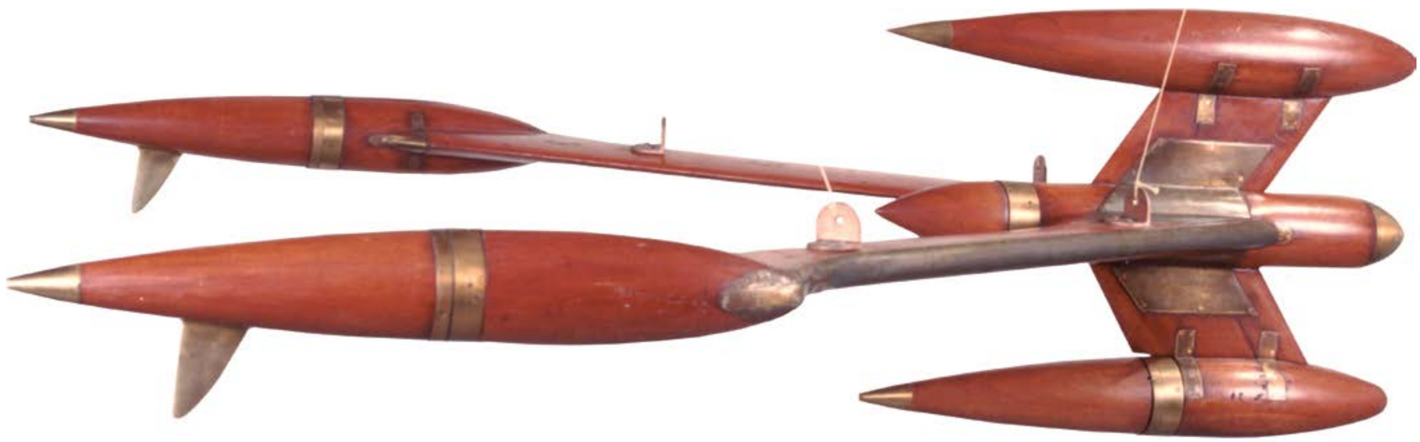
Hung by a chain over the side of the ship, a submarine signal bell was used for communication between ships and with lighthouses. It was rung by compressed air supplied by a small rubber hose.

Early Sea Mine

This sea mine was developed at NTS Newport. Early mines were fragile and dangerous to handle.

Mk 6 Sea Mine

The Mk 6 mine was one of the many explosive devices developed and tested at NTS Newport.



Circa 1920 *– Photograph of the OV1 tow body, a World War I underwater listening device. Good readings were obtained on surface craft at distances of up to 2 miles. The device was towed by a "lighter than air craft."*

1913 *– Former President Theodore Roosevelt comes ashore on a visit to NTS Newport.*

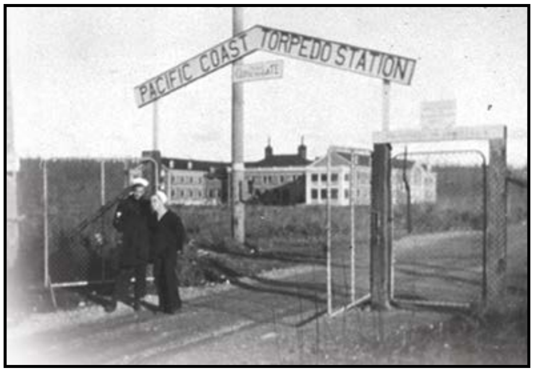
Mk 6 Depth Charge

The Mk 6 depth charge was developed at NTS Newport and used in World War I to sink German U-boats. Commonly referred to as "ash cans," the depth charge is shown here being readied for over-the-side deployment.

Women Workers at NTS Newport

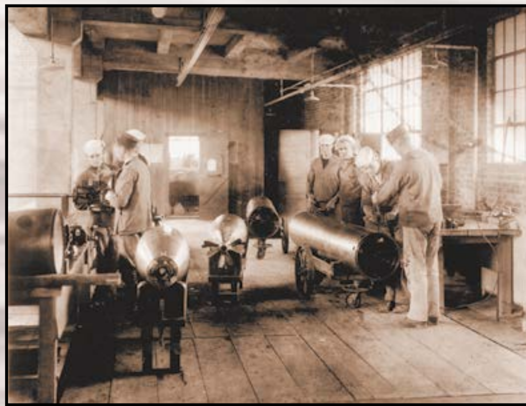
The first women employees at NTS Newport came to work in July 1917, when extensive manufacture of torpedo and depth charge primers commenced. The women are shown here assembling primers.

Circa 1912 – *USS Bainbridge (DD-1), a torpedo boat destroyer, fires a Mk 7 Bliss-Leavitt torpedo.*



1919 – *The main gate of the Pacific Coast Torpedo Station, which was established in 1914 in Keyport, WA. This torpedo station was the west coast training and depot facility for torpedoes.*

1919 – *View of NTS Newport at the end of World War I. Over the war years, NTS had expanded significantly to accommodate the increased demand for training and production.*



1919 – *A torpedo makes the rounds at the Keyport, WA, torpedo shop.*

Post-War Torpedo Development

Gould Island Firing Pier

Hammond Electrically-Controlled Torpedo

"Play Ball" at Keyport

Newport Naval Torpedo Station

Boat Plane

Pacific Coast Torpedo Station

Post-War Torpedo Development

Torpedo Training

Mk 9 Torpedo

Mk 11 Torpedo

Torpedo Drop

1920 — 1929

The Great War ended with an armistice on November 11, 1918, and the Treaty of Versailles was signed on June 28, 1919. In the interim, the Allies kept up their naval blockade, creating a great deal of hardship for the defeated Germans. The Treaty of Versailles imposed heavy reparations payments on Germany and deprived that nation of membership in the League of Nations.

Against this backdrop of global events, NTS Newport maintained the momentum from the war years with resumed torpedo development. Production had its best year ever in 1920 when initial orders for supplying torpedoes stood at 2,000 units. Naval

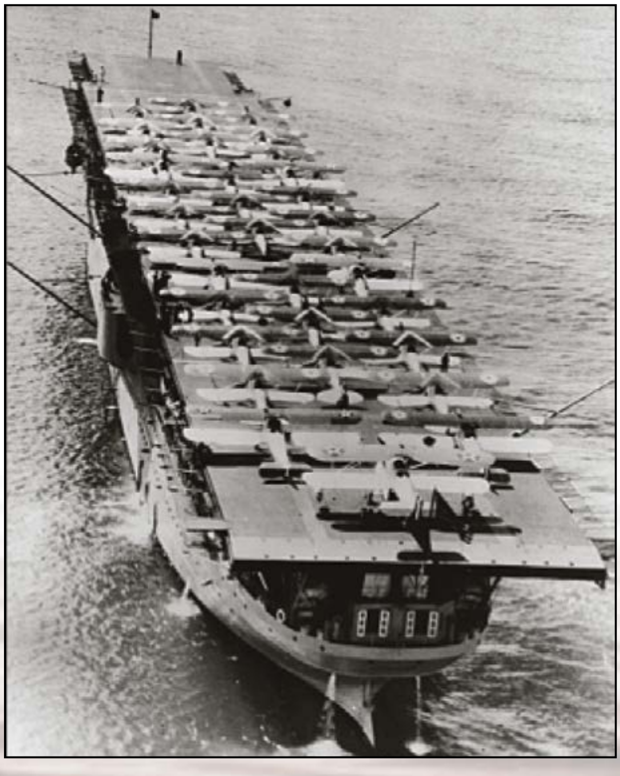
***USS Saratoga (CB-3) at Keyport** – Local school teachers and children enjoy a ride on the Saratoga. The visitors were invited to spend the day at Keyport for what was to become an annual event for many years on Armed Forces Day.*

disarmament discussions, however, started in earnest in the early 1920s, and the country saw a "peace dividend." At NTS Newport, all torpedo variants prior to the Mk 7 were declared obsolete and removed from service. Torpedo production at other naval facilities and at the E. W. Bliss Company were halted, budgets were cut, and NTS Newport suddenly found itself in survival mode. NTS Newport reverted to its earlier role as a Navy R&D facility and slowly recovered, initially by developing improvements for the operational Mk 8, Mk 9, and Mk 10 torpedoes. The development of the Mk 11 torpedo was completed in 1926, and it entered limited production in 1927. This was followed quickly by the development of the Mk 12, a destroyer-launched anti-ship torpedo that was actually an improved Mk 11 torpedo. It went into production in 1928, with 200 units produced.

A bright spot during this period was the NTS involvement in the innovative development of the air-launched torpedo. The Navy chose the Mk 7 torpedo as its first air-launched torpedo. The Mk 7 was originally developed in 1911 as an anti-surface ship weapon for launching from destroyers and submarines. As an air-launched weapon, it was initially launched at heights of 18 to 30 feet. When it was launched at 30 feet from an aircraft traveling at 55 knots, the torpedo suffered severe tail damage. Its performance was good enough, despite the rather limited launch envelope and recurrence of minimal tail damage, to prove the feasibility of an air-launched torpedo. The Navy ordered the development of its first torpedo bomber, the PT-1.

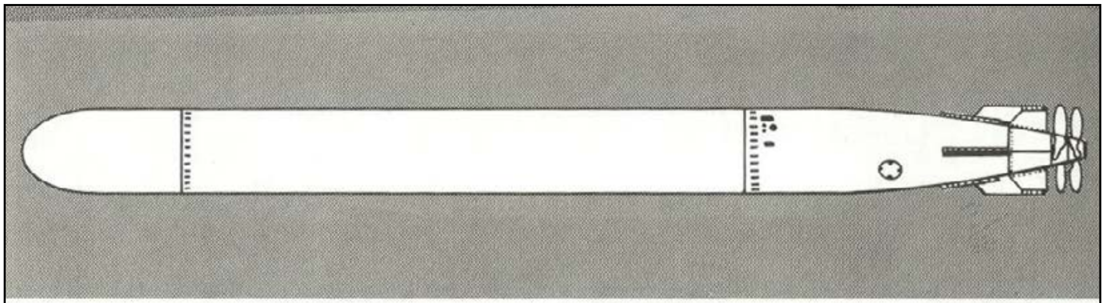
Problems were evident early on between the Bureau of Ordnance (BuOrd) and the Bureau of Aeronautics (BuAir) in reaching a common set of specifications for a torpedo designed for launch from an aircraft capable of handling the torpedo size, weight, and launch within the window of speed and height during release. BuOrd's answer was the Mk 13 torpedo, but agreement between the bureaus was slow in coming and final development was not completed until 1936.

During the 1920s, greatly reduced budgets limited research efforts at NTS to component-level developments and improvements. Innovative advancements in gyro and depth control mechanisms, an air blowing exercise head (at the end of an exercise run), an improved contact exploder, and improvements in multi-speed weapons were developed in these years. Small budgets and cost-cutting measures also led to the use of common subsystem components in the Mk 13, Mk 14, and Mk 15 torpedoes.



USS Langley, the Navy's First Aircraft Carrier *– Converted in 1920 from the collier USS Jupiter (AC-3), she was attacked by Japanese bombers in February 1942, was badly damaged, and had to be scuttled by her escorts.*

During this period, NTS also worked on the development of an electric torpedo. The project was rooted in German experiments during World War I to capitalize on the electric weapon's advantages, which included leaving no detectable wake that would provide a clear datum back to the firing ship. The German efforts were followed by contract work late in the war at the Sperry Gyroscope Company of Brooklyn, New York. At the end of the war, the Navy decided to continue the program to develop what was then called the Mk 1 electric torpedo. The task was assigned to the Navy's Experimental Station in New London, Connecticut. When the Navy closed the Experimental Station in 1919, the project and lead engineer were transferred to NTS Newport. In 1923, the first vehicle was completed and was evaluated in 10 in-water runs. It was reported that the torpedo was very quiet and wakeless and required very little service between runs. An additional 31 range runs were conducted over the next 5 years and numerous improvements were made and evaluated. The torpedo was eventually lost during a test run, and funding was not available to build another one. After a study on battery capability, BuOrd ordered the project canceled with the caveat that it could be resumed contingent on future battery improvements. A U.S. Navy electric torpedo would emerge in World War II as a Mk 18 torpedo, based on the design of a captured German G-7e torpedo.



Similar in design to the Mk 11 torpedo (but with detail refinements), Torpedo Mk 12 was a destroyer-launched, antisurface ship torpedo. This torpedo had a lower high-power setting than the Mk 11 (44 versus 46 knots) to improve reliability. The development of this torpedo by the Naval Torpedo Station, Newport, R.I., was completed in 1928. Two hundred units were manufactured by the Torpedo Station.

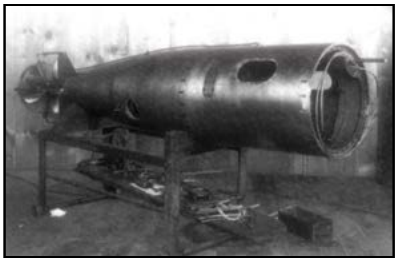
CHARACTERISTICS

PHYSICAL		PERFORMANCE	
Length	271 inches	Speed (knots)	
Diameter	21 inches	Low	27.5
Weight	3505 pounds	Medium	35.5
Propulsion	Turbine	High	44
Enabling	No	Range (yards)	
Guidance	Gyro	Low	15,000
Flask Air Pressure	2800 psi	Medium	10,000
Homing	No	High	7000
FC Settings	Mechanical		
Warhead	Mk 11 500 pounds TNT		
Exploder	Mk 3 Mod 1 Contact		

The Mk 11 torpedo, developed jointly in 1926 by NTS Newport and the Washington Navy Yard, was a three-speed anti-ship torpedo launched from a destroyer. The speed was selectable even when the torpedo was already in the launch tube. The Mk 11 was the first torpedo to be developed and produced wholly by the Navy. A major objective of the development was to make it a “Universal Torpedo” capable of being launched from any type of platform. It remained in use until 1945.

Gould Island Firing Pier

The Gould Island firing pier at NTS Newport played a pivotal role in early torpedo testing. Note the two elevators with tubes for firing torpedoes.

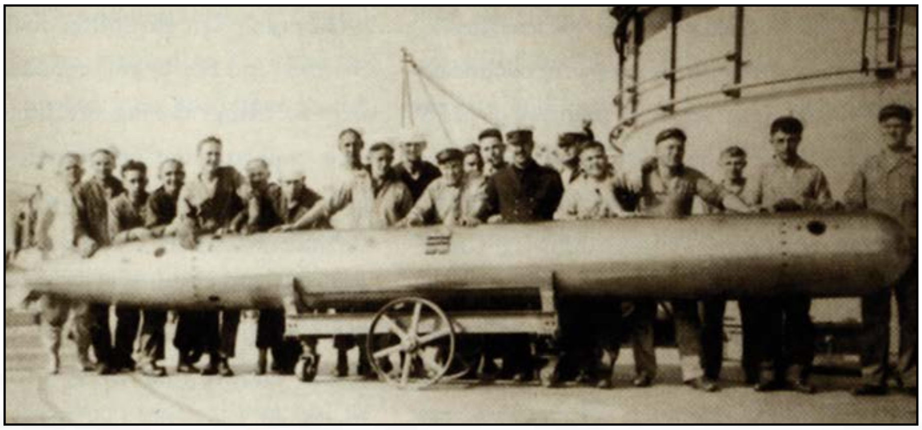


Hammond Electrically-Controlled Torpedo

In 1924, the Hammond radio controlled torpedo, built into the afterbody of a Mk 10 torpedo, demonstrated radio control from 7,000 to 9,000 yards at a torpedo depth of 12 feet at NTS Newport.

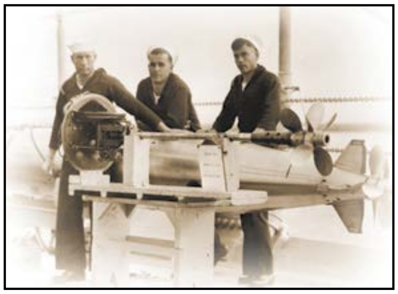
"Play Ball" at Keyport

Employees always found time for sports and recreation at defense facilities in the 1920s. This is the 1926 baseball team at the Pacific Coast Torpedo Station in Keyport.



Mk 9 Torpedo

The Mk 9 weapon was a Bliss-Leavitt torpedo developed and produced by the E. W. Bliss Company and NTS Newport. It was designed in 1915 for use on battleships. Later, the Mk 9 was modified for use on submarines.

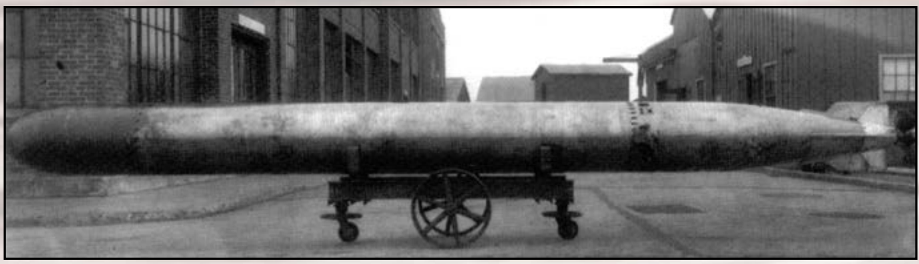


Torpedo Training

Fleet personnel at the Pacific Coast Torpedo Station being trained on a torpedo propulsion mechanism circa 1920.

Newport Naval Torpedo Station

A 1920 aerial view of NTS Newport shows Goat Island and Newport Harbor.

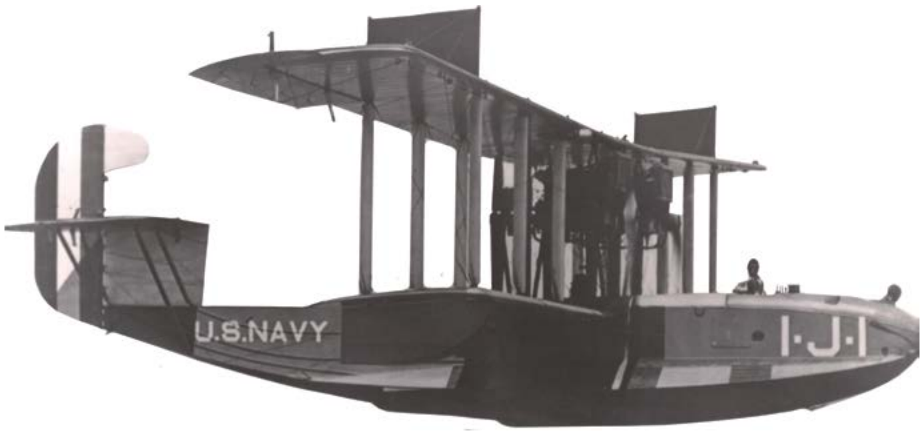


Mk 11 Torpedo

The Mk 11 torpedo, jointly developed by the Washington Navy Yard and NTS Newport, was the first torpedo to be designed totally within the Navy.

Torpedo Drop

In a 1928 NTS exercise, a Mk 7 torpedo (with drogue attached) is dropped in Newport Harbor.



Boat Plane

This 1927 photograph shows a "boat plane." This plane, which joined a ship hull to a flying craft, was used both to patrol for U-boats and to protect convoys during World War I.

Pacific Coast Torpedo Station

A 1924 aerial view of the Keyport peninsula shows the torpedo station's buildings, piers, and facilities. The town of Keyport is at the right.

Build-Up to War

1930 — 1939

After World War I, Germany had been limited to a navy of only six capital ships, all of less than 10,000 tons, and no submarines. In agreements reached at the Washington Naval Conference of 1921, in an attempt to control a nascent naval arms race, the Allies limited the United States, the United Kingdom (U.K.), Japan, France, and Italy to a tonnage ratio for capital ships of 5:5:3:1:1, respectively. The U.S. and U.K. navies were granted a maximum tonnage of 525,000 each, and submarines were accounted for separately. The Allied navies then embarked on significant new construction programs that would ensure that they had the most advanced fleets of surface ships and submarines within the constraints of the Treaty.

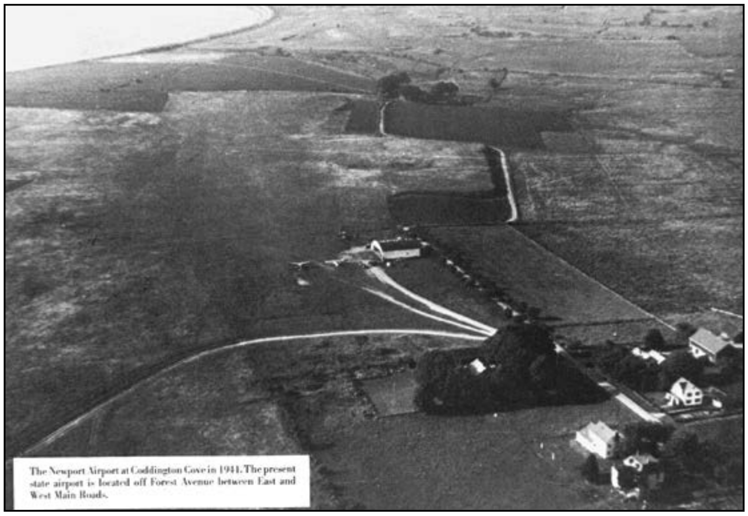
The tonnage ratio was amended in 1935 to authorize Germany to build up to 35% of the U.S. and U.K. tonnage limits for capital ships and up to 45% for submarines. Since Germany decided in 1933 to ignore the earlier agreement, the amendment merely recognized the de facto situation. By 1939, Germany was, in practice, ignoring all limits on military construction, including ships and submarines.

The U.S. Navy's building programs also increased funding for the Naval Torpedo Station during the 1930s in the areas of R&D and production of the next generation of torpedoes, launchers, and new exploder devices to support increased capabilities for the fleet.

During this period, companies such as the Submarine Signal Company of Boston were also making advances in sonar R&D for surface ships and submarines that enhanced passive sonar detection for both types of platforms and improved target bearing while submerged for submarines. All-welded submarine hulls allowed significant increases in operating depth. Another impressive development was the Mk 3 Torpedo Data Computer (Arma Corporation, Brooklyn, New York), an early fire control system for submarines. This innovation allowed analog calculation of bearing, range, and angle on the bow for input to a torpedo to set its course and gyro angle up to the time of fire for single and salvo torpedo launches. Replacing cast ingots for torpedo pressure tanks with welded shells was another major innovation in building torpedoes that reduced man-hours significantly.

A 1939 Aerial View of the South End of Gould Island *– Several seaplanes, a ramp into the water, and a hangar with the words "US NAVY" on its roof are visible in the southwest corner of the island. Test launches of the Mk 13 torpedo were started in that year. A Douglas TBD-1 Devastator was fitted with floats for these tests. The hurricane of 1938 caused significant damage to the facility, and several planes were lost or badly damaged.*

The Mk VI influence exploder was also completed in this period. The development effort was highly classified, but holding it so closely probably caused more harm than good for this emerging technology. The almost complete lack of realistic testing throughout its development and fleet introduction produced a device that did not work and had to be removed from service soon after the start of the war in the Pacific.



View of NTS Coddington Cove Annex in Early 1941 Shows Newport Airport and Hangar *– This photo was taken just before NTS began to transfer R&D development projects from Goat Island to make space for torpedo production.*

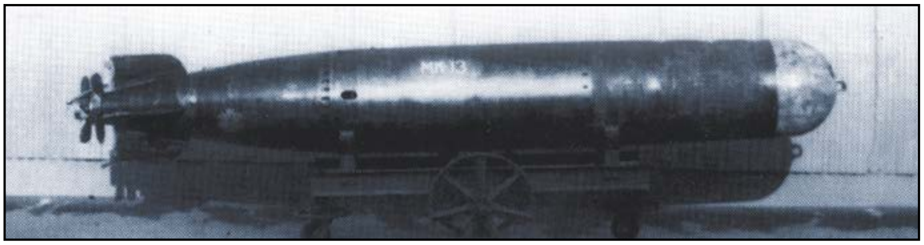
In the torpedo arena, NTS Newport developed the next generation of weapons that, after an initial period of significant problems, formed the backbone of the Navy's capabilities in both the Pacific and the Atlantic for most of World War II. The air-dropped Mk 13 torpedo was used extensively from aircraft carriers and later from PT boats in the Pacific. Over 17,000 Mk 13s were produced during the late 1930s and during the war years, into the mid-1940s.

The Mk 14 torpedo, designed specifically for submarine platforms, was another modern two-speed torpedo with a long range and a large warhead. More than 13,000 were produced, starting in the late 1930s. This torpedo did, however, have significant problems that became apparent after the start of the war and required almost 18 months to correct.

A third weapon was the surface-launched Mk 15 torpedo, with about 9,700 units built starting in the late 1930s.

