

AN OVERVIEW OF NAVAL SHIPS

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INTRODUCTION

1. The navy is a costly endeavor that typically employs advanced technology and combat tactics. Naval or war ships are specifically crafted for naval combat and peacetime roles. They differ from merchant ships in terms of purpose, design, construction, operation, and deployment. Warships serve as the primary means of projecting military power at sea and along coastal areas.¹ Navy ships are typically constructed using specialized steel alloys that enhance their resilience to damage during enemy attacks. Most naval platforms or war ships are equipped with reliable and redundant propulsion systems, advanced weapon and sensor systems, with the exception of troop transporters. Warships² are capable of operating independently or in conjunction with a squadron of specialized ships, with the fleet commander traveling aboard the flagship. These powerful ships, known as the fleet, are the most potent vessels in the group. Navy ships are classified into different categories based on their capabilities, size, and purpose³. Naval ships have been designed since ancient times to be faster and more stable than merchant ships and to carry offensive weaponry. They range from massive aircraft carriers to agile fast attack crafts. Among the various naval platforms, submarines are the stealthiest, powerful, formidable, and expensive. The navy possesses a diverse array of ships in its fleet⁴, including well-known types such as aircraft carriers, submarines, assault ships, destroyers, frigates, corvettes, and mine counter vessels.

2. The navy maintains a global presence with numerous bases around the world. A blue-water navy refers to a maritime force that has the capability to operate on a global scale, particularly in the deep waters of open oceans.⁵ Large ships such as aircraft carrier groups, submarines, destroyers, and fleet auxiliary ships travel extensively across the globe. Smaller naval vessels are also stationed in proximity to their designated areas of operation. Aircraft carriers serve as floating airfields, carrying fighter aircraft and featuring runways for the takeoff and landing of multi-role aircraft. A single carrier can accommodate approximately 60-100 aircraft. Carrier groups are highly capable naval platforms and are regarded as formidable forces when deployed. Submarines, on the other hand, operate underwater and possess a range of deterrent weapons.⁶ They are stealthy assets of the navy used for engaging enemy ships and deploying missiles. Submarines can remain submerged on patrol for periods exceeding six months. The navy also employs specialized ships for various purposes. These include command ships, coastal patrol boats, mine countermeasures ships, submarine tenders, joint high-speed vessels, sea fighters, submersibles, frigates, corvettes, patrol craft, fast attack craft, oceanographic survey ships, and surveillance ships.⁷ The essay provides an overview and analysis based on secondary information and the author's extensive practical experience in shipbuilding and as a seafarer. It serves as an informative paper, briefly describing common types of naval ships in general and warships in particular. The author offers insights into the historical chronology and technological advancements in naval ship design and development, as well as the appropriate combination of weapons and sensors to achieve optimal fleet⁸ selection for any navy.

PRE-STEAM NAVAL SHIP

3. The majority of the pre-steam ship types I discuss in the following few paragraphs are those that are currently in use or were in use a century ago.⁹ Some of these vessels have names similar to older ship types from the Age of Sail 100 or earlier, but they are distinct from one another. men of war¹¹, as they are sometimes known. However, those are further divided into sub-types according to their unique rigging methods.

a. **Armed Merchantman.** Prior to the advent of steam power, large artillery, and armored vessels, almost any ship could serve as a warship if it had the ability to carry guns or accommodate a significant number of additional crew members.¹² Although they were generally outmatched by purpose-built warships, they served as a reasonable alternative for defending against pirates, engaging in piracy, and providing supplementary firepower alongside actual combat vessels.¹³ However, with the growing importance of armor and heavy artillery, these ships gradually fell out of use, as designing a vessel capable of effectively mounting modern weapons differed significantly from the efficient transport of cargo. During the steam era, the concept of armed merchantmen experienced a brief resurgence during both World Wars. In both conflicts, Germany pursued a crucial strategy of disrupting British¹⁴ supplies. As a temporary solution, many merchant ships were armed for self-defense,

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while Germany equipped and disguised its own merchant vessels to stealthily approach unsuspecting British ships and sink them before they could request assistance.

b. **Frigates.** smaller ships designed for long-range and independent cruising, served various purposes such as scouting for larger fleets, commerce raiding, and engaging in one-on-one battles with enemies. A notable characteristic of frigates was that their armament was primarily or entirely mounted on a single gun deck, in contrast to ships-of-the-line which had multiple gun decks. ¹⁵ These vessels' independent and self-reliant nature often provided the backdrop for thrilling sailing stories. Over time, their role was superseded by cruisers, submarines, and aircraft. During their prime, the original US Navy boasted six frigates that were renowned for their exceptional construction quality and experienced crews. ¹⁶ These frigates were once feared on the seas. In a smaller and more agile navy, the frigate serves as a warship with enhanced command and control capabilities, as well as the ability to support Special Forces in amphibious operations, including task force command. Present-day frigates are formidable naval platforms equipped with a comprehensive set of asymmetric warfare systems. These systems include electro-optic sensors and remotely operated guns, enabling continuous close-range detection, tracking, and engagement of asymmetric threats¹⁷ from all directions.

c. **Battle Cruiser.** With fewer weapons but better speed and maneuverability¹⁸ over time, frigates grew in size to be as long as modern ships of the line. They were war cruisers, but as armor wasn't a factor in ship construction at the time, speed was viewed as a firepower. ¹⁹ Such a warship was the ideal choice for 1960s naval scenarios that required effective propulsion across the speed spectrum needed for the ship's objectives and tasks, ²⁰ from low speed loitering to high speed combat running.

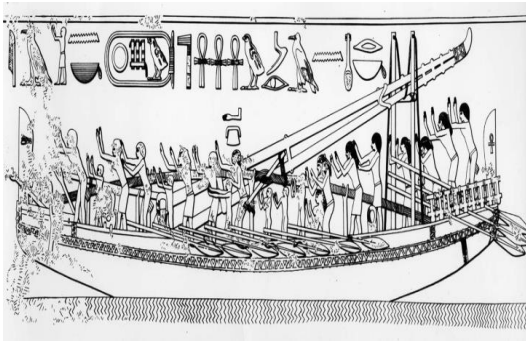


Fig 1: Egyptian Ship in 2600 BC²¹

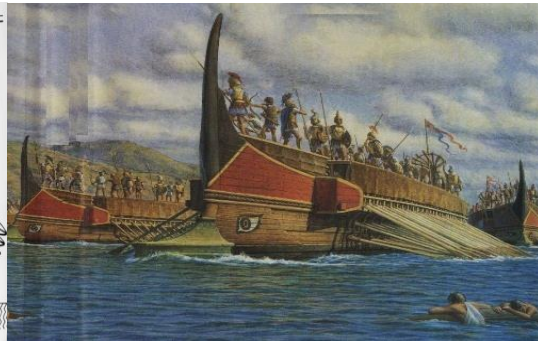


Fig 2: Greek war ship "Galley" ²²



Fig 3: Ships of the line: 19th century²³



Fig 4: HMS Victory: the oldest naval ship still in commission²⁴

d. **Ships-of-the-Line.** Large sailing vessels designed exclusively for close-quarters fighting with the opposing fleet. They were subsequently superseded by Battleships, whose type name is a condensed version of the original phrase line-of-battle ship, which were slow and highly armed. Ships of the line had two or even three decks of guns to increase their firepower, but the massive three-decker proved to be rather unpractical because it was necessary to maintain stability by having the third deck of guns very close to the waterline, meaning that the gun ports had to be locked shut in all but the calmest seas. Battleships are also known as line-of-battle ships²⁵, although their design is more closely related to frigates, notably the early ironclad armored frigates. ²⁶ The earliest ocean-going armored ships were frigates since the many gun decks of ships of the line could not be built due to the weight of the iron armor. Although the armor's weight also made it challenging to move with the speed that the

frigate was known for. Therefore, armored frigates could be thought of as a hybrid between a frigate and a ship-of-the-line with armor plate piled on top.²⁷

e. **Galleys.** Warships that relied primarily on human power and featured rows of sweeps (oars) for enhanced maneuverability compared to sailing vessels. These warships could achieve bursts of speed over short distances, but their long-range capabilities were limited. They had to be lightweight to accommodate rowers and typically lacked heavy weaponry, only carrying a small number of chase armaments.²⁸ This type of warship is the oldest known, and it continued to be utilized until the 1700s, primarily for coastal defense purposes. Many were specifically designed for boarding or ramming enemy ships. The term "galleon" originated from "galleys,"²⁹ although it eventually became a general term for large sailing ships that lacked oars altogether.

Armed Merchantman	Ships of the Line	Line-of-battle ship	Frigate	Battle cruiser
Barque or Bireme	Corvette	Yacht	Quinquereme	Man-of-war
Barquentine	Caravel	Full rigged ship	Quadrirème	Sloop-of-war
Dromon	Cog	Galley	Longship	Trireme
Bomb vessel	Clipper	Galleon	Rocket vessel	Xebec
Brig or Brigantine	Cutter	Junk and Ironclad	Liburnian	Schooner

Table 1: Historical (pre-steam) vessel types³⁰

MODERN NAVAL SHIPS

4. Modern naval forces are very fond of nuclear power. A navy can benefit greatly from having nuclear-powered vessels, including ships and submarines. Simply said, they are only constrained by the crew's endurance and other supplies, especially for subs, and do not require refueling during a sortie. They also have enough electricity to produce their own oxygen from seawater. This enables the boat to travel almost anywhere in the ocean and, if it's a submarine, stay underwater for days, if not weeks. On the other hand, before the 1950s and 1960s, the majority of ship classifications were developed. Then, ships were divided based on their size and purpose. The guided missile was created³¹ after that. The navies all over the world included "G"s into their names so that they could still be clearly differentiated between a ship armed with conventional weapons and one armed with guided missiles due to the disparity in combat strength and range. I'll introduce some key and fascinating naval terms and technologies³² before moving on to the different types of contemporary vessels. Examples include nuclear energy, guided missiles, capital ships, flagships, size, displacement, and designation issues.



Fig 5: Naval Ship in the era of WWII (German U Boat³³ and USS Iowa Class Battleship³⁴)

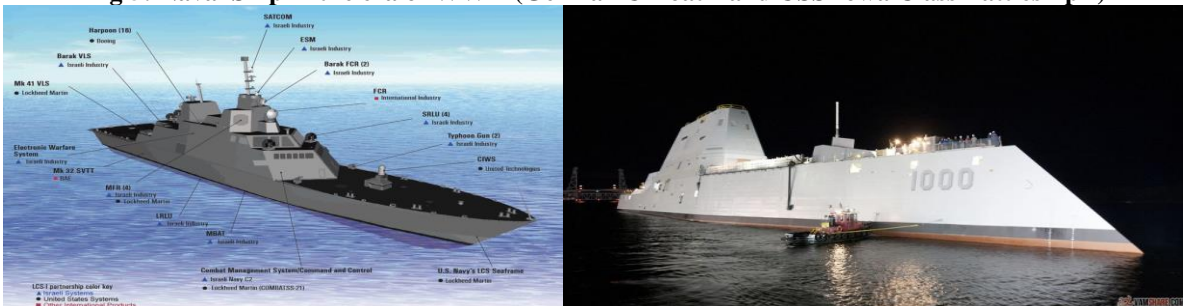


Fig 6: modern naval ship (Israel Frigate³⁵ and American Destroyer³⁶)

NUCLEAR POWER

5. As mentioned earlier, modern navies heavily rely on nuclear power. The introduction of the first US nuclear submarine, USS Nautilus³⁷, rendered many anti-submarine warfare techniques developed during World War II obsolete. These techniques relied on submarines surfacing to recharge their batteries. In naval type designations, the presence of an "N" indicates a nuclear-powered vessel. It is important to note that nuclear-powered does not necessarily mean nuclear-capable, which refers to the ability to carry nuclear weapons. Currently, all submarines in the US Navy are nuclear-powered, as are all active aircraft carriers. The USS Kitty Hawk³⁸ was the last conventionally powered carrier in service with the US Navy and was decommissioned on May 12, 2009. The immense amount of energy generated by a carrier's two reactors (eight in the case of the USS Enterprise) allows them to travel at full speed around the world indefinitely. Despite being among the largest ships in the world, they are also remarkably fast. However, there are a few drawbacks to using nuclear reactors for power. One obvious concern is radioactivity, although this is less problematic than it was in the past. Nuclear-powered vessels are also complex and expensive to maintain, especially considering the corrosive environment they operate in. One significant operational drawback of nuclear submarines is that, although they have virtually unlimited range, they cannot shut down their nuclear reactors without completely losing all systems until the reactor is started again. Restarting the reactor may be impossible without towing the submarine back to port, as emergency batteries have limited capacity.³⁹ Consequently, the reactor system, including cooling pumps and other machinery, operates continuously. This continuous operation makes nuclear submarines noisier compared to diesel-electric submarines, according to the stringent standards of modern submarine warfare. They are incapable of achieving true "silent running".

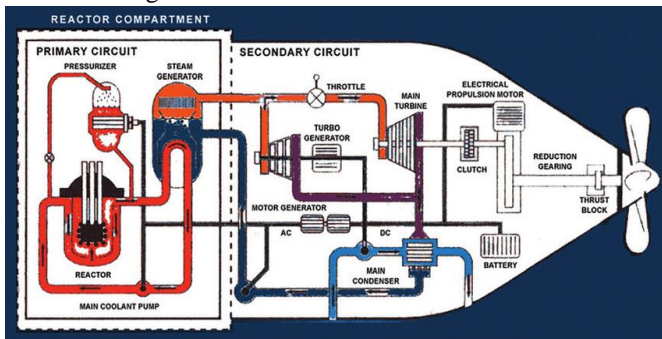


Fig 7: Pressure water naval nuclear propulsion system⁴⁰



Fig 8: Firing of anti-ship guided missile from a Frigate⁴¹

MISSILE

6. In the present day, most vessels are equipped with guided missiles, typically for defensive anti-air purposes and offensive anti-ship capabilities. Anti-ship missiles are specifically designed to target and engage ships and large boats. Many of these missiles utilize a sea-skimming technique and employ a combination of inertial guidance and active radar homing. Others utilize infrared homing to track the heat emitted by a ship.⁴² Naval platforms in modern navies worldwide include designations with the addition of "G." Examples of these designations include CG, CGN, DDG, FFG, SSG, SSGN, and so on. Anti-submarine missiles are launched from a considerable distance to deploy torpedoes into the water.⁴³ Some examples of such missiles are the American ASROC, the Soviet Russian "Silex," the Australian Ikara, and the French Malafon. Some missiles, like Ikara, are remotely controlled to approach the target area, while others, such as Malafon and ASROC, follow a ballistic trajectory after being launched into the air. Most destroyer, frigate, and corvette-level vessels carry four to eight anti-ship missiles in canisters mounted on their decks. Western navies typically use Exocet or Harpoon missiles for this purpose. To earn the "G" designation, a naval platform must have an area defense surface-to-air missile system with a range of approximately 10 nautical miles, providing the capability to defend other vessels. Older frigates and destroyers were not equipped with guided missiles.⁴⁴ However, it is worth noting that this system of designations is sometimes inconsistent. For instance, the SSGN designation may be given to submarines⁴⁵ that have limited air defense capabilities, such as a few individuals with hand-held surface-to-air missiles on the conning tower or the crew resorting to using rifles. In the context of submarines alone, the "G" indicates the presence of surface-to-surface guided missiles, like the US Tomahawk.⁴⁶ In today's advancements, all guided missiles are considered fire-and-forget smart weapons.⁴⁷ Anti-ship missiles can be categorized into four basic types.

a. Some examples of surface-to-air missiles include Arrow 2 and Arrow 3, Barak 1 and Barak 8 (Israel), Mistral 3 and Aster 30 (France), Prithvi Air Defence and MR-SAM (India), FM-3000 and HQ-19 (China), Shahab Thaqeb and Tabas (Iran), Type 93 "Closed Arrow" SAM and Type 11 Tan-SAM Kai II (Japan), Sea Dart and Sea Wolf (UK), RIM-162 ESSM and RIM-174 Standard ERAM (SM-6) (USA), S-400 and S-500 (Russia).⁴⁸

- b. Here are a few examples of multinational surface-to-air missiles:
- (1) ASRAD-R (Bolide missile): A land-based Very Short-Range Air Defense (VSHORAD) system developed jointly by Germany and Sweden.
 - (2) IRIS-T SL: A surface-to-air missile developed collaboratively by Germany, Italy, Sweden, Greece, Norway, and Spain.
 - (3) Falcon (IRIS-T SL missile): A land-based Short-Range Air Defense (SHORAD) system developed through cooperation between Germany, Sweden, and the United States.
 - (4) PAAMS/Sea Viper (MBDA Aster missile): A shipboard Short-Range Air Defense/Medium-Range Air Defense (SHORAD/MRAD) system created in a joint effort by France, Britain, and Italy.
 - (5) Barak 8: A surface-to-air missile jointly developed by India and Israel.⁴⁹
- c. An anti-ship ballistic missile (ASBM) is a military ballistic missile system specifically designed to target and strike warships at sea. These missiles possess high flight speeds, often reaching hypersonic levels, which means the kinetic energy of an ASBM alone can severely damage or completely destroy a supercarrier with a single impact from a conventional warhead. The R-27K/SS-NX-13, manufactured by Russia, was the world's first ASBM. China is reportedly developing a second-generation ASBM utilizing hypersonic maneuverable reentry vehicle technology, which has been tested on the DF-ZF.⁵⁰ This advancement allows for enhanced maneuverability during the missile's descent phase. The Indian navy currently deploys the Dhanush ballistic missile, launched from ships, for anti-ship operations.⁵¹ With a range of 750 km (470 mi), it is capable of engaging enemy ships.
- d. Here are a few examples of ship-to-ship missiles:
- (1) Ikara and Malkara: Ship-to-ship missiles developed jointly by Australia and Britain.
 - (2) EuroSpike: A ship-to-ship missile resulting from collaboration between Germany and Israel.
 - (3) RIM-116 RAM: A ship-to-ship missile developed through cooperation between Germany and the United States.
 - (4) SMART: A ship-to-ship missile system.
 - (5) K 15 Sagarika: A submarine-launched ballistic missile used for ship-to-ship engagements, developed by India.
- e. Sea skimming missiles, such as the US Harpoon, Chinese C802A, and French Exocet, are specifically designed to fly at very low altitudes. These missiles typically maintain a subsonic speed and have a range of under 100 nautical miles. It is important to note that the Chinese C802A missile has an extended range of 120 nautical miles.
- f. Missiles like the Kh-22/AS-4 "Kitchen" employ a tactic of flying at extremely high altitudes before executing a rapid terminal dive. These missiles typically operate at supersonic speeds and possess long-range capabilities.
- g. Missiles such as the P-800 Oniks and PJ-10 BrahMos operate by flying at medium to high altitudes at incredibly high speeds and then descending rapidly towards their target. These missiles are characterized by their supersonic or even hypersonic velocities. While they have relatively short ranges, they possess remarkable destructive power.
- h. The Chinese DF-21D represents a potential groundbreaking development in warfare—a ballistic missile designed specifically for ship destruction. The implications and future prospects of this approach are yet to unfold.

