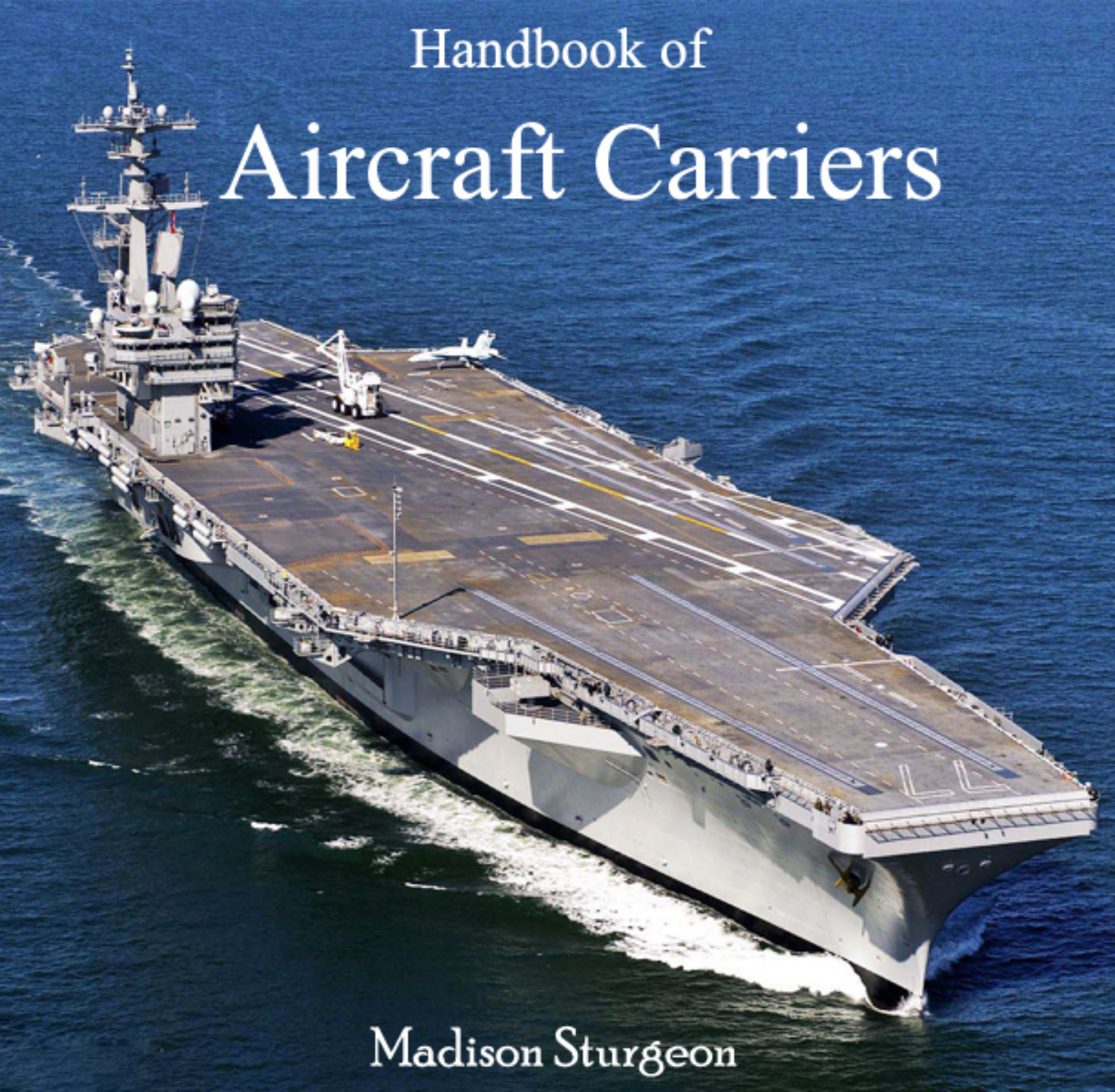
Handbook of Aircraft Carriers



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Introduction to Aircraft Carrier

From bottom to top: *Principe de Asturias*, amphibious assault ship USS *Wasp*, USS *Forrestal* and light V/STOL carrier HMS *Invincible*, showing size differences of late 20th century carriers

From foreground to background: HMS *Illustrious*, USS *Harry S. Truman*, and USS *Dwight D. Eisenhower*

An **aircraft carrier** is a warship designed with a primary mission of deploying and recovering aircraft, acting as a seagoing airbase. Aircraft carriers thus allow a naval force to project air power worldwide without having to depend on local bases for staging aircraft operations. They have evolved from wooden vessels, used to deploy balloons, into nuclear powered warships that carry dozens of fixed and rotary wing aircraft.

Future aircraft carriers

Several nations which currently possess aircraft carriers are in the process of planning new classes to replace current ones. The world's navies still generally see the aircraft carrier as the main future capital ship, with developments such as the arsenal ship, which have been promoted as an alternative, seen as too limited in terms of flexibility.

China

Varyag under tow in Istanbul

China bought the unfinished Soviet aircraft carrier *Varyag* in 2001 from Ukraine, supposedly to turn it into a floating casino. Pictures taken while in port suggest this plan has been abandoned and show that work is being carried out to maintain its military function. There is no conclusive evidence as to what role it would play in the Chinese Navy.

In late December 2008 and early January 2009, there were multiple reports of China building two conventionally powered aircraft carriers displacing 50,000–60,000 tonnes, possibly to be launched in 2015. In December 2010 China's State Oceanic Administration announced that this vessel would be finished one year earlier, in 2014. A nuclear powered carrier is planned for launch around 2020.

According to James Nolt, senior fellow at the World Policy Institute in New York, it might take China many years to develop the technology, training, and operational capability necessary for an effective carrier.