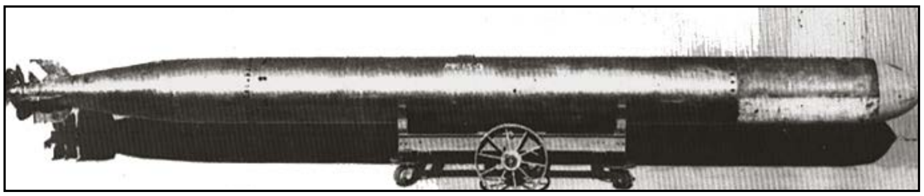
The United States entered the war with three new torpedoes that were, problems notwithstanding, state of the art for their time. What the country lacked in the years just before the start of the war was the production capability to build the vast numbers that the Navy was calling for. Both the rapid expansion of production capability and the rushed introduction of these weapons into the fleet were impressive achievements, but insufficient testing of the full torpedo led to serious problems in service. When the focus was on increasing the inventory as quickly as possible, full-up testing that included detonation—blowing up a torpedo—did not seem necessary.

Another focus was on increased training of sailors in firing and maintaining the new weapons developed at NTS Newport. The composition of the NTS workforce was also changing during this time, as a significant number of women arrived to replace the men who left to join the armed forces. Women filled all of the jobs previously done by men, including positions in the weapons production lines.



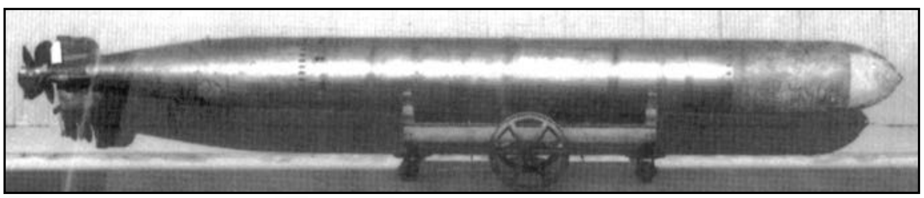
Mk 13 Torpedo

Developed at NTS in the mid-1930s, the Mk 13 was the first torpedo designed specifically for aircraft launch. It was also used as a major weapon on PT boats.



Mk 14 Torpedo

A submarine-launched torpedo developed by NTS in the early 1930s, the Mk 14 torpedo was responsible for sinking some 4,000,000 tons of Japanese shipping.



Mk 15 Torpedo

The Mk 15 was a surface ship-launched anti-ship torpedo that NTS completed in the late 1930s.

NTS Goat Island (1932)

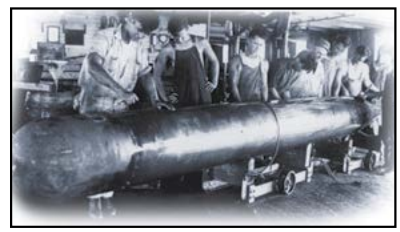
The station was a major producer of torpedoes in the 1930s and 1940s. Wartime production of torpedoes amounted to more than 18,000 units, and total production at all manufacturing facilities was 64,000 units. Due to significant expansion of the production facility, the NTS research and development work was moved to the Coddington Cove annex.

The First Operational Torpedo Squadrons

Stationed aboard the aircraft carrier Saratoga, two T4M-1 torpedo planes are armed with Mk 7 torpedoes.

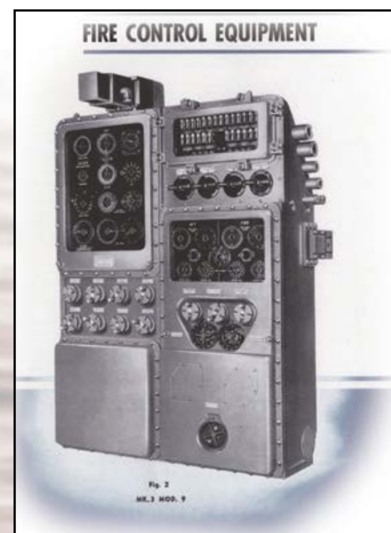
Navy Day, Newport (1934)

On display is an early Bliss-Leavitt torpedo, a weapon that was in service from 1915 to 1946.



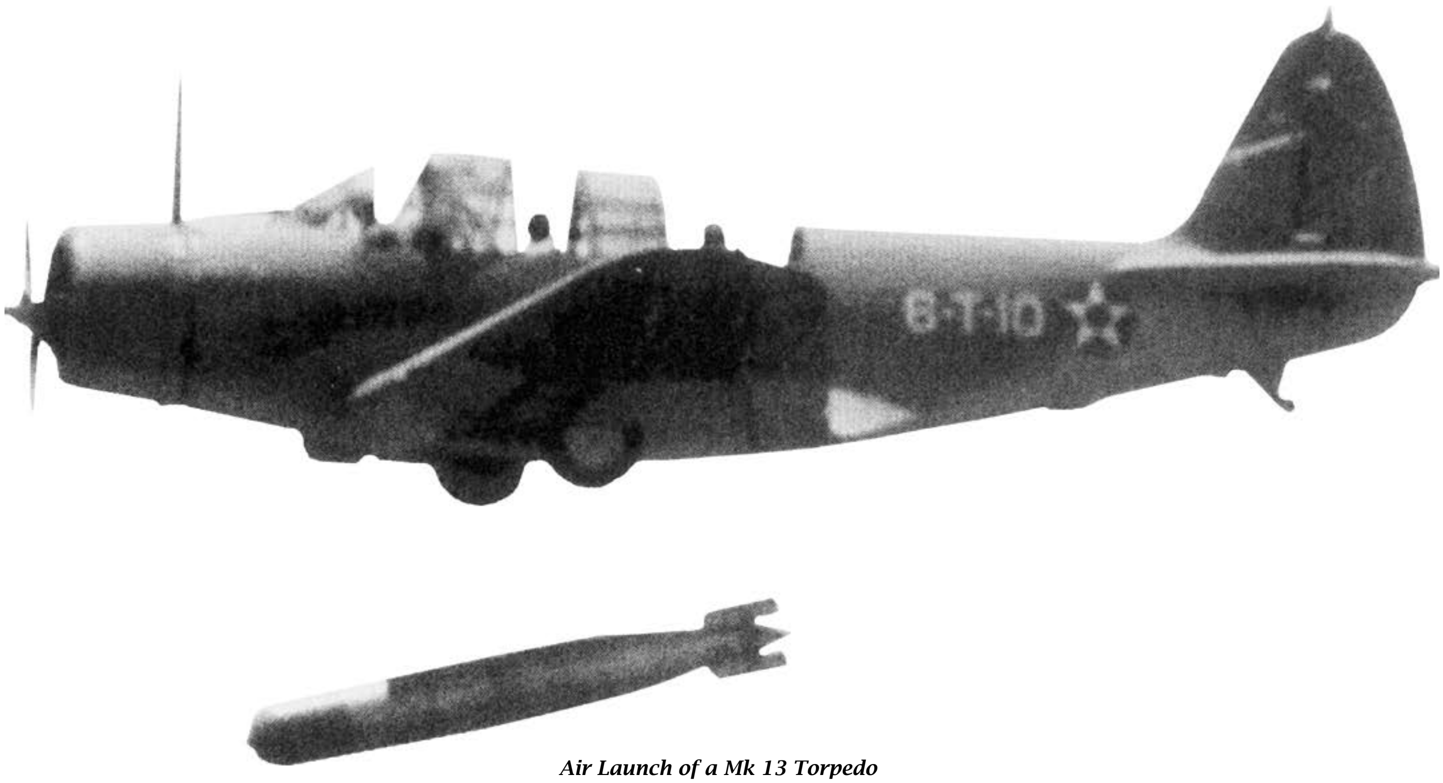
Shop Workers at NTS Keyport

A Mk 9 torpedo is being made ready for an exercise firing.



Torpedo Data Computer Mk 3 Mod. 5-8 (TDC)

This TDC was an early fire control unit capable of angle solving and real-time position keeping.



Air Launch of a Mk 13 Torpedo

A TBD-1 "Devastator" torpedo plane launches a Mk 13 torpedo on a practice run in 1941.

NTS Keyport

Aerial view of Keyport in the late 1930s.

Early Passive Sonar

Engineers examine an early passive line receiver mounted on the forward deck of a submarine.

The NTS Gould Island Firing Pier

This facility was used extensively for proofing new torpedoes.

Torpedo School Shop Work at NTS Newport

Note the Mk 14 torpedo tubes in the foreground and the Mk 15 torpedo to the left.

Machine Operators in Training

With more than 13,000 NTS Newport employees operating 24 hours a day, 7 days a week, many of the newly hired were women.

NTS Keyport's Ignitor Shop Employees

Keyport's workforce increased significantly in 1939.

Women's Role in the War

Throughout the wartime period, women played a major role at NTS: above, drafting class at Newport; lower left, stockpiling ordnance at Keyport; lower right, working a horizontal milling machine at Newport.

A Family Affair

Members of the Robinson family are shown working on a torpedo in the assembly shop at NTS Keyport.

World War II

1940 — 1949

The United States was initially reluctant to go to war in the wake of Germany's invasion of Poland in September of 1939 and declarations of war by the United Kingdom and France. Instead, the country remained neutral but adopted the role of the "Arsenal of Democracy" to ensure that the British received the supplies they needed to survive the German blockade and the unrestricted submarine warfare in the Atlantic. After the surprise attack by Japan on Pearl Harbor on December 7, 1941, the United States entered the war in both the European and Pacific theaters. Over the course of the conflict, the U.S. Navy faced two quite different challenges.

In Europe, the prime objective was defeating the German submarine threat and protecting the lifelines of supply ensuring that men and materials were available to support the retaking of the European mainland. The role of the Allies in the Pacific can be seen as almost the opposite: the U.S. submarine fleet was focused on destroying the lines of supply to Japan, which was an island nation like the United Kingdom.

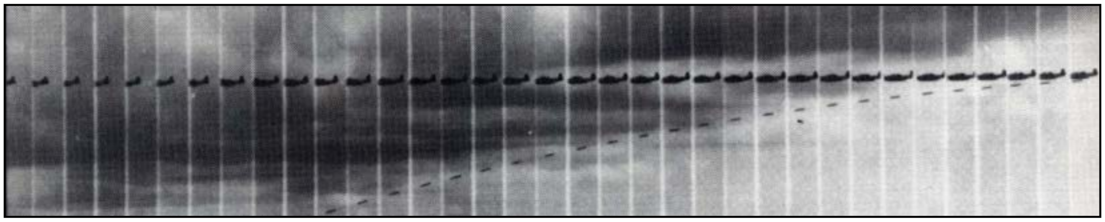
The Japanese navy's six-carrier force had crippled the U.S. Pacific Fleet in the Pearl Harbor attack, and the U.S. Navy needed time to rebuild its fleet to defeat an enemy already in control of the sea lanes. Japanese torpedoes, launched from aircraft, inflicted much of the damage by putting large holes in the ships below the waterline. That success played a significant part in elevating the role of the aircraft carrier, in both the U.S. and Japanese navies, to the major capital ship of the day.

At the start of World War II, Germany was already rapidly building a large high seas fleet, despite the limitations imposed by the Treaty of Versailles and Washington Naval Conference. This fleet was, however, still largely under construction, and the British Royal Navy had a major advantage in the number and size of ships at sea. Relatively early in the war, as the number of German submarines increased, Germany arranged its submarine fleet into U-boat "wolf packs" that were quite successful in sinking large numbers of merchant ships while sustaining very few losses. During this period, Allied merchant and Royal Navy ships were being sent to the bottom at a much faster rate than new construction could replace.

By 1943, things in the Atlantic had started to improve. The Allies had constructed significant numbers of escorts, used larger convoys, and equipped escorts with radio direction finding and radar capability. When the British broke the German Enigma code, early information on U-boat movements allowed the Allies to reroute convoys in transit. In 1943, the U.S. Navy began using the first acoustic homing torpedoes (Mk 24, air-dropped) for the initial offensive attack on the U-boats. In March 1943, for example, the German wolf packs had sunk 108 ships while losing six U-boats. By May, only 26 Allied ships had been sunk, and the U-boat loss for the period was 27. This marked a turning point in the Battle of the Atlantic.

In addition to losing a significant number of its ships in the Pacific, the U.S. Navy was faced with very real problems in torpedo performance that resulted from the lack of full system testing. The fleet found that its torpedoes did not work.

Although the Pacific Fleet submarines were off to a respectable start, a high number of missed attacks suggested that there was a serious torpedo problem. Admiral Lockwood, who served as Commander Submarine Force, U.S. Pacific Fleet (COMSUBPAC) during most of World War II, ordered controlled tests to verify a suspected torpedo depth-keeping problem. The Bureau of Ordnance in Washington and the Naval Torpedo Station at Newport were reluctant to even admit that there were any problems. Admiral Lockwood got involved in a bitter bureaucratic paper war to correct a number of serious torpedo deficiencies, including depth-keeping errors, erratic influence exploders, and faulty contact exploders. It took almost 18 months to correct all of the problems, and it was not until late in 1943 that the U.S. Navy had reliable torpedoes. Since all U.S. Navy torpedoes were similar in design, the problems were common to submarine-, surface ship-, and aircraft-launched torpedoes. The performance of all these weapons was adversely affected in the early part of the war.



Test Drop of Aircraft Torpedo Mk 13 in Narragansett Bay (1943)

NTS Newport fixed the problems affecting torpedo reliability and then turned its attention to production of the torpedoes needed to supply the growing numbers of surface ships, submarines, and torpedo bombers being produced. As production ramped up at Newport, the Navy's need to train personnel and to start up production at other locations in the country became a strain on manpower at the Newport production facility.

From the late 1930s into the 1940s, the primary concern for the Naval Torpedo Station was increasing production capability for the new Mk 13 (air-launched), Mk 14 (submarine-launched), and Mk 15 (surface-launched) torpedoes. The capacities at Newport and, later, NTS Keyport were expanded rapidly. Naval production capabilities were added in Alexandria, Virginia, and Forest Park, Illinois. Torpedoes were also produced by the Pontiac Motor Division of General Motors and the International Harvester Company.

The total numbers of weapons produced during the war were:

- Torpedo Mk 13 – 16,600
- Torpedo Mk 14 – 13,000
- Torpedo Mk 15 – 9,700
- Torpedo Mk 18 – 1,000 (electric)
- Torpedo Mk 23 – 9,600 (high-speed Mk 14)
- Torpedo Mk 24 – 4,000 (passive, acoustic, aircraft-launched, homing torpedo)
- Torpedo Mk 27 – 4,000 (submarine-launched, active/passive, homing torpedo).

Over 18,700 units of this wartime output were produced at NTS Newport alone.

The use of the torpedo in World War I demonstrated that this was a major naval weapon. When World War II began, surface ships, submarines, and aircraft were all armed with these weapons. The torpedoes listed above were, in fact, next-generation weapons—significantly improved in range, speed, and lethality—that had been developed at NTS Newport for the U.S. Navy over the previous decade.

Early in the war, a number of German electric G-7e torpedoes from U-570 were captured, and two were sent to NTS Newport in 1942. The design was copied, and Westinghouse produced over 1,000 electric torpedoes as the Mk 18. The key advantage of the Mk 18 was that, although it was much slower than the Mk 14 torpedo, it was a wakeless electric torpedo with a much lower probability of alerting the target. The Mk 18 torpedo became operational in 1943 and was used successfully in both the Pacific and Atlantic theaters.

The Mk 24 was the first U.S. torpedo with a passive homing capability. In 1940, the National Defense Research Committee sponsored the development project, with Western Electric Company as the lead developer and input from the Bell Telephone Laboratories, the Harvard Underwater Sound Laboratory (predecessor of the Naval Underwater Sound Laboratory, founded July 1, 1945) and the General Electric Engineering and Consulting Laboratories. Torpedoes were produced at Western Electric and General Electric. The Mk 24 torpedo was an air-dropped mission-abort weapon rather than a mission-kill weapon because of the small warhead size.

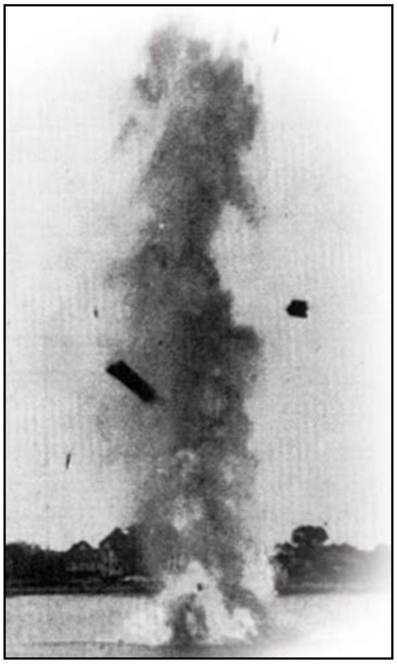
The Mk 27 was essentially the passive homing Mk 24 torpedo modified for submarine launch. It was developed by Bell and produced by Western Electric.

The overwhelming majority of the torpedoes fired during World War II were from submarines in the Pacific theater. Approximately 14,750 torpedoes were fired from submarines at 3,184 of the approximately 8,200 ships sighted, and 1,314 ships were sunk, totaling 5,300,000 tons. In addition, submarines received "probable" credit for another 78 ships totaling 203,306 tons. The confirmed total included one battleship, eight aircraft carriers, three heavy cruisers, and eight light cruisers. The 1,314 sinkings confirmed by the Joint Army Navy Assessment Committee accounted for 55% of all Japanese ship losses. The remaining 45% were lost to Army and Navy aircraft bombs, mines, and other causes.

Soon after the end of the war, two university laboratories that had played significant roles in developing homing torpedoes and improving sonar were assigned to organizations outside academia. The Harvard Underwater Sound Laboratory became the Ordnance Research Laboratory at Pennsylvania State University, and the Columbia University Division of War Research became the U.S. Navy Underwater Sound Laboratory (NUSL) at New London, Connecticut. The "Sound Lab" was destined to play a major role in the future development of NUWC.

The surrender of Germany on May 7, 1945, both ended the war in Europe for the United States and signaled the start of the Cold War, as Stalin continued to solidify Soviet gains within Europe. The dropping of two atomic bombs on Japan in August 1945 also signaled the start of the nuclear age with all of its many ramifications.

Another first after the war was the employment of the first professional women, mostly mathematicians, at the New London laboratory. The first professional women were not hired at Newport until 1961.



Warshot Test

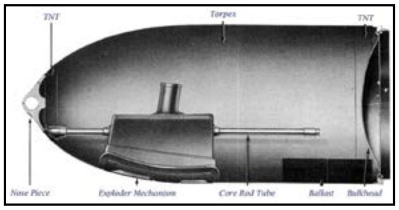
Warshot torpedo with Mk VI magnetic influence exploder destroys a submarine hull. This was the only warshot test during 19 years of pre-World War II exploder development.

Early Sonar Receiver

The receiver had a 30-inch, passive, rotatable line array.

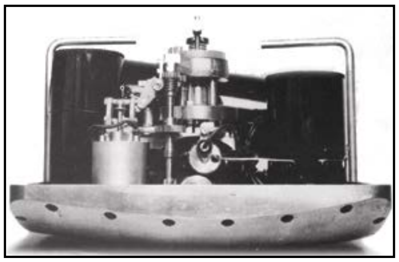
NTS Keyport Launcher Device

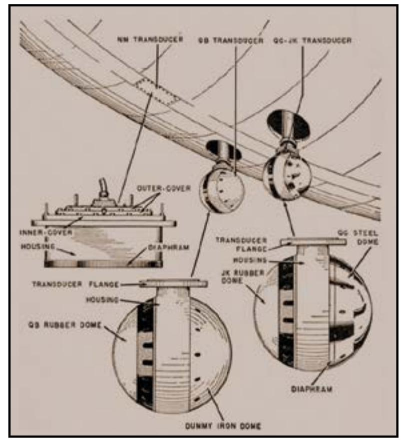
This device was used to test aircraft-launched torpedoes.



Mark VI Mod I Exploder (1941)

Significant problems were encountered with U.S. torpedoes at the start of the war—torpedoes were running 10-12 feet deeper than projected, magnetic influence exploder performance was erratic, and the contact exploder failed to detonate the warhead. These problems, which took 18 months to fully resolve, resulted from years of anemic testing of the full-up torpedo in a realistic warshot configuration.



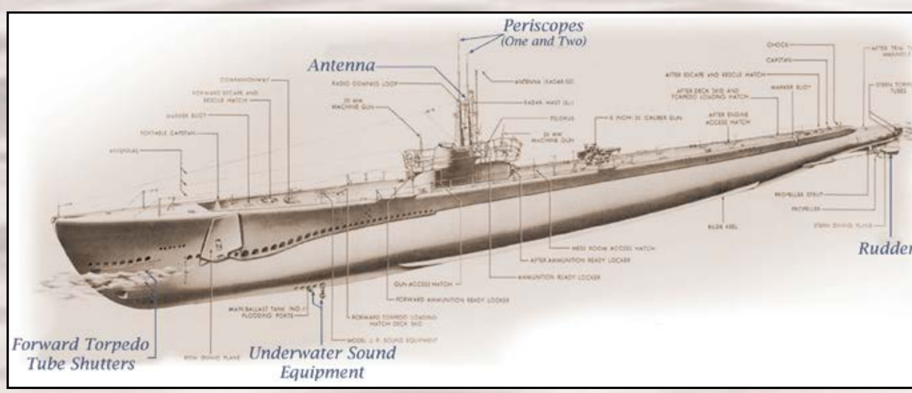


Early Sonar Transducers

The transducers are shown deployed below the surface ship's or submarine's hull.

Typical Fleet Submarine

This is the type of submarine that was is service when the United States entered World War II.



USS Seawolf (SS 197)

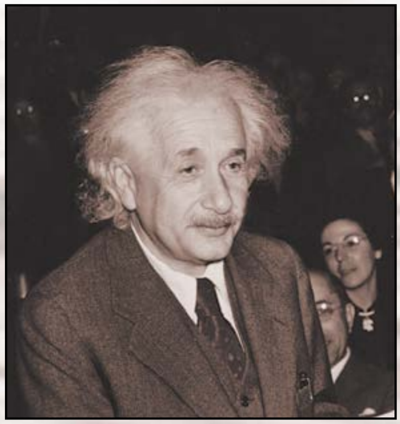
This periscope photograph shows a sinking Japanese ship torpedoed by the Seawolf in the Philippines-East Indies area in the fall of 1942.

Preparing New Production Torpedoes For Proofing

During the war years, NTS Newport produced 18,751 torpedoes. In addition, over 75,000 proofing runs and 4,300 experimental aircraft drops were conducted. In 1944, NTS Keyport fired more than 7,000 proofing torpedoes.

Battle of Midway (1942)

U.S. bombers attack Japanese carriers.



Albert Einstein

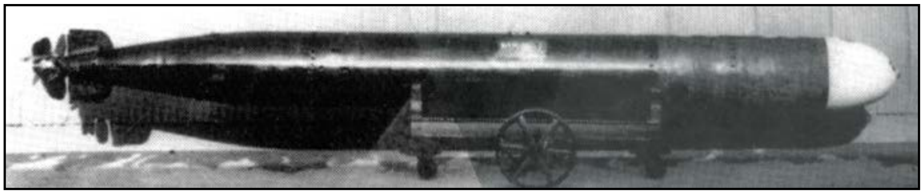
From 1943 to 1945, Dr. Einstein was under contract to the Navy as an ordnance consultant. He was paid $25.00 per day.

LT(JG) John F. Kennedy

JFK is shown here aboard PT-109. He received his PT boat training in October of 1942 in Melville, RI, on Narragansett Bay.

Torpedo Production Line

The Mk 14 torpedo production line at NTS Keyport in 1943.



Mk 16 Torpedo

The Mk 16 and Mk 17 torpedoes were "chemical" weapons developed jointly by NRL and NTS. They used highly concentrated hydrogen peroxide—a highly dangerous fuel requiring extreme care in handling.

USS San Jacinto (CVL 30)

Crew members aboard aircraft carrier San Jacinto arm a TBM torpedo plane in 1944.

Patrol, Torpedo (PT) Boat

PT boat fires a Mk 13 torpedo. The Mk 13 was a major weapon on PT boats.

Mk 18 Torpedo

The Mk 18 was an electric torpedo that was "cloned" from a captured German G7e torpedo. Used in the Pacific theater, it was credited with sinking more than a million tons of Japanese shipping.

LT(JG) George Bush

His unit was assigned to the San Jacinto in 1944. He was shot down at sea and rescued.