FLAGSHIPS

7. In naval terminology, a "flagship" refers to the leading vessel in a group of ships. It serves as the primary vessel for the commanding officer of a fleet or subdivision, and it prominently displays the commander's flag.⁵² The term "flagship" denotes a temporary designation, as a "flag officer," typically an admiral, has the flexibility to transfer their command to another ship as they deem necessary. The highest-ranking officers in the Army, Air Force, and Marine Corps are commonly referred to as general officers, whereas

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in the Navy, they are known as flag officers.⁵³ Flag officers often choose larger ships that can accommodate them and their accompanying staff, which can be quite substantial. Some ships may even have a dedicated flag bridge. Despite the presence of a flag officer, the regular captain of a ship retains authority over its operations and is not obliged to take orders from the admiral regarding their own vessel. For instance, while the admiral may provide navigation instructions, it is ultimately the captain who decides how to execute them. Flagships typically possess additional communication and data-processing facilities to enable the admiral to effectively manage the overall battle. The United States Navy is particularly active in employing separate platforms for flagships. In fact, they have an entire class of vessels known as the Blue Ridge class, which exclusively serves as command ships. These ships are presently assigned to the Sixth Fleet, based in Italy as part of USEURCOM⁵⁴), and the Seventh Fleet, based in Japan as part of USPACOM⁵⁵.



Fig 9: US Navy 7th Fleet Flag Ship (Foster)⁵⁶



Fig 10: US Navy Capital Ship (Gerald R Ford CVN)⁵⁷

CAPITAL SHIPS

8. These vessels represent the core assets of any navy, shouldering the primary combat responsibilities and holding the key to victory or defeat. In the Royal Navy, capital ships⁵⁸ consist of two carriers, two LPDs, one LPH, and nine DDGs. The United States Navy, on the other hand, boasts ten nuclear carriers, along with numerous LHAs, LHDs, and nuclear submarines, all classified as capital ships.⁵⁹ Over time, the definition of capital ships has evolved. During the Age of Sail, frigates and line-of-battleships held this distinction, while from 1860 to 1945, battle cruisers and battleships took center stage. Since the 1920s, aircraft carriers⁶⁰ have assumed the role of capital ships. However, in the present era, for smaller and modern navies, the focus has shifted towards destroyers and submarines as the primary capital ships.

SIZE AND DISPLACEMENT

9. Over time, warships of all categories have shown a tendency to increase in size and displacement. For instance, let's consider destroyers as an example. When the Spanish Destructor was launched in 1887, it had a hull measuring 192 feet in length and 25 feet in width, with a displacement of around 380 tons and a crew of 60 men. In comparison, one of the current Arleigh Burke class destroyers in the US Navy has a hull spanning 509 feet in length and 66 feet in width, with a displacement of around 10,000 tons and a crew consisting of 23 officers and 300 ratings. Similar patterns can be observed in aircraft carriers and frigates, as both have witnessed significant increases in displacement since their initial designs. The primary reason for the significant size of modern warships compared to their predecessors is their multifaceted nature and complex naval deployment. While 19th-century destroyers were originally intended as fleet escorts with a specific focus on torpedo boat destruction, modern multirole destroyers like those of the Arleigh Burke class can engage various surface, underwater, and aerial targets simultaneously⁶¹. This design philosophy is made possible by technological advancements such as miniaturization and computer networks, which enable the integration of multiple weapon systems within a single hull or allow smaller vessels to assume the functions of larger ones. Furthermore, advancements in engine and hull design have contributed to the construction of larger warships.

NAVAL SHIP DESIGNATION ISSUES

10. Some classes of ships have been given certain names like frigates or destroyers, even though their characteristics may align more closely with other types of vessels, often due to budgetary constraints, military strategy, or political reasons. For instance, the British Invincible-class STOVL carriers were referred to as "through-deck cruisers" during the approval process to secure funding and included a Sea Dart SAM system that was later removed to increase aircraft capacity. Soviet Russian carriers were called "aviation cruisers" by Moscow to circumvent restrictions on aircraft carriers passing through the Bosphorus. However, this classification was also indicative of their actual armament. Soviet carriers had limited usefulness in the Black Sea due to the presence of modern coastal-based aircraft, but they were constructed there as Ukraine housed the largest docks in the USSR. The unique armament mix was primarily driven by the prevailing Soviet naval doctrine and political opposition within the government. Similarly, Japan's Hyuga-class "helicopter destroyers" bear a striking resemblance to helicopter carriers and have the capability to operate V/STOL jets like the F-35B, which Japan plans to acquire. However, Japan's constitution prohibits an offensive military, and aircraft carriers of any kind are generally viewed as forbidden under international rules and JMSDF regulations. The JMSDF maintains that these "destroyers" will only be used for helicopter operations. Additionally, Japan has commenced the construction of even larger "helicopter destroyers" that exceed 800 feet in length and weigh over 27,000 tons, surpassing the size of many of Japan's World War II aircraft carriers. Unlike the Hyuga class, the CIWS mountings on these ships are positioned on the sides of the flight deck, allowing for unimpeded fixed-wing aircraft operations. There is speculation that Japan may also utilize an anti-submarine version of the V-22 Osprey tilt-rotor aircraft, which could explain the need for such a large vessel instead of simply building more Hyugas.⁶² Recent assertive actions by Russia and China have influenced Japan's decision-making in this regard. In a similar vein, the US Zumwalt-class "destroyers," currently under construction, could easily be reclassified as cruisers due to their considerable size. The Zumwalts surpass every light cruiser ever built by the US Navy, as well as most heavy cruisers.⁶³ This situation mirrors the reverse of the "Cruiser Gap" where acquiring destroyers appeared more cost-effective than purchasing an equivalent number of cruisers. Consequently, for the sake of Congress during a period of reduced naval budgets, the Zumwalts were classified as "destroyers." However, this approach proved relatively ineffective, leading Congress to reduce the production from the originally planned 10 ships down to only 3.



Fig 11: Japanese Hyuga class helicopter Destroyer⁶⁴



Fig 12: Indian Visakhapatnam-class Destroyer⁶⁵

MODERN NAVAL SHIPS TYPES

11. Modern naval vessels can be divided into two general categories. Examples include surface and subsurface (submarine).⁶⁶ In general, well-known terms of kinds and classes⁶⁷ are used to describe navy ships. Once more, NATO designates distinct ship classes using a variety of different codes.⁶⁸ Anti-surface warfare (ASUW), anti-air warfare (AAW), and anti-submarine warfare (ASW)⁶⁹ are the three operational domains of contemporary naval combat. Modern surface naval ships can generally be broken down into the following classes and kinds.

a. **Aircraft Carriers.** An aircraft carrier remains unrivaled in terms of self-reliance and power projection. The presence of a hostile carrier along any coastline poses a significant threat, especially when it comes to a US carrier, as its air groups often surpass the size and capability of most nations' air forces. However, only specific aircraft can operate from and land on an aircraft carrier.⁷⁰ While helicopters and certain fighters are compatible, larger aircraft like the B-52 are not suited for carrier operations. This is due to the relatively limited size of carriers compared to land-based air bases. Carrier operations are intricate and demanding tasks. During takeoff, aircraft either vertically lift off or use a ski jump ramp (common in non-US carriers) or are catapulted off the end (as practiced by the

US). The latter approach exposes pilots to high acceleration, and the aircraft must be designed to withstand the forces exerted on its nose gear while being propelled by its engines. The advantage of a full-length carrier is its ability to launch and recover larger, heavier aircraft and carry more substantial and weightier weaponry. However, in the era before jet aircraft, this was not a concern as propeller-driven aircraft were light enough to achieve lift within the limited deck space of a carrier. Landing on a carrier is a challenging task, requiring aircraft to locate the carrier and make a successful landing, taking into account factors such as wind speed and the carrier's own movement. US carriers⁷¹ employ arrestor wires, requiring aircraft to position themselves correctly to catch the wire with an arresting hook, which then rapidly decelerates the aircraft. The entire process has been likened to a controlled crash and landing on a small target. Prior to the development of vertical landing capabilities, this method, along with landing on water, was the only way to land aircraft on a ship at sea. In addition to the various limitations imposed by weight and space,⁷² corrosion is a significant issue. The corrosive effects of saltwater necessitate specialized design and corrosion-resistant equipment for maritime aircraft. Carriers designated by NATO are identified as CV or CVN.⁷³ While carriers themselves do not carry an extensive array of personal weaponry, they rely on other ships for protection against attacks, along with the support of their own aircraft. Their decks are reinforced to withstand potential missile impacts if necessary. Ideally, carriers should not be within range of surface ships, and their onboard weaponry, such as SAMs (surface-to-air missiles) and CIWS (close-in weapon systems), primarily serve anti-aircraft purposes. The first US aircraft carriers were constructed in the 1920s.⁷⁴ There are two fundamental types of carriers.

(1) **STOVL carriers.** Smaller carriers, often equipped with Harriers, specialize in accommodating short takeoff and vertical landing (STOVL) fighter-bombers or helicopters due to their relatively shorter length. These carriers offer a more cost-effective alternative and are utilized by a handful of nations, including Spain, India, Italy, and Thailand. The United States currently operates nine such carriers and continues to construct more, although in the US context, these carriers primarily serve as amphibious assault craft with the capability to carry STOVL aircraft as a secondary function. Most STOVL carriers outside of the United States incorporate a ski jump ramp, enabling their aircraft to take off with larger payloads.

(2) **Full-length carriers.** The aircraft carrier in this category is capable of carrying larger aircraft such as the F/A-18 and Su-33. Only seven nations currently possess this type of carrier: The United States, Russia, France, Brazil, China, India, and the United Kingdom. Among them, the United States has the largest fleet with 10 carriers. Within this category, two major variants exist. The original type, known as CATOBAR, is still used by the United States, France, and Brazil. It utilizes a steam catapult for launching aircraft and arrestor wires with tail-hooks for landing. The upcoming USN Gerald R Ford Class⁷⁵ carriers will introduce the use of electromagnetic catapults. The more recent variation, known as STOBAR, is a hybrid of STOVL and CATOBAR, used by Russia, China, and India. In STOBAR carriers, aircraft take off from a ski jump without catapult assistance but land using arrestor wires. CATOBAR allows for higher takeoff weight and consumes less fuel during takeoff, while STOBAR is simpler and more cost-effective,⁷⁶ still offering greater flexibility compared to STOVL carriers. Modern aircraft carriers typically feature gas turbine ship propulsion and provide significant capabilities to support humanitarian operations,⁷⁷ assuming the availability of STOVL aircraft for deployment.

Super-carriers and aircraft carriers may occasionally be used to classify aircraft carriers. The largest class of aircraft carrier is referred to as a "super-carrier" informally, and they typically have a displacement of more than 80,000 tons. The largest navy ships ever constructed are super-carriers. They frequently transport more than 100 fixed and rotary wing aircraft. Aircraft carriers in use today are all nuclear-powered. The best super carriers in the world⁷⁸ are those of the US. More efficiently than any other country's carrier, it is able to transport the greatest number of aircraft.

Aircraft carriers are immense vessels that serve as floating airbases for naval forces. Their primary role is to deploy aircraft for engaging in air combat operations, targeting airborne, surface, and shore objectives. Due to their high construction and operational costs, only ten nations, including the United States, Russia, China, France, and the United Kingdom, possess operational aircraft carriers. These carriers accommodate fighter aircraft and feature runways that enable the aircraft to take off and land.



Fig 13: Super carrier USS Enterprise⁷⁹



Fig 14: Aircraft carrier USS Abraham Lincoln⁸⁰



Fig 15: Chinese State of Art Aircraft Carrier⁸¹



Fig 16: Indian Indigenous Aircraft Carrier INS Vikrant⁸²

Typically, a carrier can accommodate around 80 to 90 aircraft on board, making it a formidable force when deployed.

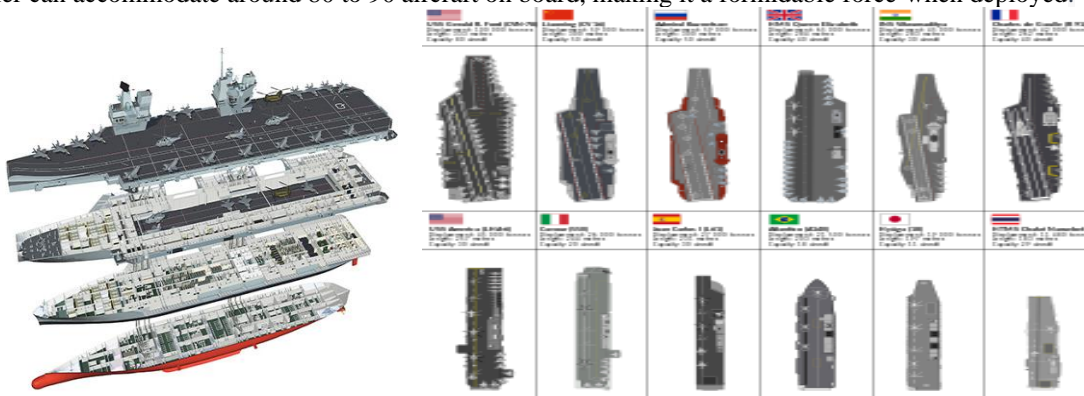


Fig 17: Comparison of size of different Aircraft Carrier in the world⁸³

HELICOPTER CARRIER SHIP

12. There are also several ships that resemble aircraft carriers and fulfill similar functions to varying degrees, but are designated differently due to their specific missions or lacking certain essential characteristics of a dedicated carrier. For instance, China's 3rd Type 075 LHD (Landing Helicopter Dock) named Anhui was commissioned with the PLA Navy. This vessel was launched in September 2019 and commenced sea trials in August 2020.⁸⁴In the modern U.S. Navy, Amphibious Assault Ships play a vital role in projecting power and maintaining a presence by serving as the cornerstone of the Amphibious Readiness Group (ARG) / Expeditionary Strike Group (ESG).⁸⁵ While they may not be classified as aircraft carriers, these ships effectively operate as helicopter carriers. Below are a few examples of such vessels.

- a. A helicopter carrier, as the name suggests, is an aircraft carrier primarily designed for operating helicopters. These carriers have also been utilized as ASW (Anti-Submarine Warfare) carriers and amphibious assault ships.

b. Examples of helicopter carrier ships include "Helicopter Destroyers," "Through-Deck Cruisers," and "Aviation Cruisers." These designations vary based on different naval purposes, doctrines, and political considerations. Often, these ships may lack the necessary equipment, deck space, or hangars to fully fulfill the role of a traditional aircraft carrier. An example is the Japanese Hyuga class, which is considered a helicopter destroyer.

c. USS Wolverine and USS Sable are possibly the only freshwater paddle-wheel helicopter/aircraft carriers in naval history. These ships, classified as Miscellaneous Auxiliaries rather than Carriers, were used for training Naval Aviators in carrier operations on Lake Michigan during World War II due to the scarcity of combat-ready CVs. They did not possess hangar decks or standard flight decks for aircraft operations.

d. The Russian Navy's Project 23900 versatile amphibious assault ship (LHD) named Mitrofan Moskalenko will serve as the flagship of the Black Sea Fleet. This advanced LHD can accommodate heavy helicopters, armored vehicles, and transport up to 1,000 Marines or more. It features a landing boats⁸⁶ dock and was developed by the Zelenodolsk Design Bureau. The first two ships of this type, the Ivan Rogov and the Mitrofan Moskalenko, were laid down at the Zaliv Shipyard on July 20, 2020.⁸⁷

e. Modern U.S. Navy Amphibious Assault Ships play a crucial role in projecting power and maintaining a presence as the cornerstone of the Amphibious Readiness Group (ARG) / Expeditionary Strike Group (ESG). These ships are essential components of the Seapower 21 pillars of Sea Strike and Sea Basing. They transport and deploy elements of the Marine Expeditionary Unit (MEU) or Marine Expeditionary Brigade (MEB) using a combination of aircraft and landing craft.⁸⁸ The Wasp-class LHDs, for example, provide the Marine Corps with both helicopter and landing craft capabilities for ship-to-shore movements. LHDs have participated in major humanitarian assistance, occupation, and combat operations involving the United States.⁸⁹



Fig 18: Russian Navy Helicopter Carrier (Ivan-Rogov-class)⁹⁰ Fig 19: France Navy Mistral Class Helicopter Carrier⁹¹



US Navy General Purpose Amphibious Assault Ship (LHA/LHD)⁹²

Fig 20:

AMPHIBIOUS ASSAULT SHIPS

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13. Amphibious, or Gators as they are known in the US Navy, are similar to a hybrid between troop transports and aircraft carriers. They are made to transport big groups of ground troops and their gear across great distances before deploying them to the shore utilizing helicopters or landing vehicles. The majority of Amphibs have an aft well deck and stern gate that they can flood to swiftly let landing craft enter and exit the ship. Additionally, they typically have a flight deck big enough to fit a transport helicopter. Some, like US LHAs and LHDs, have spacious enough flight decks and hangar bays to accommodate their own helicopters and offensive aircraft.⁹³ They, like carriers, usually have minimal defensive armament and must be safeguarded. This is often the largest ship class in navies lacking aircraft carriers. In usual US practice,⁹⁴ these ships do not operate alone, but rather as the lead ship of a larger fleet's landing force component, frequently operating together (e.g., LHD, LPD, and LSD all together with ground troops and aircraft distributed among them). The Hainan, the PLAN's first Type 075 amphibious assault ship, has acquired initial operational capability and will visit harbors and ports across the world.⁹⁵ NATO assigned these vessels the designations LS, LH, and LP. A few examples of Amphibious Assault Ships are provided below.

a. The larger variety of US amphibious assault ships are classified as LHA (Landing Ship, Helicopter, Assault) and LHD (Landing Ship, Helicopter, Dock).⁹⁶ Originally, LHAs were designed solely for deploying troops using helicopters, while LHDs had the additional capability of a well deck for launching and recovering landing craft. However, due to the US Marine Corps' request, well decks were added to LHAs as well, resulting in no operational difference between the two. Both classes also serve as VTOL (Vertical Takeoff and Landing) aircraft carriers, although their standard aircraft capacity differs significantly (20-30 vs. 70-80). They are optimized for providing close air support to ground troops. During the Cold War, they were envisioned as counterparts to World War II escort carriers (CVE) in the event of a major naval conflict.

b. The smaller variety of US amphibious assault ships are categorized as LPD (Landing Ship, Platform, Dock) and LSD (Landing Ship Dock). The primary distinction between the two lies in the fact that LPDs typically feature a hangar bay for sheltering and maintaining helicopters, making them useful as helicopter landing platforms.

c. The US LST (Landing Ship, Tank) class ships, now retired from US service but still utilized by other navies, are essentially large oceangoing landing craft. They are capable of traversing the high seas and directly depositing substantial numbers of troops, tanks, artillery, and other vehicles onto the shore. Despite the naval jokes suggesting that LST stands for "large slow target,"⁹⁷ LSTs actually had higher survival rates than many other types of ships during World War II.

d. The Spanish Juan Carlos I is a modified version of the American Wasp-class LHD, primarily designed as an aircraft carrier and secondarily as an amphibious assault ship.⁹⁸ The key modifications from the American design include the incorporation of a ski jump on the flight deck and the ability to convert the light vehicle bay into an expanded aircraft hangar as needed. Australia is also constructing a pair of ships based on this design, known as the Canberra class.

e. The Italian Cavour, similar to the Juan Carlos I, functions primarily as a light aircraft carrier and secondarily as an amphibious ship designated as LPH (Landing Platform Helicopter).⁹⁹ It features a ski jump with an unusually shallow angle, which helps reduce construction costs.

f. The South Korean Dokdo class, resembling an LHD, represents one of the smaller amphibious assault ships.¹⁰⁰ These ships serve as command and control platforms for the maritime mobile fleet and support three-dimensional landing operations as well as maritime air operations.

g. The Soviet Ivan Rogov class is a hybrid of LPD and LST, with a displacement of 14,000 tons.¹⁰¹ These ships are the largest capable of beaching themselves to offload vehicles.