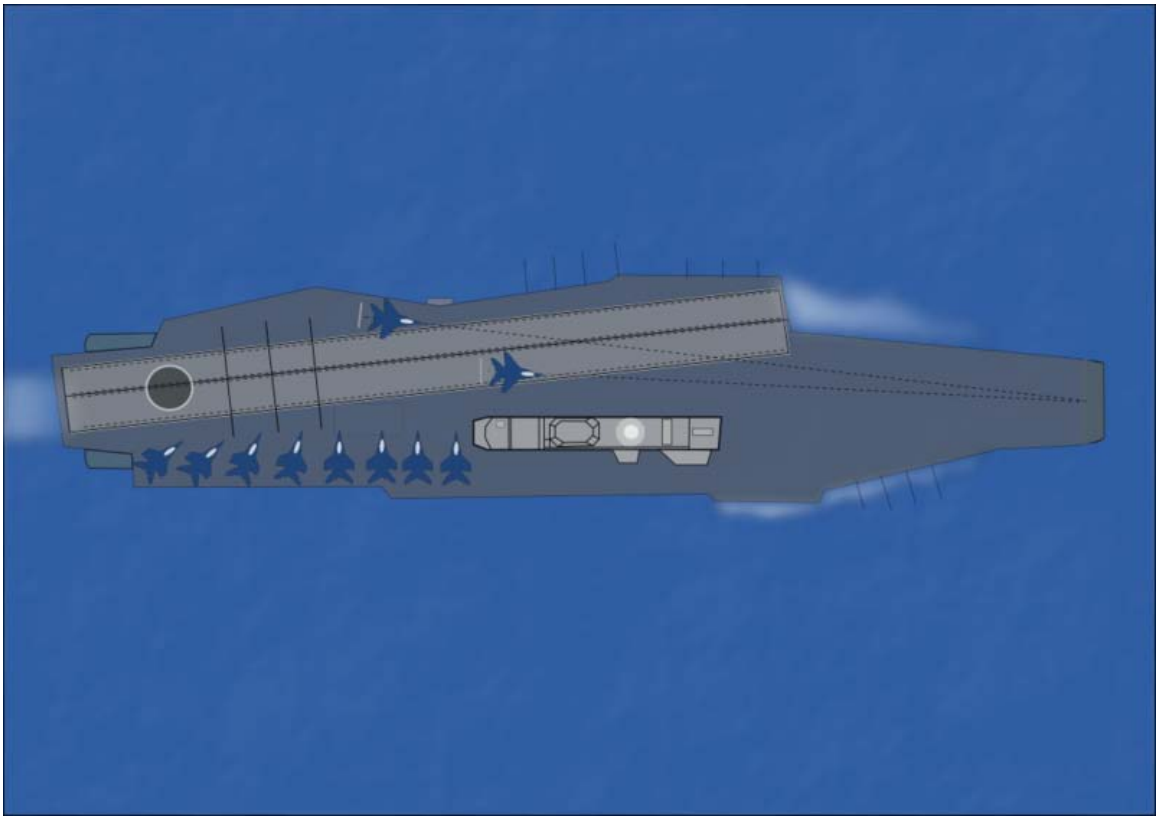
France

The French Navy has set in motion possible plans for a second CTOL aircraft carrier, to supplement *Charles de Gaulle*. The design would be much larger, in the range of 65–74,000 tonnes, and would not be nuclear-powered like *Charles de Gaulle*. There are plans

to base the carrier on the current Royal Navy design for CATOBAR operations. (The Thales/BAE Systems design for the Royal Navy is for a STOVL carrier which is reconfigurable to CATOBAR operations.)

On 21 June 2008, French President Nicolas Sarkozy decided to place France's participation in the project on hold. He stated that a final decision on the future of the French carrier would be taken in 2011 or 2012. British plans for two aircraft carriers will go ahead as planned and were in no way conditional on French participation.

India



Impression of the INS *Vikramaditya*, which is under refit for the Indian Navy

India started the construction of a 40,000-tonne, 260-metre-long *Vikrant*-class aircraft carrier in April 2005. The new carrier will cost US$762 million and will operate MiG-29K, Naval HAL Tejas and Sea Harrier aircraft along with the Indian-made helicopter HAL Dhruv. The ship will be powered by four turbine engines and will have a range of 8,000 nautical miles (14,000 km), carrying 160 officers, 1,400 sailors, and 30 aircraft. The carrier is being constructed by a state-run shipyard in Cochin. The ship is scheduled for commissioning in 2014.

As of December 2009, Navy chief Admiral Nirmal Verma said at his maiden navy week press conference that concepts currently being examined by the Directorate of Naval Design for the second indigenous aircraft carrier, the IAC-2, are for a conventionally

powered carrier displacing over 50,000 tons and equipped with steam catapults (rather than the ski-jump on the Gorshkov/Vikramaditya and the IAC) to launch fourth-generation aircraft.

In 2004, India agreed to buy the *Admiral Gorshkov* from Russia for US$1.5 billion. It is named INS *Vikramaditya*, and was expected to join the Indian Navy in 2008 after a refit. However, delays in the refit were announced in July 2007.

- INS Vikrant - decommissioned (1957–1997)
- INS Viraat - operational (1986–present)
- INS Vikramaditya - under construction
- Vikrant class aircraft carrier - under construction
- INS Vishal - planned

In July 2008, Russia increased the total price to US$3.4 billion because of unexpected cost overruns due to the deteriorated condition of the ship. In December 2008, India decided in favour of purchasing *Admiral Gorshkov* as the best option available. In February 2009, Russia asked for an additional $700 million over the originally contracted price for the completion of the reconstruction of the *Admiral Gorshkov*, bringing the total requested price to $2.9 billion. On 8 December 2009, it was reported that India and Russia ended the stalemate over Gorshkov price deal by agreeing on a price of US$2.2 billion.

Russia

Russian Navy Commander-in-Chief Admiral Vladimir Masorin officially stated on June 23, 2007, that the Navy was considering the specifications of a new nuclear aircraft carrier design for the class that was first announced about a month earlier. Production of the carriers is expected to start around 2010 at the Zvezdochka plant in Severodvinsk, where a large drydock, capable of launching vessels with more than 100,000 ton displacement, is now being built. In his statement, Admiral Masorin said that the general dimensions of the project have already been determined. The projected carrier is to have nuclear propulsion, to displace about 50,000 tons and to carry an air wing of 30–50 air superiority aircraft and helicopters, which makes her roughly comparable with the French *Charles de Gaulle*. "The giants that the US Navy builds, those that carry 100–130 aircraft, we won't build anything like that", said Admiral Masorin. The planned specifications reflect the role, traditional in the Russian Navy, of the aircraft carrier as an air support platform for guided missile cruisers and submarines.

The Russian naval establishment had long agreed, since the decommissioning of the *Kiev*-class carriers, that the only operational carrier, *Admiral Kuznetsov*, was insufficient, and that three or four carriers were necessary to meet the Navy's air support requirements. However, financial and organisational turmoil in the 1990s made even the maintenance of *Admiral Kuznetsov* a difficult undertaking. The improvement in Russia's economic situation after the year 2000 has allowed a major increase in defence spending. Admiral Vladimir Vysotsky announced on Navy Day 2008 that Russia plans to build five or six

carriers of the new design for deployment in the Northern and Pacific fleets, starting around 2012–2013. The new carrier groups are planned to be at full strength around 2050–2060. According to sources from the United Shipbuilding Corporation the new carriers will carry new fifth-generation fighters as well as unmanned aerial vehicles and have a displacement of up to 60,000 metric tons.

While planning for new carriers, and carrying out design projects, the Russian government has not committed to building the carriers. Russia's economic climate is not yet sufficient to allow the construction and support of additional carriers in the short term.

The Russian Navy expects to have a blueprint for the next generation aircraft carrier by the end of 2010.