NTS Newport During the War Years

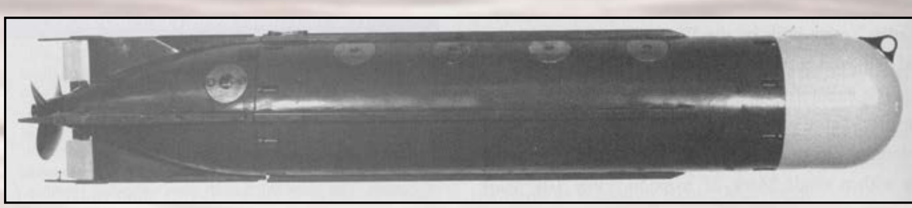
Goat Island is in the foreground, with the city of Newport in the background.

Surface Launcher

A Mk 15 surface-launched torpedo is fired from a destroyer using a Mk 14 tube.

Columbia University Division of War Research, Fort Trumbull, New London

The Columbia Division building ("L" shaped building in foreground) became the U.S. Navy Underwater Sound Laboratory in 1945.



Mk 27 "Cutie" Torpedo

The "Cutie" was a submarine-launched version of the Mk 24 homing torpedo developed by Bell Telephone and produced by Western Electric.

Coddington Cove

An early 1940s aerial view of NTS Newport's expansion at Coddington Cove (NUWC's present location).

Mk 24 "Fido" Mine

This air-launched torpedo was the first Allied passive, acoustic, homing torpedo (initially called a mine for security purposes). It was a joint development by Western Electric, Bell Telephone, and Harvard Underwater Sound Lab.

Army-Navy E Award Ceremony

NTS Keyport workers gather for an Excellence Award presentation in 1945.

NUSL Open House (1948)

Thad Bell (at right) presents an overview of ongoing sonar efforts at the Navy Underwater Sound Laboratory, in New London, CT.

The Nuclear Era Begins

1950 — 1959

At the end of World War II, the U.S. armed forces demobilized, and a drawdown in the Navy began. Ships were scrapped and mothballed on a large scale, which reduced the fleet from over 1,200 vessels at the end of the war to approximately 250 major ships and submarines by June of 1950. However, even as the number of platforms diminished, the Navy was poised for technological innovation that would dramatically alter the fleet.

From just after the end of World War II and throughout this decade, a major focus of the Navy was harnessing the power of the atom, which included a submarine development program that resulted in USS *Nautilus* (built in 1952–1954). The extremely rapid design and construction of the *Nautilus* owed much to the effort

***Navy Destroys North Korean Hwa-chon Reservoir Dam with Mk 13 Torpedoes** – Conventional bombing had failed to destroy the dam. This was the last U.S. use of torpedoes in combat. At right, photo of plane and Mk 13 torpedo en route to the dam.*

and influence of Admiral Hyman G. Rickover, "Father of the Nuclear Navy." The *Nautilus* was a conventional World War II submarine with a nuclear power plant. At the same time, the Navy was experimenting with a more hydrodynamically optimized hull shape. The teardrop-shaped hull of USS *Albacore*, built in 1952–1953, increased the boat's underwater speed and reduced its acoustic signature, but the *Albacore* still had conventional propulsion. Nuclear propulsion and the teardrop hull were first combined in USS *Skipjack*, commissioned in 1959. The *Skipjack* class was the fastest U.S. nuclear submarine until USS *Los Angeles* was launched in 1974.

In the surface fleet, the Navy was also quick to move forward with a platform with a proven war record and add the nuclear energy advantage. The nuclear-powered carrier USS *Enterprise* was built in 1958–1961. Surface sonar systems provided significant increases in capability, starting with the development of the AN/SQS-26 sonar in 1955 and its installation on a surface ship in 1960. This sonar system provided direct path detection as well as bottom bounce and convergence zone capabilities.

When the nuclear submarine became an operational reality for the U.S. Navy in the 1950s, its high performance and essentially unlimited submerged endurance posed a major challenge to torpedo designers. The modest performance of existing acoustic homing torpedoes, developed during and just after the war, severely limited their effectiveness against the new high-performance nuclear submarines. There was an urgent need for more advanced technology to allow the development of high-performance ASW torpedoes to counter the emerging Soviet nuclear submarine threat.

The torpedo's transition from an artisan-designed weapon, such as the Mk 13, Mk 14, and Mk 15 of World War II, to scientific-based designs, such as the Mk 48 and Mk 46, was accomplished in this decade. In fact, it was accelerated during the 1950s when the U.S. Navy initiated a program to develop undersea weapon subsystem technologies in the naval laboratories.

In the immediate post-war period, the Navy directed the naval laboratories to conduct exploratory development programs in their areas of technical excellence to scientifically demonstrate the feasibility of advanced subsystem concepts. With the technical focus on the subsystem level, a detailed understanding of the subsystem technologies quickly began to evolve.

NTS Newport Before Disestablishment in 1951 *– During World War II and the following year, from January 1939 to June 1946, NTS produced a third of the 62,000 torpedoes manufactured for the Navy. Late in 1945, the facility was placed in caretaker status. The Naval Underwater Ordnance Station (NUOS) was established at the Coddington Cove annex in 1951 to replace NTS Newport.*

In the 1950s, one by one, the artisan skills of torpedo design were replaced by basic scientific theory as research efforts in hydrodynamics, propulsion, and control systems began to produce a firm foundation for the scientific design of the torpedo subsystems that the next generation of weapons needed to meet the nuclear threat.

The Mk 45 was the first and only U.S. torpedo to have a nuclear warhead. It was a passive wire-guided weapon with an 11-kiloton warhead. This warhead was also used in both the Mk 101 (LuLu) nuclear depth charge—a nuclear capability for surface ships—and the Mk 105 depth bomb.

The foundation of future U.S. Navy torpedo design had been laid in the Project Nobska findings of December 1956. The Nobska ASW study was performed by a high-level committee established by the Navy in 1955 and coordinated by the National Academy of Science. One conclusion was that fast homing torpedoes were both possible and needed. The development of a reliable wire-guidance capability for a submarine-launched torpedo was also given a high priority at the time. The Research Torpedo Configuration (RETORC) programs, funded by BuOrd, commenced soon after the study conference, in the latter part of the 1950s. The RETORC I, a lightweight design, resulted in the Mk 46 torpedo, which entered service in 1963. Its heavyweight counterpart, RETORC II, was developed into the Mk 48 torpedo, which entered service in 1968.

A radical submarine redesign, proposed in 1956 and developed by the Navy Underwater Sound Laboratory, placed a large sonar sphere in the streamlined submarine bow.

***Visitors to New 3D Underwater Tracking Range in Dabob Bay, WA, at the Naval Torpedo Station, Keyport** – Interested officials included (third from left) Vice Admiral Hyman Rickover, Chief of the Naval Reactor Branch of the Atomic Energy Commission.*

The sphere allowed three-dimensional sonar operation for greater detection range. To make room for the spherical sonar, the torpedo tubes were relocated to a midship position and angled outboard. The first submarine built with this arrangement was USS *Tullibee* (SSN 597) in 1961.

The first nuclear-powered submarine capable of carrying long-range ballistic missiles was USS *George Washington* (SSBN 598), which entered service in December 1959 carrying 16 Polaris A-1 missiles. The emergence of nuclear submarines as a component of the U.S. nuclear triad was a significant accomplishment in the Cold War arms race.

In 1951, the Naval Torpedo Station on Goat Island was closed, and NTS in Newport, Rhode Island, was disestablished. All ongoing research and development (R&D) projects were consolidated at the Coddington Cove site, under the cognizance of the new Naval Underwater Ordnance Station (NUOS). Drawing on its NTS roots as an R&D experimental station, NUOS was tasked with continuing R&D on the many scientific and engineering advances made in World War II, and the organization was expanded to match the wider scope of its post-war mission. The new charter emphasized the development of torpedo subsystems and ASW technology. The Mobile Acoustic Torpedo Target (MATT), for example, was initially developed by NUOS. This target acted as a submarine target in the early stages of testing acoustic homing torpedoes. The MATT was an early version of the Mk 27 and Mk 30 mobile targets. NUOS also developed the Mk 37 Mod 1 wire-guided torpedo, for mid-course guidance, in this period (late 1950s and into the 1960s). In this decade, the Naval Ordnance Depot in Keyport became the Naval Torpedo Station. The Navy's first 3D underwater range for tracking torpedoes was developed and installed in Dabob Bay, Washington, in the 1950s by the Applied Physics Laboratory at the University of Washington (APLUW) in conjunction with the Naval Torpedo Station at Keyport.

Electronic Surveillance Measurement (ESM) Antenna

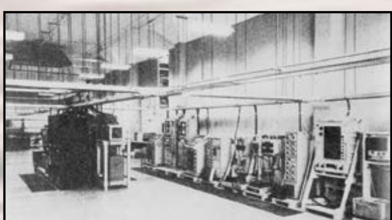
Two NUSL engineers examine an experimental omnidirectional, multiband ESM antenna.

USS Nautilus Masts

Among the raised masts seen here on Nautilus are the Type II and Type III periscopes and various communication and electronic sensors.

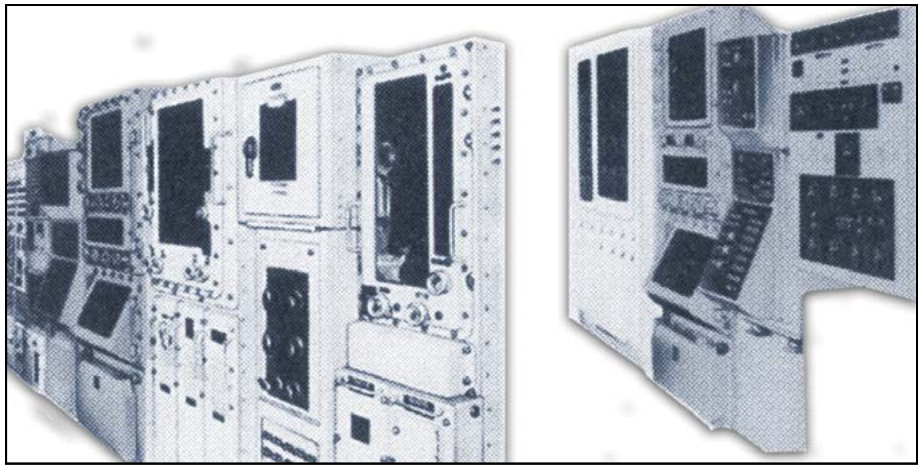
USS Albacore (AGSS 569) (1953–1972)

Albacore, shown here cruising off the coast of Rhode Island, had a hydrodynamically optimized hull for submerged performance. She had diesel-electric propulsion but was used to evaluate many technologies that were later employed in nuclear submarines.



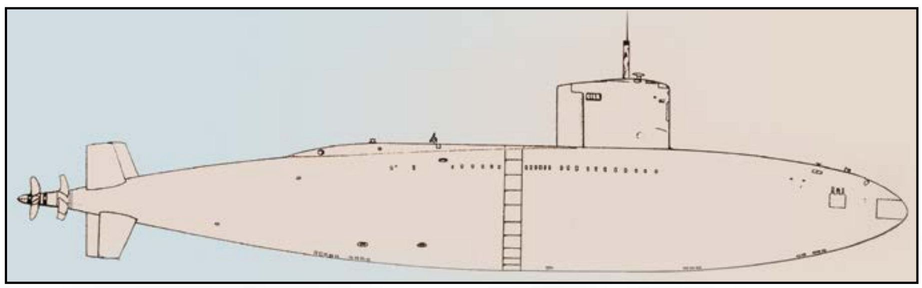
Naval Underwater Ordnance Station (NUOS)

This photo shows a fire control laboratory in NUOS Building 112 at NTS Newport's Coddington Cove annex.



Mk 101 and Mk 106 Fire Control Systems

The Mk 101 Fire Control System replaced the Mk 4 Torpedo Data Computer that was in use at the end of World War II. The large number of submarines in the fleet made the cost of fitting them all with the Mk 101 prohibitive. The Mk 106, a modification of the Mk 4 TDC with some added capability, was developed to greatly lower the cost of the fire control systems.



USS Albacore Characteristics

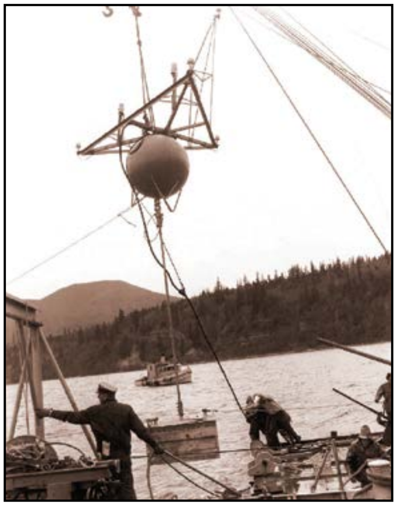
Albacore had a teardrop shape and no torpedo tubes. Bow-mounted sonars were evaluated in her forward space. She was also used for initial towed array testing. Also shown here are her X-fin configuration and contra-rotating screws.

Bikini Atoll

Underwater nuclear detonation at Bikini Atoll in 1946.

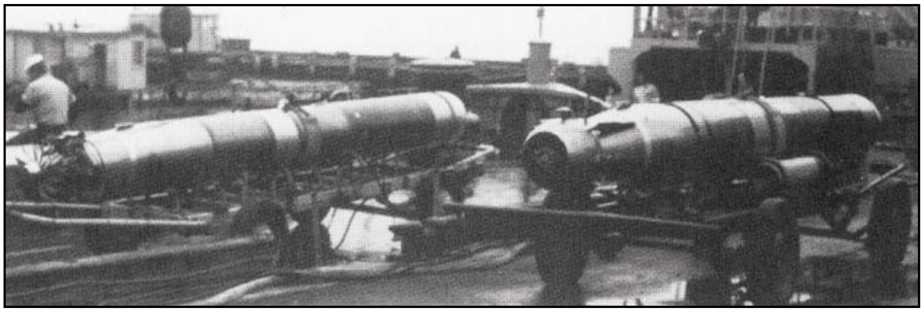
Mk 45 Torpedo

Developed by the Applied Physics Laboratory at the University of Washington, the Mk 45 was a wire-guided weapon with a nuclear warhead. It had no homing capability, and it used the wire guidance system of the Mk 37 torpedo.



NTS Keyport Tracking Range

High-frequency acoustic installation in progress at Dabob Bay, which was the Navy's first 3D tracking range.



Research Torpedoes

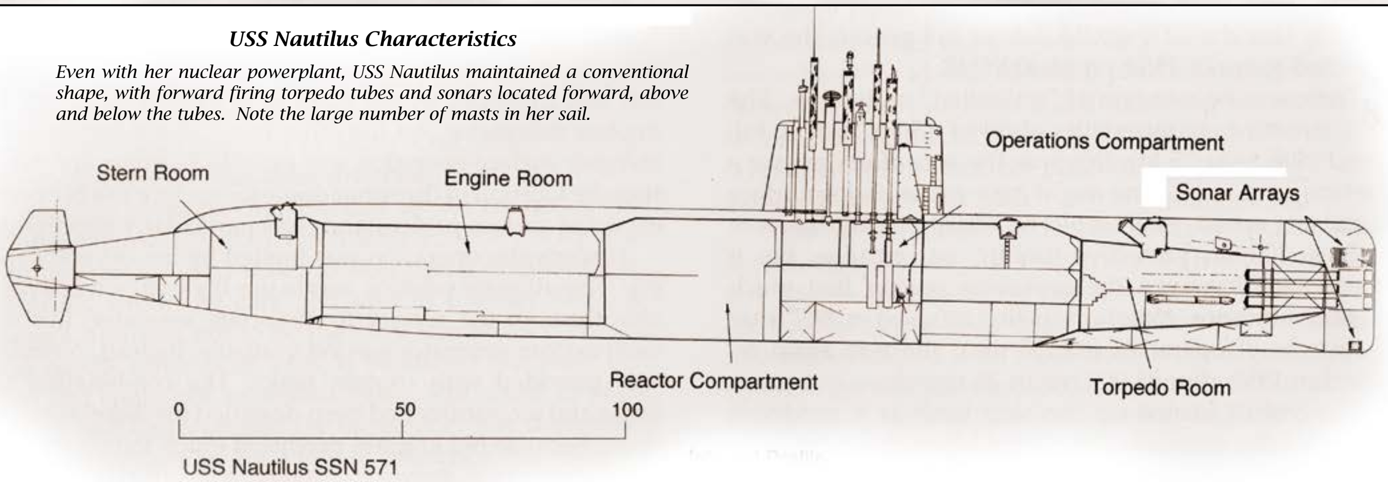
The early heavyweight RETORC II torpedoes shown here were the predecessors of the Mk 48 weapon. The one on the left has an experimental propulsor, and the one on the right has a pumpjet. The RETORC I program at the Naval Ordnance Test Station in Pasadena, CA, led to the development of the Mk 46 torpedo.

USS Nautilus (SSN 571) (1954–1980)

Nautilus (above, below, and at right) was the world's first nuclear submarine. At 11 a.m. on January 17, 1955, she put to sea for the first time and signaled her historic message: "Underway on nuclear power."

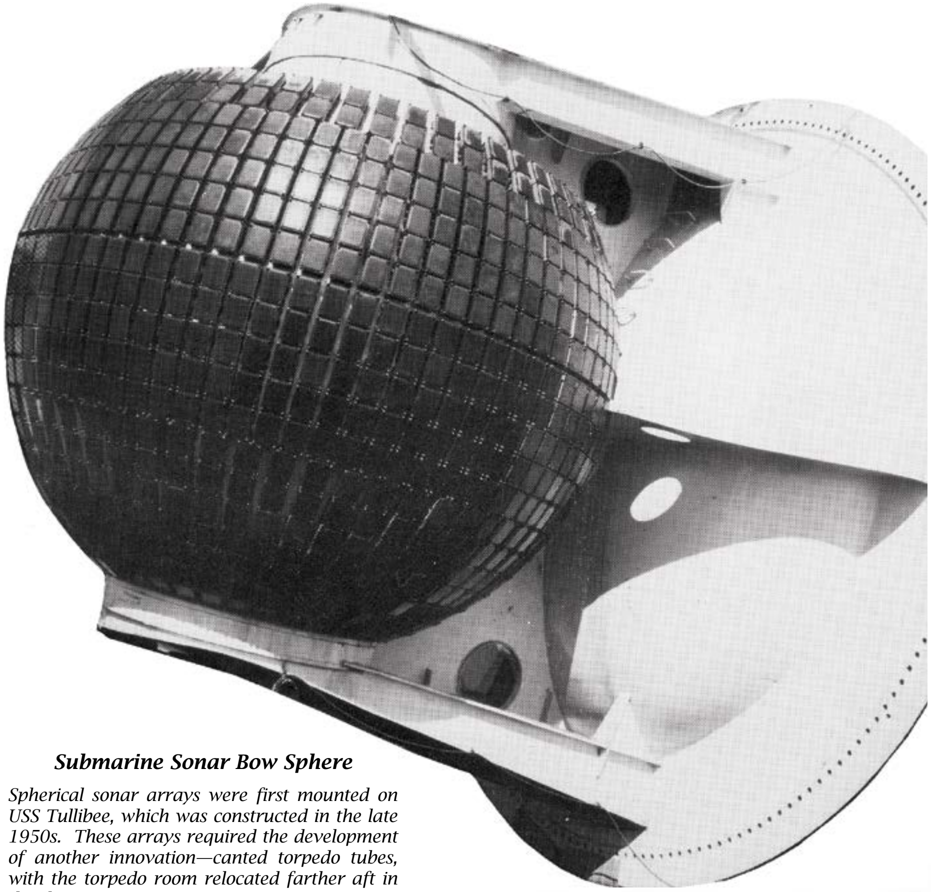
USS Nautilus Characteristics

Even with her nuclear powerplant, USS Nautilus maintained a conventional shape, with forward firing torpedo tubes and sonars located forward, above and below the tubes. Note the large number of masts in her sail.



Mk 35 Universal Torpedo

The Mk 35 was an antisubmarine weapon that could be fired from either a surface ship or a submarine, using the then recently developed Mk 102 Fire Control System. The torpedo used a seawater-activated battery.



Submarine Sonar Bow Sphere

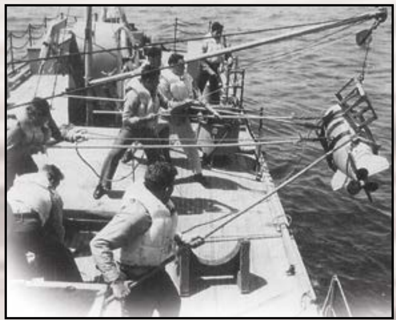
Spherical sonar arrays were first mounted on USS Tullibee, which was constructed in the late 1950s. These arrays required the development of another innovation—canted torpedo tubes, with the torpedo room relocated farther aft in the ship.

Keyport's 40th Birthday (1955)

Guests and visitors at Keyport's Open House celebration line Pier #1 to watch a torpedo firing demonstration.

NTS Keyport

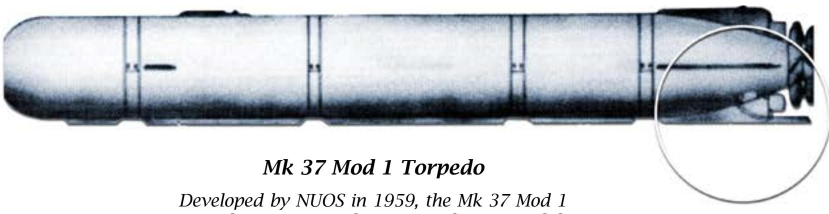
A Mk 37 torpedo is fired from a launch pier in the late 1950s.



Mobile Acoustic Torpedo Target (MATT)

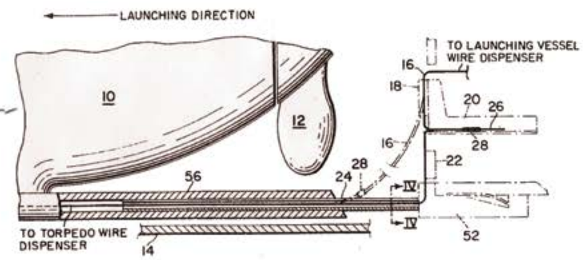
A recovery team hauls in a MATT. These targets acted as submarines during tests of early acoustic homing torpedoes. The MATT was an early version of the Mk 27 and Mk 30 mobile targets.

Admiral Rickover Inspecting USS Nautilus



Mk 37 Mod 1 Torpedo

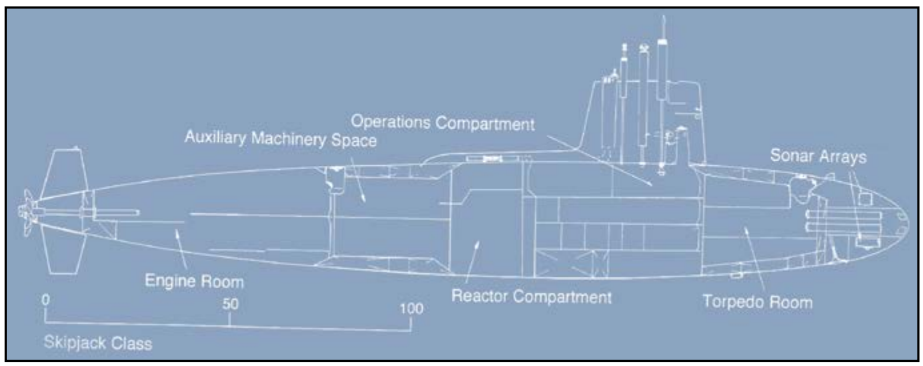
Developed by NUOS in 1959, the Mk 37 Mod 1 torpedo incorporated a wire guidance capability; it was 26 inches longer than the Mod 0.



The guidance wire was stored in a canister attached to a roller in the bottom of the tube. The wire was spliced to the end of the torpedo wire coil after tube loading. Initially, no protective flex hose was used. Submarine speed was limited to about 3 knots during wire deployment.

Central Torpedo Office, Coddington Cove

CTO employees outside NUOS building 107. Formed in 1942, CTO became an independent activity in 1947.



USS Skipjack Characteristics

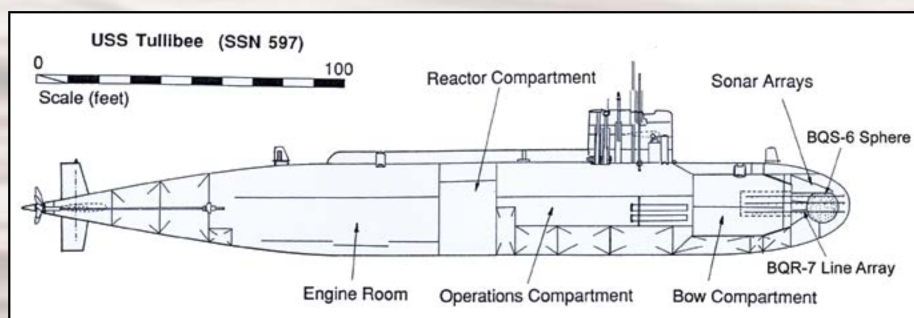
Although she had the new Albacore hull shape, USS Skipjack maintained forward firing tubes with sonar laid out above and below the tubes, similar to the Nautilus arrangement.