Fig 21: Indian Navy multipurpose Assault ship¹⁰²



Fig 22: US Navy Amphibious Assault ship USS Essex (LHD 2)¹⁰³

LANDING CRAFT

14. Landing craft are small ships with limited endurance that transport troops from a ship to the shore. They are often launched from transports or Amphibious Assault Ships and cannot operate independently.¹⁰⁴ Most are essentially boats with a shallow draft and a front ramp for transporting personnel and bigger vehicles such as trucks or tanks.¹⁰⁵ NATO classifies such vessels as LC, LCU, and LCAC.¹⁰⁶ A few instances of Landing Craft are provided below.

- a. The renowned Higgins Boat, a wooden landing craft, was manufactured in large quantities for the US and its allies during World War II and beyond.¹⁰⁷ Their use in combat is vividly depicted in movies like Saving Private Ryan and numerous others.
- b. The US LCU (Landing Craft, Utility) is employed for the transportation of naval personnel and materials.¹⁰⁸
- c. The US LCAC (Landing Craft, Air Cushion) introduces a unique concept that replaced the LCU. It is a hovercraft capable of flying a few feet above the waves and can even drive up onto the shore to provide vehicles with a more stable foundation for unloading.¹⁰⁹ The remarkable advantage of LCACs lies in their resemblance to small aircraft, as they are incredibly difficult to run aground unless intentionally driven into significant obstacles such as rocks, cliffs, trees, or structures. They can facilitate amphibious forces landing in previously inaccessible areas, defying the notion of any beach being out of reach. LCACs are also considerably faster than average landing craft, although they come with a trade-off of larger size and reduced carrying capacity relative to their size.
- d. Various amphibious armored vehicles can serve as landing craft when required, and they conveniently double as ground transportation for troops once they are ashore. These vehicles offer the advantage of being better armed and armored compared to most landing craft. However, they have the drawback of being relatively slow while swimming and require a particularly calm beach with a gentle slope for safe landing.¹¹⁰ Examples of such vehicles include the US AAV-7 and LAV-25, as well as the Russian BRDM and BTR series vehicles.



Fig 23: Navy LCU ship¹¹¹



Fig 24: Amphibious Transport Dock Ship¹¹²

BATTLESHIP

15. A battleship is a large armored navy vessel that served as the capital ship of the world's navies from around 1860 to World War II. It replaced the wooden-hulled, sail-driven ship of the line and surpassed cruisers and destroyers in terms of weaponry, armor, and size.¹¹³ However, with the decommissioning of the last Iowa-class ships, no battleships remain in active service worldwide.¹¹⁴ Several of them have been preserved as museum ships, either floating or in dry-dock. In NATO designation, battleships are referred to as BB. Battleships were renowned for their incredible durability, capable of withstanding numerous hits from shells, bombs, and torpedoes. They were designed to engage opponents of similar size, sacrificing some speed for enhanced protection. Their nickname in naval circles is the "Big Boys." Before World War II, battleships were the largest and most powerful warships, armed with massive guns ranging from 9 inches to 18 inches in diameter. These guns could launch projectiles weighing over a ton, reaching distances of up to 35 miles, while the battleships themselves boasted thick armor plates.¹¹⁵ During World War II, battleships became outdated due to advancements in aircraft and submarine weaponry, and later, guided missiles. However, it is worth noting that even submarines and some of those weapons are now considered obsolete. Modern shipboard radar and computer-guided anti-aircraft and anti-ship systems have proven highly effective. This is the primary reason why the US Navy kept the four Iowa-class battleships in active service until the 21st century. These battleships even saw action during the 2003 invasion of Iraq, unleashing the fury of their 16-inch guns. By the time of their retirement, they were equipped with long-range Tomahawk missiles as well.

16. In addition to engaging in ship-to-ship combat, battleships played a crucial role in providing effective fire support for amphibious operations and destroying enemy shore positions. During World War II, US battleships were primarily employed in battling Japanese coastal forts rather than engaging enemy ships directly. The term "battleship" originated as a contraction of the earlier term "line-of-battle ship,"¹¹⁶ which referred to ships that possessed the necessary heaviness and power to participate in the line of battle during the era of Wooden Ships and Iron Men.¹¹⁷ During that period, the more common abbreviation for "line-of-battle ship" was "Ship of the Line." From a historical perspective, battleships are generally categorized into two main types: Pre-Dreadnought Battleships and Dreadnoughts. This division arises from the significant differences in design doctrine and employed technology between these two types. The introduction of the British HMS Dreadnought revolutionized battleship design by incorporating several new design concepts and technological advancements into a single vessel. This groundbreaking design rendered every previous battleship obsolete, marking a significant turning point in naval warfare. Example of battleships has been given below.

a. The USS Texas, the first battleship commissioned by the US Navy in 1892, was built in response to the Brazilian Navy's acquisition of the Riachuelo. The Riachuelo was believed to have the capability to defeat the entire US Navy in open combat. Both the Texas and its quasi-sister ship, the Maine, were designed based on battleships that were popular among European navies at the time. However, by the time they entered service, both ships were considered outdated. The Maine met a tragic fate with an unexplained explosion in Havana Bay, while the Texas played a significant role in the Battle of Santiago de Cuba during the Spanish-American War.¹¹⁸ It contributed to the destruction of the Spanish Atlantic Fleet as it attempted to escape to the sea.

b. The Mikasa, the flagship of Togo Heihachiro during the Russo-Japanese War,¹¹⁹ was armed with a mixed battery of guns, including two turrets with four 12-inch guns and a combination of 3-inch and 6-inch guns in broadside arrangements. It gained fame for leading the Japanese fleet in the Battle of Tsushima Strait, where the Russian Second Pacific Squadron was intercepted and mostly destroyed in their attempt to reinforce Vladivostok. The Mikasa has been preserved as a museum ship since 1922 and remains permanently docked at Yokosuka.¹²⁰ It is the sole surviving pre-dreadnought battleship in the world.

c. The Dreadnought, completed in 1906 and scrapped in 1921, was a British battleship that revolutionized the design of subsequent battleships. Previous battleship designs typically featured two turrets (one forward and one aft) housing the main guns, along with smaller turrets for secondary guns along the sides of the superstructure.¹²¹ This design proved inefficient as the reduced power of the secondary guns did not justify their weight, and aiming the guns accurately was challenging. The only way to aim naval guns effectively at the time was to estimate the correct angle and observe the splashes of the missed shells to adjust subsequent shots. However, distinguishing between the splashes of a 12-inch shell and a 10-inch shell at long range was impossible. The Dreadnought addressed these issues by featuring only 12-inch guns, a total of ten, which was an unprecedented level of firepower at the time.

d. Japan came close to beating the Dreadnought by a few months with the Satsuma, but due to budget constraints, they could only afford enough high-quality guns to equip four turrets. The remaining turrets were fitted with twelve 10-inch guns. If Japan had settled for 10-inch guns in all turrets, battleships with a single-caliber main armament might have been referred to as "Satsumas" once they entered service.

e. The USS South Carolina, designed before the Dreadnought and Satsuma, featured a more efficient gun layout. It was the first battleship to have all of its turrets mounted on the centerline and the first to utilize super-firing turrets, where one turret was positioned directly above another. This configuration allowed the South Carolina to possess the same level of armor and an 8-gun broadside,¹²² despite being smaller than the Dreadnought. However, construction progress was slow, and the ship was not even laid down until two weeks after the Dreadnought entered service.

f. The Iowa class, completed in 1944 and subsequently retired between 1998 and 1999 after various periods of active service, represents one of the finest battleship designs constructed by the United States. One of the ships from this class, the USS Missouri, is now anchored at Pearl Harbor as a museum, serving as a reminder of its home port during World War II.¹²³ It was on the deck of the USS Missouri that the end of World War II was marked.

g. The Yamato class, completed between 1941 and 1942 and subsequently sunk between 1944 and 1945, comprised the largest battleships ever constructed, weighing over 65,000 tons, which was 20,000 tons heavier than the Iowa class. These battleships were armed with nine massive 18.1-inch guns, a secondary armament of twelve (later reduced to six) 6.1-inch guns, a tertiary armament of twelve (later increased to twenty-four) 5-inch guns, and eventually, one hundred sixty-two 25mm anti-aircraft cannons. They also featured excellent armor protection, with the thickest belt armor and turret faces ever seen on a battleship. However, they had a significant flaw in their torpedo protection design, and Japanese armor quality was not the best.¹²⁴ During the Battle off Samar, the Yamato suffered the ignominious fate of being forced to retreat without inflicting any damage on the enemy, despite its larger size compared to the entire US fleet it faced. Figure 26 below shows the chronological development of different types, classes, and sizes of battleships in the US Navy.



Fig 25: Iowa-class battleship (US Navy)¹²⁵

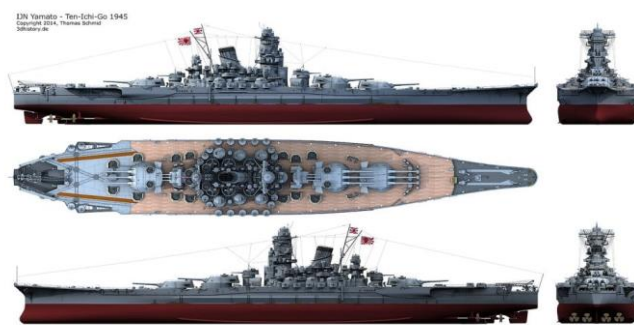


Fig 26: largest battleships in History Yamato (Japan Navy)¹²⁶

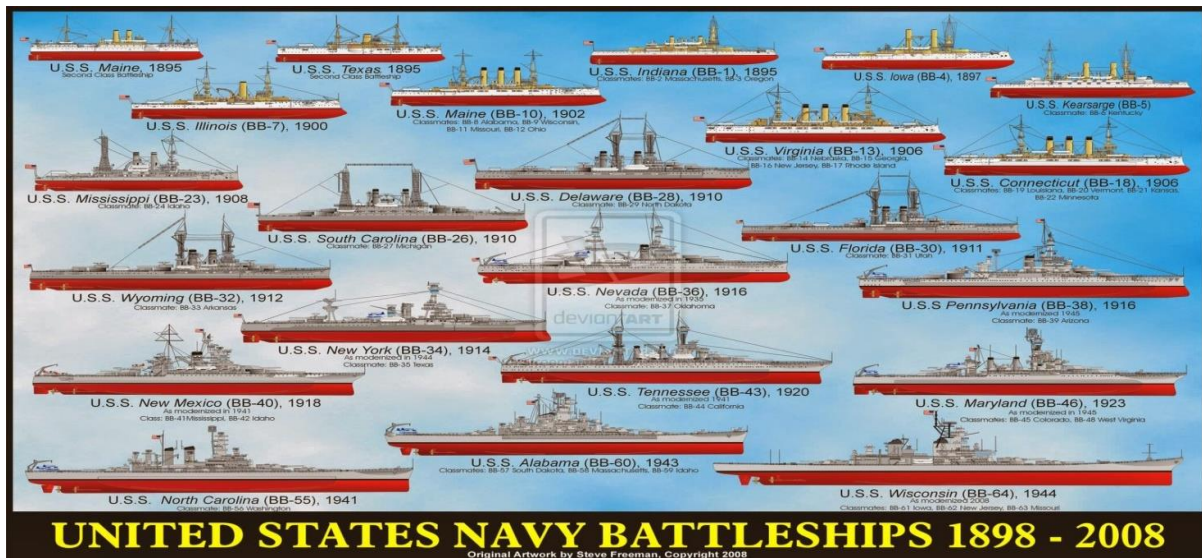


Fig 27: Chronological Development of different Types, Class and Size of Battleship of US Navy^{127, 128}

CRUISER

17. A cruiser is a large warship designed for high speed and extended range, capable of protecting its own fleet and coastlines while posing a threat to enemy forces. Currently, only the United States, Russia, and Peru maintain active cruiser fleets, although the distinction between cruisers and destroyers has become increasingly blurred. In fact, newer destroyer models such as the US Navy's Zumwalt class often surpass cruisers in terms of size and firepower. The US Navy operates a series of guided missile cruisers equipped with Tomahawk, Harpoon, and other missiles, specifically designed for defense against enemy aircraft and missiles. Within NATO, cruisers are designated as CA, CB, CL, CG, CGN, CBGN. However, modern cruisers are primarily found in the most powerful navies, serving as the heaviest surface combatants alongside aircraft carriers. These warships are relatively scarce in number.¹²⁹

18. Cruisers were originally employed for independent, long-range operations, which defined the role rather than a specific ship type. Today, cruisers occupy the position just below aircraft carriers as the largest surface combatants and the heaviest ships designed for surface-to-surface engagements. The first cruisers emerged in the 1870s, leading to a proliferation of various types, ranging from small scout cruisers to massive armored cruisers that rivaled pre-Dreadnought battleships in size. During World War I, the primary cruiser types were armored cruisers, known for their armor protection, and the generally smaller but faster protected cruisers. As World War I progressed, most navies began replacing protected cruisers with light armored cruisers. Following the war, cruiser classifications were divided into light and heavy types¹³⁰ based on armament rather than size. While pre-war armored cruisers and post-war heavy cruisers exhibited significant design differences, and similarly, there were distinctions between protected cruisers and light cruisers, their roles were generally similar. Heavy cruisers (designated as CA, stemming from the earlier armored cruiser classification) were armed with 8-inch guns or, in rare cases like the unique Alaska-class large cruisers, even larger guns. On the other hand, light cruisers (designated as CL)¹³¹ carried smaller guns, typically 6-inch main guns but occasionally in the range of 5.5 inches. Since the types were primarily defined by gun size rather than the number of guns, the United States, Britain, and Japan circumvented treaty limitations on heavy cruisers by constructing light cruisers equipped with numerous smaller guns that matched the firepower of heavy cruisers, all while boasting comparable armor protection.

19. The United States and Britain also developed specialized anti-aircraft cruisers (designated as CLAA) equipped with a significant number of dual-purpose guns, such as 4.7 inch, 5 inch, or 5.25 inch guns, serving as their primary armament. These ships essentially resembled oversized destroyers with slightly enhanced armor, representing an early instance of the blurring line between cruiser and destroyer roles. The CLAA can be seen as enlarged destroyers with a modest increase in armor protection. Gun-armed cruisers gradually phased out after World War II, and today, cruisers primarily rely on missile systems and serve as escorts for carriers in air defense operations. The Aegis system, installed on several types of cruisers and destroyers, constitutes the primary carrier protection system of the United States. It is an automated Surface-to-Air Missile (SAM) system designed to intercept and destroy anti-ship missiles.¹³² The system allows for cooperative engagement, wherein one ship can control the missiles of other compatible ships in

the fleet, thereby reducing the vulnerability to anti-radar missiles by minimizing the number of targeted radars. Developed during the Cold War, the Aegis system demonstrated its combat effectiveness during the Gulf War in 1991. Presently, only three nations, namely the United States, Russia, and Peru, maintain operational cruisers. France operates a hybrid helicopter carrier/cruiser, primarily utilized as a training ship during peacetime. These active cruisers are classified as guided missile cruisers (CG), carrying anti-ship and/or land-attack missiles. Notably, Peru's Almirante Grau remains the world's last active gun cruiser.

20. The terms "helicopter cruisers," "aviation cruisers," or "through-deck cruisers" have been historically used to refer to aircraft carriers.¹³³ However, there are instances where a helicopter cruiser may denote an actual cruiser with an extensive helicopter hangar and flight deck. Examples of such ships include the French Jeanne d'Arc, the Italian Vittorio Veneto, and the Soviet Moskva class. It is important to note that these specific ships are no longer in active service. Presented below are examples of various cruisers.

- a. One of the most well-known cruisers today is the Ticonderoga class, which is a guided missile cruiser operated by the United States.
- b. The Russian Slava class, currently referred to as the Moskva class,¹³⁴ sustained minor damage during the Russian-Georgian war in 2008.
- c. During World War II, the American Atlanta class consisted of anti-aircraft light cruisers armed with a total of 16 5-inch guns. While they were ineffective against heavier warships, they proved valuable in early night battles due to their torpedoes and limited anti-aircraft capabilities. The advent of radar greatly enhanced their gun range even in poor visibility.
- d. The British Town class cruisers were prominent during World War II. One of these cruisers, HMS Belfast, is now a museum ship located in London.
- e. The Soviet Sverdlov class cruisers, which are the last conventional gun cruisers in the world, include the Mikhail Kutuzov, currently preserved as a museum ship in Novorossiysk.
- f. The Greek museum ship Georgios Averof, originally a pre-dreadnought battleship,¹³⁵ is the sole remaining armored cruiser globally. It served as the Greek flagship in both World Wars, surviving due to the crew's decision to disobey orders to scuttle the ship and instead seek refuge in Alexandria when Greece was occupied by the Nazis.



Fig 28: US Navy Ticonderoga-Class Cruisers¹³⁶



Fig 29: Russian Navy Cruiser Pyotr Veliky¹³⁷

BATTLE CRUISERS

21. Very massive cruisers with battleship-like armament are referred to as battle-cruisers. Dreadnought armored cruiser¹³⁸ was the initial name suggested for the first battle-cruisers. However, this was abbreviated to battle-cruiser since it was thought to be unwieldy. The regrettable inclination to treat battle-cruisers as though they were appropriate for genuine battleships would increase as a result of the new moniker. These days, just one type—the Russian Project 1144 Orlan/Kirov—are given this label. A cruiser fueled by nuclear weapons that has an amazing arsenal (aircraft carriers have more, but they are on their air wings). Actually, it's just a very large cruiser. The years before World War I saw a brief heyday for battle-cruisers. They were designed to be a hybrid of a battleship and an armored cruiser, with the speed and protection of a cruiser and the armament of a battleship, as their name suggests. So they referred to themselves

as Glass Cannon. Battleships could travel at top speeds of around 20 knots during the period, whilst cruisers and battle-cruisers could travel at least as fast as 28 knots. While in theory advantageous, a number of issues quickly surfaced in actual conflict. In particular, because of their armament, admirals tended to deploy them alongside their battleships. They frequently lacked sufficient armor to withstand a collision with their rivals, which resulted in all of the capital ship losses for both sides at the Battle of Jutland. By the time World War II arrived, the two kinds had essentially combined to form the fast battleship, and the Washington Treaty's cancellation of the final British battle-cruiser design was the sole reason the name stuck. It was even better armored and equipped.

22. The concept of battle-cruisers persisted among various nations. The Washington Naval Treaty of 1922 imposed limitations on ship sizes and types for each navy. Specifically, cruisers were restricted in size and armament, with a maximum gun caliber of 8 inches and a displacement of 10,000 tons. Despite these restrictions, all sides recognized the need for ships capable of countering cruisers in the event of war and thus developed contingency designs for cruiser killers. Germany, operating under slightly different restrictions from the Treaty of Versailles but still bound by the 10,000-ton limit, began constructing Pocket Battleships.¹³⁹ These were cruisers armed with 11-inch guns and displacing 12,000 tons, which they managed to represent as treaty-compliant by claiming a 10,000-ton displacement on paper. Japan conceptualized the B-65 cruiser, while the United States, after the treaty expired, constructed and deployed the Alaska class. Like battleships, battle-cruisers primarily served as escorts for aircraft carriers and engaged in shore bombardment during World War II. Unfortunately, World War II demonstrated that the improvements in battle-cruiser armor were insufficient. Both HMS Hood¹⁴⁰ and the Kirishima, battle-cruisers equipped with enhanced armor protection, succumbed to modern battleships in combat, such as the Bismarck and the USS Washington, respectively. NATO designated battle-cruisers as CC and CBGN. However, due to their impressive name, battle-cruisers continue to have a disproportionate presence in fiction.