Spain

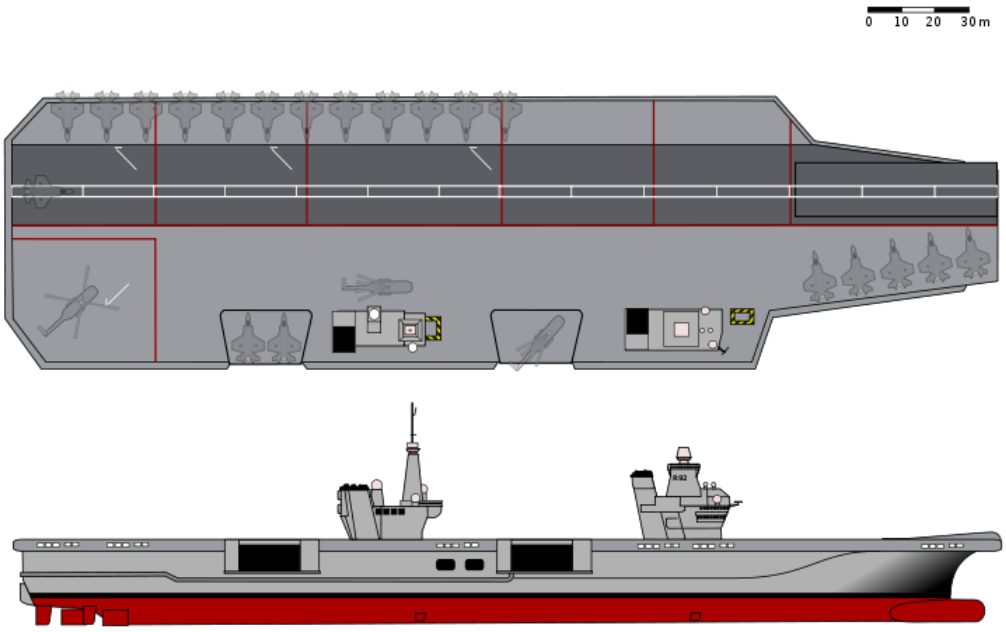
The 231-metre-long, 27,000 tonne *Juan Carlos I* for the Spanish Navy was approved in 2003, and its construction started in August 2005, with the shipbuilding firm Navantia in charge of the project. The ship was launched on 10 March 2008, and is due to be commissioned in 2011. *Juan Carlos I* is designed to operate both as an amphibious assault ship and as STOVL aircraft carrier, depending on the mission assigned. The design was made keeping in mind the low-intensity conflicts in which the Spanish Navy is likely to be involved in the future. When configured for air operations the ship will displace 24,660 tonnes and will be able to carry a mixed force of up to 30 aircraft comprising AV-8B+ Matadors, F-35s and helicopters. The ship is provided with a ski-jump and a three-dimensional radar-based combat system.

Japan

The JMOD FY2010 budget request included 116.6 billion Yen for a new 22DDH "helicopter destroyer" built to a design significantly larger than the 16DDH Hyuuga Class. The ship would eventually replace the destroyer Shirane, which was scheduled to be decommissioned in fiscal 2014.

It is designed to be a vessel which is conscious of the Chinese Navy, and to support civil disaster relief operation and the United Nations Peace Keeping Operations (PKO). The planned helicopter destroyer will have a length some 25% greater than the 197 meter 16DDH Hyuuga. At 248 meters [813 feet] the 22DDH is comparable to the Italian Cavour of 244 meters. The full-length aircraft carrier type deck extends from the bow to the stern. The light displacement was reported as 19,500 tons, a 44% increase over the 16DDH, while the full loaded displacement is probably comparable to the 27,000 ton displacement of the Italian Cavour.

United Kingdom



Impression of the *Queen Elizabeth*-class, two of which are under construction for the Royal Navy.

The Royal Navy has signed a deal to build two new larger STOVL aircraft carriers, the *Queen Elizabeth*-class, to replace the three *Invincible*-class carriers. The ships are to be named HMS *Queen Elizabeth* and HMS *Prince of Wales*. They will be able to operate up to 40 aircraft, and will have a displacement of around 65,000 tonnes. The two ships are due to enter service in 2016 and 2018 respectively, two years later than originally planned. Their primary aircraft complement will be made up of F-35C Lightning IIs, and their ship's company will number around 1450. The two ships will be the largest warships ever built for the Royal Navy. Although initially designed to be configured for STOVL operations, at least one of the carriers will be built to CATOBAR configurations to allow the F-35C to be operated, as announced in the 2010 Strategic Defence and Security Review.

United States

Artist's impression of the US *Gerald R. Ford*-class aircraft carrier

The current US fleet of *Nimitz*-class carriers are to be followed into service (and in some cases replaced) by the *Gerald R. Ford*-class. It is expected that the ships will be more automated in an effort to reduce the amount of funding required to maintain and operate its supercarriers. The main new features are implementation of Electromagnetic Aircraft Launch System (EMALS) (which replace the old steam catapults) and unmanned aerial vehicles.

With the decommissioning of the USS *John F. Kennedy* in March 2007, the U.S. fleet comprises 11 supercarriers. The House Armed Services Seapower subcommittee on July 24, 2007, recommended seven or maybe eight new carriers (one every four years). However, the debate has deepened over budgeting for the $12–14.5 billion (plus $12 billion for development and research) for the 100,000 ton *Gerald Ford*-class carrier (estimated service 2015) compared to the smaller $2 billion 45,000 ton *America*-class amphibious assault ships able to deploy squadrons of F-35B.

Chapter- 2

History of the Aircraft Carrier

Flight deck of HMS *Formidable* with battleship HMS *Warspite* in background (right), operations off Madagascar, April 1942

Aircraft carriers are warships that evolved from balloon-carrying wooden vessels into nuclear powered vessels carrying dozens of fixed and rotary wing aircraft. Since their introduction they have allowed naval forces to project air power great distances without having to depend on local bases for staging aircraft operations.

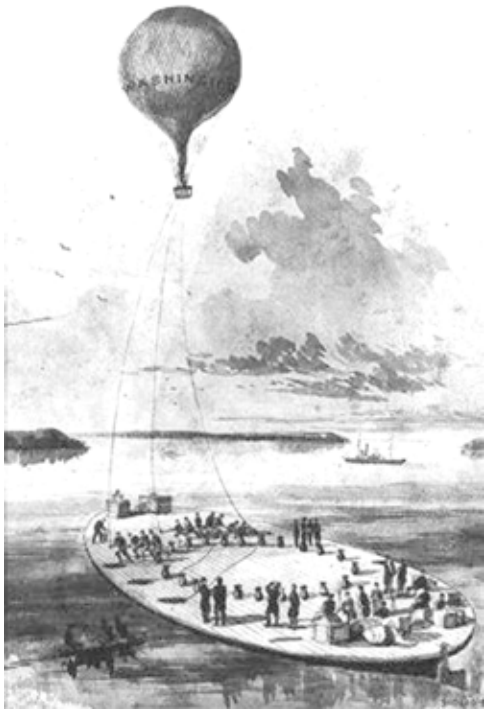
Balloon carriers were the first ships to deploy manned aircraft, used during the 19th and early 20th century, mainly for observation purposes. The advent of fixed wing aircraft in

1903 was followed in 1910 by the first flight from the deck of a US Navy cruiser. Seaplanes and seaplane tender support ships, such as HMS *Engadine*, followed. The development of flat top vessels produced the first large fleet ships. This evolution was well underway by the mid 1920s, resulting in ships such as the HMS *Hermes*, *Hōshō* and the *Lexington*-class aircraft carriers.