USS Skipjack (SSN 585) (1959–1990)

USS Skipjack, launched in May 1958, was the lead ship in a class of nuclear-powered submarines that introduced the Albacore hull shape.

USS Tullibee (SSN 597) (1960–1988)

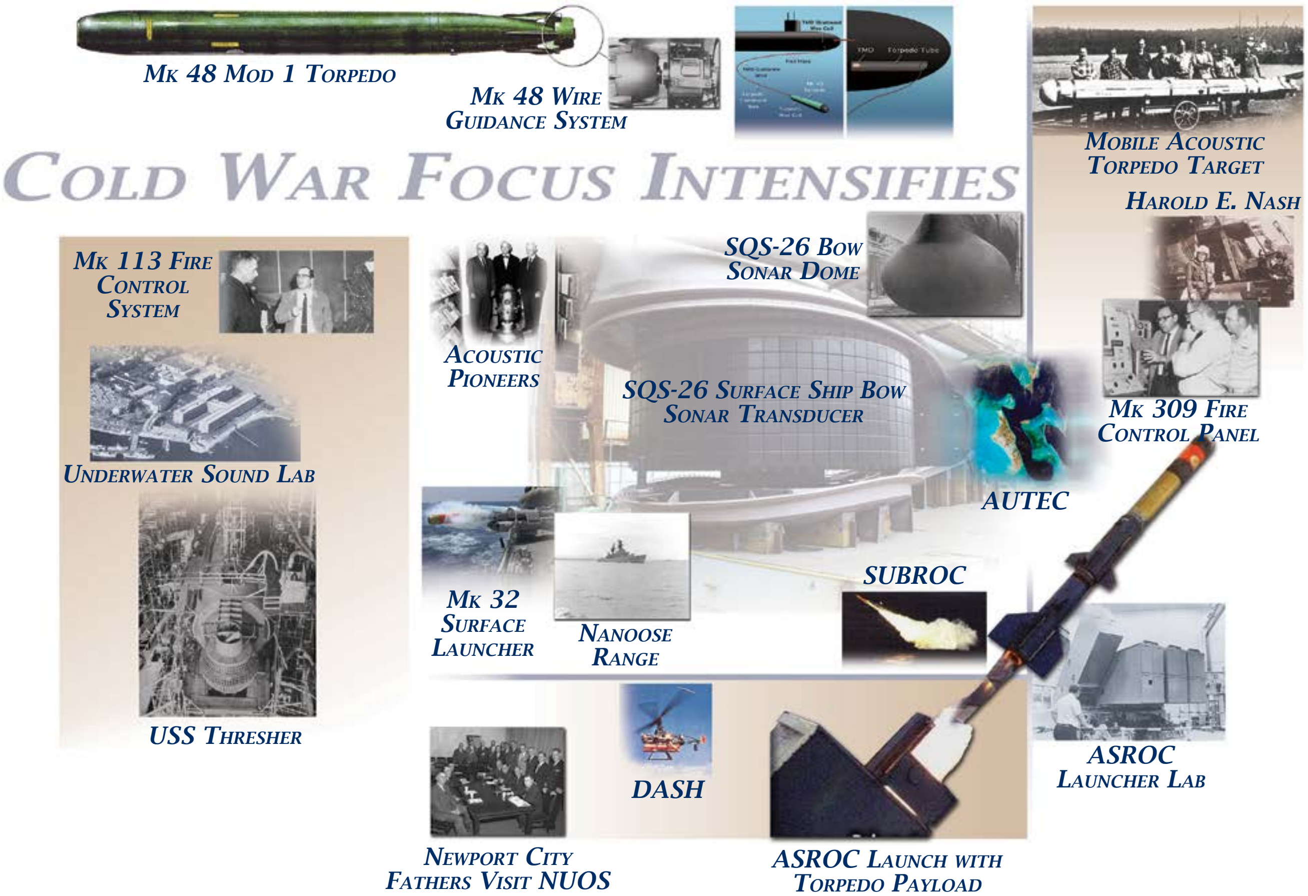
Tullibee, whose keel was laid in May 1958, was the result of a CNO study (Project Nobska) authorized in 1956. The study by the National Academy of Science emphasized stealth and long-range sonar.



USS Tullibee Characteristics

The nuclear-powered USS Tullibee had three major innovations: a large sonar sphere in the bow, angled torpedo tubes located amidships, and a quiet turbo-electric powerplant.

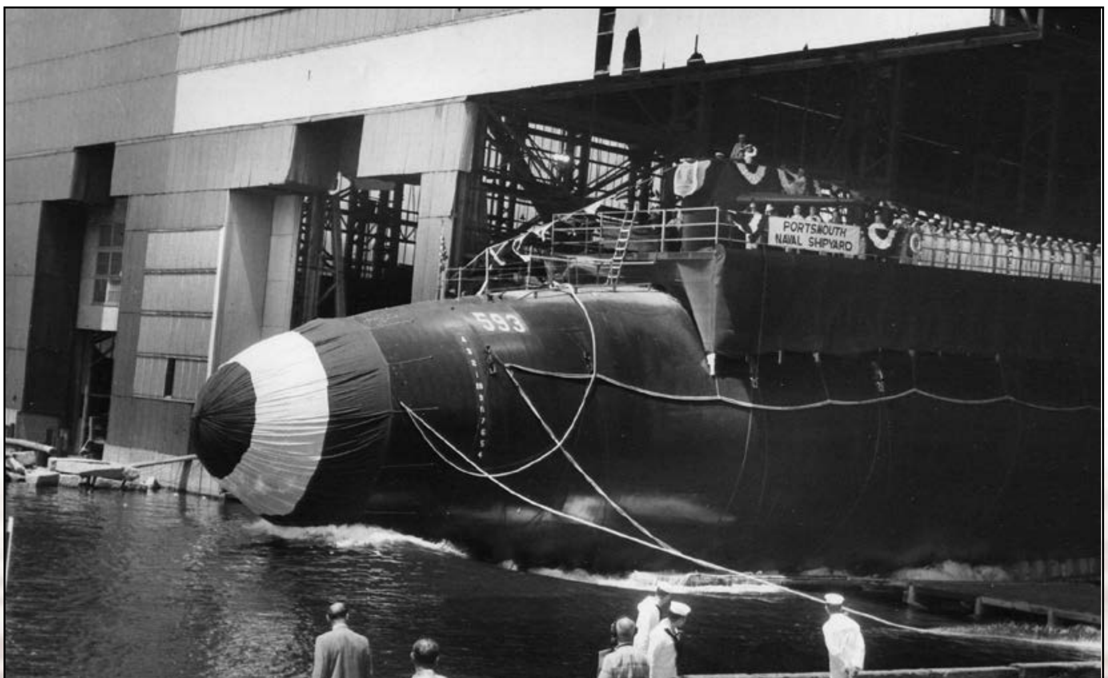
Cold War Focus Intensifies



1960 — 1969

In the 1960s, Cold War tensions escalated as the United States and the Soviet Union each sought to gain an advantage in the balance of power. The military build-up around the globe and the proliferation of nuclear weapons made the world a more dangerous place. The danger was perhaps never more evident than during the October 1962 Cuban missile crisis when the Soviet placement of nuclear missiles 90 miles off the American shore brought the superpowers perilously close to the brink of nuclear conflict.

The effects of the Cuban missile crisis were both immediate and long-term. A telephone hotline was set up in 1963 to allow instant contact between the American and Soviet leaders in the event of a crisis, and by the close of the decade the Nuclear Test Ban Treaty and Nuclear Non-Proliferation Treaty had been signed. The missile crisis also demonstrated the need for a strong Navy capable of providing a scaled response while supporting strategic deterrence as the sea-based leg of the American nuclear triad.



***Thresher*-Class Submarine with New Hydrodynamically-Shaped Bow Dome** – *The new dome shape and the large AN/BQS-6 spherical array in the dome (the torpedo tubes were canted to accommodate it) greatly improved sonar performance with lower self-noise and longer detection ranges. The Mk 113 system was also rapidly improving fire control, which was still analog in the 1960s but moving toward digital. USS Thresher (SSN 593) was lost at sea on April 10, 1963.*

The Navy stepped into the nuclear role first by developing and fielding Polaris nuclear-tipped missiles (in service 1961–1996). Development of the large ballistic missile submarines ("boomers") from which the missiles could be fired had started in the 1950s. USS *George Washington*, the first operational nuclear-powered ballistic missile submarine (SSBN), carrying Polaris missiles, had entered service in December 1959 and conducted the first SSBN deterrent patrol in November 1960–January 1961.

Ongoing games of "cat and mouse" between Soviet and U.S. attack submarines were prevalent during the Cold War.

In 1963, the Central Torpedo Office (CTO) was renamed the Naval Underwater Systems Engineering Center to reflect the expansion of its mission to operational fire control systems and launchers. Under NTS Newport from 1941 to 1947, CTO had coordinated wartime production of torpedoes at all sites. In 1947, it had become a separate activity under BuOrd with responsibility for operational torpedo programs. In 1966, the Center merged with the Naval Underwater Ordnance Station (NUOS) as the Naval Underwater Weapons Research and Engineering Station (NUWS).

The Mk 37 Mod 0 torpedo entered the fleet in 1956 as the next-generation submarine-launched heavyweight torpedo. It was quickly followed by Mk 37 Mods 1 and 2, developed by NUOS in Newport and Vitro Corporation. The Mk 37 Mod 1 was developed in the late 1950s; fleet introduction began in 1960. It provided the Navy with its first wire-guidance torpedo capability. The basic Mk 37 was lengthened by 26 inches, and 270 pounds of explosives were added to its warhead. A key to this torpedo development and deployment was the coordinated support effort that used all of the technical expertise and system-level capability at NUOS to modify all of the launcher tubes and submarine fire control systems. Although the Mk 37 performance was seen as wanting when measured against the new nuclear submarine threat, the introduction of a wire link between the torpedo and launch submarine was the foundation for future torpedo development, both in providing the link and developing the tactics for its most effective use.

In the early 1960s, the RETORC II test vehicle program underway at the Ordnance Research Laboratory at Pennsylvania State University and at NUOS provided in-water demonstrations of the feasibility of a high-performance, variable-speed, acoustic homing torpedo. The new technology could provide the quantum leap needed to counter the nuclear submarine threat.

By the mid-1960s, a program for the engineering and production was in place for industry to develop the Mk 48 torpedo to meet requirements covering speed, depth, endurance, and homing. The scientific efforts underway at NUOS to help meet these and future requirements included modeling and reducing self-noise and radiated noise, new materials and seals to allow for much deeper torpedo operating depths, improved transducers, improved exploders, adaptive beam formation, drag reduction using a number of unique approaches, and improvements to two-way wire communications with the weapon. By the late 1960s, a number of flexible modular test vehicles had been developed at NUOS to demonstrate many of these advances, often several in a single in-water run. This direct, hands-on involvement in the development and demonstration of new technology made NUOS a major contributor to development and testing of advanced heavyweight torpedoes, a position it continues to maintain to the present day.

In this decade, an international underwater range was developed jointly by the U.S. Navy and the Royal Canadian Navy. The Naval Torpedo Station in Keyport and its Canadian counterpart developed the range at Nanoose in British Columbia, Canada.

USS Dolphin (AGSS 555), an Experimental Research Submarine Built in 1965 *– The Dolphin, used to support deep sensing and other R&D programs, is shown here in Stillwater Basin at the Naval Underwater Systems Center, Newport.*

A second range was developed off the east coast as the Atlantic Undersea Test and Evaluation Center (AUTEC)—a deep-water range complex at Andros Island in the Bahamas. Both of these facilities provided tools for testing many underwater systems.

Mobile targets were another innovation. The Mk 27 mobile target was developed to support in-water tests of the Mk 48 torpedo. Subsequent development produced the more flexible mobile acoustic torpedo target (MATT) and the Mk 30 ASW mobile target. Mobile targets were also used to provide surface ships, submarines, and aircraft with realistic, reliable, and economical ASW training.

In New London, the Naval Underwater Sound Laboratory made many advances in this decade in the development, testing, and implementation of large sonar systems for both submarines and surface ships. The Submarine Tactical Array Sonar System (STASS) was begun in the 1960s. The "Sound Lab" was involved in all phases of the AN/SQS-26 program, including extensive tests at sea. There were new developments in underwater acoustic measurements, variable depth towed sonars operating below the layer, and towed array technology.

In 1969, the NUWS organization celebrated a century of Navy undersea technology. While two major wars and a century of experimentation had revolutionized undersea warfare, the station continued to be the principal research and development and testing and evaluation center for the Navy's underwater weapons systems. Its mission had expanded to include research, development, test, evaluation, engineering, and technical assistance to responsible bureaus in the areas of procurement, production, maintenance, and quality assurance, logistics, and design cognizance as well as in-service and technical assistance to the fleet.

While there were many notable advances in undersea warfare and technologies in this decade, two significant tragedies underlined the serious challenges of the marine environment. The first was the loss of USS *Thresher* (SSN-593) on April 10, 1963. The second loss was USS *Scorpion* (SSN-589) on May 22, 1968. In both cases, all aboard these nuclear submarines perished. The submarine safety program (SUBSAFE) was established as a result of the *Thresher* loss and continues to the present as a submarine certification requirement and process.

100th Anniversary Celebration
1869–1969

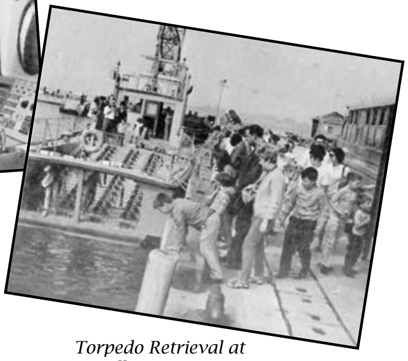

CENTENNIAL HIGHLIGHTS
(Cut Out and Save)
27 August - Press Preview Open House and Luncheon
6 September - Family Day Open House
(Rain Date - 7 Sep)
18 September - Technical Seminar
19 September - Commemorative Day Program
19 September - Anniversary Ball

Family Day

" This Facility... for 100 years contributed mightily to this nation's leadership in undersea technology."

Senator Pell's Anniversary Address

"...In the coming age of the oceans, NUWS need never fear for lack of a mission."



Torpedo Retrieval at Stillwater Basin

Technical Seminar

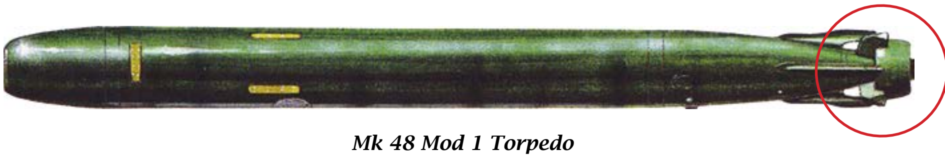
Presentations/Tours

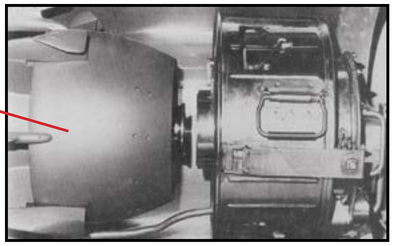
Anniversary Ball

The Commodore's Navy Band

Commemorative Day

Newport Artillery Company



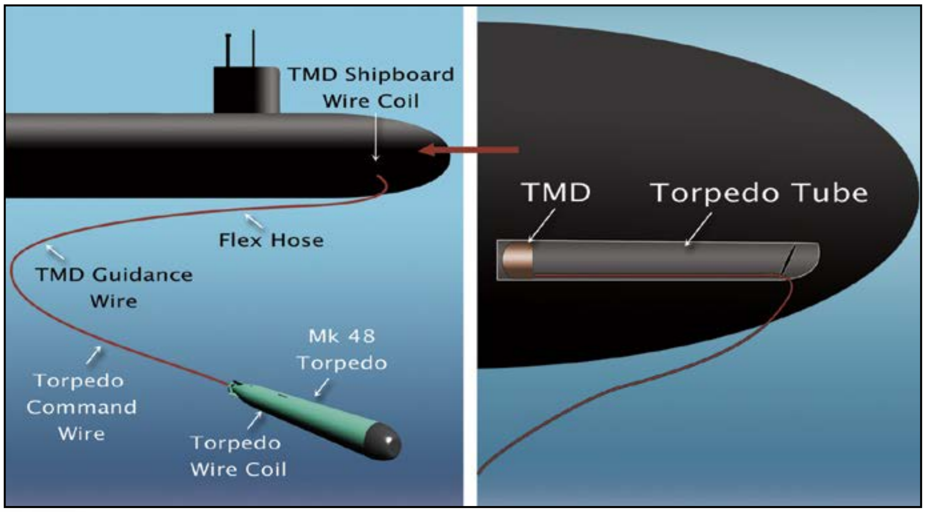


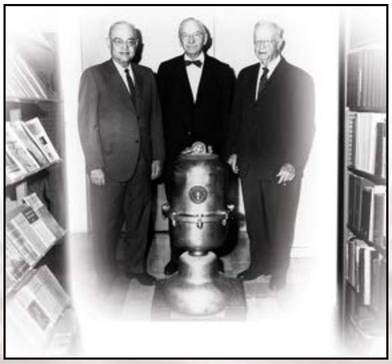
Mk 48 Mod 1 Torpedo

The Mk 48 torpedo originated in the Navy's in-house Research Torpedo Configuration (RETORC) program begun in 1963, which led to the development of Mk 48 Mods 0/2. In 1967, a new version was started with a substantially redesigned acoustic homing system and a piston engine propulsion system, which became the Mk 48 Mod 1. Both versions were evaluated, and the Navy ultimately chose the Mod 1 for production. The Mk 48 Mod 1 torpedo became operational in 1972.

Mk 113 Fire Control System

Systems engineer Earle Messere discusses Fire Control System Mk 113 in the mid-1960s with Dr. Joel Lawson, the Director of Navy Laboratories. (Messere went on to become the NUSC Technical Director some 20 years later.)

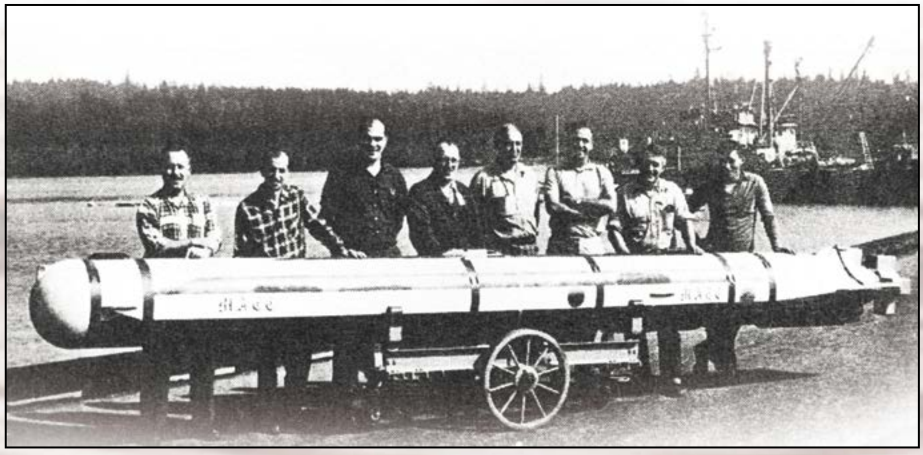




Acoustic Pioneers at NUSL's 25th Anniversary

Shown attending the Navy Underwater Sound Laboratory's 25th anniversary in July 1966 are three of the Navy's early leaders in underwater acoustic research: (left to right) Dr. F. V. Hunt (Director of the Harvard Underwater Sound Laboratory in World War II), Dr. J. Warren Horton (Technical Director (emeritus) of NUSL), and Dr. Harvey C. Hayes (former Head of the Naval Research Laboratory's Sound Division).

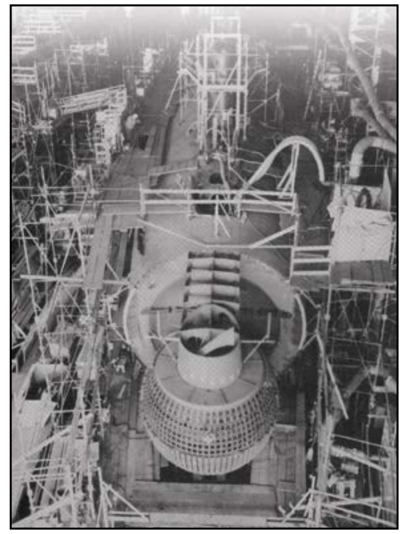
Shown in the foreground is a submarine bell, manufactured in the early 1900s by the Submarine Signal Company of Boston. The submarine signal bell was an early step on the path of sonar development.



Mobile Acoustic Torpedo Target (MATT) Field Team at Keyport, WA

The MATT field team poses for a photo in the late 1960s. NUOS established a field station at Keyport, WA, to evaluate Phase II MATT vehicles on the Dabob Bay Test Range.

AN/SQS-26 Surface Ship Bow Sonar Transducer



USS Thresher (SSN 593) (1961–1963)

USS Thresher shown under construction at Portsmouth Naval Shipyard in April 1960. Note the sonar sphere, with its lower half already populated with transducer elements.

On April 10, 1963, while engaged in a deep test dive, Thresher was lost at sea. On December 20, 1963, the Submarine Safety (SUBSAFE) program was established; it continues today as a submarine certification requirement and process.

Navy Underwater Sound Laboratory

At Fort Trumbull, New London (circa 1962).

Newport City Fathers Visit NUOS

The entire city council receives a briefing from NUOS management (circa 1965).

Mk 32 Surface Launcher

The Mk 32 surface launch tubes, introduced in 1960, allowed the firing of 123/4-inch lightweight torpedoes against submarine targets. The Mk 46 torpedo being fired was first introduced into the fleet in 1963.

Harold E. Nash as Sixth Fleet Science Advisor

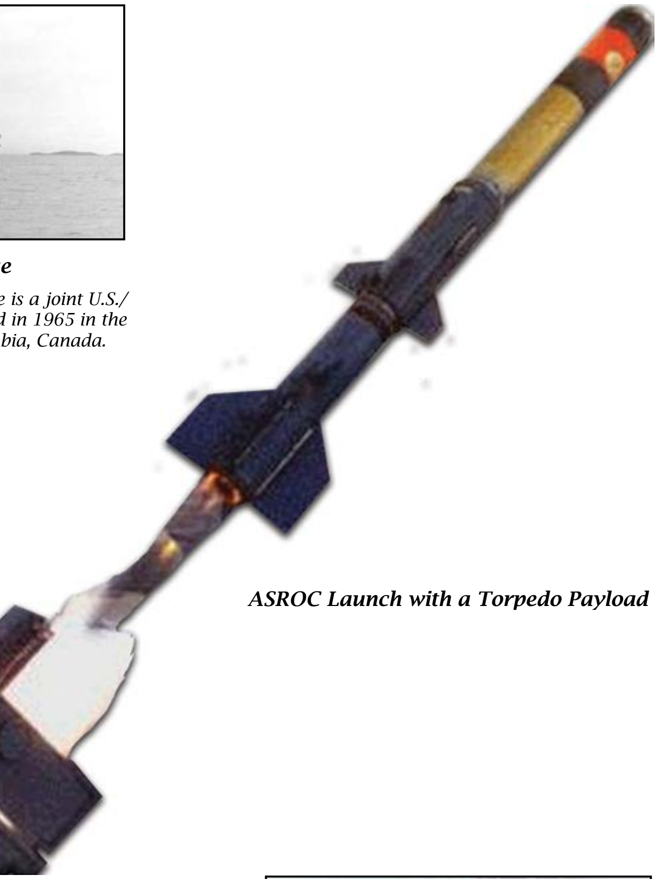
Nash was the first Technical Director of NUSC.

Explaining Mk309 Control Panel

C. Roger Wallin (left) with senior Navy officers.

Nanoose Range

The Nanoose torpedo test range is a joint U.S./Canadian test facility developed in 1965 in the Strait of Georgia, British Columbia, Canada.



ASROC Launch with a Torpedo Payload

AN/SQS-26 Bow Sonar Dome

AN/SQS-26 bow dome on USS Willis A. Lee (DDG 37) circa 1966.