Fig 30: Battle Cruiser (Kirov-class battle Cruiser, Russia Navy)¹⁴¹

DESTROYER

23. Destroyers are highly agile and swift naval vessels utilized to protect larger ships during attacks from short-range adversaries. The majority of powerful naval¹⁴² forces maintain a fleet of destroyers. In naval terminology, a destroyer is a fast and maneuverable warship with long endurance, primarily intended for escorting larger vessels within a fleet, convoy, or battle group.¹⁴³ Prior to World War II, destroyers were light vessels with limited capability for extended operations¹⁴⁴ in open seas. Destroyers are specifically designed to provide defense against land, air, surface, and submarine threats. They serve as a crucial component of numerous navies, with many currently in service and more under construction. Equipped with formidable weaponry, including missiles, large-caliber guns, small-diameter weapons, and torpedoes, destroyers are the largest type of naval ship in many fleets and serve as the backbone of larger naval

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forces. While generally smaller than cruisers, destroyers surpass frigates in size. Several destroyers are primarily designed for engaging enemy ships and conducting submarine warfare. Most navies classify destroyers and frigates based on size rather than specific roles, enabling them to deploy destroyers with both anti-submarine and air-defense capabilities. The term "destroyer" originated from their original purpose as "torpedo-boat destroyers," conceived by the British Navy in the late 19th and early 20th centuries to safeguard battleships against nimble, fast torpedo boats. The early destroyer design proved to be the most effective in countering torpedo boats. During World War I and World War II, the threat posed by torpedo boats diminished with the rise of submarines. Consequently, destroyers were predominantly employed in submarine warfare, convoy defense, and providing radar and anti-aircraft coverage for larger ships. NATO designates destroyers with various designations, including DD, DDG, DDR, DL, and DLG. One could argue that the fundamental role of destroyers has remained unchanged throughout history: to destroy torpedo boats, submarines, and enemy aircraft.

24. Contemporary destroyers are capable of engaging and neutralizing enemy ships, in addition to fulfilling the roles mentioned earlier.¹⁴⁵ The emergence of radar and guided missile technology has significantly expanded the capabilities of modern ship designers, providing them with increased flexibility and precision in deploying their firepower. It can be said that modern cruisers, destroyers, and frigates collectively fall under the category of escorts.¹⁴⁶ It is customary for most destroyers to be equipped with at least one helicopter on board, primarily employed for tasks such as submarine hunting, search and rescue operations, and general utility purposes. Example of some destroyers has been given below.

a. The American Arleigh Burke class of destroyers employs a similar Aegis system as the Ticonderoga class cruisers, effectively making them compact cruisers.¹⁴⁷ Japan operates the Kongou and Atago classes, which closely resemble the Arleigh Burke class and serve as their most potent warship type. South Korea operates the King Sejong the Great class, a slightly larger variant with 25% more missile capacity and other minor enhancements. These destroyers primarily focus on providing air defense capabilities through guided missiles. Additionally, American ships have the ability to launch a significant number of Tomahawk land-attack cruise missiles. The Japanese versions, however, do not possess this capability due to the categorization of Tomahawks as prohibited "offensive" weapons. Instead, the Korean ships utilize domestically-designed Hyunmoo-3C cruise missiles, which resemble enlarged versions of the Harpoon anti-ship missile. Both missile systems are capable of engaging surface warships and conducting surface bombardments. The Arleigh Burke class stands as the most prolific destroyer class since World War II.

b. The Zumwalt-class destroyer is a group of three United States Navy guided-missile destroyers designed as stealthy multi-mission ships. These vessels revolve around their Advanced Gun Systems (AGS), turrets equipped with 920-round magazines, and employ unique Long Range Land Attack Projectile (LRLAP) ammunition.¹⁴⁸ Despite being 40% larger than an Arleigh Burke-class destroyer, the Zumwalt-class destroyer exhibits a radar cross-section (RCS) comparable to that of a fishing boat,¹⁴⁹ according to a spokesman from the Naval Sea Systems Command. The ship's gas turbines drive a ship-wide electrical grid, generating over 75 megawatts of power, enough to illuminate a small town.

c. The Project 18 NGD (Next Generation Destroyer) is a class of Anti-Ballistic Missile Destroyers designed for the Indian Navy, expected to replace the Rajput-class Guided Missile Destroyers. These future destroyers will feature the Univer vertical launch system (UVLS), providing the capability to launch various types of missiles from their silos.¹⁵⁰ The Project 18 NGD will become the most heavily armed warships in the history of the Indian Navy, comparable to cruisers by international standards.¹⁵¹ Alongside land-attack cruise missiles, anti-ship cruise missiles, and surface-to-air missiles, these vessels will also carry Anti-Ballistic Missiles similar to the US Navy's Arleigh Burke-class destroyers, equipped with RIM-161 Standard Missile 3¹⁵² (SM-3).

d. The Japanese National Security Strategy (NSS) is a comprehensive document outlining the country's diplomatic, defense, and economic security policies for the next decade. According to the Defense Buildup Program, the Japan Maritime Self-Defense Force (JMSDF) plans to increase the number of Aegis destroyers (DDG) from the current eight to ten, with a future goal of having 12 ships equipped with the Aegis Weapon System (AWS) by the end of the decade. The JMSDF intends to replace its aging destroyers (DE, DD) with Mogami-class FFMs, potentially including DDGs as replacements for two of these vessels.¹⁵³ Upgraded versions of the Type 12SSM will be incorporated into the Aegis destroyers, aiming to extend the range from approximately 200 km to at least 900 km and eventually 1,200 km. The upgraded missiles will also feature modified shapes to reduce radar cross-section (RCS) and enhance stealth¹⁵⁴ capabilities.

- e. In 2023, the Chinese Navy commissioned a new generation of destroyers called the Type 055 Destroyer (NATO designation: Renhai class). These eight ships made their official debut on state television on April 21st, coinciding with the 74th anniversary of the Chinese Navy. The primary role of the Type 055 destroyers is to provide robust area air defense capability¹⁵⁵ to Chinese carriers, specifically the Liaoning (CV-16) and Shandong (CV-17). Additionally, Type 055 destroyers can serve as flagship vessels for surface action groups, facilitating command and control functions for other destroyers and frigates.
- f. The American Spruance class played a significant role in providing anti-submarine warfare (ASW) capabilities for carrier battle groups during the Cold War. They were the largest destroyer class of that era and exceeded the tonnage of pre-World War II light cruisers.
- g. Originally designed for the Iranian navy under the preliminary name of Kouroush class, the four-ship Kidd class destroyer was instead integrated into the US Navy following the Iranian Revolution. These ships were frequently deployed to the Middle East, and their design included significant improvements to air conditioning. Subsequently, the Kidd class destroyers were transferred to Taiwan and renamed the Kee Lung class.
- h. The American Fletcher class, built during World War II, stands as the largest and most numerous class of destroyers ever constructed. With 175 ships commissioned for the US Navy, many were subsequently sold to other countries. The Mexican Navy decommissioned the last remaining Fletcher class destroyer in 2001.
- i. The Allen M. Sumner class (58 ships), Robert H. Smith class, and Gearing class (98 ships) destroyers were closely related and featured superior armament and more efficient layouts. Due to their improved design and slightly larger hulls, some of these destroyers remained in US service until the late 1970s to early 1980s. Modifications included replacing the torpedo tubes with an ASROC launcher and incorporating a hangar for an armed drone helicopter in the 1950s.
- j. The Russian Udaloy class destroyers exemplify destroyers primarily designed for anti-submarine warfare. They are roughly equivalent to the American Spruance class¹⁵⁶ and serve as the Soviet counterpart.
- k. The Russian Sovremenny class destroyers serve as another example of destroyers primarily focused on engaging other ships using long-range anti-ship missiles while providing air defense.¹⁵⁷ China also operates a few similar destroyers.
- l. The Russian Kashin Mod class destroyers were initially intended as Tattletales, closely monitoring US carrier battle groups and relaying information on their activities.¹⁵⁸ In the event of war, these destroyers were to turn and retreat while firing backward-facing missiles as a last-resort attempt to sink the carrier. The Russian Navy currently operates one ship of this class, while the Indian Navy possesses five vessels of the similar Rajput class, featuring forward-pointing missiles.¹⁵⁹
- m. The British Type 42 or Sheffield classes were designed to provide anti-aircraft missile protection for British aircraft carriers. These destroyers, which are relatively small for their class, are also utilized by Argentina. Interestingly, they participated on both sides of the Falklands War.
- n. The newest British destroyer class is the Type 45 or Daring class,¹⁶⁰ primarily designed for air defense with stealth features. These destroyers have a significant carrying capacity for various weapons, which are only deployed when necessary.
- o. The Japanese Fubuki class destroyers, dating back to the late 1920s, were instrumental in transforming destroyers into the formidable, all-purpose vessels they are today. Known for their speed, powerful armament, and devastating torpedoes, the Fubuki class played a crucial role in World War II, despite their aging status.
- p. The Akizuki class represented a major advancement, approximately twice the size of the Fubuki class and nearly 50% larger than contemporary American destroyers like the Fletcher class. Although predating the era of guided missiles, the Akizuki class was the first specialized anti-aircraft destroyer.
- q. The U.S. Navy has expressed its desire for the next-generation warship, the DDG(X), to be equipped with hypersonic missiles and lasers that are ten times more powerful than the Navy's existing laser weapons. This vision is outlined in the most

detailed outlook to date for the DDG(X), utilizing the combat system developed from the Flight III Arleigh Burke destroyers, incorporating the new SPY-6 air search radar and Baseline 10 Aegis combat system.¹⁶¹ The DDG(X) is projected to support 600-kilowatt lasers, providing the capability to intercept hostile guided missiles.¹⁶² Construction of this warship is estimated to commence in 2028, as stated by the Navy in 2022.¹⁶³



Fig 31: British Type 45 Daring class Destroyer¹⁶⁴



Fig 32: Japanese modern Aegis missile Destroyer¹⁶⁵



Fig 33: American Zumwalt class destroyers DDG 1000¹⁶⁶



Fig 34: Chinese 052C/052D Kunming Class Destroyer¹⁶⁷



Fig 35: US Navy next-generation Destroyer program¹⁶⁸

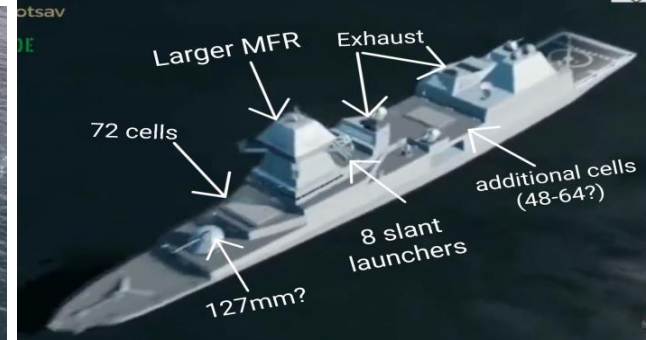


Fig 36: Indian Navy next-generation Destroyer (Project 18)¹⁶⁹



Fig 37: Chronological Development of different Types, Class and Size of Destroyers of US Navy

FRIGATE

25. During the 17th to early 18th centuries, the term "frigate" was used to describe a fully rigged ship known for its speed and maneuverability. These vessels were primarily employed in scouting, escort, and patrol duties.¹⁷⁰ In contemporary usage, a frigate is a type of small escort ship that plays a crucial role in safeguarding convoys from submarine threats while also fulfilling anti-aircraft responsibilities. Frigates are equipped with radar systems, surface-to-air missiles, anti-ship missiles, and anti-submarine equipment. Nowadays, many frigates are equipped with helicopters to enhance their submarine hunting capabilities. These vessels typically have a displacement of around 3000 tons, can reach top speeds of 30 knots or more, and accommodate a crew of approximately 200 personnel. Frigates serve as offensive platforms, carrying surface-to-surface missiles, surface-to-air systems, a 76 mm gun, close-in weapons, and torpedoes. They are involved in counterdrug operations and provide defensive capabilities when escorting other ships. Generally smaller in size compared to destroyers, frigates are primarily designed for anti-submarine warfare and anti-aircraft roles.¹⁷¹ It is worth noting that many frigates, even in modern navies, lack guided missile systems. The modern usage of the term "frigate" emerged in the 1940s when the Royal Navy reintroduced it to refer to sub-hunting vessels. The original guided missile frigates were later reclassified as cruisers, but the term "frigate" remained in use. Prior to that, the role fulfilled by modern frigates was known as Destroyer Escort (DE), which focused on hunting submarines and forming the outer defense ring for convoys. Frigates are typically the smallest warships capable of accommodating helicopters. In NATO designations, frigates are identified as FF, FFG, or DE.

a. The Oliver Hazard Perry class frigates from the United States were primarily designed for submarine hunting but also feature an impressive anti-aircraft missile system considering their size. These frigates have been widely exported and are utilized by several countries including Spain, Taiwan, Turkey, Greece, Egypt, Bahrain, Poland, and Australia. Some navies operate ex-US ships, while others have their own Perry class frigates.

b. The FREMM (Frégate Européenne Multi-Mission in French and Fregata Europea Multi-Missione in Italian) is a versatile frigate family jointly designed by Naval Group and Fincantieri.¹⁷² Aquitaine, the lead ship of this class, was commissioned by the French Navy in November 2012. Italy has ordered six general-purpose and four anti-submarine variants, while France has ordered six anti-submarine variants and two air-defense¹⁷³ variants. The FREMM frigates have also been exported to various countries.

c. The British Type 23 or Duke class frigates are larger in size compared to Type 42 destroyers and were primarily designed for submarine hunting. These frigates were prominently featured in the James Bond movie "Tomorrow Never Dies." They

employ the excellent "Sea Wolf" anti-aircraft missile system for self-defense. While its range is limited for protecting other ships, it boasts remarkable accuracy, capable of shooting down targets as small as a 4.5-inch artillery shell.

d. The Lafayette class frigate, a French-designed vessel, was initially recognized as a "stealth frigate" due to its unique stealth design during its time. The reduced radar cross-section of these frigates is achieved through features such as a clean superstructure, angled sides, and radar absorbent material.¹⁷⁴ The superstructure is constructed using light alloy and glass-reinforced plastic, reducing top weight. These ships employ a modular inner structure composed of prefabricated modules, resulting in a construction time of less than two years.¹⁷⁵ The Lafayette class frigates are utilized by France, Singapore, and Taiwan.

e. The Russian project 11356 frigates, an evolution of the renowned project 1135 Krivak class frigate, are now known as the Talwar class in India and the Admiral Grigorovich class in Russia. These frigates are based on a proven hull design but feature an entirely new armament system, including the supersonic Brahmos/Onyx anti-ship missiles, advanced sensors, and electronic packages. Additionally, the frigates have a stealthier superstructure, making them formidable combat vessels.

f. The Formidable-class multi-role stealth frigates are the latest surface platforms in service with the Republic of Singapore Navy. These frigates are derived from the French Navy's La Fayette-class frigate.¹⁷⁶ RSS Steadfast, commissioned on 5 February 2008, was constructed by ST Marine Engineering Company in Singapore during the late 2000s. The Formidable class exhibits a significantly reduced profile compared to the La Fayette class and other derivatives, achieved through a smaller superstructure and the use of enclosed sensor mast technology.¹⁷⁷

g. The F126, also known as frigate 126 or Fregatte 126, is a future German frigate class intended to replace the F123 Brandenburg-class frigates in the German Navy. These ships will be the largest surface warships to join the German Navy since World War II. The first ship is scheduled for commissioning in 2028.¹⁷⁸ The F126 frigates are planned to be mission modular, reflecting the Navy's need to conduct extended overseas deployments with an aging fleet influenced by Cold War requirements.¹⁷⁹



Fig 37: FREMM modern Frigate 140mX6000tons¹⁸⁰



Fig 38: Steadfast Stealth Guided Missile Frigate¹⁸¹



Fig 39: Royal Malaysian Navy State of Art Frigate¹⁸²



Fig 40: German modern Frigate 166mx10000tons (F 126)¹⁸³

CORVETTE

26. A corvette is a nimble and compact naval vessel that falls in size below a frigate. Corvettes today serve various roles such as coastal patrol craft, missile boats, and fast attack craft. However, unlike modern frigates, corvettes lack the necessary endurance and seaworthiness for prolonged voyages.¹⁸⁴ These modern corvettes typically carry a complement of torpedoes, missiles, and machine guns, and they have a displacement ranging from 1000 to 2,000 tons. They fulfill vital duties such as antisubmarine operations, anti-aircraft defense, and coastal patrols in the navies of smaller nations around the world. Acting as smaller variants of frigates, they are primarily designed for coastal responsibilities, and many have grown close in size to frigates themselves. Corvettes are relatively small, swift, and maneuverable, and they generally possess lighter armament compared to frigates.¹⁸⁵ They are commonly deployed by navies of countries that border smaller seas. In some cases, smaller navies located near major oceans employ corvettes for more demanding tasks and make necessary modifications accordingly.¹⁸⁶ NATO designates corvettes as FFL Examples of few corvettes have been given below.

- a. The new Stereguschiy class of Russian ships is remarkable for its ability to accommodate a full-fledged helicopter, complete with a hangar and helipad, within a displacement of just 2500 tons. True to Russian ship design, it boasts heavier armament compared to many frigates, although this comes at the cost of compromised¹⁸⁷ crew habitability.
- b. The Sa'ar 5 class corvettes from Israel, much like their Sa'ar 4.5 missile boat counterparts, push the boundaries of how heavily armed a ship of their size can be. These corvettes carry an impressive arsenal, including 8 Harpoon anti-ship missiles, 64 Barak anti-aircraft missiles, a Phalanx CIWS system, 6 anti-submarine torpedo tubes, and a Panther anti-submarine helicopter.¹⁸⁸ Although they previously carried 8 smaller Gabriel anti-ship missiles, these were removed due to concerns about the ships' stability. Despite this modification, the Sa'ar 5 class manages to pack firepower comparable to that of a full-sized frigate into a compact 1200-ton package. Additionally, with a top speed of 33 knots, they surpass the velocity of most full-sized frigates.
- c. The Visby stealth corvettes¹⁸⁹ from Sweden and the Magdeburg stealth corvettes¹⁹⁰ from Germany serve as excellent examples of modern corvettes.
- d. Since 2013, the PLA (Navy) has introduced the advanced stealth missile corvette 056 into its fleet. This cutting-edge corvette represents the latest development in naval history, combining speed, formidable capabilities, and long-range anti-ship missiles.¹⁹¹



Fig 41: Corvette sa'ar 5 of the Israel¹⁹²



Fig 42: Chinese Stealth Missile Corvette Type 056¹⁹³



Fig 43: A Swedish Visby-class stealth corvette¹⁹⁴



Fig 44: Corvette Magdeburg of the German Navy¹⁹⁵

LITTORAL COMBAT SHIPS

27. The Littoral Combat Ships (LCS) represent a new generation of versatile vessels in the US Navy, offering a wide range of capabilities. These ships have been designated as LCS¹⁹⁶ by NATO. The LCS has the remarkable ability to swiftly transition between different missions such as mine hunting, serving as platforms for unmanned boats and helicopters, conducting special operations warfare, and performing reconnaissance. One of the key design considerations for the LCS is the utilization of a minimal crew size to effectively

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reduce operating costs. It is important to note that the littoral combat ship (LCS) is the pioneering member of a novel family of surface ships for the US Navy,¹⁹⁷ distinct from the DD(X) class, which falls under the broader umbrella of future US surface combat ships. The LCS stands out as a rapid and highly maneuverable surface combat vessel, closely integrated into a networked system. Its specialization lies in addressing the pressing need for shallow draft vessels capable of countering evolving asymmetric threats in littoral or coastal waters, including coastal mines, stealthy diesel submarines, and the potential transportation of explosives and terrorists via small, swift, armed boats. Although the US Littoral Combat Ship (LCS) bears similarities to a corvette, the US Navy has deliberately refrained from using the corvette classification for any of its ships, even predating the existence of a particular sports car. Notably, these ships boast an exceptional top speed of 45 knots, which is remarkable for any warship, leading to speculation that aligning the ship name with a sports car could have been appropriate.¹⁹⁸ In early 2015, the US Navy made the decision to reclassify these ships as frigates and intends to equip them with sufficient armament to meet the qualifications for the frigate designation.