Most early aircraft carriers were conversions of ships that were laid down (or had even served) as different ship types: cargo ships, cruisers, battlecruisers, or battleships. During the 1920's, several navies started ordering and building aircraft carriers that were specifically designed as such. This allowed the design to be specialized to their future role, and resulted in superior ships. During the Second World War, these ships would become the backbone of the carrier forces of the US, British, and Japanese navies, known as fleet carriers.

World War II saw the first large-scale use of aircraft carriers and induced further refinement of their design, leading to several variants. Escort carriers, such as USS *Bogue*, were built as a stop-gap measure to provide air support for convoys and amphibious invasions. Subsequent Light aircraft carriers, such as USS *Independence*, represented a larger, more "militarized" version of the escort carrier concept. Although the light carriers usually carried the same size air groups as escort carriers, they had the advantage of higher speed as they had been converted from cruisers under construction.

Early history



The Union Army balloon *Washington* aboard the Navy barge *George Washington Parke Custis*

The earliest recorded instance of using a ship for airborne operations occurred in 1806, when Lord Cochrane of the Royal Navy launched kites from the 32-gun frigate HMS *Pallas* in order to drop propaganda leaflets. The proclamations against Napoleon Bonaparte, written in French, were attached to kites, and the kite strings were set alight; when the strings had burned through, the leaflets landed on French soil.

Just over 40 years later on 12 July 1849, the Austrian Navy ship *Vulcano* was used for launching early aircraft. A number of small Montgolfiere hot air ballons were launched with the intention of dropping bombs on Venice. Although the attempt largely failed due to contrary winds which drove the balloons back over the ship, one bomb did land on the city.

Later, during the American Civil War, about the time of the Peninsula Campaign, gas-filled balloons were used to perform reconnaissance on Confederate positions. The battles soon turned inland into the heavily forested areas of the Peninsula, however, where balloons could not travel. A coal barge, the *George Washington Parke Custis*, was cleared of all deck rigging to accommodate the gas generators and apparatus of balloons. From the barge Professor Thaddeus S. C. Lowe, Chief Aeronaut of the Union Army Balloon Corps, made his first ascents over the Potomac River and telegraphed claims of the success of the first aerial venture ever made from a water-borne vessel. Other barges were converted to assist with the other military balloons transported about the eastern waterways, but none of these Civil War crafts ever took to the high seas.

Balloons launched from ships led to the development of balloon carriers, or balloon tenders, during World War I, by the navies of Great Britain, France, Germany, Italy, Russia, and Sweden. About ten such "balloon tenders" were built, their main objective being aerial observation posts. These ships were either decommissioned or converted to seaplane tenders after the war.

The first seaplane carrier, the French *La Foudre* (right, with hangar and crane), with one of her *Canard Voisin* seaplanes taking off, during tactical exercises in June 1912

The invention of the seaplane in March 1910 with the French *Le Canard* led to the earliest development of a ship designed to carry airplanes, albeit equipped with floats: in December 1911 appears the French Navy *La Foudre*, the first seaplane carrier, and the first known carrier of airplanes. Commissioned as a seaplane tender, and carrying float-equipped planes under hangars on the main deck, from where they were lowered on the sea with a crane, she participated in tactical exercises in the Mediterranean in 1912. *La Foudre* was further modified in November 1913 with a 10 meter flat deck to launch her seaplanes.

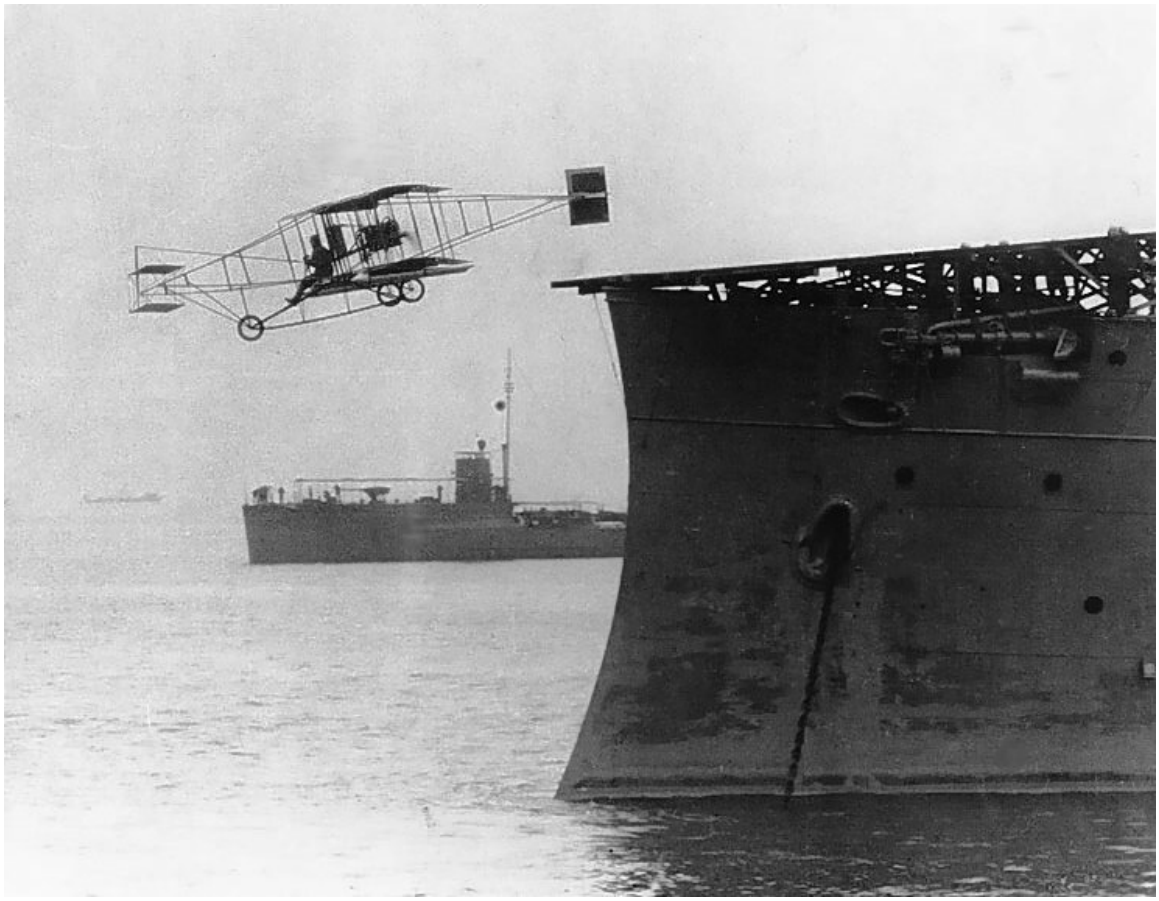
HMS *Hermes*, temporarily converted as an experimental seaplane carrier in April–May 1913, was also one of the first seaplane carriers, and the first experimental seaplane carrier of the Royal Navy. She was originally laid down as a merchant ship, but was converted on the building stocks to be a seaplane carrier for a few trials in 1913, before being converted again to a cruiser, and back again to a seaplane carrier in 1914. She was sunk by a German submarine in October 1914. The first seaplane tender of the US Navy was the USS *Mississippi*, converted to that role in December 1913.