Antisubmarine Missile (SUBROC)

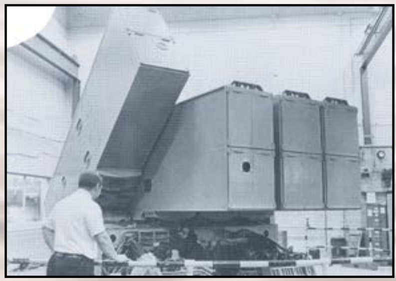
SUBROC was an underwater-launched anti-submarine weapon (similar to ASROC). Two versions—a nuclear depth charge and a torpedo—were developed, but only the former was ever implemented aboard a U.S. submarine.

Drone Anti-Submarine Helicopter (DASH)

The Mk 32 surface launch tubes in the Drone Anti-Submarine Helicopter (DASH) carried two Mk 44 lightweight torpedoes. The DASH supported the longer detection and localization ranges of the new AN/SQS 26 sonar under development in the early 1960s. Several helicopters were modified by the Advanced Research Projects Agency (now DARPA) to add television cameras and remotely fired machine guns to deploy in Vietnam, where DASH was a very early tactical UAV.

Atlantic Undersea Test and Evaluation Center (AUTEC)

This is an overhead view of the Tongue of the Ocean (TOTO) off Andros Island at AUTEC. Construction of the weapons and sonar ranges at AUTEC started in 1964.



ASROC Launcher Laboratory at NUOS

ASROC (antisubmarine rocket) was a solid-fuel, rocket-propelled, ballistic, standoff missile fired from surface ships against submarine targets. ASROC had two basic configurations—a torpedo version and a nuclear depth charge version. NUOS's ASROC Laboratory played a key role in missile development and in resolving in-service ASROC issues.

Mary Rita Powers

A mathematician who joined the Navy Underwater Sound Laboratory in 1946 and received the Decibel Award in 1979

Helen G. McCabe

Joined the Navy Underwater Sound Laboratory in 1945 and received the Decibel Award in 1971

Eleanor Harris

An electronics engineer who joined the Navy Underwater Sound Laboratory in the mid-1950s as the first woman in New London's trainee program

Toby Silverman

An electrical engineer who was the first woman in Newport's Student Trainee Program in 1959

Dr. Helen Sternberg

A mathematician who joined the Navy Underwater Sound Laboratory in 1970 and was known for mentoring many young women professionals

Eleanor Keys

An engineering draftsman whose career spanned NTS, NUOS, and NUSC, she was also a prominent lecturer on African American history

Dorothy "Dot" Bing

Joined Newport in the mid-1970s and was a leader in the field of Equal Employment Opportunity programs

Margaret "Pat" Brummer

With a 50-year career in federal service, she was also known as a member of the New England Tennis Hall of Fame

Susan Maloney

"Breaking the Ice" -

A Woman Scientist in the Arctic

Patricia Dean

An electrical engineer who joined NUSC in Newport in 1976, became the first SES executive as Head of the Surface Undersea Warfare Department, and later served as Acting Executive Director for NUWC

Kelly Murphy and Suzanne Chellis

"Breaking the Ice" -

Women Scientists in the Arctic

Pamela Lisiewicz

An electrical engineer who joined Targets in 1980, received patents for Unmanned Undersea Vehicle work, and became NUWC Director of Strategy

Cathy Young

Joined NUSC in Keyport in 1985 as an engineer in the In-Service Engineering Department and became the first woman to head a technical department

Trevor Kelly Bissonnette

A mechanical engineer who joined Weapons/ Launchers Engineering in 1982 and became the FMS International Customer Advocate

Dr. Marilyn Berliner

Significant achievements in fiber-optic and towed array sensors, modeling, and analysis for which she received the Decibel Award

Candie Desjardins

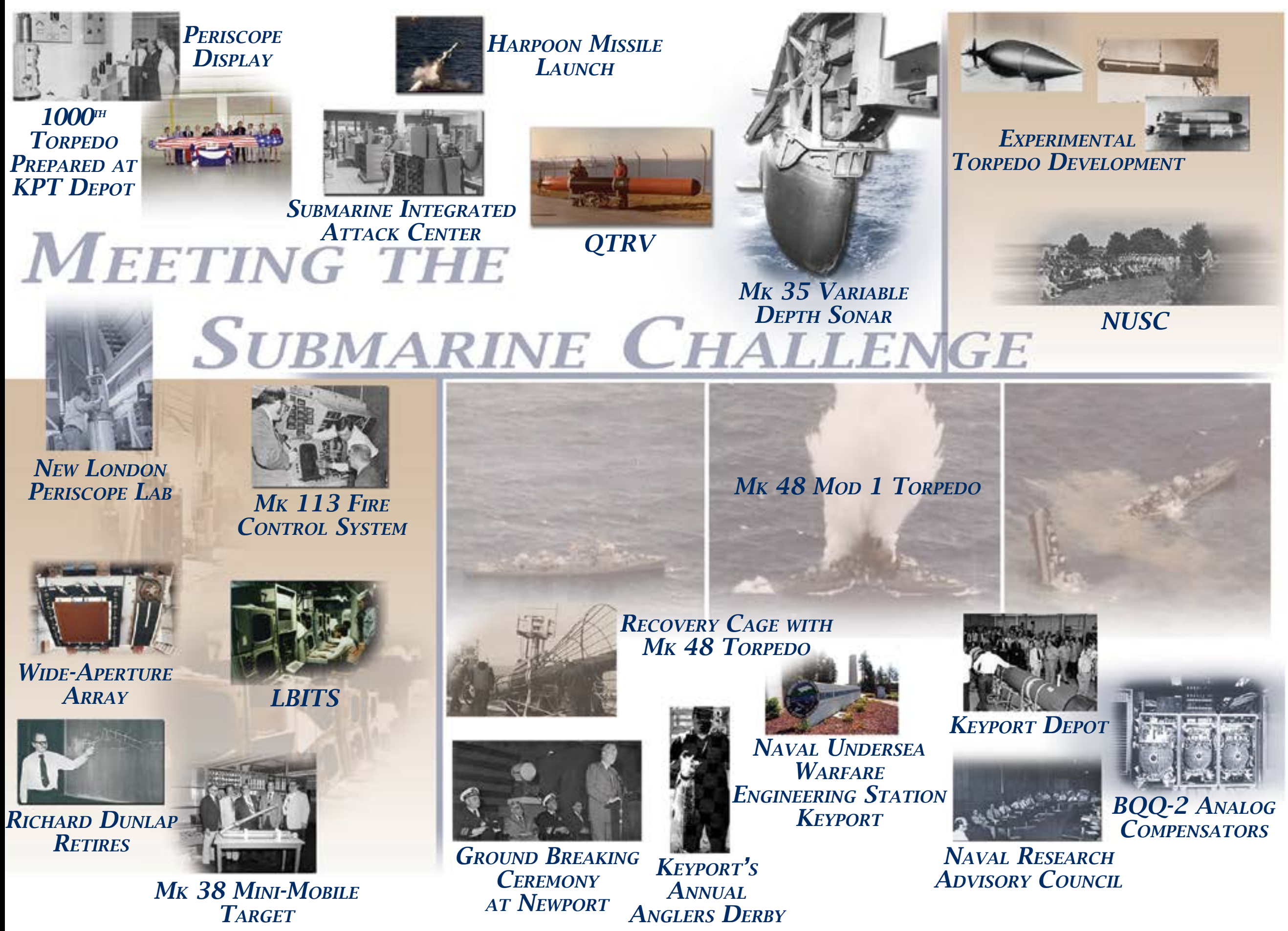
A mathematician who joined Undersea Ranges in 1981 and became the Program Manager of the Educational Outreach Program

Molly Magee

A mathematician who joined Product Engineering in 1975 and retired as NUWC's Chief Financial Officer

Mary Wohlgemuth

Joined NUSC as a mathematician in 1983, became Head of the Torpedo Systems Department in 2000, and served as Technical Director of NUWC Division Newport from 2012 to 2017


Periscope Display
Harpoon Missile Launch
1000th Torpedo Prepared at KPT Depot
Submarine Integrated Attack Center
QTRV
Mk 35 Variable Depth Sonar
Experimental Torpedo Development
NUSC
Meeting the Submarine Challenge
New London Periscope Lab
Mk 113 Fire Control System
Mk 48 Mod 1 Torpedo
Wide-Aperture Array
LBITS
Recovery Cage with Mk 48 Torpedo
Keyport Depot
Naval Undersea Warfare Engineering Station Keyport
BQQ-2 Analog Compensators
Richard Dunlap Retires
Mk 38 Mini-Mobile Target
Ground Breaking Ceremony at Newport
Keyport's Annual Anglers Derby
Naval Research Advisory Council

1970 — 1979

In the 1970s, the United States embarked on a policy of détente with the Soviet Union. However, the need for a global U.S. Navy presence remained strong, both because of ongoing Cold War tensions and an increasingly connected international economy. Coupled with the dramatic expansion and modernization of the Soviet navy, these factors increased the pressure on the newly renamed Naval Underwater Systems Center (NUSC) to continue to deliver innovative capabilities to meet fleet requirements. The détente collapsed in 1979 with the Soviet invasion of Afghanistan.

NUSC's Seneca Lake Acoustic Measurement Facility in Upstate New York

The U.S. Navy's ballistic missile submarines continued to be a strong leg in the U.S. strategic nuclear deterrence triad while the fleet's attack submarines became more and more effective at finding and trailing Soviet submarines, particularly in the Atlantic Ocean. U.S. confidence in its technologically superior platforms and their ability to operate at their full potential was high early in the decade. By the mid-1970s, however, there was growing concern in Washington because of high levels of Soviet defense spending and global engagement and reduced U.S. military spending in the post-Vietnam years. In June 1978, Admiral James L. Holloway III concluded that the U.S. Navy then had only a "slim margin of superiority" over the Soviet navy.

When the Naval Underwater Systems Center (NUSC) was formed in 1970 by merging the Naval Underwater Weapons Research and Engineering Station (NUWS) and the Navy Underwater Sound Laboratory (NUSL), NUSC's primary mission was redefined from a broad ASW warfare role to the more specific role of supporting submarines in naval warfare. The Naval Torpedo Station in Keyport continued as a separate activity. New London's skill set, with expertise in sonar and electromagnetic systems, made an ideal match with Newport's expertise in weapon, launcher, fire control, and combat systems for developing component- and system-level advances for submarine platforms and for developing sonar systems for surface ships. The integrated product line approach to research, development, test, and evaluation (RDT&E) at NUSC began in this decade.

When the new Mk 48 torpedo entered the fleet in 1972, NUSC supported the massive effort required to introduce this highly advanced new weapon system. In conjunction with the AN/BQQ-5 submarine sonar and the Mk 113/117 fire control systems, the Mk 48 Mod 1 torpedo provided a significant advance in capability and performance. Supporting the installation and technical and operational evaluations of this new weapon system in the fleet and establishing its effectiveness was a major undertaking for NUSC.

NUSC conducted thousands of fleet torpedo firings and follow-on test and evaluation (FOT&E) exercises to provide an extensive database for assessing weapon effectiveness and analyzing overall system performance. This effort also clarified the emerging need for all-digital subsystem combat systems and interfaces to handle the rapid growth and sophistication of the submarine systems for rapidly expanding and increasingly complex submarine missions.

Development of the Mk 48 Mod 3 torpedo started soon after the fleet introduction of the Mod 1 weapon. The Mod 3 provided an upgraded two-way wire communications link that input actual sonar system and torpedo data to the submarine fire control system in real time during the torpedo run to achieve enhanced performance.

Soon after, NUSC headed a crash program to provide Mod 4 upgrades to the Mk 48 torpedo to counter the Soviet *Alfa*-class submarine threat. In 18 months, upgrade kits were delivered that expanded the operating envelope in both speed and depth.

A series of innovative torpedo test vehicles was also developed at NUSC during the 1970s to evaluate a broad range of technologies. The Deep Experimental Torpedo (DEXTOR) was a test vehicle that could operate at depths up to 4000 feet. The External Deep Diving Torpedo (EXTOR) tested torpedo seal technology for deep-depth, long-term, external storage of weapons on submarines. A quiet torpedo vehicle was used for in-water tests to develop and evaluate both self-noise and radiated noise reduction techniques, which led to NUSC's role as the program manager of the Naval Sea Systems Command (NAVSEA) quieting program. Several drag reduction demonstration vehicles were used extensively for in-water evaluation of drag reduction technology based on shape, suction, heating, and injection of long-chain polymers into the boundary layer.

***Main AUTEC Support Base and Downrange Tracking Complex on Andros Island in the Bahamas in 1974** – This test range installed in the Tongue of the Ocean (TOTO) provided the ability to track underwater sound in roughly 500 square miles of deep ocean. The AUTEC laboratory now performs integrated three-dimensional hydrospace/aerospace trajectory measurements covering the entire spectrum of undersea simulated warfare.*

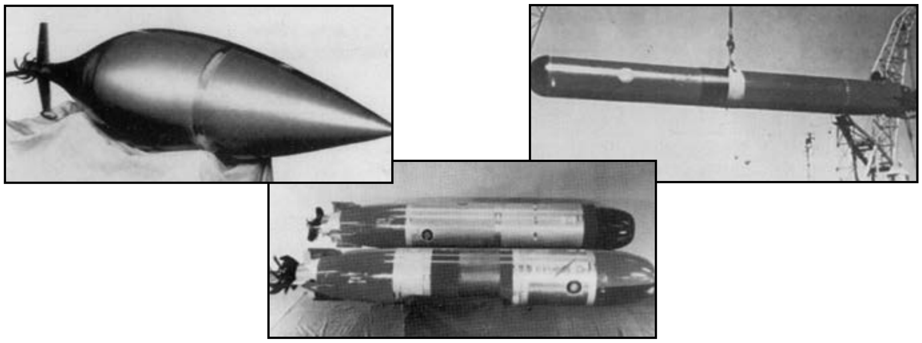
Late in the decade, NUSC projected a need for a larger-sized lightweight torpedo to counter the dramatic increases in threat submarine performance. An in-house development was initiated to address the technical challenge of applying minicomputers and digital technology to a 16-inch-diameter lightweight torpedo test vehicle. This "universal" torpedo demonstrated that launching a digital lightweight torpedo with a significantly larger warhead from multiple platforms was feasible and that it would provide significant increases in overall capability.

By the end of the decade, the scientific, predictive design of modern torpedoes had been demonstrated with extensive aid from new computer programs. The technical challenge was shifting to the emerging use of minicomputers and digital technology to develop new software-controlled torpedoes and submarine combat systems. The Mk 48 Advanced Capability (ADCAP) program was initiated at this time to develop a new, high-performance, digital homing system for the Mk 48 torpedo to counter the proliferating submarine threat.

In 1978, the Naval Torpedo Station in Keyport was renamed the Naval Undersea Warfare Engineering Center to reflect its growing mission responsibility.

Periscope Display

John Merrill (left), Head of the Submarine Electromagnetic Systems Department at the NUSC New London Laboratory, shows periscope electro-optic sensors to Caesar Spero (center), Associate Director for Submarine Systems, and CAPT Frank Victor (right), New London Officer-in-Charge, in 1978.



Experimental Torpedo Development

Three advanced test vehicles from the 1970s: above left, one of several vehicles used to study drag reduction through boundary layer manipulation; above right, the Deep Experimental Torpedo (DEXTOR), used to demonstrate new structures and seals for deep-depth, externally carried torpedoes; below, the Fixed Round Simple Torpedo (FIRST), used to predict control system and hydrodynamic performance.

1,000th Torpedo Prepared at Keyport Depot

A major milestone was reached in the late 1970s with the production of the 1,000th torpedo. These 1,000 units included both warshot and exercise weapons (1978 photo).

Submarine Integrated Attack Center

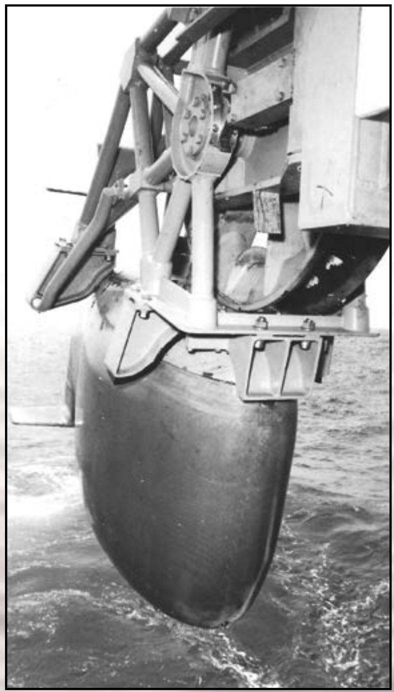
This NUSC Newport facility (shown in 1975) supported advanced combat systems research and development programs.

Harpoon Missile Launch

An encapsulated Harpoon missile is launched from a submarine. Harpoon, which came into service in 1977, is an over-the-horizon anti-ship missile that can be launched from a variety of platforms.

New London Periscope Lab

The Type 18 periscope in the NUSC New London periscope laboratory. At the forefront of the Navy's Type 18 periscope program, NUSC was involved in the design, development, and fleet introduction. NUSC performed the initial installation on USS Cavalla (SSN 684) in 1976.

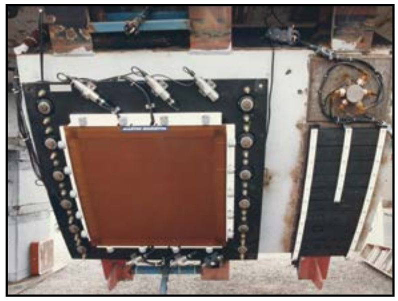


Mk 35 Variable Depth Sonar (VDS)

The independent Mk 35 VDS was used in conjunction with the AN/SQS-26 sonar to operate below the acoustic layer. In this photo, a Mk 35 VDS is being launched from USS Glover (AGDE 1), a specially configured destroyer used by NUSC New London for at-sea sonar test and evaluation in the 1970s.

Mk 113 Mod 10 Fire Control System

The Mk 113 Mod 9 analog fire control system for Polaris and Poseidon submarines was developed successfully by NUSC after a competition with the Naval Ordnance Laboratory. Development of the Mk 113 Mod 10 digital fire control system (in the photo) for attack-class submarines followed in 1973.



Wide Aperture Array (WAA)

An early experimental component of the Wide Aperture Array in use during sonar testing.

Quiet Torpedo Research Vehicle (QTRV)

The QTRV was used extensively for developing and testing quieting techniques for both radiated noise and self-noise. Data from the self-noise experiments led to the improved torpedo contours that were later incorporated in the ADCAP torpedo (1978 photo).

Land-Based Integrated Test Site (LBITS)

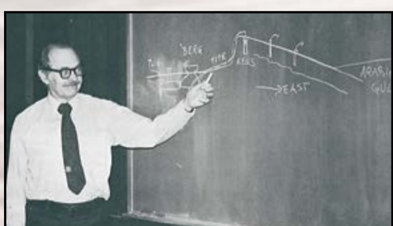
LBITS, in NUSC New London, replicated the surface ship sonar systems hardware used in the fleet. Continually updated, LBITS played an important role in incorporating new systems into the fleet and in resolving technical and operational questions.

Mk 38 Mini-Mobile Target

During an August 1975 visit to Keyport, Mark Hansen (center), of NAVSEA, is seen holding a Mk 38 mini-mobile target. With him (left to right) are Don Campana, J. L. Krause, Bill Yokum, and Ed Lesinski, Keyport's Technical Director.

Keyport's Annual Anglers Derby

Ed Lesinski, Keyport's Technical Director, shows off his catch at the NTS Anglers Derby.



Richard Dunlap Retires

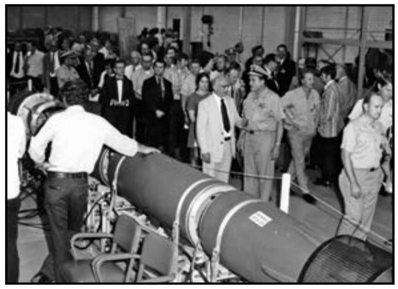
Mr. Dunlap joined the Naval Torpedo Station (NTS) Newport in 1948 as its first degreed employee. He received his B.S. and M.S. degrees from the Massachusetts Institute of Technology in 1940 and 1941. During his career, he served as Associate Director of Research and Director of Long-Range Planning before retiring in 1979.

Ground Breaking Ceremony at Newport

Senators Claiborne Pell (at the podium) and John Pastore (second from left) participate in a ground breaking ceremony at NUSC Newport. The two senators were longtime supporters of NUSC and the Navy.

Naval Undersea Warfare Engineering Station Keyport

The original Naval Torpedo Station at Keyport, founded in 1914, was reorganized in 1974 as the Naval Undersea Warfare Engineering Station. At that time, depot responsibility for the Mk 48 Mod 1 torpedo was reassigned from the contractor to Keyport.



Keyport Depot

Attendees gather at the dedication ceremony for Keyport's Mk 48 torpedo depot in 1971.

Naval Research Advisory Council (NRAC)

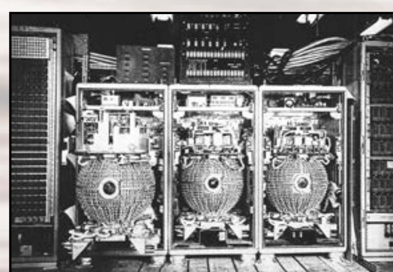
NRAC members attended two days of presentations and discussions with NUSC scientists and engineers in June 1973.

Mk 48 Mod 1 Torpedo

The Mk 48 Mod 1 torpedo was a submarine-launched weapon capable of attacking both submarine and surface targets; it entered service in February 1972 after a "shoot-out" against the Mk 48 Mod 0 version. The Mod 1 was heavily supported by teams from Newport and Keyport. The photographic sequence shows an example of the weapon's capability during a "SINKEX" performed against USS Moore early in the Mk 48's fleet introduction. The Mod 1 was followed in December 1977 by the Mod 3, which had an improved telemetry system. In a rapid response to an emerging threat, the Mod 4, featuring increased depth capability and improved Doppler detection capability, was successfully tested by the end of 1979 and delivered to the fleet in December 1980. This was a 13-month program from initiation to fleet initial operational capability (IOC).

Recovery Cage with Mk 48 Torpedo

A Mk 48 torpedo in a helicopter recovery cage that was developed at NUSC Newport (photo from mid-1970s).



Analog Compensators in Early AN/BQQ-2

Three compensators formed the passive search, tracking, and active sonar beams for the large AN/BQS-6 spherical array in the AN/BQQ-2. These compensators were the last of the analog beamformers developed in the 1960s and used well into the 1970s.

Naval Underwater Systems Center (NUSC)

Ceremonies on July 1, 1970, marked the establishment of the Naval Underwater Systems Center at Newport. The new center was formed by the merger of the Navy Underwater Sound Laboratory in New London and the Naval Underwater Weapons Research and Engineering Station in Newport. This organization served the Navy throughout the Cold War era.

Integrated Systems Focus

1980 — 1989

The election of President Ronald Reagan in November 1980 ushered in the "Reagan Revolution," which was built in part on a promise to restore America's military superiority. During the 1980s, the Reagan administration embarked on an unprecedented military build-up, including pursuing Secretary of Defense Caspar Weinberger's "Star Wars" missile defense and a 600-ship Navy that was strongly supported by Secretary of the Navy John Lehman. The foreign policy focus shifted from détente to rollback, and the Reagan Doctrine became the rationale for providing military assistance to anti-Soviet "freedom fighters" around the globe.

Navy ship construction during the 1980s increased significantly, including the *Ohio*-class ballistic missile submarines, *Nimitz*-class nuclear powered carriers, and *Los Angeles*-class attack submarines. New or improved weapon systems were also added to the fleet, such as the Mk 48 ADCAP torpedo and the Tomahawk land attack, Harpoon anti-ship, and high-speed, anti-radiation (HARM) missiles. The venerable battleships USS *Iowa* (BB-61), USS *New Jersey* (BB-62), USS *Missouri* (BB-63), and USS *Wisconsin* (BB-64) once again put to sea with 16-inch guns and new Tomahawk surface-to-surface missile batteries.

NUSC played the lead role in the first major upgrade of the operational Mk 48 Mods 1/3/4, provided configuration management for the in-water FOT&E for these weapons, and worked with the Hughes Aircraft Company to develop the ADCAP Mod 5 upgrade in which the entire front end of the torpedo was replaced. The ADCAP developed in the early 1980s by NUSC and Hughes led to a 1985 production contract for Hughes; ADCAP in-service use started with initial operational capability (IOC) in 1988.

NUSC's Submarine Antenna Test Range on Fishers Island, NY

This unique facility had a ground-level test pool (at right, inland from the large tidal pool) with two hydraulically operated antenna masts that were used to test submarine mast antennas. The island facility was located about 8 miles from the New London Laboratory, across Fishers Island Sound.