Fig 45: USS Independence (LCS-2)¹⁹⁹



Fig 46: USS Independence and USS Freedom in a convoy²⁰⁰

OFFSHORE PATROL VESSEL

28. The Offshore Patrol Vessel (OPV) is a remarkably adaptable ship specifically designed to fulfill a range of vital roles related to Economic Exclusion Zone management. These roles encompass safeguarding coastal areas, providing maritime security, facilitating effective disaster relief efforts, conducting surface rescues, performing surveillance operations, and supporting missions in challenging sea conditions.²⁰¹ OPVs can vary in size, spanning from smaller than a corvette to as large as a frigate. They can comprise fast attack craft, missile boats, and torpedo boats. Typically, OPVs represent the smallest warships under the command of naval forces. NATO has designated these vessels as OPVs. In the present day, OPVs generally have a displacement of approximately 1500 tons and are armed with light guns and missiles. Their primary responsibilities involve countering piracy, combating drug trafficking, and fulfilling other peace-time naval roles within offshore areas. Modern OPVs can be likened to 3rd class cruisers in terms of classification. They are characterized by excellent sea-keeping abilities, extended range, comfortable accommodation, ease of maintenance, and reliability. Although they may appear to be under-armed considering their size,²⁰² OPVs compensate for this with their slower speed.



Fig 47: OPV 90 of Turkey Navy by TAIS²⁰³



Fig 48: Indian Coast Guard modern OPV by GSL²⁰⁴

MINELAYERS

29. The primary purpose of a minelayer is to deploy naval mines in both open waters and along coastal areas. These ships are particularly favored by navies that have shallow coastlines, extensive archipelagos, or long stretches of coastline. Naval mines can pose a significant threat in narrow straits, harbors, and shallow seas, as even a single mine has the potential to sink a large vessel. Minelayers typically possess excellent seafaring capabilities and feature a flush deck with integrated mine rails, shafts, and/or scuttles. It is relatively straightforward to convert a passenger ferry or a roll-on/roll-off merchant ship into a minelayer by attaching mine rails to the car deck and loading the mines on board. To deploy the mines, the stern gate is lowered, allowing them to be released. In the past, there were instances of destroyer-minelayer hybrids, but nowadays, such conversions would be deemed wasteful since destroyers possess significant combat capabilities.



Fig 49: A Turkish Navy Minelayer²⁰⁵



Fig 50: Belgium Navy Minesweeper²⁰⁶

MINESWEEPERS

30. There exists an old joke in the navy that goes, "Any ship can be a minesweeper...once." This jest highlights the unique purpose of minesweepers, which are specifically designed for detecting and neutralizing naval mines and explosives. These vessels are typically small, slow, and lacking in significant defensive capabilities. However, they are equipped with specialized features such as non-magnetic hulls made of wood or fiberglass, maneuvering thrusters or pods that enable them to navigate in any direction with exceptional agility, and diving facilities that allow them to approach and disarm mines without triggering detonation. In modern times, many minesweepers are equipped with Unmanned Underwater Vehicles (UUVs) that assist in locating and neutralizing mines from a safe distance. According to NATO classification, minesweepers are designated as Mine Counter Measures (MCM) ships.²⁰⁷ During World War I and II, when minesweepers were unavailable or impractical, a tactic employed to create a path through a minefield involved taking an older merchant vessel and filling it with buoyant materials such as wood, cork, or cardboard. These makeshift minesweepers would then be driven through the minefield at full speed. Although this approach was risky for the courageous crew tasked with piloting the ship, the objective was to trigger as many mines as possible using the vessel itself. Despite the additional flotation and damage absorption, any ship subjected to repeated mine hits will eventually become non-seaworthy and sink. The US Avenger MCMs and the German Seehund MCMs²⁰⁸ are two examples of minesweepers in service today.

COASTAL DEFENSE SHIPS

31. This particular class of ship gained significant popularity among the naval forces of smaller countries. Rather resembling mobile coastal artillery batteries than true blue water vessels, these ships were typically comparable in size to frigates but boasted the armament of a heavy cruiser. They were commonly referred to as armored ships.²⁰⁹ Despite their formidable firepower, many of them remained in active service until the 1960s, showcasing their enduring capabilities.

MISCELLANEOUS SHIP TYPES

32. Special purpose ships encompass a range of distinct vessels, such as command ships, coastal patrol boats, mine countermeasures ships, submarine tenders, joint high-speed vessels, sea fighters, submersibles, sailing frigates, oceanographic survey ships, and surveillance ships.²¹⁰

FAST ATTACK CRAFT

33. A fast attack craft, often known as a FAC, is an offensive warship that is quick, small, nimble, and armed with anti-ship missiles, a cannon, or torpedoes. Since they lack the sea-keeping and all-around defensive ability to survive in blue water,²¹¹ they typically operate closer to the land. The fuel, storage, and water supplies are also restricted by the vessel's size. They typically range in size from 50 to 400 tons and travel at 25 to 50 knots.

SMALL BOATS AND CRAFT

34. Small boats are employed for many different things, such as special missions and riverine operations. These include survey boats, hovercrafts, landing craft, missile boats, torpedo boats, rigid-hull inflatable boats, patrol boats, and landing craft.²¹²

PATROL BOATS AND CRAFT

35. These vessels are also referred to as FAC (Fast Attack Craft) and FIAC (Fast Inshore Attack Craft). They are relatively small in size, with some resembling large speedboats, and are primarily utilized for coastal operations. In terms of NATO designation, these ships are classified as PC (Patrol Ship Coastal) and LPC (Large Patrol Ship).²¹³ Their design prioritizes speed and maneuverability rather than extended range. These craft can be employed in significant numbers to overwhelm larger ships. For instance, the Iranian Navy has been known to train for swarm attacks using such vessels, and the Tamil Tigers, a rebel group in Sri Lanka, effectively utilized them in combat. However, it should be noted that swarm attacks often result in high casualty rates, even when successful. These small boats do not possess extensive armor and are primarily designed to withstand small arms fire. Modern PC and LPC variants are equipped with short-range guns and missiles. The US Cyclone class PCs and the Australian Armidale class PCs serve as excellent examples of these types of vessels.



Fig 51: Very Fast Patrol Craft (PC)²¹⁴



Fig 52: BD Navy Durjoy Class Large Patrol Craft (LPC)²¹⁵

GUNBOATS

36. Gunboats are nimble and swift watercraft, characterized by their compact size and equipped with lightweight, high-rate-of-fire cannons. They are particularly favored by navies that operate along coastlines conducive to swift and elusive tactics, and they have gained significant popularity in riverine warfare.²¹⁶ In fact, this type of warship played a role in shaping the concept of Gunboat Diplomacy. Gunboats range in size, with the largest ones classified as corvettes and the smallest ones categorized as patrol boats. According to NATO classification, gunboats are designated as PG. A notable example of a gunboat is the USN Assault Support Patrol Boat (ASPB)²¹⁷.

TORPEDO BOATS OR PT BOATS

37. These small boats were equipped with torpedoes and predominantly saw use during World War II. However, most of them have become obsolete with the advent of anti-ship missiles. Consequently, they naturally evolved into missile boats. In terms of NATO designation, these boats were referred to as PT (Torpedo Boat). During their heyday, they occupied a unique position somewhere between destroyers, aircraft, and submarines. Similar to submarines, their potent torpedoes granted them the capability to inflict significant damage on even the largest vessels, including battleships. Torpedo boats boasted a remarkable firepower-to-weight ratio, surpassing that of any other vessel. Their small size, maneuverability, and high speed provided effective defense against close-range threats for fleets. However, they also shared certain disadvantages with submarines and had some unique limitations.²¹⁸ Their onboard provisions were even more restricted than those of submarines, limiting their range and endurance in battle. They couldn't match the speed of aircraft and were more vulnerable to attacks from other ships and planes. The emphasis on speed and firepower left no room for armor. Eventually, their role evolved into that of commandos and raiders within the naval force. They conducted hit-and-run attacks, executed night assaults under smokescreens, performed infiltration missions, facilitated the extraction of VIPs from hostile areas, and served as scouts.

38. After World War II, PT boats gradually became obsolete as other vehicles and weapons proved more effective in fulfilling their roles.²¹⁹ Submarines and missile boats took over their responsibilities. However, certain countries, like Iran, have recently revived the

concept by employing semi-submersible boats, guided torpedoes, and swarm tactics as a cost-effective countermeasure against larger, more expensive ships. These tactics are particularly effective for launching surprise attacks²²⁰ and inflicting damage on larger vessels. Typically, the boats lie in wait, partially submerged, before surfacing to fire their torpedoes and quickly retreating. Three notable incidents have contributed to the fame of PT boats in naval history.

- a. During the early days of World War II, a flotilla consisting of six PT boats played a crucial role in evacuating General Douglas MacArthur, along with his family and staff, from the Philippines. Their remarkable feat involved evading over 600 nautical miles of treacherous ocean and safely delivering the general to Australia. This daring operation not only earned every member of the squadron a silver star but also garnered Lieutenant Commander (later Vice Admiral) John D Bulkeley, the commanding officer, the prestigious Medal of Honor. The evacuation of MacArthur became a testament to tactical brilliance, seamanship, and served as a morale booster while becoming a source of inspiring Allied propaganda throughout the war.²²¹
- b. PT-109 gained significant fame during and after World War II when it collided with the Japanese Fubuki-class destroyer, Amagiri. What made this incident particularly noteworthy was the fact that the commanding officer of PT-109 at the time was John F. Kennedy,²²² who later became the President of the United States. The story of Kennedy's survival and his heroic efforts to save his crew turned him into a war hero and played a role in his eventual election as President.
- c. In Italy, PT boats hold a prominent place in naval history due to their extensive use by the Italian Navy during World War I. Serving as armed motorboats, they achieved a Crowning Moment of Awesome when a couple of torpedoes sank the Austrian flagship.²²³ This remarkable accomplishment solidified the reputation of PT boats in Italy and showcased their effectiveness in combat.



Fig 53: PT 109 is a WWII Petrol Boat²²⁴



Fig 54: Skorea Launhes Guided Missile Boat²²⁵

MISSILE BOATS

39. Missile boats have emerged as the logical successors to torpedo boats, exchanging the slow and short-ranged torpedoes of World War II for the fast and long-range missiles of today. While they share some of the limitations of their predecessors, missile boats have managed to enhance their long-range striking capabilities²²⁶ in certain cases. Similar to torpedo boats, these vessels typically concentrate a significant amount of firepower within a compact and delicate structure. During the Cold War, the Soviet Union embraced the concept of numerous small and agile ships that could engage in hit-and-run or hit-and-sink attacks against enemy vessels. They armed these boats with surface-to-surface anti-ship missiles, notably the P-15/SS-N-2 Styx. In contrast, the United States, favoring fewer but more potent and survivable large ships, initially lagged behind in the development of missile boats. However, as the dominance of anti-ship missiles became more apparent, the U.S. also began incorporating them into their naval forces. The effectiveness of missile boats was demonstrated in various conflicts. In the Six-Day War of 1967,²²⁷ an Israeli missile boat successfully sank an Egyptian destroyer. Several countries embraced this concept, leading to the export of these boat-building technologies by the Soviet Union. India notably utilized missile boats to their advantage during the 1971 war with Pakistan. While the United States possessed some missile boats, they ultimately retired them due to concerns over cost-effectiveness. NATO designates missile boats as PTM.

40. Missile boats have been found to have limitations when operating in modern environments, primarily due to their small size and the significant space occupied by large anti-ship missiles, which hinders their ability to mount an effective defense against aircraft

and helicopters. However, Israeli missile boats have managed to defy expectations by achieving remarkable levels of armament relative to their size. Despite this achievement, their small size poses challenges to their seaworthiness, with limited accommodation facilities, range, and seagoing capabilities. These boats are vulnerable to air attacks and face morale issues, particularly when manned by conscripts who are aware of their expendable status. Nevertheless, they excel in dense archipelagos or areas with complex coastlines, where they can exploit hiding spots and carry out their strike operations. Few examples of missile boats have been given below.

- a. The Soviet Russian Project 205 Tsunami/Osa class serves as a notable example of PTM. Among naval conscripts, the Osa II class was generally disliked due to their service onboard.²²⁸
- b. The Skjold class PTM, belonging to the Norwegian Navy, holds the distinction of being the world's fastest warships, reaching speeds of over 60 knots. They are also the first operational stealth warships.²²⁹
- c. The Pegasus class missile boats²³⁰ were part of the US Navy's fleet. These hydrofoil missile boats were highly agile and boasted a substantial armament for their size, including 8 Harpoon missiles and a rapid-fire 76mm gun, offering double the firepower of an "Osa" class. Although plans were made for at least 30 boats, only 6 were constructed and they did not see significant action before being retired. Notably, they surpassed the Russian "Osa" class missile boats in speed by 15 knots.
- d. The Sa'ar 4.5, the standard missile boat utilized by Israel, exemplifies the characteristics of modern missile boats with its respectable armament. Each ship is equipped with 8 Harpoon or 6 Gabriel anti-ship missiles, as well as 16 to 32 Barak anti-aircraft missiles. The vessel features two gun turret positions capable of mounting a 3-inch gun, a 25mm auto-cannon, or a Phalanx CIWS. Some versions even included a helipad and hangar.²³¹ Despite being under 500 tons in displacement and reaching a speed of 34 knots, they maintain a formidable presence.

RIGID(HULL) INFLATABLE BOATS (RIB, RHIB)

41. Essentially, these are compact and swift speedboats featuring a rigid hull for structural integrity and inflatable pontoons for buoyancy. Typically, they are outfitted with a light to medium machine gun. Serving as auxiliary vessels, many naval crafts carry multiple units of these boats for various operations such as boarding, port security, search and rescue, and general-purpose tasks. The latest iteration of this vessel²³² type is known as RIBs (Rigid Inflatable Boats). Throughout history, they have been referred to by different names including Gigs, Barges, Cutters, Yachts, Runabouts, and simply Boats²³³, depending on their designs. Boghammar is an improvised combat vessel typically created by mounting a machine gun, anti-aircraft cannon, or recoilless rifle onto a speedboat. Such boats are often preferred by third-world countries, particularly in regions of chaos or underdevelopment, as well as by pirates. The name Boghammar originated from the Swedish speedboat manufacturer Boghammar Marin AB,²³⁴ which produced the first armed speedboats for the Iranian Navy. These types of boats are designated as RIB or RHIB by NATO.

AUXILIARY OR SUPPORT SHIPS

42. Support ships play a vital role in ensuring the operational readiness of naval forces by providing essential provisions. These include combat stores ships,²³⁵ ammunition ships,²³⁶ fast combat support ships,²³⁷ cargo and pre-positioned supply ships, rescue and salvage²³⁸ vessels, fleet tankers,²³⁹ oil tankers, tender vessels, tug boats, and hospital ships.²⁴⁰ Hospital ships, in particular, serve as fully equipped floating hospitals with emergency operating theaters, recovery beds, medical personnel including doctors, nurses, and dentists. They are deployed during times of war and major natural disasters. Auxiliary ships form the backbone of any naval fleet. These ships carry additional supplies such as food, fuel, spare parts, and ammunition. They can also serve intelligence and command functions. While they may have limited defensive capabilities, they require protection from other ships. Many of these ships are specifically designed to provide refueling, rearming, and resupply capabilities to other ships at sea, enabling them to extend their operational endurance without returning to port. This practice, known as Underway Replenishment,²⁴¹ was developed in the 1920s and 30s and proved to be a significant advantage for the United States. By 1944, during the Pacific theater of World War II, the US fleet was able to operate freely and sustainably for extended periods. NATO designates these types of ships as AA. There are large numbers of subtypes.²⁴²

AKV- Cargo ship and aircraft ferry.

APB- self-propelled barracks ship.

AGF- Miscellaneous research ship.

AFS- Combat Stores Ship; carries ammo and various other supplies

AO- Oiler; carries fuel and other liquids.

AOE- Fast Combat Support Ship. A large ship that carries fuel, ammo, and supplies. The "E" stand for "everything".

AH- Hospital Ship.

AD- Destroyer tender, carries supplies, repair parts, and support facilities for destroyers. Now obsolete, they were common back when destroyers were much smaller and had shorter endurance. Present days destroyers are big size and carry enough stores.

AS- Submarine tender.

AGI- intelligence gathering vessels, basically spy ships or disguised as trawlers.

LCC- Command Ship. Originally meant for the commander of an amphibious assault. Here LC stands for landing craft. It was expected a naval commander would travel by carrier or battleship. The US Navy now uses these to command entire theaters (like Pacific or Atlantic theaters). Example of such ships are as follows.

Chiwawa class oiler (AO); five used by US Navy in World War II.

Berlin class replenishment ship uses by Germany.

Project 160 Altay class. Old Soviet Russian oilers.

Sacramento class fast combat support ship (AOE). First four used by the US Navy until 2005. They were the first supply ships to keep pace with a carrier battle group.



Fig 55: IN Supply ship Refueling Destroyer and Cruiser²⁴³



Fig 56: US Navy Hospital ship moving with the fleet²⁴⁴



Fig 57: US Navy Combat Store ship moving with the fleet²⁴⁵



Fig 58: Russian Navy Auxiliary Combat Ship for Fleet²⁴⁶

SUB SURFACE SHIPS (OR SUBMARINES)

43. Submarines, also known as sub-surface vessels, possess the ability to travel and operate underwater, equipped with a variety of weapons. Modern submarines, particularly those powered by nuclear energy, have the capability to carry both torpedoes and ballistic nuclear missiles on board, allowing them to remain submerged on patrol for up to six months.²⁴⁷ Submarines are often characterized as silent hunters, and there is a well-known navy joke that states submarines are "boats" in which the number of sinkings equals the number of surfacings. In their early days, submarines were primarily submersibles that spent the majority of their time on the surface and only dove when engaging in attacks or evading capture. Throughout the first half of the 20th century, submarines instilled a sense of paranoia due to their capacity for launching surprise attacks. The mere possibility of a submarine, armed with torpedoes, operating in a given area could tie up multiple ships. However, modern submarines have expanded their capabilities to include anti-ship and land-attack missiles, rendering the need for deck guns obsolete, as they increase underwater noise and are less powerful than modern torpedoes anyway.²⁴⁸ Any anti-aircraft capacity is limited to handheld surface-to-air missile launchers carried in waterproof containers. While submarines can

operate independently, it is common for a US carrier group to include a couple of submarines for protection. In addition to conventional submarines, there are four basic types of modern submarines, including U-boats (submarines primarily used by Germany during World War II) and air-independent submarines that do not rely on external air sources.