Many cruisers and capital ships of the inter-war years often carried a catapult-launched seaplane for reconnaissance and spotting the fall of the guns. It was launched by a catapult and recovered by crane from the water after landing. These were highly successful during World War II; there were many notable successes early in the war as shown by HMS *Warspite*'s float equipped Swordfish during the Second Battle of Narvik in 1940, where it spotted for the guns of the British warships, ensuring seven German destroyers were sunk, and sinking the German submarine *U-64* with its own bombs. The Japanese Nakajima A6M2-N "Rufe" floatplane, derived from the Zero, was a formidable fighter with only a slight loss in flight performance; one of its pilots scored 26 kills, a score only bettered by a handful of American pilots throughout World War II. Other Japanese seaplanes launched from tenders and warships sank merchant ships and conducted small-scale ground attacks.

Genesis of the flat-deck carrier

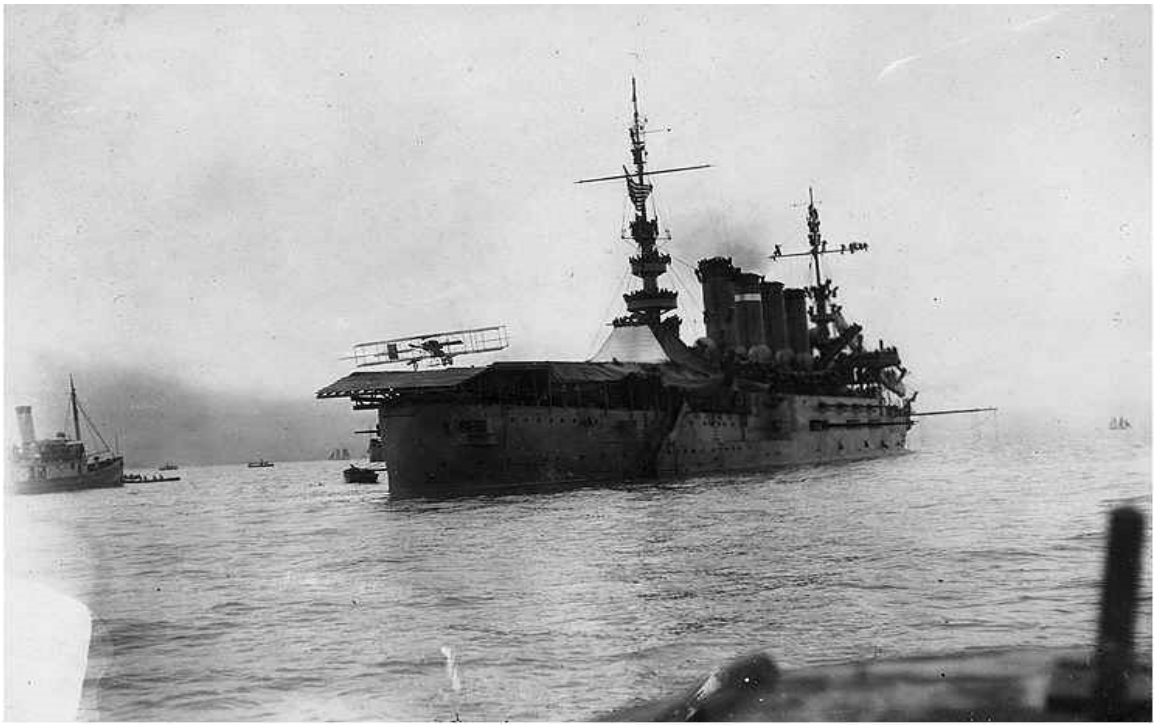
> "An airplane-carrying vessel is indispensable. These vessels will be constructed on a plan very different from what is currently used. First of all the deck will be cleared of all obstacles. It will be flat, as wide as possible without jeopardizing the nautical lines of the hull, and it will look like a landing field."
>
> Clément Ader, *L'Aviation Militaire*, 1909

As heavier-than-air aircraft developed in the early 20th century, various navies began to take an interest in their potential use as scouts for their big gun warships. In 1909 the French inventor Clément Ader published in his book *L'Aviation Militaire* the description of a ship to operate airplanes at sea, with a flat flight deck, an island superstructure, deck elevators and a hangar bay. That year the US Naval Attaché in Paris sent a report on his observations.



Eugene Ely takes off from USS *Birmingham*, 14 November 1910

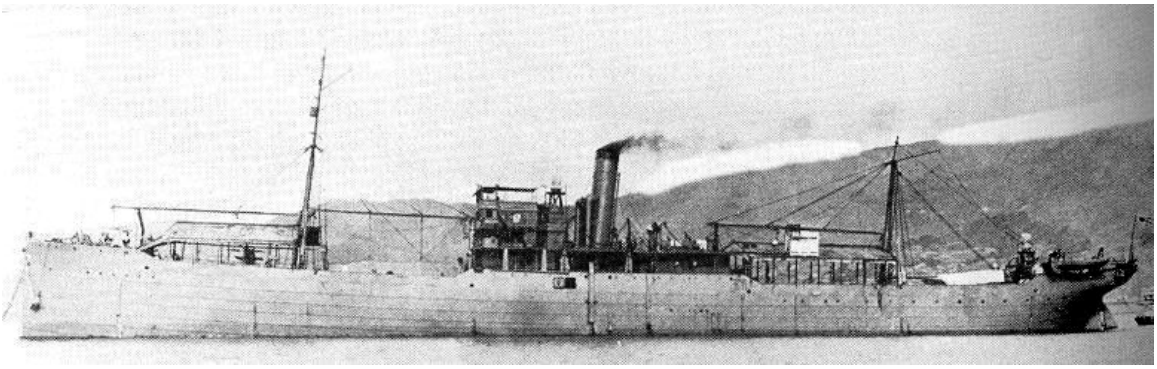
A number of experimental flights were made to test the concept. Eugene Ely was the first pilot to launch from a stationary ship in November 1910. He took off from a structure fixed over the forecastle of the US armored cruiser USS *Birmingham* at Hampton Roads, Virginia and landed nearby on Willoughby Spit after some five minutes in the air.