After the 1970 organizational change, the sonar, periscope, electromagnetic, and communications systems and technology developed at the New London Laboratory could be even more effectively integrated with the overall submarine combat system. In sonar, this included the AN/BQQ-5 bow-mounted spherical array sonar system, both large-diameter and small-diameter towed line arrays, and the AN/BQG-5 Wide Aperture Array—a flank array that provided longer-baseline tracking of targets. In

Mk 50 Lightweight Hybrid Torpedo

The Mk 50 lightweight torpedo (above), propelled by a Stored Chemical Energy Propulsion System (SCEPS) and a pump jet propulsor, was originally designed to replace the Mk 46 lighweight torpedo. Mk 50 development started in 1974 under the Space and Naval Warfare Systems Command (SPAWAR) Systems Center Pacific (SSC Pacific) in San Diego. Production started in 1991. Because it was expensive to exercise, it was replaced by the Mk 54 lightweight hybrid torpedo (below). The Mk 54 utilized components from both the Mk 50 (transducer and processing) and Mk 46 (propulsion system and propulsor) torpedoes.

Mk 54 Lightweight Hybrid Torpedo

Newport, NUSC had been designated the technical direction agency for the Mk 117 all-digital fire control system in the 1970s. The Mk 1 Combat Control System, an integrated combat control system initiated in 1979, evolved from the Mk 117 as the focus on integrated weapons systems increased.

The advent of the scientifically designed torpedo, sonar systems, communications systems, and other submarine-based systems—all with digital software-based implementations and interfaces input to an overall combat system suite—introduced a new era of significant technical and system-level challenges. The increasing complexity and rapid advancement of technology, the accelerating half-life of the hardware itself, and an increasingly challenging threat created many difficulties. Managing change and baseline configurations while ensuring that innovation was not lost required significant effort and full-spectrum management of the whole combat system and all of its very complex interactions at both the component and system levels in order to rapidly transition new technology into the existing baseline systems.

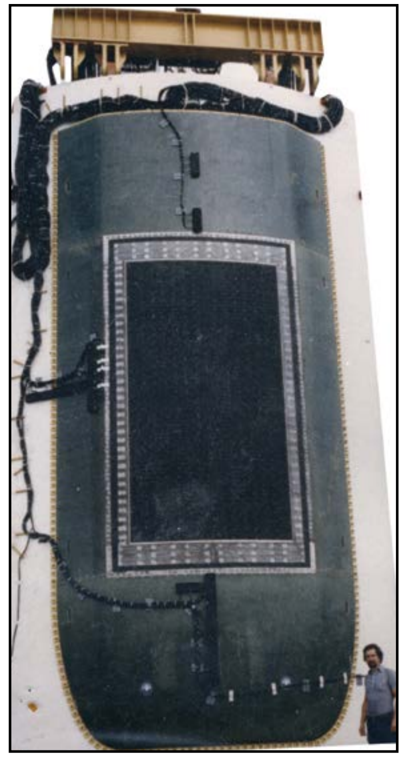
The fall of the Berlin Wall, the very symbol of Cold War division, in November 1989 signaled how greatly the international military situation had changed over the decade. The Soviet Union itself dissolved 13 months later—the victim of a failing economy and radical reforms introduced by Soviet president Mikhail Gorbachev. The Cold War was effectively over.

NUSC R/V Ranger in 1988

NUSC-based R/V Ranger was a research vessel with an air-over-water torpedo launching system.

Mk 48 Mod 5 Advanced Capability (ADCAP) Torpedo at the Heavyweight Torpedo Depot at the Naval Underwater Systems Engineering Center (NUWEC) in Keyport

The ADCAP torpedo was developed in the 1980s with NUSC Newport as the Technical Design Agent and Hughes Aircraft Company as the prime contractor. The all-digital weapon entered service in 1988. It has a software-based homing system with a low-noise transducer. A significant development effort focused on reducing the torpedo's self-noise by optimizing nose contours and isolating vibration.

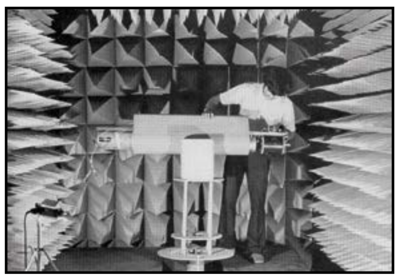


Wide Aperture Array (WAA) Sonar

A single panel of a WAA sonar system awaits in-water testing at the Seneca Lake Sonar Test Facility in Dresden, NY. Three such panels installed on each side of the submarine improved sonar acoustic performance significantly.

Torpedo Propulsion Facility

CAPT J. Guy Reynolds (later VADM Reynolds) receives a status update from NUSC Newport's Philip Tabor on the Mk 48 torpedo propulsion unit. Roger Bridge, the Mk 48 Program Manager, is at the far right.

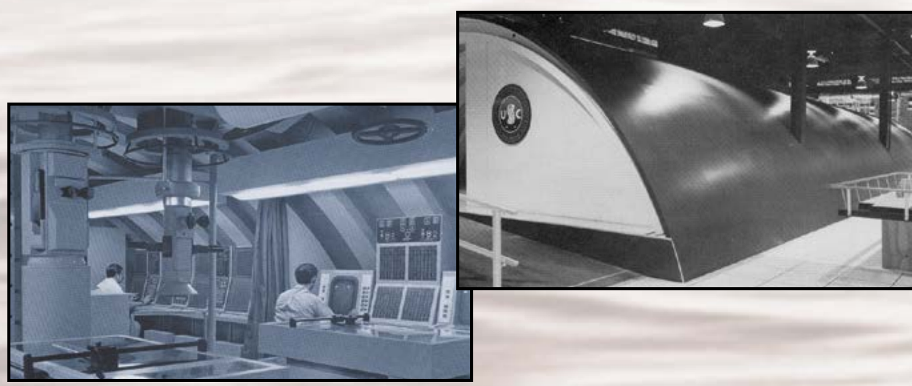


Antenna Radiation Pattern Measurement Anechoic Facility

The New London facility for measuring antenna radiation patterns covered frequencies from 150 MHz to 30 GHz (1982 photo).

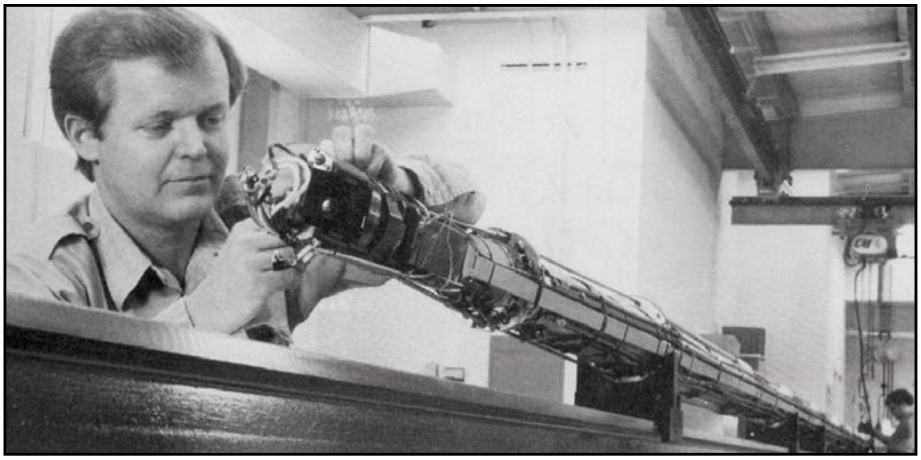
Festival of Trees

For many years, NUSC (later NUWC) hosted a "Festival of Trees" each December in Building 80 at Newport. Navy and civilian organizations decorated the trees and vied for prizes awarded on the basis of voting by festival visitors.



Submarine Operational Test Bed

Developed in the 1980s, this test bed was a full-scale submarine mockup for combat system operational evaluation. It was used for both near-term and advanced concepts. Views of the internal (left) and external (right) test setup are shown.



Periscope R&D Test Facility

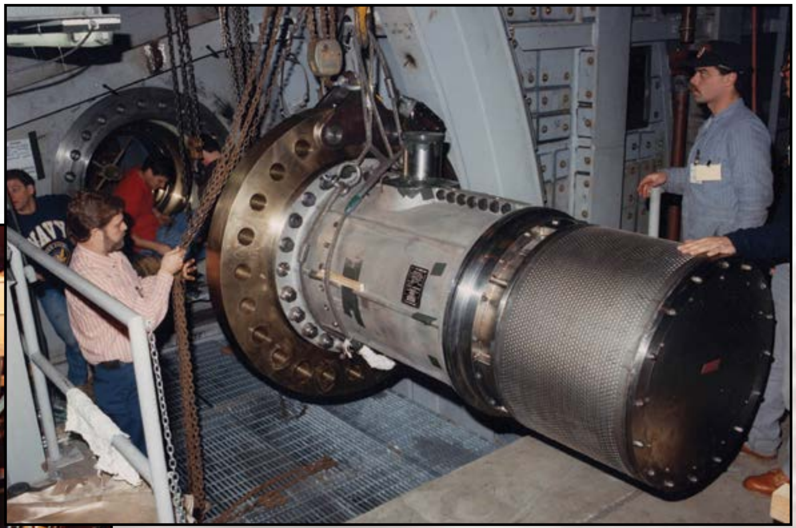
Pre-installation adjustments are made to a Trident periscope at the Periscope R&D Test Facility in New London in 1984.

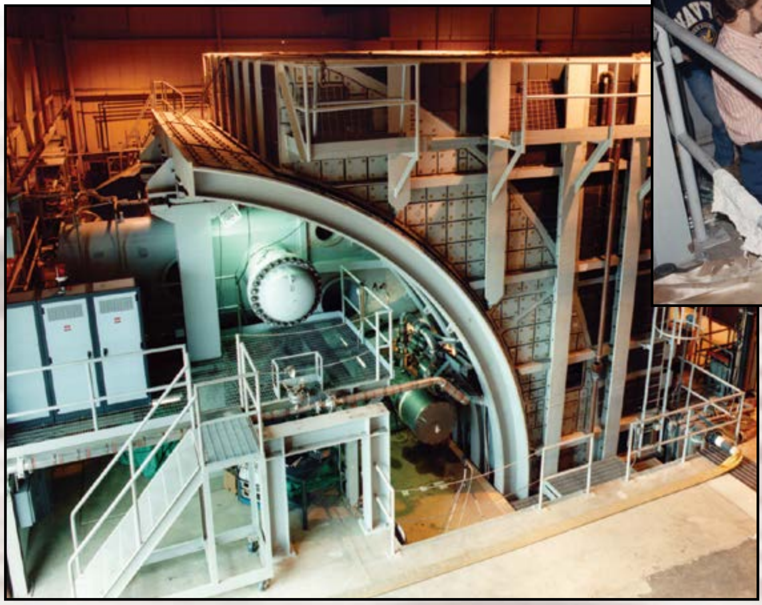
NUSC's Astronaut

Dr. Paul D. Scully-Power, a senior oceanographer at NUSC New London, was chosen by the National Aeronautics and Space Administration (NASA) in 1984 as a Payload Specialist for the 13th Space Shuttle Challenger mission. He traveled 3.4 million miles in 133 orbits of the earth.

Periscope Facility

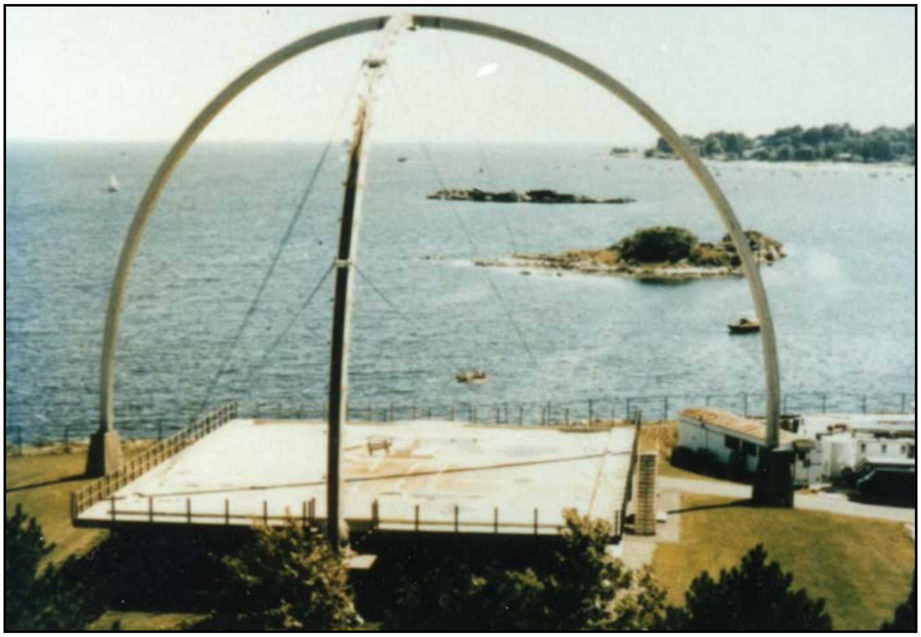
A tour of the Periscope Facility at the NUSC New London Laboratory in the mid-1980s.





Torpedo Launchers Work

Development of the Mk 21 turbine pump ejection system (above) started in 1986. The system's major focus was quiet operation. It was first fielded on SSN 21 in 1990. At left is the Advanced Submarine Launcher Facility with the Mk 21 turbine pump installed. With its ocean simulation tank, this facility allowed evaluation of launch noise under ocean noise background conditions.



The Submarine Antenna Overwater Arch Measurement Facility

This unique test facility for evaluating antenna performance in a typical submarine operating environment was initially installed at the New London Laboratory in 1981. The hemispherical pattern of submarine antennas are measured over a seawater ground plane. When the New London Laboratory was closed in the early 1990s, this facility was disassembled, moved to Newport, and reconstructed near Pier 2.

Mk 30 Target Depot at NUWEC in Keyport

The depot facility at NUWEC in Keyport served the Navy's entire Mk 30 program.

TROV Torpedo Recovery Vehicle at NUWEC in Keyport

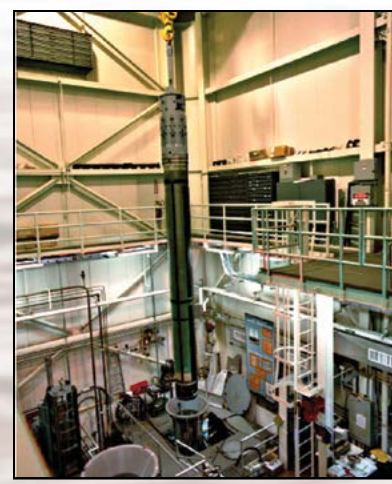
The TROV was a 40-hp vehicle capable of diving to depths of 1,000 meters. It was developed at Keyport to use on the NUWEC ranges for torpedo recoveries, salvage operations, and accident investigations.

Towed Array Facility

Development and fabrication of experimental towed arrays at NUSC New London Laboratory were performed in a former supermarket in the city. Conversion of the building provided the large open space required to prototype the thin-line towed arrays needed for submarines.

Queen Elizabeth II visits Andros Island

In 1985, Queen Elizabeth II came to Andros Island to dedicate a rose garden and to tour the Atlantic Undersea Test and Evaluation Center (AUTEC). The Royal Navy has utilized the AUTEC range for many years for exercises.

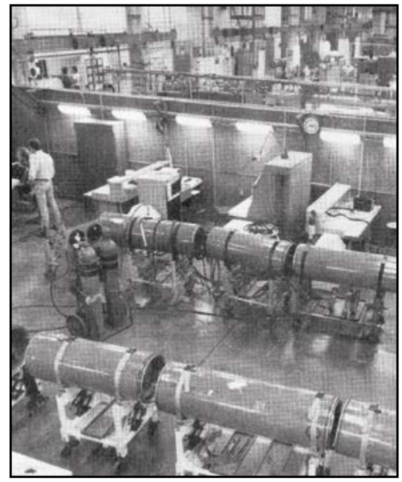


Launcher Laboratory

An encapsulated Tomahawk missile is raised into a vertical loading position at the Newport Launcher Laboratory.

Ice Camp

Ice Exercise (ICEX) 1985 supported evaluation of Mk 48 torpedo performance in adverse environments. In the insets, a torpedo is recovered through a hole cut in the ice: a diver maneuvers the torpedo under the ice (right), and the torpedo is lifted by a helicopter (left).

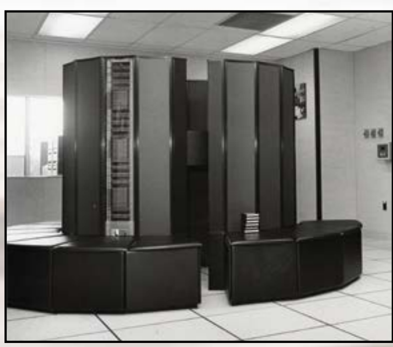


AUTEC Laboratory

Mk 30 mobile torpedo targets are prepared in the AUTEC laboratory for use in torpedo firing exercises on the AUTEC range in this mid-1980s photo.

Mk 50 Lightweight Torpedo

An experimental launch of a Mk 50 lightweight torpedo from a Mk 32 torpedo tube is performed on a test range at Keyport. The Mk 50 was developed in the 1980s to replace the Mk 46 torpedo under the leadership of SPAWAR in San Diego (SCC Pacific). The Technical Design Agent role was transferred to NUWC in the early 1990s under a Base Realignment and Closure Action.



CRAY X-MP/28 Supercomputer

Dedicated at NUSC Newport in April 1988, this supercomputer was at the time the most powerful computer in New England. It supported NUSC's scientific computing needs and its engineering efforts through the Defense Advanced Research Projects Agency (DARPA) worldwide computer network, which was the predecessor of the Internet.

OA-9070 Submarine Thinline Handling System

The OA-9070 was critical to U.S. Navy ASW. The handling system allowed submarines to deploy and retrieve long towed arrays. These arrays improved the ability to search for enemy submarines. This handling system was located in the aft main ballast tank. The stowage drum (at right in the photo) could hold almost 1 mile of tow cable and array.

Berlin Wall Falls in 1989

The fall of the Berlin Wall on November 9, 1989, symbolizing the end of the Cold War, was soon followed by discussions of a "Peace Dividend."

Aftermath of the Cold War

1990 — 1999

At the end of the Cold War, the U.S. Navy's strategy and force structure were directed primarily at fighting a conventional enemy on the high seas. The fall of the Soviet Union replaced the relative order of a bipolar global system with greater uncertainty as threats multiplied from regional rivalry, terrorism, transnational crime, nationalism, and ethnic and religious conflicts.

NUWC New London Laboratory in Early 1990s

The New London Laboratory was closed by BRAC action, and the personnel and most functions were moved to the Newport site. Several major new construction projects provided office, laboratory, and test facilities at the Newport site to support the move.

The U.S. Navy struggled to clarify its mission in the post-Soviet world. Throughout the 1990s, the Cold War distribution of the Atlantic and Pacific fleets remained unchanged, with 55% of the fleet based in the Atlantic and 45% in the Pacific. A 25% budget reduction for the military was in the works as part of the "peace dividend," and technology developments were making each new ship and weapon system more expensive.

In this period, in the aftermath of the fall of the Berlin Wall and the dissolution of the Soviet Union, the Navy analyzed the changes in the threats and in its resources with an eye to the future to help formulate its new direction. "The Way Ahead," published in April 1991, was the first study to signal the need for a rebalancing of the Navy's forces and goals. It called for a needed change of focus, new deployment patterns, a forward presence, and an increasing need for littoral operations and facing the changing nature of sea control.

Published in September 1992, "… From the Sea: Preparing the Naval Service for the 21st Century" became one of the most widely cited Navy studies of the post–Cold War period and gained prominence as an expression of U.S. Navy and Marine Corps strategic thinking.

Manta Test Vehicle (MTV)

The Manta Test Vehicle (MTV) was developed to meet the need for an unmanned undersea vehicle (UUV) with a larger payload and energy capacity. NUWC Division Newport designed the MTV as a test platform for innovative UUV concepts of the future. The concept was based on the technology developed for the NUWC 21-inch UUV that grouped heavyweight torpedo hull sections to provide larger sections for payload, energy, and propulsion. Its futuristic design incorporates a custom fiber-reinforced plastic outer hull.

Reductions in Number of Combatants Achieved in This Period

Ship Category	FY1989	FY1994	FY1999	% Cut/Increase
Strategic Submarine	36	18	18	−50%
Cruise Missile Submarine	0	0	0	0%
Nuclear Attack Submarine	96	88	57	−41%
Conventional Attack Submarine	3	0	0	−100%
Aircraft Carrier	15	12	12	−20%
Battleship	4	0	0	−100%
Cruiser	40	35	27	−33%
Destroyer	68	41	52	−24%
Frigate	100	51	37	−63%

"Forward … From the Sea" was published in November 1994 and was intended to update and expand "the strategic concepts articulated in our [the U.S. Navy's] 1992 paper to address specifically the unique contributions of naval expeditionary forces in peacetime operations, in responding to crises, and in regional conflicts."

Published in 1997, "Anytime, Anywhere: A Navy for the 21st Century," the final strategic document of the 1990s, presented a strategic vision for how the Navy intended to approach the current and future security environment that was unfolding.

To help meet the challenges of the strategic shift within an austere budget environment, there was a significant decrease in the number of ships (see the table above), and a Base Realignment and Closure (BRAC) process was implemented. The BRAC had a very direct impact on naval R&D laboratories like NUWC.

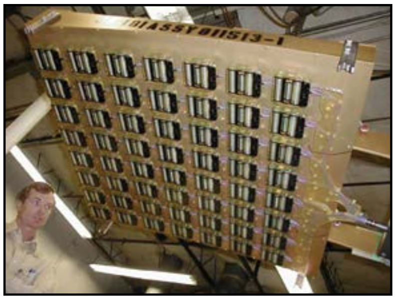
Over several rounds of realignment and consolidation, the BRAC process resulted in the formation of four major Navy warfare centers—for air, surface, undersea, and command and control. More BRAC rounds, based on the Adolph Commission recommendations of 1991, marked the next several years.

On January 2, 1992, as part of the BRAC process, the Naval Underwater Systems Center in Newport and the Naval Undersea Warfare Engineering Center in Keyport were disestablished and restructured as separate divisions of the new Naval Undersea Warfare Center (NUWC), with Center headquarters co-located with Division Newport in Rhode Island. The NUSC New London Detachment was disestablished, and its functions and personnel were moved to Division Newport. In this consolidation, lightweight torpedo development projects were moved to Division Newport, and lightweight torpedo maintenance and fleet support were moved to Division Keyport. In 1995, as missions were further realigned, the NAVSEA Naval Combat Systems Engineering Station in Norfolk, Virginia, and the Naval Research Laboratory (NRL) Underwater Sound Reference Division, Detachment Orlando, in Orlando, Florida, were also incorporated into the NUWC Division, Newport organization.

Sinking of the Royal Australian Navy Decommissioned River-Class Destroyer Escort HMAS Torrens by a MK 48 Torpedo Fired from HMAS Farncomb, a Collins-Class Submarine, in the Farncomb's Combat System Trials

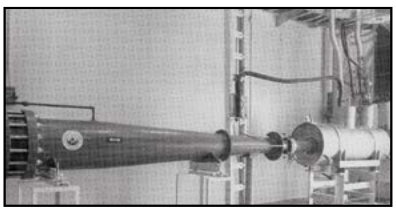
NUWC's strong product-line organization, complemented by its center-wide analysis capability and supported by simulation and analysis capabilities in each of the product lines, fostered a robust systems-level approach to undersea warfare. A large number of innovative technologies were also developed and demonstrated over this decade. A few of these new developments are listed below:

- Large unmanned undersea vehicles, including key in-water demonstrations of the Manta test vehicle that utilized technology from several product lines.
- One of the first demonstrations of an underwater projectile breaking the underwater sound barrier.
- A unique superconducting electromagnetic thruster facility and the application of its results to a quiet—"no moving parts"—propulsor effort.
- Common software technology for torpedo guidance and control enhancements.
- The *Virginia*-class submarine concept of operations (CONOPS) laboratory test bed for evaluating all aspects of CONOPS—fleet personnel, data presentation, equipment placement, and human factors issues.
- A unique elastomeric bladder submarine launcher.
- A broad range of periscope and electronic warfare components and systems.



Lightweight Sonar Array Panel

A lightweight sonar array panel is prepared for testing at Division Newport's Seneca Lake Test Facility.