DIESEL-ELECTRIC SUBMARINES

44. These submarines represent the modern iteration of World War II U-boats, featuring significant upgrades such as extended underwater endurance, improved sensors, homing torpedoes, and enhanced speed. They rely on diesel engines while on the surface and utilize powerful batteries to propel themselves underwater. In certain aspects, they offer advantages over nuclear-powered submarines.²⁴⁹ Their smaller size allows them to operate more effectively in shallow waters, and they tend to be quieter without the continuous operation of a nuclear reactor. Under favorable conditions, they can pose a greater threat than theoretically more powerful nuclear submarines due to their reduced noise signature. However, they are slower, have shorter operating ranges, and typically cannot spend extended periods submerged below periscope depth. If confronted by a moderate to large opposing surface or air force, their chances of evading detection and escape are minimal. The United States, United Kingdom, and France have ceased employing these submarines in combat roles, whereas Russia and China maintain a significant number as they find them suitable for their specific operational requirements. Smaller navies that rely on submarines have no alternative but to utilize this type. Notably, Israel's Dolphin class submarines,²⁵⁰ despite being diesel-electric, are technically capable of carrying nuclear-armed missiles, granting Israel a regional second-strike capability. Given Israel's concerns about Iran obtaining nuclear weapons in the near future, it is plausible that the Israeli Defense Forces are preparing for this potential scenario. A Pakistani diesel-electric submarine, PNS Hangor, achieved the first submarine-to-surface ship kill since World War II during the 1971 conflict with India,²⁵¹ marking one of the two successful submarine attacks since 1945. There are few examples of SS and SSK patrol and coastal-defense submarines.

- a. The Collins class submarines²⁵² of Australia, despite facing initial challenges and controversy, are now widely regarded as the top-performing submarines in this category today.
- b. The Russian Kilo class submarines²⁵³ exemplify the characteristics of Russian submarines. They are relatively compact and exceptionally silent, enjoying considerable success in export markets, particularly in Asia. Countries such as India, China, and Vietnam have acquired these submarines.
- c. Germany continues to manufacture a significant number of high-quality U-boats for various nations. Notably, the Israeli Dolphin class submarines, which were based on Howaldtswerke-Deutsche Werke's (HDW) 209 class submarines,²⁵⁴ were built in Germany.
- d. The Swedish Gotland class submarines deviate from the typical limitations of diesel-electric submarines in terms of submergence duration. These submarines are reputed to remain submerged for extended periods, thanks to their Air Independent Propulsion (AIP) system, although their speed is limited to 5 knots during AIP operations.²⁵⁵ The Gotland class submarines feature a unique X configuration for their tail planes, differing from the conventional + configuration of two rudders and two dive planes. This design enhances maneuverability and allows the submarine to land on the ocean floor without risking damage to the planes.

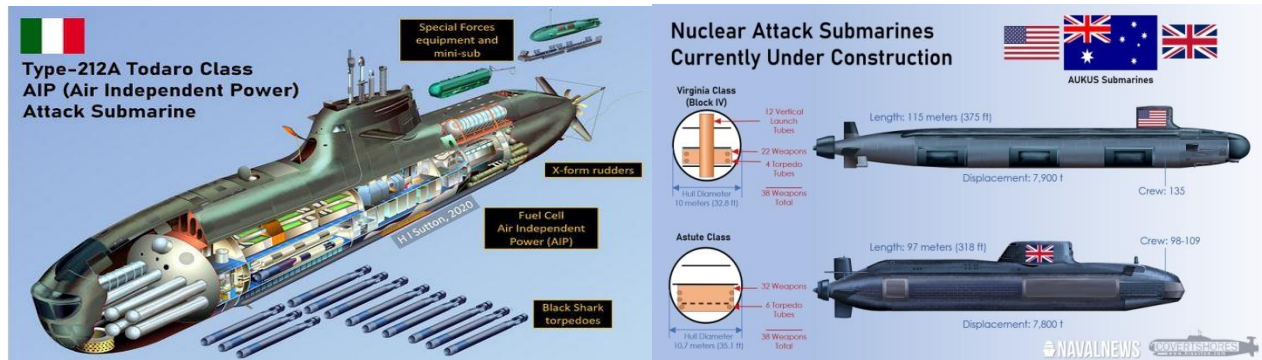


Fig 59: Italian Navy's Near Future AIP Submarine (NFS)²⁵⁶ Fig 60: Australia's Aukus nuclear power Submarine²⁵⁷

NUCLEAR ATTACK SUBMARINES

45. These particular types of submarines surpass the speed of diesel-electric submarines and can sometimes even outpace most surface ships. Nuclear attack submarines offer two additional advantages. Firstly, they possess the capability to remain at sea for extended periods of time. By generating their own oxygen from seawater and filtering out carbon dioxide from the air, a nuclear attack submarine can stay submerged for months until their onboard food supplies are depleted. Secondly, unlike diesel-electric submarines, they do not require periodic surfacing to recharge their batteries through a process known as snorkeling, where the sub extends a snorkel above water level to draw in air for the engines. This characteristic makes them significantly more difficult to detect by ships and aircraft. However, these fast-attack boats, as referred to by the US Navy, are incredibly costly to construct and maintain. Only the United States, Russia/USSR, Britain, France, China, and India currently operate these submarines, while Brazil is in the process of developing some with assistance from France.

46. During times of war, the primary role of an SSN (nuclear attack submarine) can be divided into two main objectives: safeguarding friendly ships against enemy submarine attacks and locating and disabling enemy ballistic missile submarines ("Boomers"). These submarines are highly adept at remaining undetected, making them frequently utilized for intelligence gathering and clandestine operations. Since the conclusion of the Cold War, a significant mission for nuclear submarines has been the transportation of special operations forces. Within NATO, the designation SSN is given to nuclear attack submarines.²⁵⁸ Throughout the Cold War and presumably even today, attack submarines from both sides would endeavor to shadow the adversary's missile submarines, prepared to eliminate them if necessary. Instances of SSN submarines specifically assigned for coastal defense and patrol purposes are relatively scarce.

- a. The majority of the US Navy's fast-attack fleet consists of the Los Angeles Class²⁵⁹ submarines. However, some of these have been decommissioned in favor of the newer Virginia class submarines. The latter versions of the Los Angeles Class, as well as all the Virginia class submarines, are equipped with 12 vertical launch tubes for Tomahawk cruise missiles. Additionally, they have the capability to carry missiles internally.
- b. Within the US Navy's inventory,²⁶⁰ there are also three Seawolf class submarines. These submarines are renowned for being the fastest and most powerful attack submarines ever constructed. Originally, there were plans to build several dozen of them, but due to the end of the Cold War, it was deemed that they were "too powerful." The Virginia class submarines, while slightly less capable, offer a similar level of performance and are significantly more cost-effective.
- c. The Trafalgar Class²⁶¹ submarines of the Royal Navy are reputed to possess the most advanced sonar systems globally. The older Swiftsure-class submarines will soon be replaced by the Astute-class submarines.
- d. The primary fast-attack submarine of the Soviet Russian Navy is the Akula class,²⁶² which NATO designates as the Akula (Shark). The Soviet Navy assigned the name "Shchuka-B" to the missile submarines referred to as the Typhoon class by NATO, as the Akula class represented an improvement over the Shchuka (NATO name Victor III). Despite being a new hull design, it inherited the name.
- e. The Alfa class²⁶³ submarines were highly advanced during the time of the Soviet Union. They featured a welded Titanium hull, enabling them to reach immense dive depths. These submarines also incorporated a lead-bismuth cooled reactor of significant power and an unprecedented level of automation that remains unparalleled to this day. However, they were not particularly stealthy, as it is challenging to maintain stealth while operating at 44 knots underwater. Nevertheless, at cruising

speeds, they were comparable to other Soviet submarines of the era. Due to their high cost, only a limited number of Alfa class submarines were built.

f. The modern Russian Project 885 Yasen class submarines serve as a counterpart to the US Seawolf²⁶⁴ class submarines. They are similarly expensive to build, and even more so than their ballistic missile counterparts, which are considerably larger. Many analysts anticipate the emergence of a more cost-effective class akin to the Virginia class after an initial series of Yasen class submarines is constructed, especially considering that the Akula class submarines are aging.

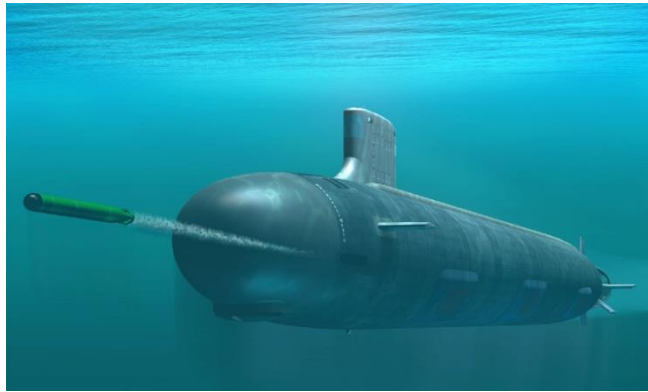


Fig 61: Navy's Virginia class Submarine²⁶⁵



Fig 62: Russian Alfa Class Submarine²⁶⁶

GUIDED MISSILE SUBMARINES

47. During World War II, German U-Boats employed a tactic known as Wolf Packs, wherein they would attack allied convoys on the surface in large formations. These U-Boats would utilize torpedoes and deck guns to target and sink vulnerable freighters. NATO designates guided missile submarines as SSGNs.²⁶⁷ With the introduction of guided missiles, a single SSGN submarine became capable of executing such attacks independently. These submarines would conceal themselves underwater and launch volleys of cruise missiles towards merchant vessels within convoys. Alternatively, they could position themselves undetected near enemy coastlines and launch missiles at strategic targets such as airbases, railway bridges, and other critical structures. During the Cold War, this strategy was a specialty of the Soviet Navy, employing submarines from the Echo, Charlie, Oscar I, and Oscar II classes. Some of these submarines were deployed to hinder the United States' ability to resupply its European armies during wartime or to target carrier battle groups that posed a threat to the Soviet homeland.²⁶⁸ There were also diesel-powered versions of submarines, including the Whiskey Long Bin and the Juliett, which sported Western-sounding names. Subsequently, the US Navy converted certain Ohio Class missile submarines into SSGN configuration. This was achieved by utilizing the earlier boats from the class that were incompatible with the newer Trident II missiles. The conversions enabled these submarines to carry a substantial number of Tomahawk cruise missiles for conventional land or sea-based attacks. However, this resulted in the peculiar situation of having two distinct classes of Ohio submarines simultaneously in service: the SSGNs and the remaining SSBNs from the original class.



Fig 63: Russian Eco Class Subs Launching missile²⁶⁹

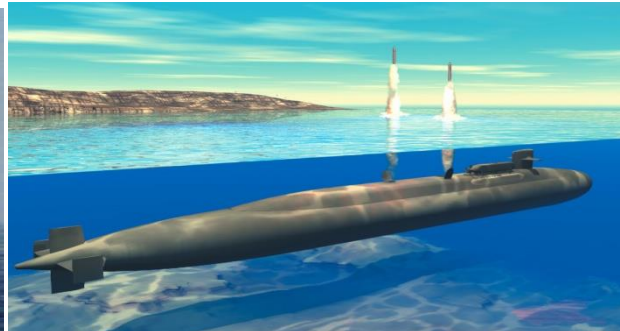


Fig 64: US Ohio Class missile Subs Launching missile²⁷⁰

BALLISTIC MISSILE SUBMARINES

48. These large submarines, commonly referred to as "Boomers," are notable for their capacity to carry nuclear-armed ballistic missiles. These missiles are typically equipped with Multiple Independent Reentry Vehicles (MIRVs), allowing them to potentially target numerous locations simultaneously. Additionally, these submarines are equipped with torpedoes, primarily used for self-defense, although they are not exclusively conventional-tipped. NATO designates submarines equipped with ballistic missiles as SSBNs. The primary purpose of an SSBN is to remain concealed until it receives orders to launch its missiles. Submarines at sea have an advantage in terms of concealment compared to large, stationary land-based installations. Maintaining silence and remaining undetected are of utmost importance. In the unfortunate event of a nuclear attack on a country, SSBNs would be prepared to launch retaliatory strikes at a later time. Currently, five nations operate Boomers: the United States, Russia, Britain, France, and China. The US and Russian fleets, in particular, have provided a fertile ground for fictional portrayals due to the dramatic potential inherent in the confined environment of a submarine capable of initiating worldwide destruction. There are few examples of SSBN patrol and coastal-defense submarines.

- a. The Soviet Akula/Typhoon class consists of six highly recognizable and exceptionally large submarines, making them the largest ever constructed. Currently, one of these submarines remains in service in Russia, serving as a test platform.
- b. The USS Alabama, famously depicted in the movie *Crimson Tide*, is a genuine member of the US Ohio Class submarine fleet.
- c. The backbone of the Soviet Russian ballistic missile submarine fleet comprises the submarines of the Defn class, also known as Delta III/IV, as designated by NATO.
- d. The Columbia-class submarines, previously referred to as the Ohio Replacement Submarine and SSBN-X Future Follow-on Submarine, are a forthcoming series of nuclear-powered ballistic missile submarines intended to replace the Ohio-class vessels in the United States Navy. Construction of the first submarine commenced on October 1, 2020, and it is scheduled to be commissioned into service in 2031.²⁷¹ Consequently, the Ohio Class submarines are expected to remain in active service until 2031.²⁷²



Fig 65: USS Sam Rayburn: hatches for her Polaris missiles²⁷³ Fig 66: A Russian Project 941 (Typhoon class) SSBN²⁷⁴

Aircraft carrier	Cruiser	Ballistic Missile Submarines	Fleet Tanker	Large Patrol Craft
Amphibious assault ship	Destroyer	Guided Missile Submarines	Hospital ship	Patrol Craft
Escort aircraft carrier	Frigate	Nuclear Attack Submarines	Survey, Research ship	Submarine chaser
Amphibious transport dock ship	Littoral Combat Ship	Air Independent Submarines	Fleet Cargo Ship, Aircraft Ferry	Patrol Boat
Dock landing ship	Corvette	Diesel-Electric Submarines	Combat Store Ship, Combat Support Ship	Missile Boat
Battleship	Offshore Patrol Vessel	Conventional Submarine	Submarine, Seaplane, Destroyer tender	Torpedo Boat
Dreadnought	Minesweeper	U-Boat	Intelligence Gathering Vessels	Gunboat
Battle-cruiser	Minelayer		Self-propelled Barracks Ship	PT Boat

Table 2: Different types of modern warship

WARSHIP DESIGNING AND MODERN SHIP CONSTRUCTION PROCESS

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49. Ship design is a complex and iterative process that aims to fulfill a variety of techno-economic requirements, which can sometimes be conflicting. The design process typically involves four stages, namely concept design, preliminary design, contract design, and detail design. The initial two stages, concept design and preliminary design, are collectively referred to as basic design.²⁷⁵ During the concept design stage, a series of calculations and analyses are conducted to generate documentation and models that outline the essential specifications for constructing the ship. This phase is of utmost importance as it ensures that the ship meets the client's requirements for commercial vessels or fulfills the intended purpose for naval ships. It serves as a vital link in the design process, translating the client's demands or mission objectives into tangible naval architectural and engineering features. Naval shipbuilding and the development of conceptual solutions typically involve several overarching processes to prepare for the design phase.²⁷⁶ Those are included:

- a. Ships function and mission.
- b. Principle dimensions associated with purpose, mission, roles and local restriction.
- c. Ships basic features and concept design.
- d. Primary calculations to ensure compliance of Class Rules, applicable of conventions and international regulations.
- e. Construction of ship in accordance with suitable and sustainable technical procedures with safety standards, regulations, and methods.
- f. Selection of propulsion and machinery package according to desire speed, purpose and mission.
- g. Selection of material, equipment, systems and other essentials to solve the assigned task and ensure habitability of the naval platform.
- h. Selection of armament, gun, missile, torpedo, sensor, combat system, command and control system, etc as to accomplish the assigned mission and task of the naval platform for warship

50. The functions related to ship modeling are distributed across various applications to accommodate the mentioned constraints. Each application is utilized independently and repeatedly throughout different stages of the design process, such as concept design, basic design, detailed design, and production design.^{277, 278} Consequently, the shipbuilding process can be divided into distinct design and manufacturing stages. The design stage further comprises contract design, which involves negotiations with the ship owner, basic design to meet the owner's requirements, and detailed design from a functional perspective. On the other hand, the manufacturing process encompasses pre-processing, fabrication, assembly, precedence outfitting, painting, block erection, out-fitting, and other intricate processes that occur over an extended period.²⁷⁹ Figure 1 illustrates the shipbuilding process, which may vary and introduce complexity based on the owner's requirements, distinguishing it from other conventional processes.

51. Shipbuilding is a comprehensive process that encompasses intricate design and production aspects. Designers follow a set of stages during the design phase, while shipyards implement specific stages during the production phase to transform the design into an actual ship.²⁸⁰ Over time, the shipbuilding industry has evolved to construct ships with steel hulls and structures, but alternative materials like metal alloys have also been introduced. For instance, aluminium alloys are widely used in the construction of lightweight, small-sized vessels, while special metals like titanium are employed in specific cases. Figure 2 illustrates the stages of the shipbuilding process. Ship design takes into consideration various factors, including the availability and suitability of materials, limitations and capabilities of the shipyard, structural design requirements, appropriate hull form, use of identical components in structural connections, efficient utilization of shipyard and ship facilities, material and work content minimization, ease of transport, storage, and assembly, as well as facilitating the erection of assemblies and components. Advanced outfitting processes and minimizing welding and cutting are also considered in the design process to optimize efficiency.²⁸¹

52. **Digital Model Approach.** Due to programmatic, organizational, and technical factors, the Navy has traditionally relied on physical prototypes as a key component of its platform design approach. These physical prototypes serve the purpose of testing operational concepts specific to the platform, with less emphasis on integration with other systems. While physical prototyping is essential for effective material design, it falls short in providing crucial information necessary for fulfilling concepts like distributed maritime operations, which require seamless integration of sensors and shooters across different times and locations. The Navy's legacy approach also involves document-based systems engineering, which generates static design artifacts such as drawings, specification

documents, and test plans. In order to comply with regulatory, statutory, or component requirements, numerous design documents, approximately one hundred, are typically produced within the Defense Acquisition System. The accumulation of these document libraries becomes cumbersome and poses significant challenges for integrated product teams when decisions need to be made, often resulting in rows of bookshelves filled with documents.

53. Digital engineering utilizes models and authoritative data to effectively coordinate and integrate all disciplines and phases of work throughout the entire life cycle of a platform or system. By employing a central digital model, design teams have access to a single source of truth that ensures consistency and integration. These digital models can simulate real-world physics and conditions, or they can be functional models designed to explore various system configurations. This model-based approach offers engineers and acquisition professionals the ability to evaluate designs in a digital environment with a high level of accuracy before investing in costly physical prototypes. The comprehensive integration of digital design played a crucial role in the success of the US Navy's Virginia-class submarine program. The use of computer-aided design (CAD) software²⁸², enabled the creation of geometric models that facilitated tasks such as piping arrangement, maintenance task analysis, and the arrangement of physical objects. However, it's important to note that CAD is just one tool within the broader digital transformation toolkit, typically employed after system requirements have been defined and the system's basic form has taken shape. While CAD models are highly valuable, they lack the capability to facilitate trade-offs in the same way as an integrated digital model.