Eugene Ely makes first carrier landing on 18 January 1911

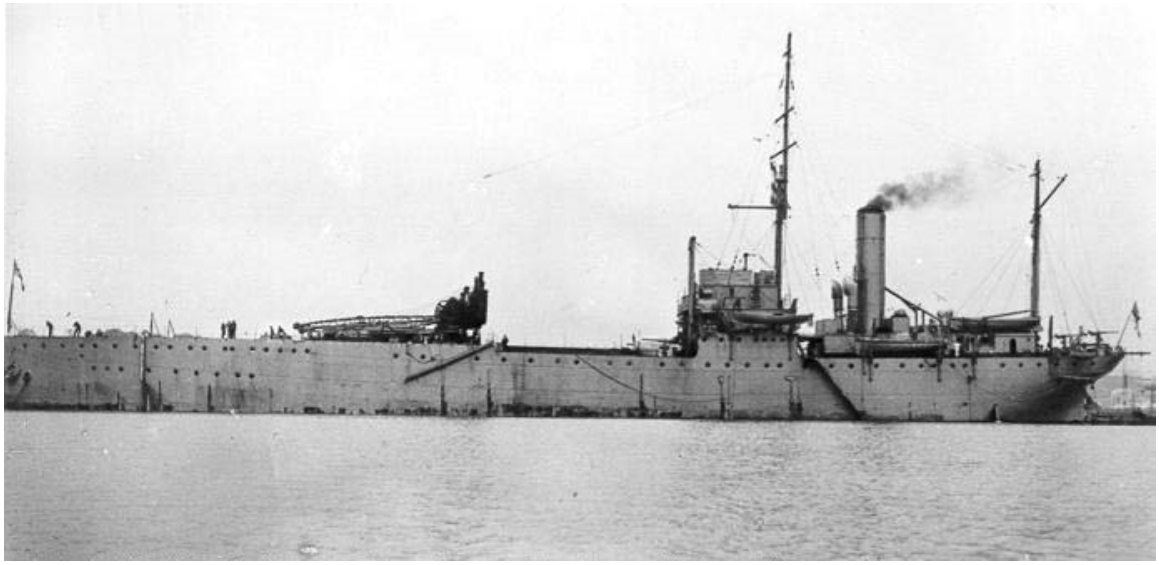
On 18 January 1911, he became the first pilot to land on a stationary ship. He took off from the Tanforan racetrack and landed on a similar temporary structure on the aft of USS *Pennsylvania* anchored at the San Francisco waterfront—the improvised braking system of sandbags and ropes led directly to the arrestor hook and wires described below. His aircraft was then turned around and he was able to take off again. Commander Charles Rumney Samson, Royal Navy, became the first airman to take off from a moving warship on 9 May 1912. He took off in Short S.38 from the battleship HMS *Hibernia* while she steamed at 15 kn (17 mph; 28 km/h) during the Royal Fleet Review at Weymouth, England.

World War I



The Japanese seaplane carrier *Wakamiya* conducted the world's first naval-launched air raids in September 1914.

The first strike from a carrier against a land target as well as a sea target took place in September 1914 when the Imperial Japanese Navy seaplane carrier *Wakamiya* conducted the world's first naval-launched air raids from Kiaochow Bay during the Battle of Tsingtao in China. The four Maurice Farman seaplanes bombarded German-held land targets (communication centers and command centers) and damaged a German minelayer in the Tsingtao peninsula from September-6 November 1914, when the Germans surrendered. On the Western front the first naval air raid occurred on 25 December 1914 when twelve seaplanes from HMS *Engadine*, *Riviera* and *Empress* (cross-channel steamers converted into seaplane carriers) attacked the Zeppelin base at Cuxhaven. The attack was not a complete success, although a German warship was damaged; nevertheless the raid demonstrated in the European theatre the feasibility of attack by ship-borne aircraft and showed the strategic importance of this new weapon.



HMS *Ark Royal*, a seaplane carrier also equipped with two regular aeroplanes, was arguably the first modern aircraft carrier.

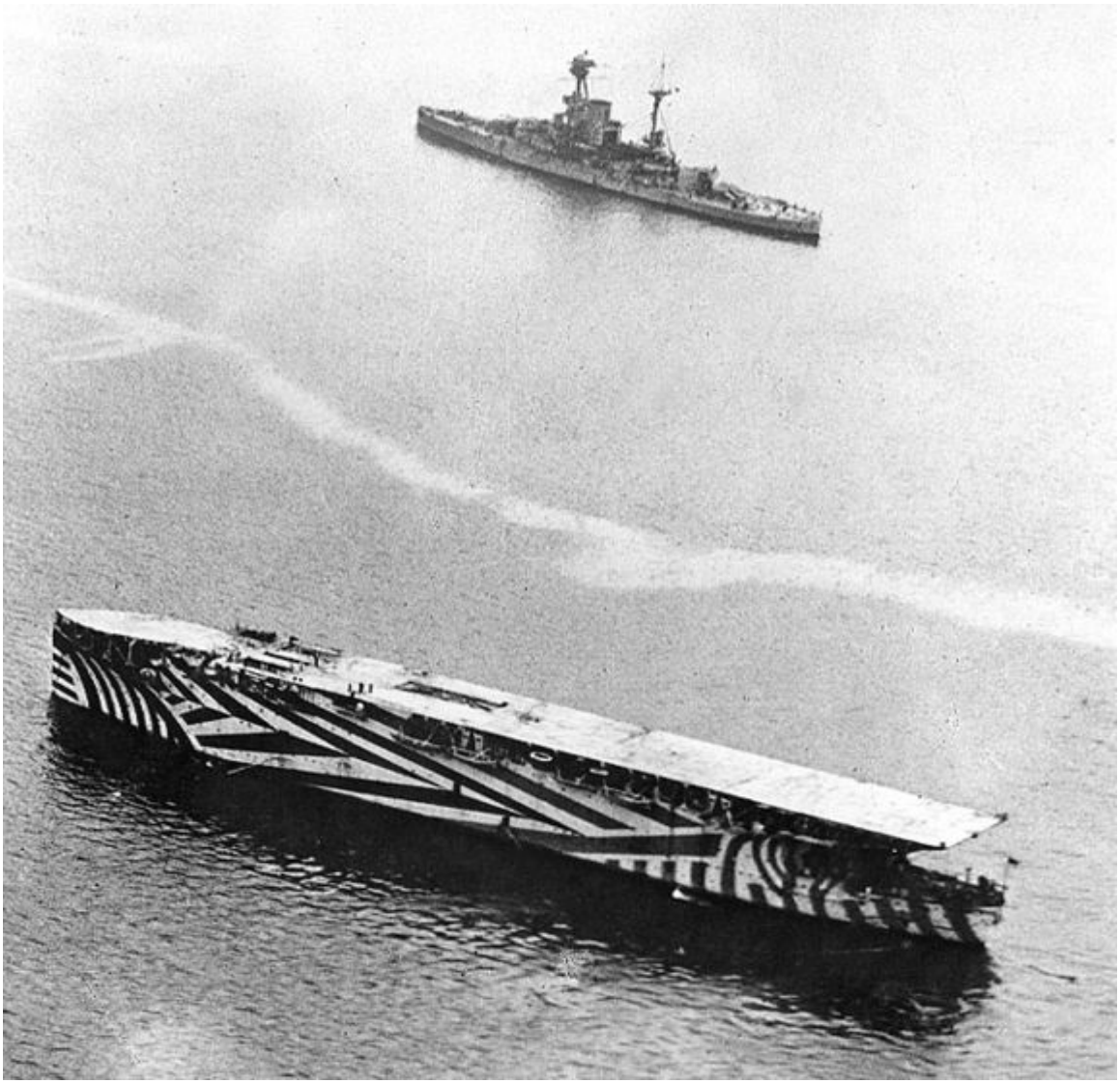
HMS *Ark Royal* was arguably the first modern aircraft carrier. She was originally laid down as a merchant ship, but was converted on the building stocks to be a hybrid airplane/seaplane carrier with a launch platform. Launched on 5 September 1914, she served in the Dardanelles campaign and throughout World War I.