Superconducting Electromagnetic Thruster (SCEMT) Laboratory

This unique facility for the study of magneto hydrodynamics and its application to quiet propulsion was designed and built and began operating in the early 1990s.

Type 8 Mod 3 Periscope

A Type 8 Mod 3 periscope undergoes certification in this 1993 photo of the Periscope R&D complex. The facility allowed for work on up to six fully operational periscopes at a time.

New London Waterfront Key Landmark

On 2 July 1993, onlookers witnessed the end of an era as the Underwater Sound Laboratory water tower in New London, CT, was taken down. It was constructed in 1969 but was not used for several years before its demolition.

MK 48 Advanced Capability (ADCAP) Torpedo

An ADCAP torpedo being serviced at Division Newport. Division Newport is the ADCAP Technical Direction Agent and the In-Service Engineering Agent. Division Keyport is responsible for the Depot and Intermediate Maintenance.

Working Together

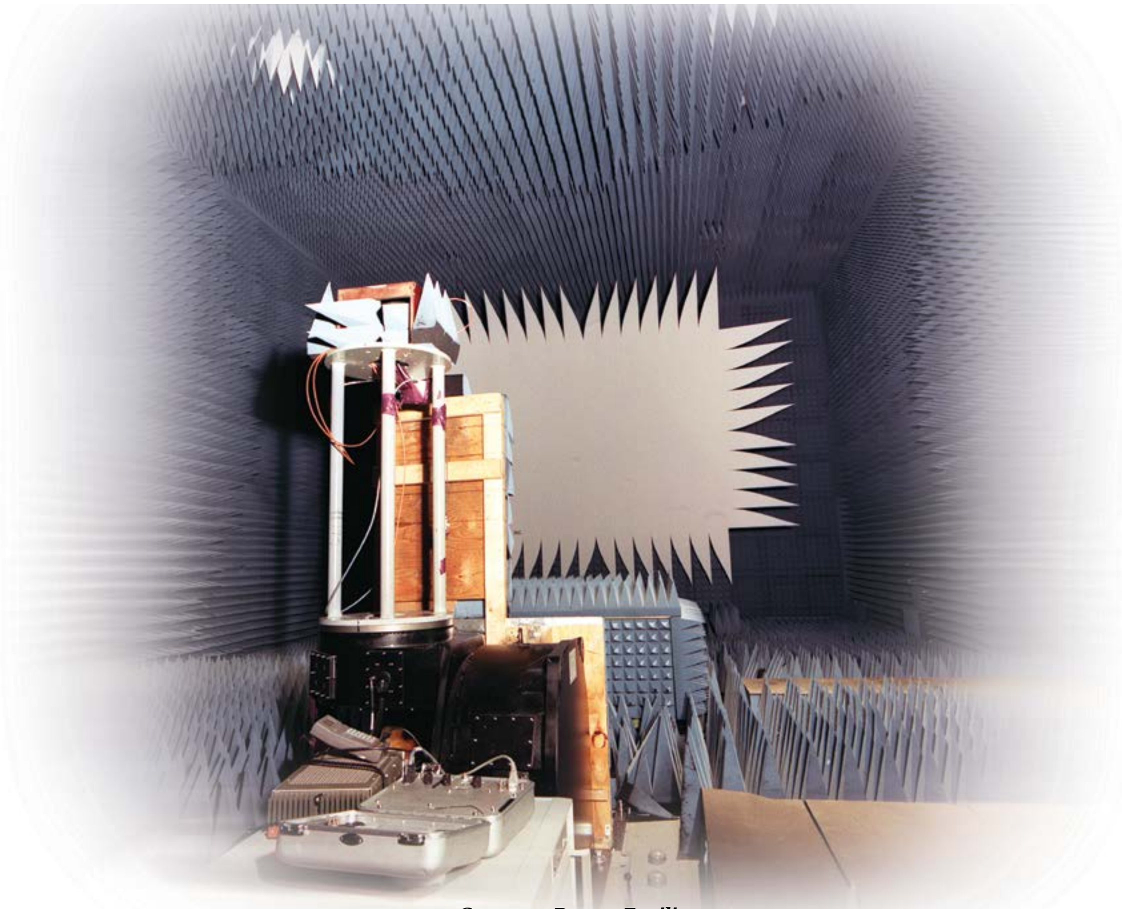
A Division Newport half-length Swampworks torpedo is being loaded on Division Keyport's yard torpedo test (YTT) craft for an on-range firing.

Mk 48 Advanced Common Technology G&C Section

The Mk 48 Torpedo Guidance and Control (G&C) section is being integrated with software in the Weapons Analysis Facility at Division Newport.

New London BRAC

Two BRAC commissioners speak at the New London Detachment about the military value of its functions, expertise, and facilities to be transferred to Newport.



Compact Range Facility

An array undergoes evaluation at Division Newport.

Heavyweight Test Vehicle (HTV)

A Heavyweight Test Vehicle enters the water after launch from the HTV Launcher developed by Division Keyport for testing countermeasure anti-torpedo defensive systems.

1,000th ADCAP Torpedo Completed

Division Keyport celebrates the completion of the 1,000th Mk 48 ADCAP torpedo.

The Elastomeric Ejection System

The ejection system, designed for submarine torpedoes and missiles, is explained to program office visitors to the Launcher Laboratory by Rich Coupland of the Launcher Department.

Trident Command and Control System Laboratory

The Trident Ship Control Station and the Commanding Officer's Display Console in the laboratory during integration testing.

Lightweight Torpedo Testing

Mk 46 lightweight torpedo hardware undergoes Intermediate Maintenance Activity (IMA) testing at Division Keyport, which operates both the Depot and the only fully certified IMA for lightweight torpedoes.

Briefing Aboard USS Yorktown (CG 48)

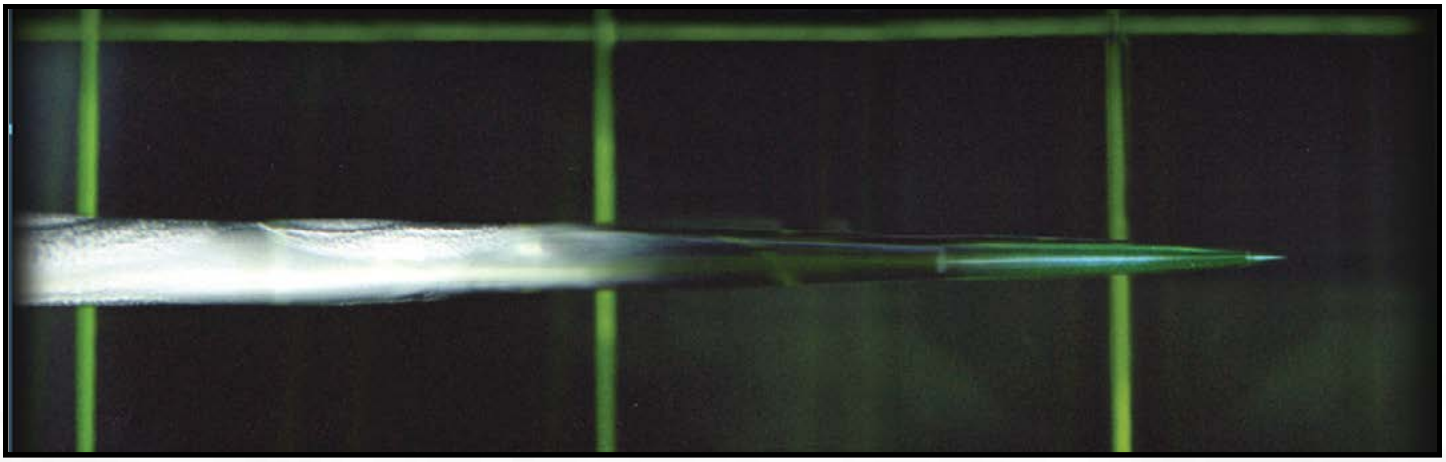
CAPT Stephen Logue, Commander of NUWC Division, Newport, and Patricia Dean, Head of the Surface Ship Sonar Department, receive a briefing on "smart ship" technologies.

Mk 30 Target with Countermeasures Attached

In-water testing at AUTEC demonstrated the feasibility of launching a countermeasure from the Mk 30 target without adverse effect on the target's in-water performance.

Concept of Operations Exercise

In 1995, a Virginia-class Concept of Operations Exercise (COOPEX) was held in the Warfare Systems Presentation Facility at Division Newport. The exercise demonstrated operational employment, equipment arrangement, the use of fleet personnel, and human factors issues.



Breaking the Underwater Sound Barrier

1997 photo of projectile speed exceeding 1,500 meters per second.

VADM George Sterner (COMNAVSEA)

VADM George Sterner (left) receives a briefing at Division Newport's Anechoic Wind Tunnel during a 1997 visit, while RADM Shipway looks at the equipment from another perspective.

Secretary of Defense William Cohen

SECDEF William Cohen and the Rhode Island Congressional Delegation were briefed at NUWC Division Newport on September 26, 1997, on the Division's programs and many unique research, test, and evaluation facilities.

Manta Test Vehicle (MTV)

This view of the MTV highlights its tail, which features radio frequency line-of-sight communications, UHF SATCOM, phased array, and acoustic communications capabilities.

Manta Test Vehicle with Torpedo and Acoustic Sensors

The MTV carries both a Mk 48 ADCAP torpedo and a U.K. array of acoustic sensors (blue canister) during an in-water dynamic run.

Manta Unmanned Undersea Vehicle Concept

New London Detachment Decommissioning

CDR Patricia Cherchio, the first woman Officer-in-Charge of the New London Detachment, is presented the flag lowered during the decommissioning ceremony on March 31, 1997.

AN/BLQ-10 Electronic Support Measures (ESM)

Used for electronic surveillance, the ESM system has automatic direction-finding capability integrated into the ESM mast (shown in the inset).

Submarine Imaging System (SUBIS)

Display for an improved digital imaging system for the Type 18 Periscope. The SUBIS was also used later with the nonpenetrating Photonics Mast.

Diverse Threats Emerge

2000 — 2015

Throughout the decade, the nation, the Navy, and NUWC continued to adapt to rapid changes emerging in the threat environment. The diversity of threats—hostile acts from terror organizations, state-sponsored threats from Iran and North Korea, new challenges from China, and renewed threats of aggression from a stronger Russia—has prompted updates to the Navy's strategic planning. Further, dramatic breakthroughs in fundamental areas of science and technology, coupled with the accelerated dispersal of new developments via the Internet, have posed additional challenges for NUWC as the warfare center has sought to best support the existing Navy while planning for the future fleet.

Today, and for the foreseeable future, the U.S. Navy must first of all maintain a strong forward presence where and when it is needed through credible demonstrations of power, either overt—surface and air—or covert—submarines and UUVs. Global access must be assured at all times, and any anti-access or access denial efforts must be met with the will to demonstrate a full range of military responses anywhere in the world's international waters. A strong commitment to U.S. allies and partners must also be maintained, as well as the Navy's commitment to its long-standing missions of deterrence, sea control, and maintaining maritime dominance. Moreover, these goals must be met while tailoring the Navy's resources to fiscal constraints, which is a tall order.

NUWC has mapped its R&D profile to guidance issued by the DoD and the CNO to align with Navy and NAVSEA future requirements. For example, the Defense Innovation Initiative issued by the Secretary of Defense in 2014 sought to give the U.S. military a larger competitive advantage over adversaries, especially in areas of anti-access and area-denial, guided munitions, undersea warfare, cyber and electronic warfare, human-machine teaming, war gaming, and new concepts of operation.

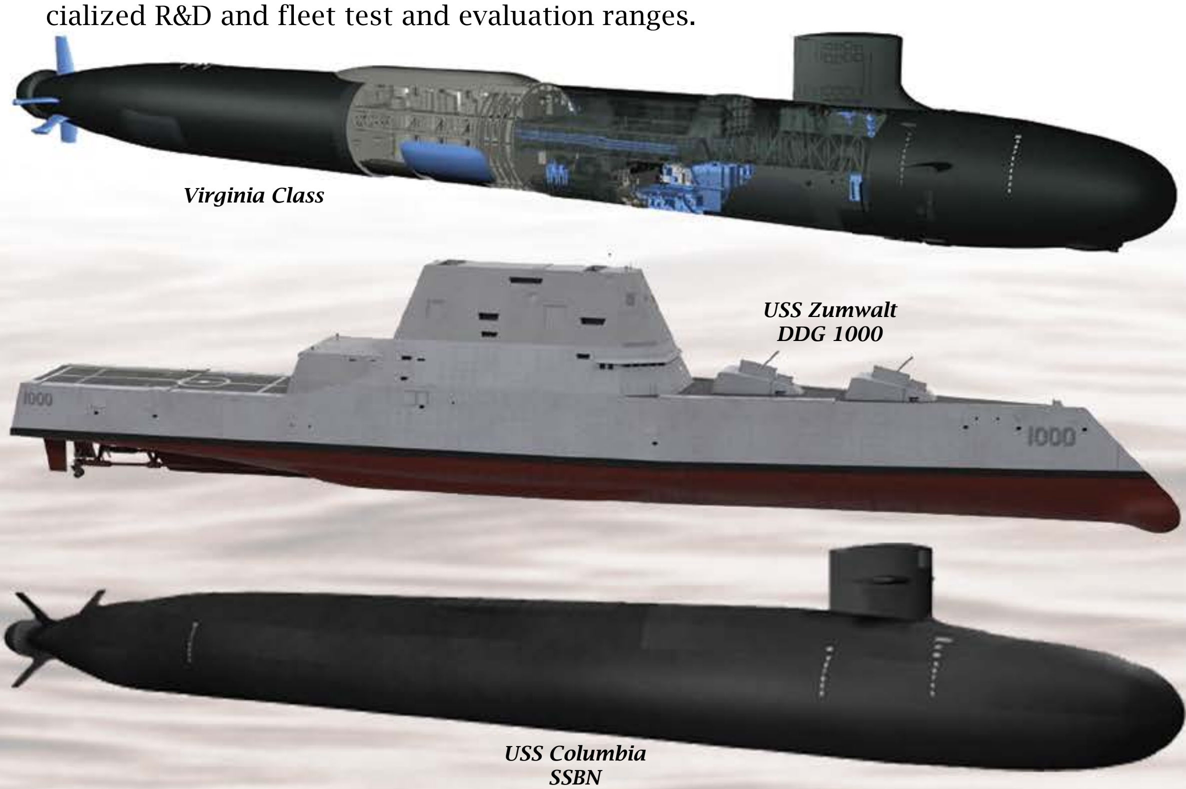
Achieving "high velocity learning" (HVL) at every level is a key line of effort called out in "A Design for Maintaining Maritime Superiority," released in January 2016 by Admiral Richardson. In June 2016, the Secretary of Defense unveiled "Force of the Future" initiatives to modernize regulations governing how the Department of Defense recruits, develops, and retains military and civilian employees.

In May 2016, "A 21st Century Science, Technology and Innovation Strategy for America's National Security," from the White House, recognized the technology trends affecting national security, including implications for the U.S. military as it adapts to emerging asymmetric and unpredictable threats and more sophisticated and effective weapons threatening access to the sea, air, space, and cyber domains. NUWC was then already investing in new technologies—unmanned and autonomous systems, engineered materials, nanotechnology, cyber-physical systems, synthetic biology, for example—while further developing stealth technology and precision-guided munitions.

With its strong technical capabilities and its long history as a leading innovator, NUWC is well positioned to fill its full-spectrum responsibility to provide advanced undersea combat systems for both submarines and surface ships. NUWC remains committed to assisting in the success of naval programs by providing unbiased technical advice and innovative solutions.

The accomplishments of the past two decades testify to NUWC's ability to meet the challenges posed as future USW threats become more diverse and capable. Just a few examples are the Advanced Combat Control Center, Submarine Bridge Trainer, Submarine Multi-Mission Team Trainer, new sonar arrays with very advanced processing for surface ships and submarines (towed arrays, Lightweight Wide Aperture Array, chin array, Large Aperture Bow Array), improved Mk 48 Mod 7 heavyweight and Mk 54 lightweight torpedoes, a full range of unmanned autonomous undersea and surface vehicles with new capabilities, quiet weapon launchers, the addition of large-diameter tubes to the attack submarine for launching weapons and UUVs, and many technological advances in the masts for periscopes and imaging systems.

NUWC's expertise in undersea warfare technology and systems for both submarines and surface ships will support the full range of the Navy's submarine, surface ship, and unmanned vehicle requirements of the future. The talented NUWC workforce is highly skilled and is supported by unique development and test facilities and specialized R&D and fleet test and evaluation ranges.



Virginia Class

USS Zumwalt
DDG 1000

USS Columbia
SSBN
Ohio Class Replacement

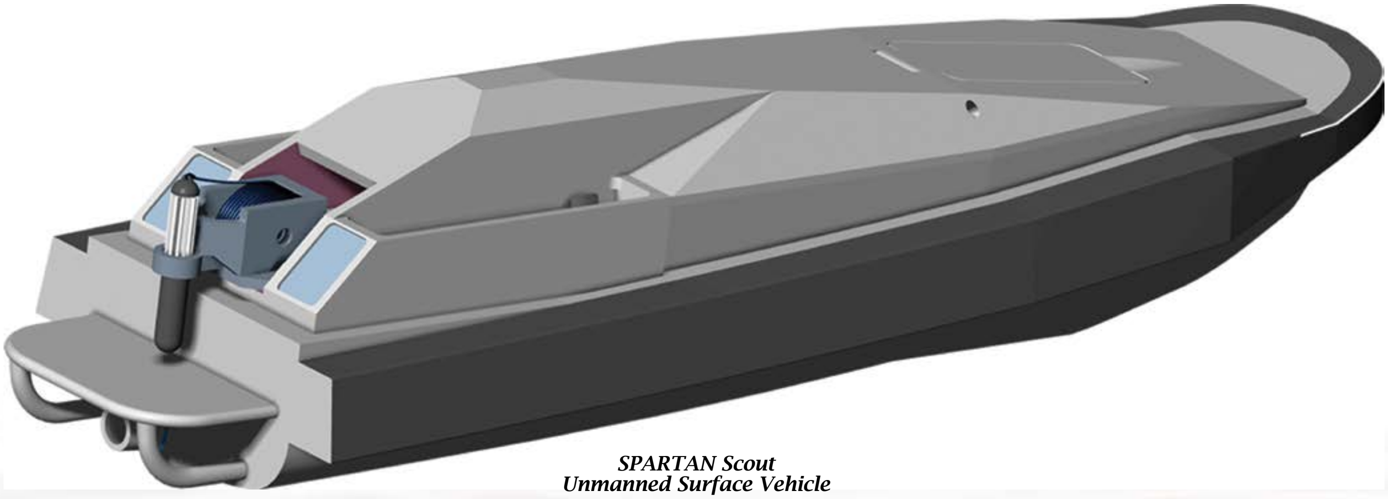
(Models not to scale)

Torpedo Launch from Unmanned Surface Vehicle (USV)

The SPARTAN USV launches a Mk 54 Lightweight Torpedo.

Periscope Laboratory

NUWC engineers test a periscope in the Submarine Periscope Laboratory.



SPARTAN Scout Unmanned Surface Vehicle

Keyport Range Facility

Keyport personnel load countermeasures on a submarine.

First Operational Unmanned Surface Vehicle Deployment

USV deployed with USS Gettysburg (CG 64) on May 12, 2003.

Mary Wohlgemuth

Mary Wohlgemuth (center), NUWC Torpedo Systems Department Head, visits the Defence Science and Technology Organisation (DSTO) of Australia in 2006. Shown with her are (left to right) Commodore Rick Shalders RAN, Commodore Boyd Robinson RAN, RADM William Hilarides USN, and Dr. Nanda Nandagopal, DSTO.

Mk 54 Lightweight Torpedo Undergoing Assembly

The Mk 54 achieved initial operational capability (IOC) in 2004. Division Newport was the Technical Direction Agent and In-Service Engineering Agent; Division Keyport was the Depot and Intermediate Maintenance Agent.

Decibel Award

In an August 2009 ceremony, Peter Herstein (center) receives the Decibel Award, NUWC's highest award for excellence in sonar and acoustics. Mr. Herstein is surrounded by past Decibel Award recipients.

NUWC Technical Director Don McCormack

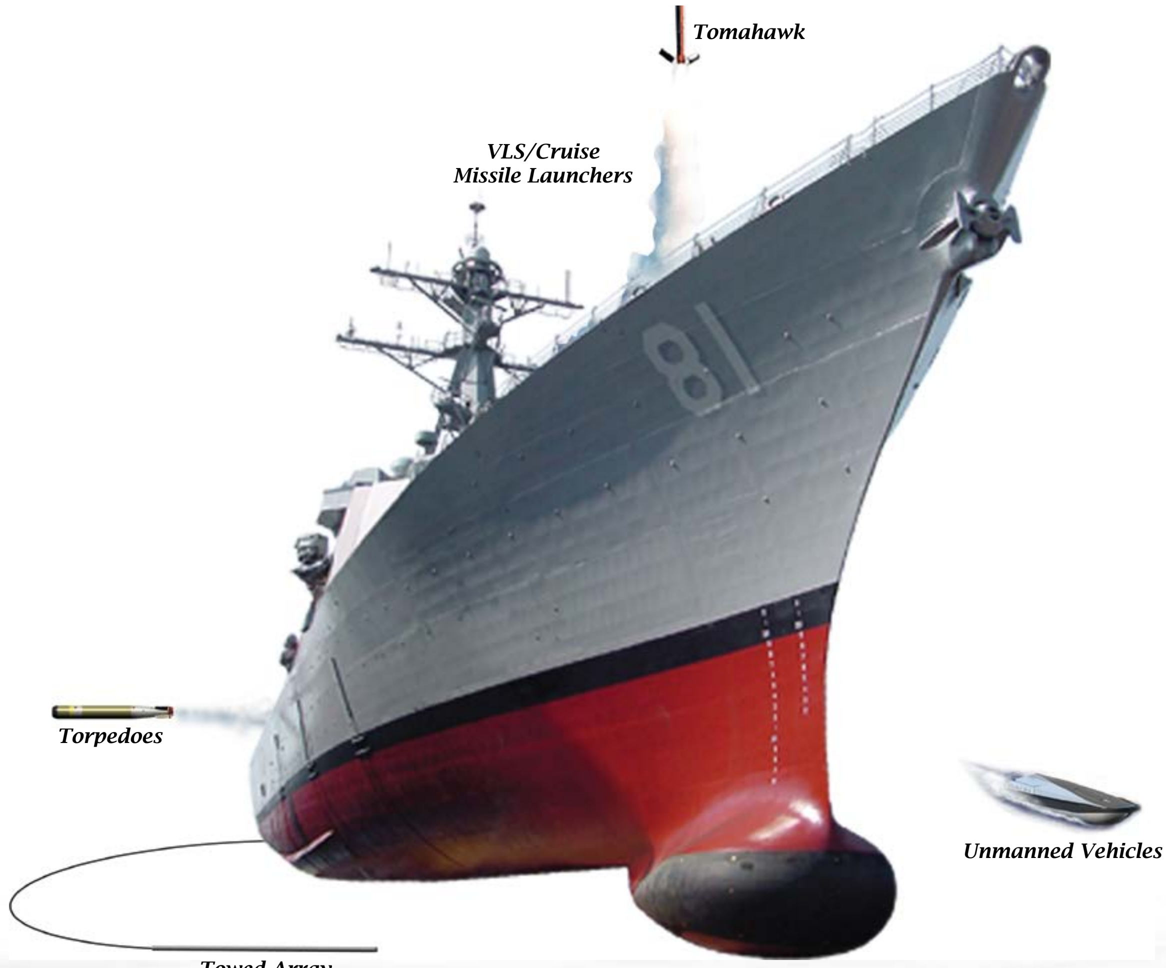
Mr. McCormack was appointed the Technical Director of NUWC in July 2005 and was appointed the Executive Director of the Naval Surface and Undersea Warfare Centers in March 2014.

Alan Kent

Alan Kent, Technical Director of NUWC Division Keyport (right), speaks with Congressional staffers during a tour of an Intermediate Maintenance Activity for heavyweight torpedoes.

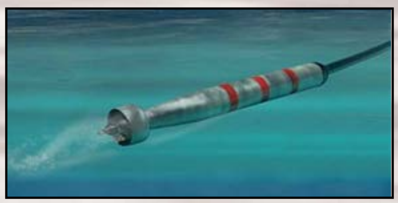
Don McCormack

NUWC Technical Director Don McCormack (right) meets with students from North Carolina Agricultural and Technical State University. The students were giving an outbrief on their summer experience at NUWC.