Figure 67:
Modular
construction
of modern
submarine²⁸³
(Virginia-class nuclear
power
submarine of
the US
Navy)²⁸⁴

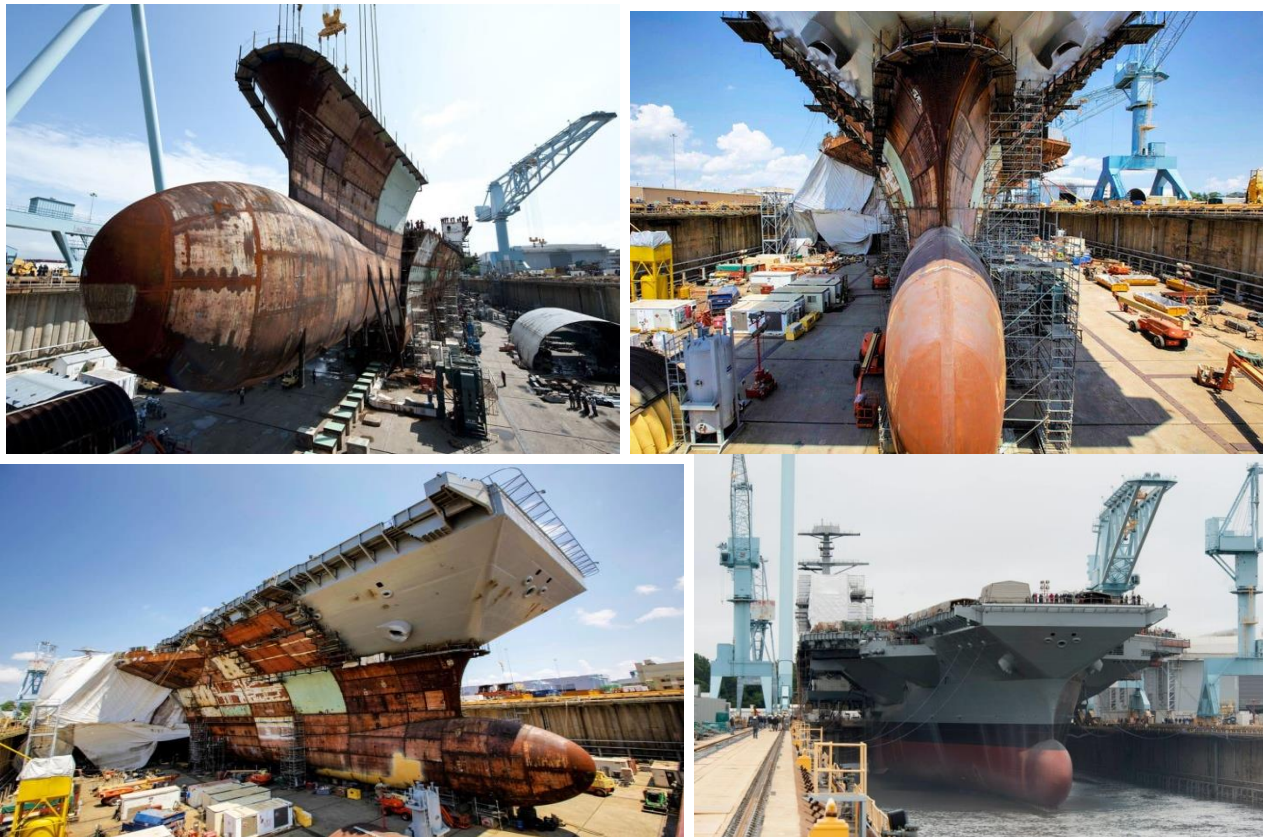


Figure 68: Modular construction of modern aircraft carrier (Aircraft Carrier Gerald R Ford Class CVN 78 of the US Navy)²⁸⁵

AMAZING TECHNOLOGY OF SUBMARINE

54. The modern nuclear-powered submarine boasts a crew of less than 200 individuals, comparable to an infantry company. However, these highly skilled submariners possess an incredible amount of power and hold the ability to command the seas or even bring about the destruction of an entire civilization. This concentration of power is made possible through various cutting-edge technologies, including rocketry, acoustics, hydrodynamics, nuclear power, advanced chemistry, and unique materials. Unlike other military innovations of the 20th century such as tanks, aircraft, and nuclear explosives, submarines still maintain their reputation as a truly secretive and stealthy service²⁸⁶. Currently, the US Navy focuses on the construction of one type of submarine, the versatile Virginia Class, which will soon be joined by the Columbia Class ballistic missile submarine. In contrast, Russia is concurrently building six distinct classes of submarines, with many already operational and others in different stages of construction at Russian shipyards. By the year 2040, Russia is expected to possess an exceptionally formidable submarine force.²⁸⁷ Meanwhile, China continues to enhance its navy and military capabilities through new innovations and surprises on a daily basis. To gain a deeper understanding of the history and operations of submarines, refer to the accompanying video.²⁸⁸

55. Conventional submarines face a significant challenge due to the limited energy capacity of their electric batteries. This limitation allows them to remain submerged for only a few days at low speeds or a few hours at high speeds. However, air-independent propulsion submarines²⁸⁹ have made significant advancements in addressing this constraint. Nuclear-powered submarines, which are not necessarily equipped with nuclear weapons, offer substantial advantages and operational capabilities over conventional diesel-electric submarines. Nuclear propulsion is completely independent of air, enabling submarines to stay submerged for extended periods without the need for frequent surfacing as required by conventional submarines. Nevertheless, due to the high cost associated with nuclear technology, only a select few of the world's military powers possess nuclear submarines. Incidents and accidents involving radiation have occurred on Soviet Navy submarines, while the US Navy has successfully operated its nuclear submarines without any incidents or accidents since the commissioning of the USS Nautilus in 1954.²⁹⁰

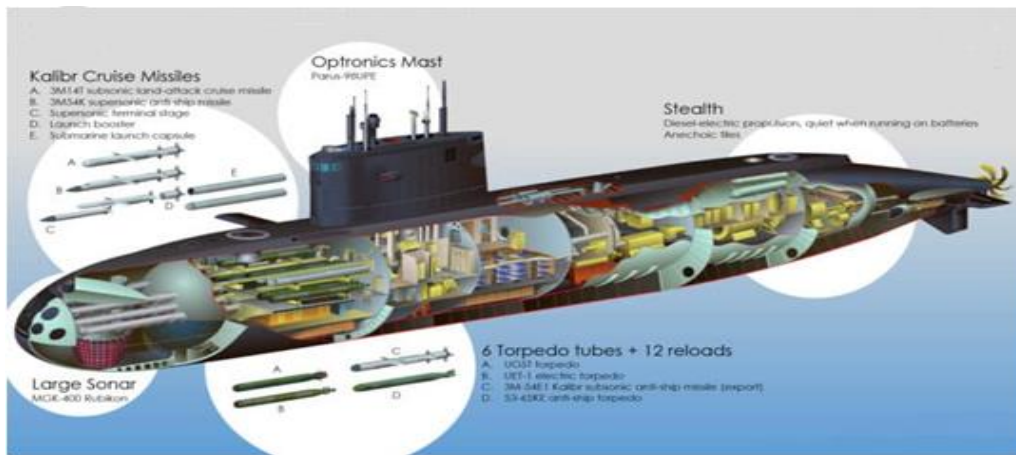


Figure 69: Russian Navy Kilo class submarine 3D view²⁹¹

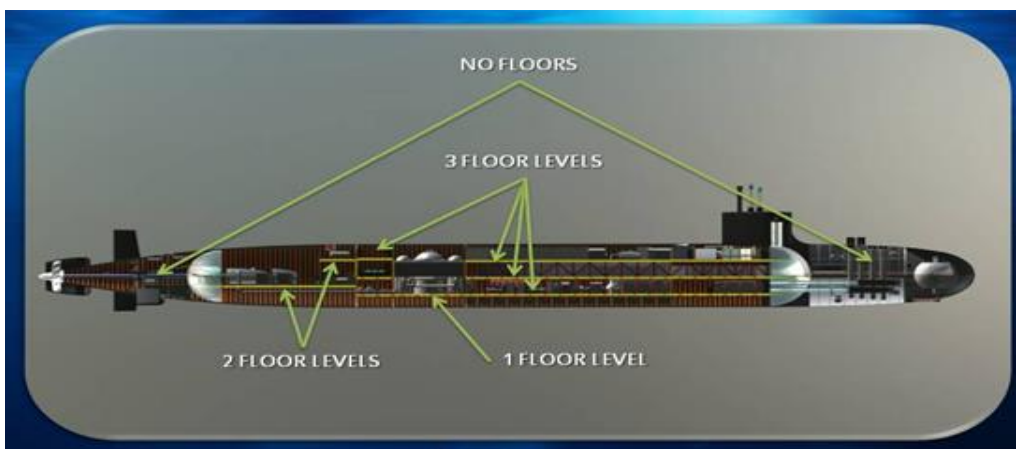


Fig 70: US Navy Virginia class nuclear submarine modular hull construction²⁹²

56. Nuclear ballistic-missile submarines are widely recognized as powerful strategic weapons, primarily due to their remarkable capability to remain submerged for extended periods and remain hidden under arctic ice for months. These submarines operate with exceptional stealth and are extremely challenging for the enemy to detect. The world witnessed the construction of its first nuclear-powered submarine following the successful development of a nuclear propulsion plant by a dedicated group of scientists and engineers at the Naval Reactors Branch of the Bureau of Ships and the Atomic Energy Commission. The key distinction between nuclear and conventional submarines lies in their power generation systems. Nuclear submarines utilize nuclear reactors to generate electricity, which in turn powers electric motors connected to the propeller shaft or produces steam to drive steam turbines.²⁹³ However, maintaining the stealth aspect of nuclear propulsion even when the submarine is stationary poses a significant challenge. This necessitates the cooling of the reactor to dissipate approximately 70% of its generated heat into seawater. Consequently, a thermal wake or plume of warm water is created, rising to the surface and potentially detectable by thermal imaging systems. Additionally, the continuous operation of the reactor generates steam noise that can be detected by passive sonar. Furthermore, the large size and capacity of the reactor pump introduce additional noise when circulating reactor coolant. In contrast, conventional submarines operate with almost complete silence by utilizing their electric motors.²⁹⁴ These factors contribute to the distinctive characteristics and considerations associated with nuclear-powered submarines.

57. Currently, the US Navy possesses a fleet of 18 Ohio-class nuclear submarines, which includes 14 ballistic missile submarines (SSBNs) and 4 cruise missile submarines (SSGNs). These submarines hold the distinction of being the largest ever built for the US Navy, with a submerged weight of 18,750 tons. While they rank as the world's third-largest submarines, they are surpassed in size only by the Russian Navy's Typhoon class (48,000 tons) and Borei class (24,000 tons) submarines. The Ohio-class submarines boast an impressive capacity to carry 14 Trident missiles, each loaded with three thermonuclear warheads. This means that a single submarine has the capability to effectively neutralize any target below the level of a major nuclear power.²⁹⁵ In addition, the Ohio-class submarines

can accommodate more missiles than both the Borei and Typhoon classes.²⁹⁶ As part of the US nuclear triad, the SSBN submarines are armed with up to 24 Trident II submarine-launched ballistic missiles (SLBMs). On the other hand, the SSGN submarines can carry a maximum of 154 Tomahawk cruise missiles and can also launch Harpoon missiles through their torpedo tubes. The decommissioning of the first Ohio-class SSBN is scheduled for 2029. The Columbia-class, which was officially designated on December 14, 2016, is expected to be commissioned in 2031,²⁹⁷ replacing the Ohio-class submarines.

58. The US Navy has developed and currently operates the Virginia Class, a highly advanced nuclear-powered fast attack submarine (SSN). Its primary purpose is to replace the aging fleet of Los Angeles Class attack submarines while offering a cost-effective and adaptable multi-mission stealth platform for theater commanders. The Virginia Class submarines have been specifically designed to excel in various war-fighting missions, with a particular focus on littoral operations, and they incorporate several innovative features that significantly enhance their capabilities. One notable feature of the Virginia Class SSNs is the fly-by-wire ship control system, which improves the submarine's maneuverability in shallow waters. Additionally, they have specialized features to support special operation forces, such as the ability to reconfigure the torpedo room to accommodate a large number of personnel and equipment for extended missions, as well as future off-board payloads. The class also includes a spacious lock-in/lock-out chamber for divers. By replacing traditional periscopes with two Photonics Masts equipped with color, high-resolution black and white, and infrared digital cameras mounted on telescoping arms, the Virginia Class SSNs have enabled the ship's control room to be relocated lower and away from the hull's curvature. This results in more space and a better layout, enhancing the commanding officer's situational awareness. Furthermore, the Virginia Class submarines are designed to remain technologically advanced throughout their operational life. This is achieved through modular construction, open architecture, and the use of commercial off-the-shelf components. Such an approach enables the rapid integration of new systems and payloads, ensuring that the submarines maintain a high level of capability and relevance throughout their service. Overall, the Virginia Class submarines represent a highly advanced and versatile platform that enhances US national security by providing theater commanders with a robust and effective means to carry out a wide range of war-fighting missions. Operation of US Virginia class submarine has been shown in those two video.^{298, 299}

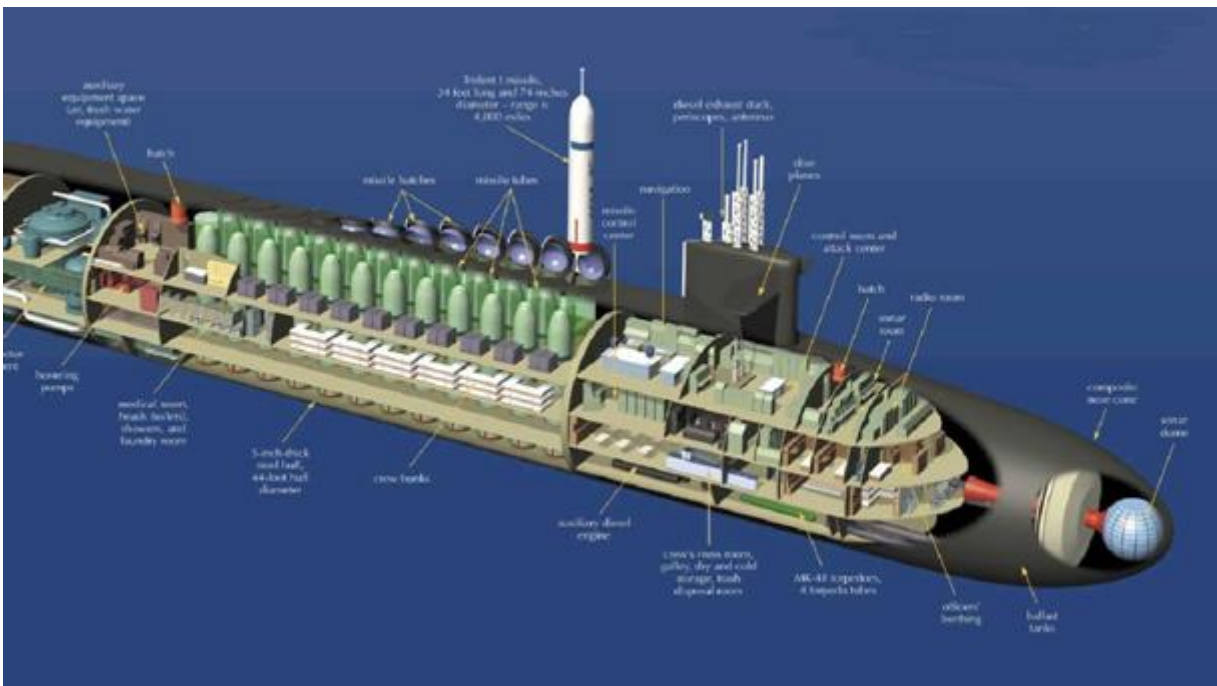


Fig 71: US Navy Ohio class nuclear-powered submarine with single hull design³⁰⁰

59. Since its commissioning in 2004 with USS Virginia (SSN 774), the design of the Virginia Class submarine has been continuously evolving. With each successive block of the Virginia Class SSNs, the design incorporates additional capabilities and advanced technology while also reducing costs.

The initial two blocks of the Virginia Class submarines feature a vertical launch system (VLS) in the bow, allowing for the deployment of 12 Tomahawk missiles, similar to the preceding Los Angeles-class attack submarines. However, the most significant design change to the Virginia Class submarines comes with Block V, which introduces the Virginia Payload Module (VPM). This incorporates an 84-foot section into the existing submarine design, housing four large-diameter payload tubes capable of carrying seven Tomahawk missiles each. The introduction of VPM-equipped submarines offers a cost-effective solution to restore the US Navy's undersea strike capacity, which is projected to decrease by 60% with the retirement of the Ohio Class SSGN force by 2028. The first VPM-equipped submarine was constructed in 2019. The open architecture design of the VPM enables the submarine to accommodate a wide range of capabilities, including various weapons, unmanned systems such as Large Displacement Unmanned Undersea Vehicles, seabed sensors, and other undersea capabilities. As the global threats to national security continue to evolve, the submarine industrial base remains committed to delivering submarines that enable the US Navy to effectively meet these challenges.³⁰¹ While the Virginia Class submarines may not be the Navy's newest design, continuous upgrades and the integration of new technologies ensure that each block of the Virginia Class submarines is progressively more capable than its predecessors.



Fig 72: US Navy Virginia Class nuclear submarine with single hull design³⁰²

60. The US Navy's ballistic missile submarines possess the capacity to carry a significant number of intercontinental missiles, some of which can house multiple warheads. These missiles are substantial in size, and a single submarine is capable of accommodating over 100 nuclear warheads. These submarines are primarily designed for silent and covert operations, and their main purpose is not typically engaging surface ships or other submarines. However, they may carry smaller missiles and torpedoes for self-defense. The Soviet Navy developed a double hull design, which allowed for a broader body and increased missile capacity. This design features two cylindrical inner hulls placed side by side, connected to reinforce the submarine's structure. Soviet/Russian submarines have crew compartments made of titanium and interconnected spheres, enabling them to dive to depths that most military submarines cannot reach. On the other hand, the US prefers smaller ballistic missile submarines, known as Boomers, with smaller missiles and hulls. Ballistic missile submarines play a crucial strategic role, while hunter/killer or attack submarines are more tactically employed, such as safeguarding carrier fleets or tracking down enemy submarines and surface ships. These submarines are smaller, faster, and equipped with powerful sensors. They do not require a large missile capacity but may carry smaller nuclear missiles or torpedoes. During World War II, Japan developed a side-by-side hull design intended for carrying and launching bombers, which facilitated a large and stable structure. Although these submarines never saw significant action, their purpose was to bomb the Panama Canal.³⁰³ Russia considers its nuclear weapons as the ultimate insurance policy against NATO intervention in Ukraine. At the Army 2022 defense expo, Rubin, the Russian submarine design bureau, unveiled the latest design for a ballistic missile submarine named 'Arcturus.' This submarine showcases an angled outer hull with sloping sides and streamlined contours, resembling modern low-observable aircraft. The design aims to enhance the submarine's stealth capabilities and ability to deflect incoming active sonar, similar to other designs like the German-designed Type-212CD³⁰⁴ and the British Dreadnought Class ballistic missile submarine.³⁰⁵ Russian nuclear power submarine operation has been shown in this video.³⁰⁶

61. The United States has a rich history of submarines, dating back to the Turtle, the world's first combat-worthy submersible.³⁰⁷ The development of U.S. Navy submarines is depicted in Figure 70, illustrating the chronological progression. Today, the U.S. Navy boasts the largest and most advanced submarine fleet worldwide. The U.S. Navy operates three main types of submarines: ballistic missile submarines, attack submarines, and cruise missile submarines.³⁰⁸ All submarines in the U.S. Navy are powered by nuclear energy. Ballistic missile submarines are dedicated to carrying nuclear submarine-launched ballistic missiles for strategic purposes. Attack submarines have diverse tactical missions, including engaging enemy ships and submarines, launching cruise missiles, and conducting intelligence operations. Cruise missile submarines perform similar tasks to attack submarines but emphasize their capability to carry and launch larger quantities of cruise missiles.³⁰⁹ The U.S. Navy's undersea fleet surpasses the surface fleets of most other nations across the globe.³¹⁰ Figure 71 provides a visual representation of the six dozen nuclear-powered submarines that make up the U.S. Navy's operational force. The graphic showcases 18 Ohio-class submarines at the top, which were constructed in the 1980s. While 14 of these Ohio-class vessels remain dedicated to nuclear deterrence missions, 4 have been converted to carry 154 Tomahawk land attack cruise missiles³¹¹ due to arms control agreements. In the middle of the graphic are the three Seawolf-class attack submarines. These submarines were designed during the Cold War to engage deep-diving Soviet submarines and operate in polar ice conditions. The Seawolf-class submarines are large, heavy, and highly capable attack submarines, primarily tasked with hunting down and neutralizing enemy submarines and surface vessels.³¹² The remaining submarines in the graphic represent the 48 Los Angeles- and Virginia-class nuclear attack submarines. These submarines also carry Tomahawk cruise missiles for land attack operations and are an integral part of every deployed U.S. carrier battle group, responsible for detecting and eliminating enemy submarines. The number of submarines in the U.S. fleet is subject to change, as two new Virginia-class submarines are added each year, while older Los Angeles-class submarines are retired. However, by 2029, the Ohio-class submarines will be replaced by the new Columbia-class ballistic missile submarines,³¹³ which are currently under development.