On 2 August 1917, Squadron Commander E.H. Dunning, Royal Navy, landed his Sopwith Pup aircraft on the HMS *Furious* in Scapa Flow, Orkney, becoming the first man to land a plane on a moving ship. He was killed 5 days later during another landing on *Furious*.

Other carrier operations were mounted during the war, the most successful taking place on 19 July 1918 when seven Sopwith Camels launched from HMS *Furious* attacked the German Zeppelin base at Tondern, with two 50 lb (23 kg) bombs each. Several airships and balloons were destroyed, but as the carrier had no method of recovering the aircraft

safely, two of the pilots ditched their aircraft in the sea alongside the carrier while the others headed for neutral Denmark.

Inter-war years



The first full-length flat deck, HMS *Argus* in 1918

The Washington Naval Treaty of 1922 placed strict limits on the tonnages of battleships and battlecruisers for the major naval powers after World War I, as well as not only a limit on the total tonnage for carriers, but also an upper limit of 27,000 t (27,000 long tons) for each ship. Although exceptions were made regarding the maximum ship tonnage (fleet units counted, experimental units did not), the total tonnage could not be exceeded. However, while all of the major navies were over-tonnage on battleships, they were all considerably under-tonnage on aircraft carriers. Consequently, many battleships and battlecruisers under construction (or in service) were converted into aircraft carriers.

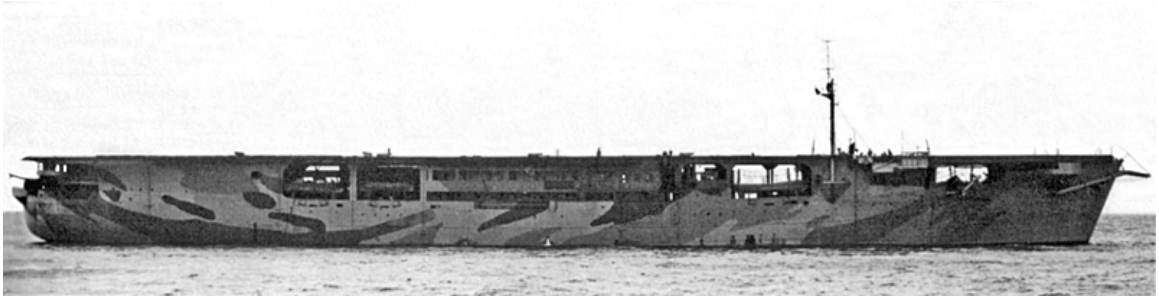
The IJN's 1922 *Hōshō* was the world's first built-from-the-keel-up aircraft carrier

The first ship to have a full-length flat deck was HMS *Argus*, the conversion of which was completed in September 1918, with the United States Navy not following suit until 1920, when the conversion of USS *Langley* (an experimental ship which did not count against America's carrier tonnage) was completed. The first American fleet carriers would not enter service until November, 1927 when the USS *Saratoga* was commissioned. (USS *Lexington* was commissioned in December of that year.)

The first purpose-designed aircraft carrier to be laid down was the HMS *Hermes* in 1918. Japan began work on *Hōshō* the following year. In December 1922, *Hōshō* became the first to be commissioned, while HMS *Hermes* began service in July 1923. *Hermes*' design preceded and influenced that of *Hōshō*, and its construction actually began earlier, but numerous tests, experiments and budget considerations delayed its commission.

By the late 1930s, carriers around the world typically carried three types of aircraft: torpedo bombers, also used for conventional bombings and reconnaissance; dive bombers, also used for reconnaissance (in the U.S. Navy, aircraft of this type were known as "scout bombers"); and fighters for fleet defence and bomber escort duties. Because of the restricted space on aircraft carriers, all these aircraft were of small, single-engined types, usually with folding wings to facilitate storage. In the late 1930s, the RN also developed the concept of the armoured flight deck, enclosing the hangar in an armoured box. The lead ship of this new type, HMS *Illustrious*, commissioned in 1940.

World War II



HMS *Audacity* was the world's first escort carrier

Aircraft carriers played a significant role in World War II. With seven aircraft carriers afloat, the Royal Navy had a considerable numerical advantage at the start of the war as neither the Germans nor the Italians had carriers of their own. However, the vulnerability of carriers compared to traditional battleships when forced into a gun-range encounter was quickly illustrated by the sinking of HMS *Glorious* by German battlecruisers during the Norwegian campaign in 1940.

This apparent weakness to battleships was turned on its head in November 1940 when HMS *Illustrious* launched a long-range strike on the Italian fleet at Taranto and signalled the beginning of the end of the battleship as the most important capital ship in a fleet. This operation incapacitated three of the six battleships in the harbour at a cost of two of the 21 attacking Fairey Swordfish torpedo bombers. Carriers also played a major part in reinforcing Malta, both by transporting planes and by defending convoys sent to supply the besieged island. The use of carriers prevented the Italian Navy and land-based German aircraft from dominating the Mediterranean theatre.

In the Atlantic, aircraft from HMS *Ark Royal* and HMS *Victorious* were responsible for slowing the German battleship *Bismarck* during May 1941. Later in the war, escort carriers proved their worth guarding convoys crossing the Atlantic and Arctic oceans.

HMS *Victorious* during World War II

Germany and Italy also started with the construction or conversion of several aircraft carriers, but with the exception of the nearly-finished *Graf Zeppelin*, no ship was launched.

Many of the major battles in the Pacific Ocean involved aircraft carriers. Japan started the war with ten aircraft carriers, the largest and most modern carrier fleet in the world at that time. There were seven American aircraft carriers at the beginning of the hostilities, although only three of them were operating in the Pacific.

Drawing on the 1939 Japanese development of shallow-water modifications for aerial torpedoes and the 1940 British aerial attack on the Italian fleet at Taranto, the 1941 Japanese surprise attack on Pearl Harbor was a clear illustration of the power projection capability afforded by a large force of modern carriers. Concentrating six carriers in a single striking unit marked a turning point in naval history, as no other nation had fielded anything comparable.