Surface Ship USW

Dipping Sonar



Countermeasures
and Defensive Systems

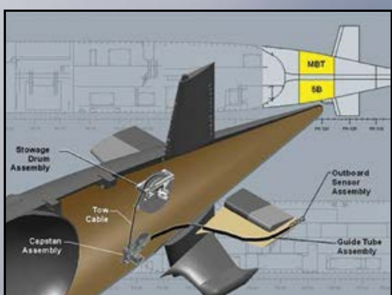
Land-Based Integrated
Test Site (LBITS)

Fully Tested Modular System Installation

Submarine Multi-Mission Team Trainer (SMMTT)

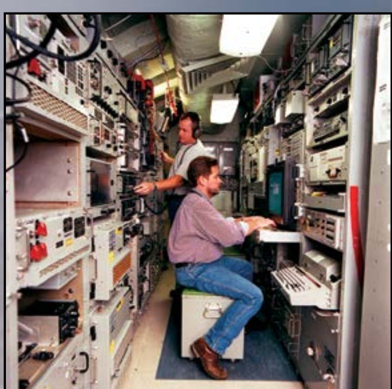
Submarine Bridge Trainer

Integrated Combat Control System



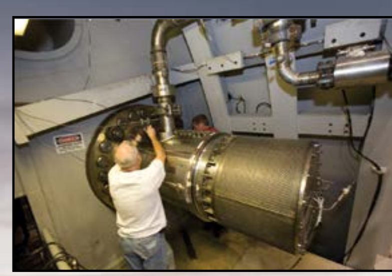
Thin Line Towed Arrays and Handling Systems

Virginia-Class



Common Radio Room

Towed Array



Weapon Launcher System

Countermeasures and Defensive Systems

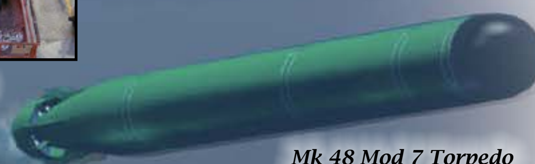
Integrated Combat Control System

Full Range of Masts
and Periscopes

Vertical Launcher System (VLS)

Deep Submergence System
Certification Lock Out Truck

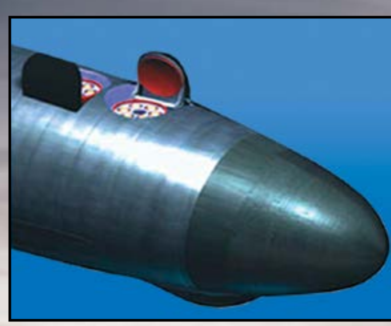
Virginia Payload Tube



Mk 48 Mod 7 Torpedo

Submarine

Sonar Chin Array



Submarine Bow and Sonar Dome

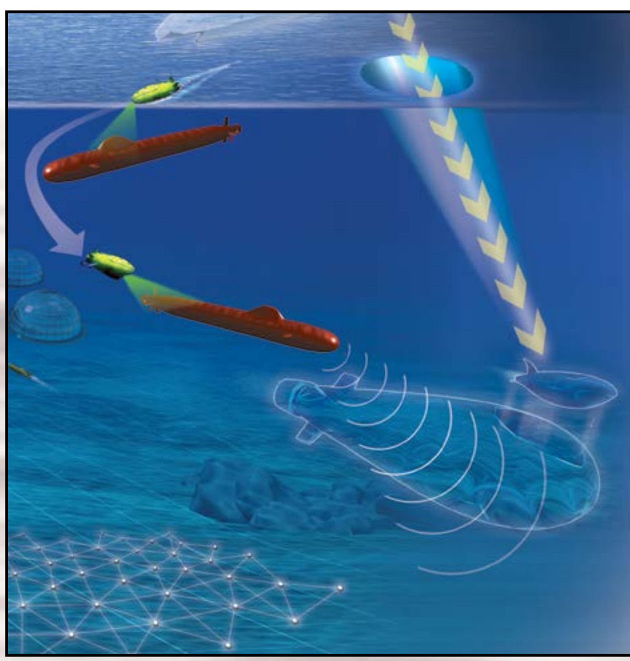
Unmanned Undersea Vehicles

THE FUTURE: SEABED TO SPACE

2016 ⟶ AND BEYOND

The USW challenges that will be encountered by the future Navy in undersea, surface, land, air, space, and cyber domains are already being envisioned and addressed at the Naval Undersea Warfare Center. This chapter displays a small selection of the technologies being analyzed for exploitation to meet future mission requirements. Even though many of these technologies are still well over the horizon in terms of our ability to fully capitalize on them and, equally important, to protect ourselves from our adversaries' ability to use them against us, NUWC will continue to build on its tradition of excellence and innovation to sustain the level of USW capability that is so critical to the Navy and the nation. The technological context for NUWC developments to support the Navy "from seabed to space" is described best by some excerpts from a 2016 presentation by the Executive Director, Donald F. McCormack, in which he articulated his view of NUWC's path to future success:

> We are living in an era of extremely rapid social and technological change, marked by both dramatic breakthroughs in fundamental areas of science and technology and accelerated dispersal of new capabilities. Many of the advances in biology, chemistry, physics, natural science, data analytics, quantum computing, robotics, and artificial intelligence have the potential to drastically alter the landscape of future warfare, and specifically undersea warfare (USW). Will we be ready for it? The answer boils down to a single choice: we can either be disrupted or be the disruptors. We, in partnership with government, industry, and academia, must innovatively apply the right technologies to address the most critical challenges for USW component areas, including observation and sensing, command and control, engagement, and platform design.



Futuristic Scenarios Employing Unmanned Vehicles, Direct Satellite Communications, "Cloaked" Submarines, and "Stealth" Detachable Command and Control Pods

At upper left, a large-scale unmanned vehicle (yellow) capable of extended patrols and searches operates on both the surface and undersea against a threat target (red).

At lower right, the sonar ping from the threat submarine fails to detect a "cloaked" unmanned submarine platform (white outline). The stealth platform is fully automated with low self- and radiated noise and cloaked target strength observables. With no need for life support capability, the platform could be optimized for sensor and payload capability and could remain deployed and undetectable for very long periods in the ocean environment.

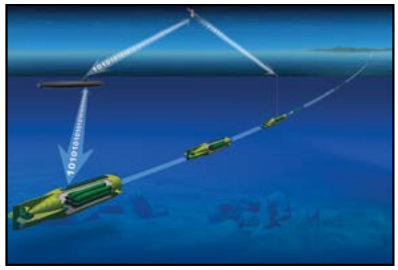
Above the cloaked platform, a detachable command and control pod (white outline) receives a communication (yellow chevrons) direct from a satellite. The pod is manned by a small crew, robotically assisted, with periodic personnel exchanges at sea.

These technological breakthroughs are driven by significant and rapid advances in hardware capabilities, statistical and computational methods, computer science, artificial intelligence and the biological and natural sciences.

Exploiting the synergistic intersection of these breakthroughs will hold the potential to drastically change USW in the future.

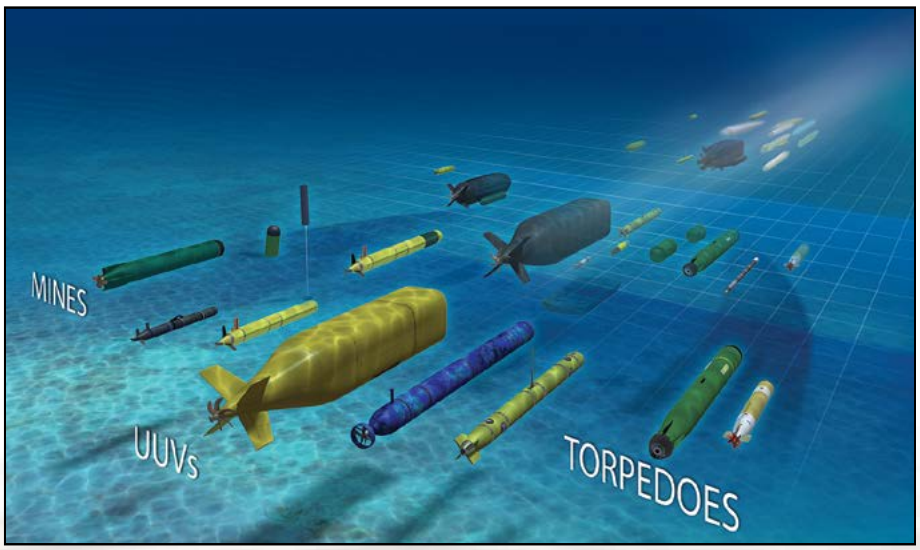
Technologists and warfighters will have to incorporate these innovations into new systems doctrine and training. The picture of the future is one where humans and machines will interact seamlessly. The societal, ethical, and military implications will be profound. The challenge is great and exciting!

Increased Importance of Cyber Warfare Domain

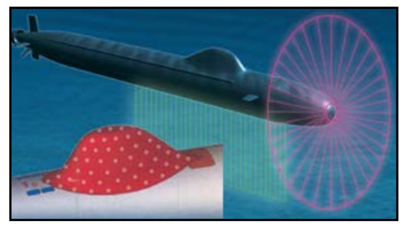


Long Range Retargetable Weapon Delivery Capability

Directed Energy Weapons



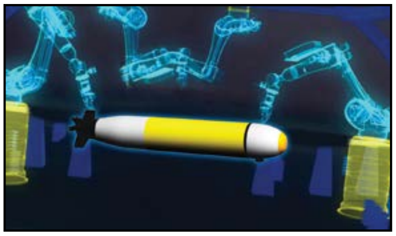
Future Unmanned Undersea Technology Multimission Vehicles and Payloads



Future Platform Stealth Sail with Sensors and Weapons Payload Capability

UAV Launch from Submarine Platform

Virginia-Class Near-Term and Future Large-Diameter Payload Module and New Sonar Bow Array

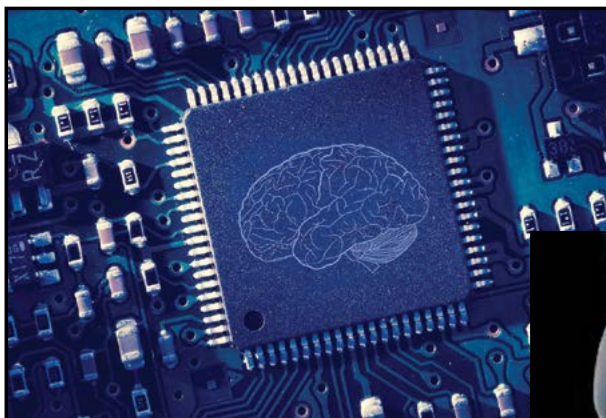


3D Printing and Manufacturing

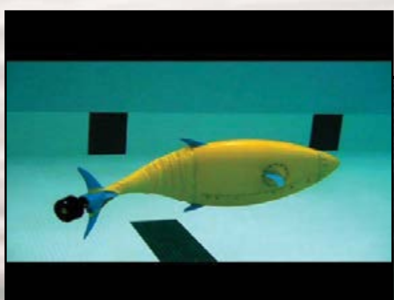
Big Data Analysis Allows for Persistent Surveillance and Situational Awareness

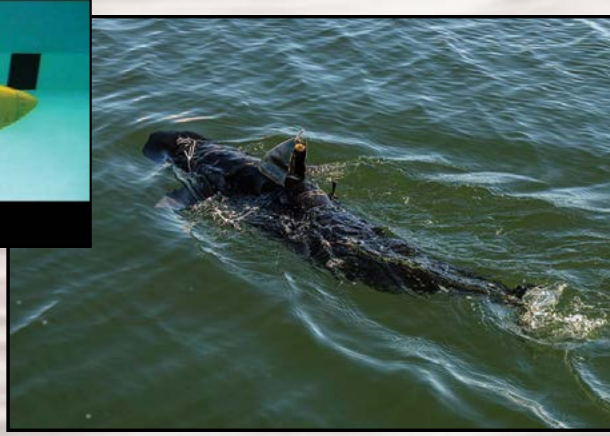
Humanoid Robot Divers

Advanced Railgun



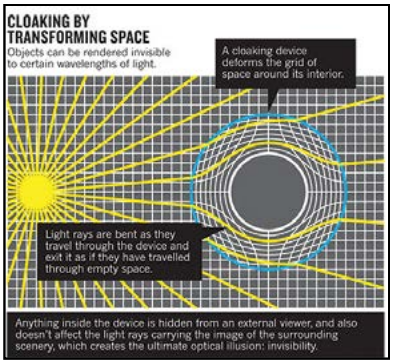
Neuromorphic Chips





Biomimicry

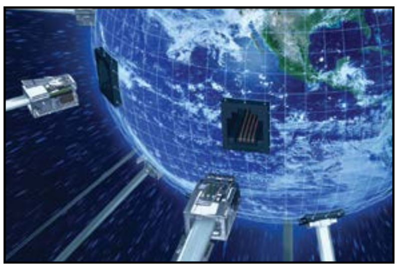
Neuromorphic Chips



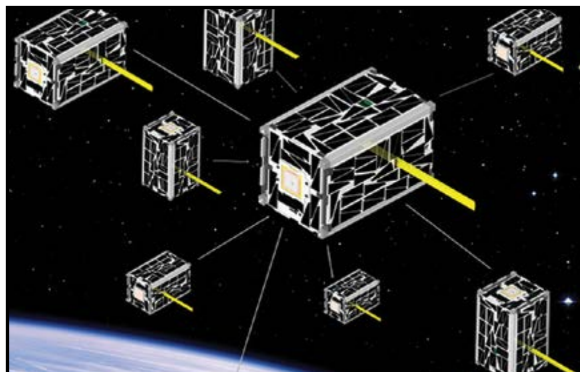
Advances in Material Science and Nano Technology Enable Stealth

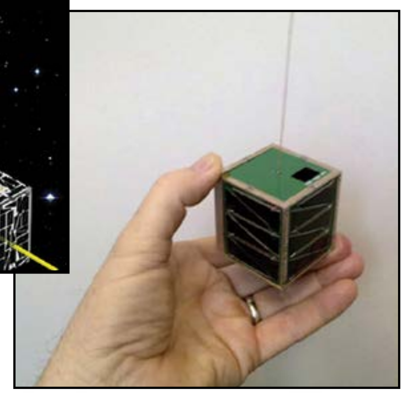
Advances in Robotics Enables Reduced Manning in Future Submarine Concepts

Inexhaustible Power and Energy

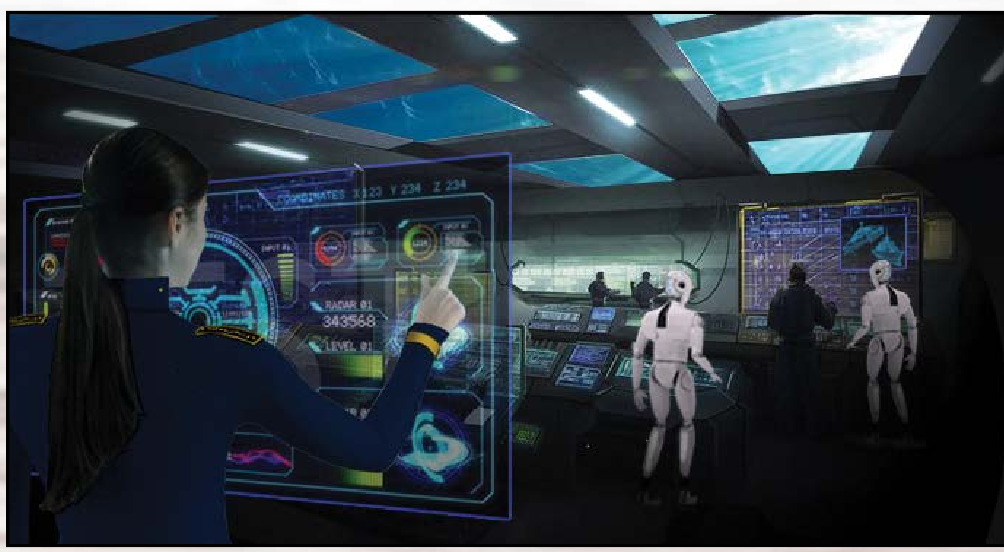


The OceanNet of Everything Allows for Ubiquitous Observation

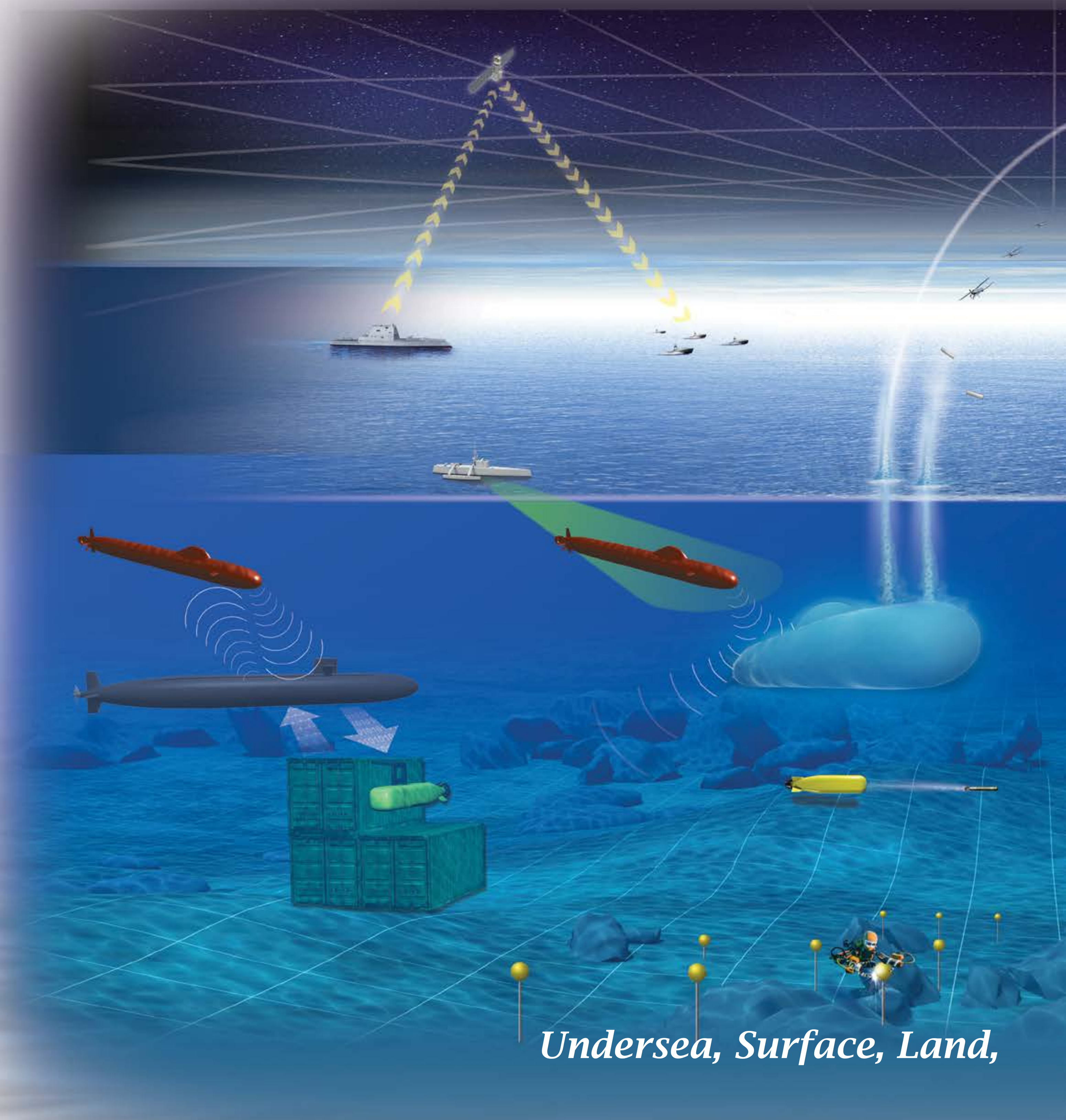


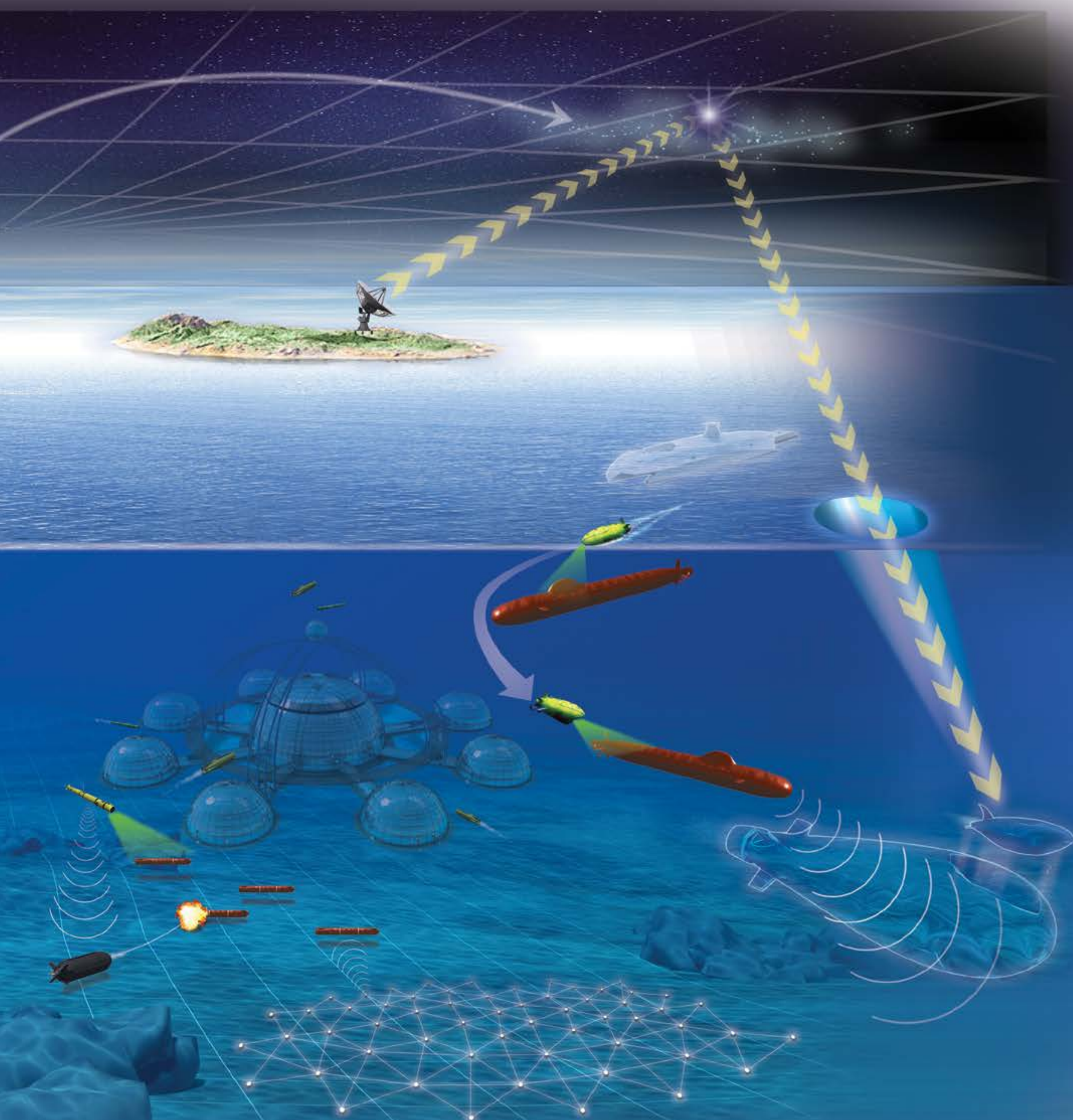


Clusters of Nano Satellites



Future Command & Control


Undersea, Surface, Land,



Air, Space, and Cyber

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Warfare Centers

25th Anniversary 1992 - 2017

Our Path Into The Future

As the NAVSEA Warfare Centers commemorate our 25th anniversary, we recognize that our mission hasn't changed dramatically since 1992, but our operating environment certainly has. Our success in the future will depend on learning to operate in surroundings marked by the rapid development and adoption of technology with a much greater degree of both opportunity and uncertainty and our ability to be at the forefront of innovative technology development and rapid integration of these developments into the fleet. Our future lies in our ability to do this.

J. Daniel Howard, Under Secretary of the Navy, signs the charter authorizing the establishment of the Naval Surface Warfare Center and the Naval Undersea Warfare Center on Dec. 22, 1991, as Gerald A. Cann, Assistant Secretary of the Navy for Research and Development, looks on in Cann's office at the Pentagon. The Warfare Centers officially stood up in 1992.

The Undersea and Surface Warfare Centers continue close collaboration across a broad range of technolgies and systems.

Newport, Past and Present

Keyport, Past and Present