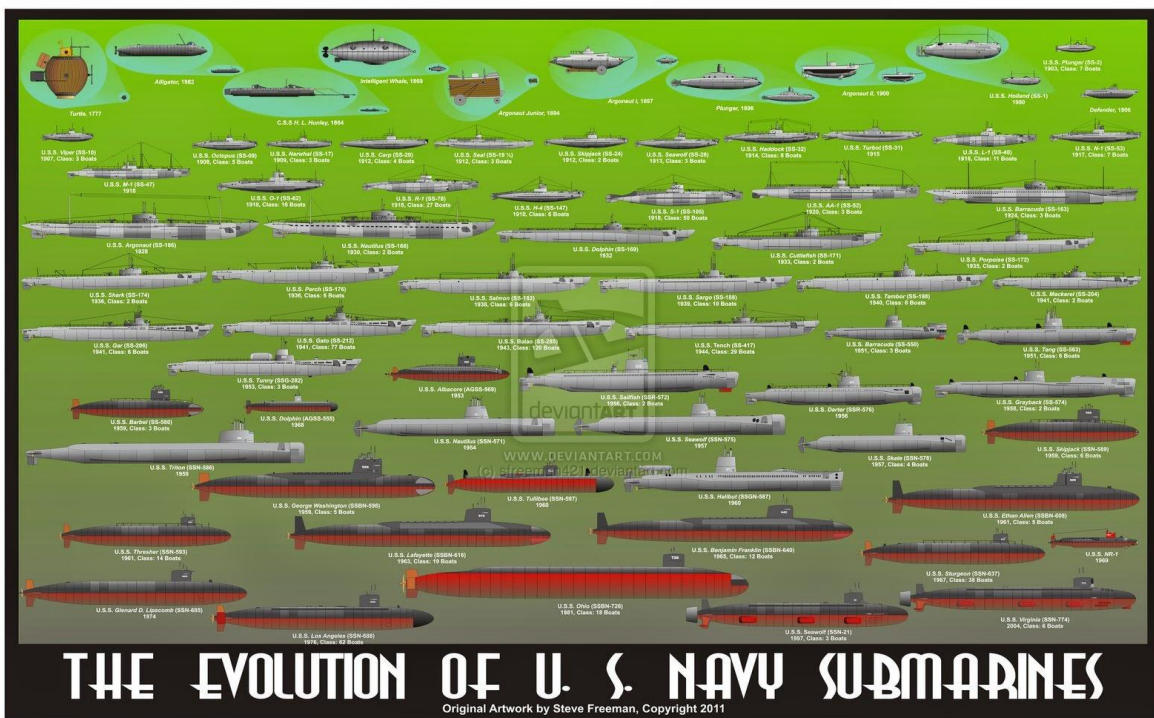


Fig 73: Chronological Development of different Types, Class and Size of Submarines of US Navy³¹⁴

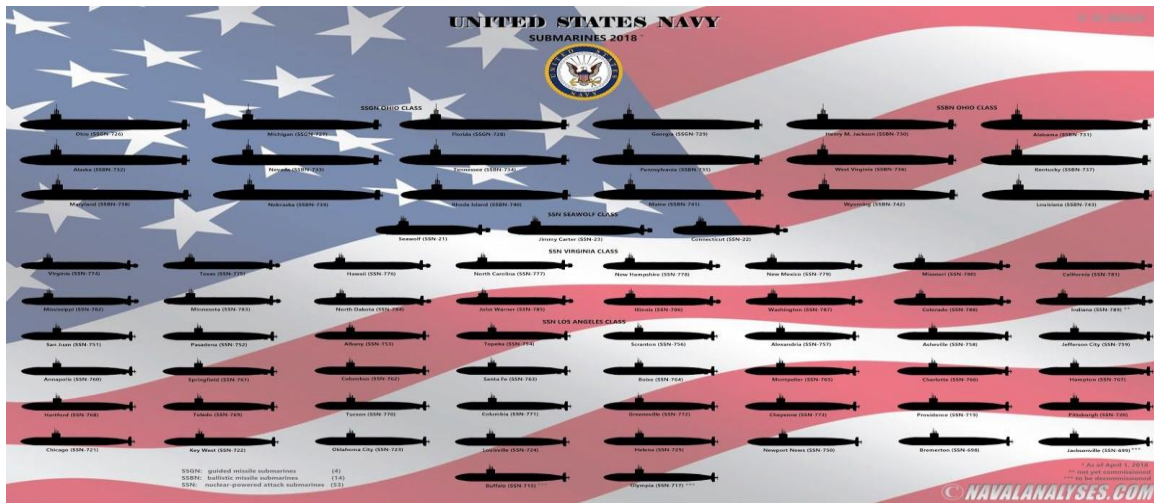


Fig 74: All the fighting submarine of US Navy³¹⁵

AMAZING TECHNOLOGY OF AIRCRAFT CARRIER

62. An aircraft carrier refers to a battleship that serves as a floating airfield, equipped with a full-length flight deck and facilities for aircraft storage, loading, deployment, and recovery.³¹⁶ Historically, the carrier has taken the place of battleships as the centerpiece of a powerful naval fleet from both tactical and strategic perspectives. Its ability to operate in foreign waters is among its many advantages. Essentially, an aircraft carrier is a unique and versatile floating airport. Former U.S. Secretary Henry Kissinger famously described an aircraft carrier as equivalent to 100,000 tons of diplomacy,³¹⁷ emphasizing its symbolic and influential role. The first successful takeoff from a platform on the deck of the U.S. cruiser Birmingham in Virginia was achieved by Eugene Ely, a civilian pilot, on November 30, 1910. Subsequently, on January 18, 1911, Ely utilized arresting wires connected to sandbags on a specially constructed platform aboard the battleship Pennsylvania in San Francisco Bay. The British Navy also conducted carrier experiments, leading to the construction of HMS Argus, a modified merchant ship hull that became the first operational carrier with an unobstructed flight deck. Although the Argus was not deployed in combat due to the conclusion of World War I, both the United States and Japan quickly adopted the British carrier model. In March 1922, the USS Langley, a converted collier ship, became the first American aircraft carrier in the fleet. The Japanese carrier Hosyo, planned and constructed from the ground up as an aircraft carrier, entered service in December 1922.³¹⁸ These milestones marked significant advancements in carrier technology and demonstrated the increasing importance of these vessels in naval operations.

63. Aircraft carriers can be classified based on the type of aircraft they accommodate and their operational roles. Serving as the flagship of a fleet, an aircraft carrier allows naval forces to project air power globally without relying on local bases for aircraft operations. On September 24, 1960,³¹⁹ the United States achieved a significant milestone by launching the world's first nuclear-powered carrier, the Enterprise. Alongside this development, there are also light carriers equipped with advanced electronic systems for submarine detection and helicopter carriers designed specifically for amphibious assault operations. Additionally, there has been a shift from outdated anti-aircraft armaments to missile-based systems. Another classification criterion for carriers is their versatility, with multipurpose carriers possessing multiple capabilities.³²⁰ Furthermore, carriers can be classified based on the methods employed for aircraft takeoff and landing. There are four primary classifications that align with the current practices of navies worldwide. Number of aircraft carrier are in operation under different navy has been shown in this video.³²¹

64. **Catapult-assisted takeoff barrier-arrested recovery (CATOBAR).** All existing CATOBAR (Catapult Assisted Take-Off But Arrested Recovery) carriers are powered by nuclear energy and are designed to accommodate the largest, heaviest, and most heavily armed aircraft.³²² Currently, there are twelve operational carriers of this type. The United States possesses eleven fleet carriers, which include ten Nimitz-class carriers, one Gerald R. Ford-class carrier, and one Charles de Gaulle-class carrier.

65. **Short takeoff barrier-arrested recovery (STOBAR).** These types of carriers are typically limited in their capacity to carry smaller, lighter fixed-wing aircraft with restricted payloads.³²³ An example of a STOBAR (Short Take-Off But Arrested Recovery) carrier is Admiral Kuznetsov, which is primarily designed for air superiority and fleet defense missions rather than extensive strike or

power projection capabilities.³²⁴ Currently, there are five operational carriers of this kind, with China, India, and Russia each operating two carriers.

66. **Short take-off vertical-landing (STOVL).** This type of carrier is primarily capable of accommodating aircraft with short take-off and vertical landing (STOVL) capabilities. These aircraft are often characterized by their smaller payloads, lower performance capabilities, and higher fuel consumption compared to other types. However, modern STOVL aircraft, such as the Lockheed Martin F-35B Lightning II,³²⁵ exhibit significantly improved performance. Currently, there are a total of fourteen carriers of this type in service. The United States operates nine STOVL amphibious assault ships, while the United Kingdom and Italy each operate two, and Spain operates one.

67. **Helicopter carrier.** Helicopter carriers share a similar appearance to other aircraft carriers but have a distinct purpose of exclusively transporting helicopters.³²⁶ Some of these carriers are categorized as amphibious assault ships,³²⁷ which are designed to land on hostile territory and provide support to ground forces. The presence of helicopter carriers significantly enhances a nation's ability to engage the enemy at sea. These vessels offer a more affordable and compact alternative to traditional carriers. They serve various roles, including supply operations, search and rescue (SAR), medical evacuation (MEDEVAC), submarine detection, combat surveillance, personnel insertion/extraction, and general reconnaissance.³²⁸ Currently, there are a total of seventeen operational carriers of this type. Japan operates four,³²⁹ France and Australia each operate three, China, Egypt, and South Korea each operate two, and Brazil and Thailand each operate one.

68. The accompanying video showcases^{330, 331} the current active aircraft carriers and provides key information about them. Additionally, it highlights ten upcoming aircraft carriers that are expected to be commissioned in the near future. The Gerald R. Ford (CVN 78)³³² stands out as the latest and most technologically advanced nuclear-powered aircraft carrier ever constructed for the US Navy. This carrier will eventually replace the Enterprise (CVN-65) and the existing Nimitz-class carriers. While the new ships' hulls bear similarities to the Nimitz class, they incorporate numerous cutting-edge innovations.³³³ The implementation of automation has reduced the crew size, resulting in lower overall costs throughout the lifespan of the Gerald R. Ford-class ships. These carriers are designed to support a minimum of 160 sorties per day for 30 days, with a surge capacity of 270 sorties per day. Equipped with state-of-the-art technology, the new Gerald R. Ford-class carriers will facilitate 25% more sorties, generate three times the power with improved efficiency, and enhance the quality of life for the crew. These aircraft carriers feature advanced nuclear reactor architecture for increased power generation and have the capacity to accommodate up to 90 aircraft. The construction and maintenance of such carriers involve significant investments in the billions of dollars. It is worth noting that modern helicopter carriers offer nations a unique and cost-effective capability at sea.³³⁴ However, in CVN 78, traditional steam catapults are being replaced with Advanced Arresting Gear and the Electromagnetic Aircraft Launch System (EMALS)³³⁵ for aircraft launch and recovery operations.

69. The design and construction of the Gerald R. Ford class aircraft carriers were undertaken by Newport News Shipbuilding, utilizing a comprehensive 3D dimensional product model created in the CATIA simulator by Dassault Systems.³³⁶ The design of the CVN 78 class incorporated improved pathways for weapons mobility, significantly reducing horizontal ship motions that would require additional human resources. Newport News Shipbuilding, located in Newport News, Virginia, and a division of Huntington Ingalls Industries (formerly Northrop Grumman Shipbuilding), was responsible for assembling the carrier. This shipyard is the sole facility in the United States with the capability to construct nuclear-powered aircraft carriers. The total cost of designing and constructing the Gerald R. Ford carrier amounted to \$14 billion, with \$5 billion allocated to research and development and \$9 billion for construction.³³⁷ Figure 6 below showcases different stages of construction and the final product of the Gerald R. Ford aircraft carrier (CVN 78). Additionally, the provided videos offer a detailed look at the construction process of the USS Gerald R. Ford.^{338, 339}

70. On April 10, 2023, Turkey unveiled the world's first drone carrier and largest domestically built battleship. The TCG Anadolu, constructed at the Sedef shipyard in Istanbul, boasts impressive dimensions, measuring 231 meters (758 feet) in length and 32 meters (105 feet) in width. It has a capacity to transport up to 94 vehicles, including 13 tanks, along with combat helicopters and military drones.³⁴⁰ The video clip indicates that Turkey has modified the design of the Anadolu Landing Helicopter Dock (LHD) to accommodate a greater deployment of unmanned aerial vehicles (UAVs).³⁴¹ Recent satellite and open-source images, shared by USNI News contributor H I Sutton, reveal that Iran's sectarian naval force is converting a dry dock located at the entrance to the Persian Gulf into a drone aircraft carrier. The dry dock is being used to transform a former merchant container ship, Shahid Mahdavi, into a vessel capable of carrying both helicopter and fixed-wing unmanned aerial vehicles.³⁴² The conversion is taking place at the Iran Shipbuilding and Offshore Industries Complex Co (ISOICO) in Bandar Abbas, near the Strait of Hormuz. The Iranian drone carrier is based on the hull of a large cargo ship, measuring 240 meters in length. It is anticipated that vessels like Shahid Mahdavi and Shahid Bagheri will be built as part of this project.³⁴³ The development of advanced drones and drone carriers is underway for powerful navies such as the US, China, UK, France, and India.³⁴⁴ These countries are focusing on equipping future fleet carriers with a greater number of drones compared to manned

aircraft. To gain insights into the ten most potent and technologically advanced navies in the world, the provided link offers an intriguing video clip.³⁴⁵



Figure 75: Turkey unveils its first drone Carrier³⁴⁶ Iran is building drone aircraft carrier³⁴⁷



Fig 76: Construction stages and images of the latest nuclear powered aircraft carrier Gerald R. Ford(CVN 78) for US Navy^{348, 349}

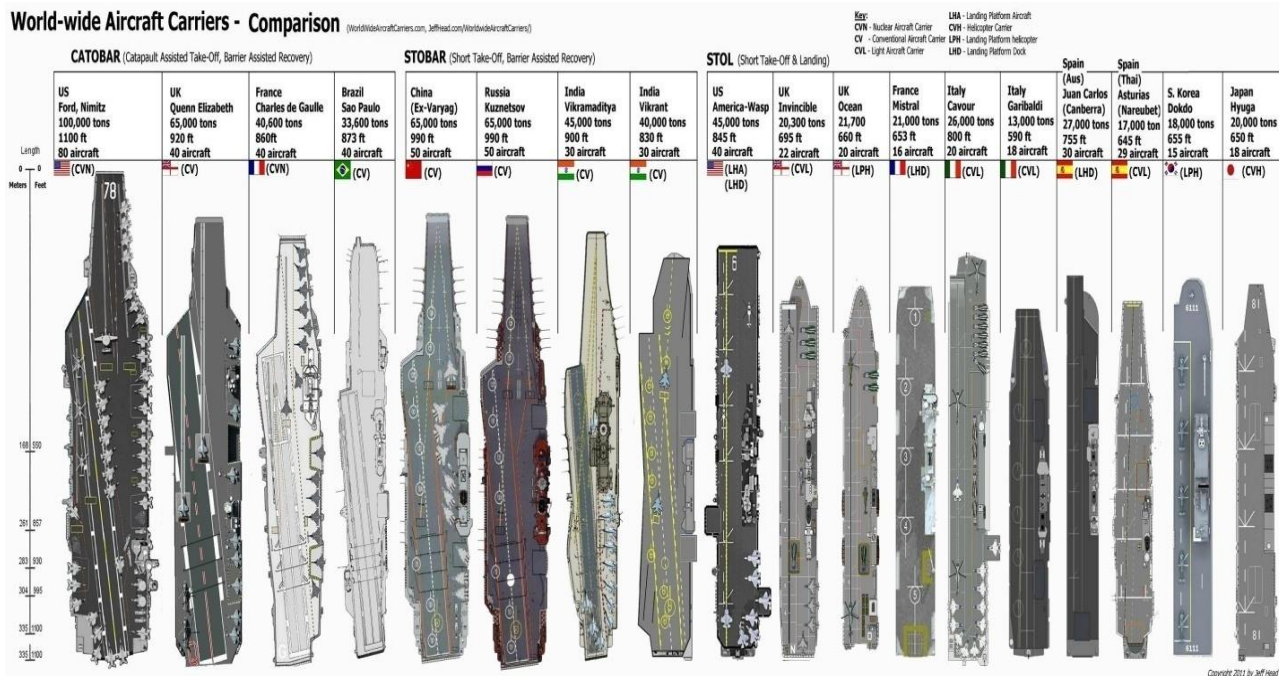


Fig 77: Different Types, Class and Size of Aircraft Carrier around the World³⁵⁰

CONCLUSION

71. Naval vessels are the result of a historical and technological progression stemming from wars, particularly World Wars I and II, as well as political strategies. They are constructed using methods distinct from merchant ships, with the purpose of carrying weaponry, ammunition, sensors, machinery, and supplies for the crew. These ships are designed to handle and utilize these resources effectively whenever necessary. Additionally, they are built to be faster than merchant ships and to withstand damage during emergency situations. The navy employs a diverse range of ships, each serving its own unique purpose and responsibilities. Across the globe, there are hundreds of navy ships, ranging from small vessels to enormous aircraft carriers. Modern navies utilize various types and classes of ships to fulfill their operational requirements. The most prominent and recognizable surface ships today include aircraft carriers, helicopter ships, amphibious assault ships, cruisers, destroyers, frigates, corvettes, offshore patrol vessels (OPVs), minesweepers, fast attack crafts (FACs), missile boats, and more. Among the most well-known and formidable sub-surface vessels are diesel-electric submarines, air-independent propulsion (AIP) submarines, guided missile submarines, ballistic missile submarines, and nuclear attack submarines. Auxiliary ships form the backbone of any naval fleet, and they come in a variety of types such as combat stores ships, ammunition ships, fast combat support ships, cargo and pre-positioned supply ships, rescue and salvage ships, fleet tankers, oil tankers, tender vessels, tugboats, hospital ships, and others.

72. Nuclear-powered ships and submarines are highly valuable naval platforms for powerful navies. These vessels possess the advantage of not requiring refueling during operations and have sufficient power for propulsion and electricity generation. Ship designations were predominantly established prior to the 1950s and 60s, categorized by size and role. However, with the advent of guided missiles, there was a significant shift in ship size and design. The disparity in range and combat capability between ships armed with conventional guns and those armed with guided missiles led to the inclusion of "G" in the designations, ensuring accurate classification by navies worldwide. Submarines serve as stealthy assets for naval forces, enabling them to engage enemy ships and deploy missiles. A nuclear-powered submarine can remain submerged on patrol for up to six months. Aircraft carriers, on the other hand, are colossal seaborne airbases utilized by the navy. Their primary function is to deploy aircraft for air combat operations, targeting airborne, surface, and shore objectives. Modern aircraft carriers are typically nuclear-powered but come with high construction and operational costs. As a result, the navy employs a diverse range of ships, each with its specific purpose and responsibilities.

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