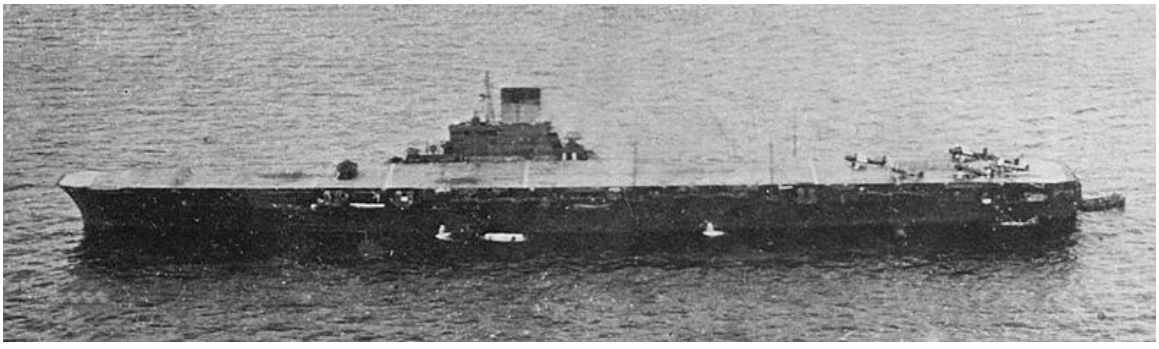
Four US Navy carriers right after the war, showing size and length differences: *Saratoga* (bottom), an early battlecruiser conversion; *Enterprise* (2nd from bottom), an early fleet carrier; *Hornet* (3rd from bottom), a war-time built *Essex*-class carrier; and *San Jacinto* (top), a light carrier based on a cruiser hull.

Meanwhile, the Japanese began their advance through Southeast Asia, and the sinking of *Prince of Wales* and *Repulse* by Japanese land-based aircraft drove home the need for this ship type for fleet defence from aerial attack. In April 1942, the Japanese fast carrier strike force ranged into the Indian Ocean and sank shipping, including the damaged and undefended carrier HMS *Hermes*. Smaller Allied fleets with inadequate aerial protection were forced to retreat or be destroyed. The Doolittle Raid (bombers from a U.S. carrier attacking Tokyo) forced the recall of the Japanese strike force to home waters. In the Coral Sea, US and Japanese fleets traded aircraft strikes in the first battle where neither side's ships sighted the other, and carriers fought each other for the first time. At the Battle of Midway all four Japanese carriers engaged were sunk by planes from three American carriers (one of which was lost); the battle is considered the turning point of the war in the Pacific. Notably, the battle was orchestrated by the Japanese to draw out American carriers that had proven very elusive and troublesome to the Japanese.

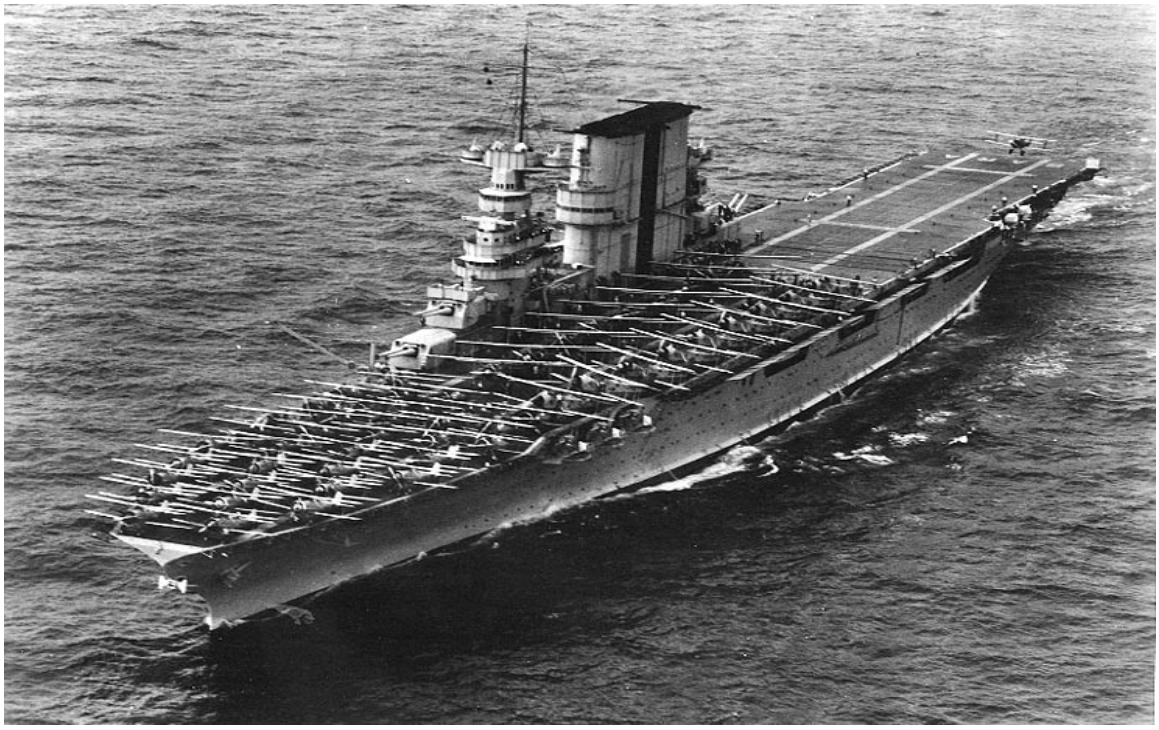
Subsequently the US was able to build up large numbers of aircraft aboard a mixture of fleet, light and (newly commissioned) escort carriers, primarily with the introduction of the *Essex* class in 1943. These ships, around which were built the fast carrier task forces of the 3rd and 5th Fleets, played a major part in winning the Pacific war. The Battle of the Philippine Sea in 1944 was the largest aircraft carrier battle in history and the decisive naval battle of World War II.

The reign of the battleship as the primary component of a fleet finally came to an end when U.S. carrier-borne aircraft sank the largest battleships ever built, the Japanese super battleships *Musashi* in 1944 and *Yamato* in 1945. Japan built the largest aircraft carrier of the war: *Shinano*, which was a *Yamato*-class ship converted before being halfway completed in order to counter the disastrous loss of four fleet carriers at Midway. She was sunk by the patrolling US submarine *Archer-Fish* while in transit shortly after commissioning, but before being fully outfitted or operational, in November 1944.

Important innovations just before and during World War II



Japanese carrier *Taihō* had a hurricane bow



USS *Saratoga* c. 1935

Hurricane bow

A hurricane bow is a completely enclosed hangar deck, first seen on the American *Lexington*-class aircraft carriers which entered service in 1927. Combat experience proved it to be by far the most useful configuration for the bow of the ship among others that were tried, including second flying-off decks and an anti-aircraft battery (the latter was the most common American configuration during World War II as built into the long-hull *Essex*-class). This feature would be re-incorporated into American carriers post-war. The first Japanese carrier to incorporate a hurricane bow was *Taihō*.

Light aircraft carriers

Prior to the beginning of the war, President Franklin D. Roosevelt noticed that no new aircraft carriers were expected to enter the fleet before 1944, and proposed the conversion of several *Cleveland*-class cruiser hulls that had already been laid down. They were intended to serve as additional fast carriers, as escort carriers did not have the requisite speed to keep up with the fleet carriers and their escorts. The actual U.S. Navy classification was small aircraft carrier (CVL), not light. Prior to July 1943, they were just classified as aircraft carriers (CV).

The Royal Navy made a similar design which served both them and Commonwealth countries after World War II. One of these carriers, HMS *Hermes*, is still in use as India's INS *Viraat*.

Escort carriers and merchant aircraft carriers

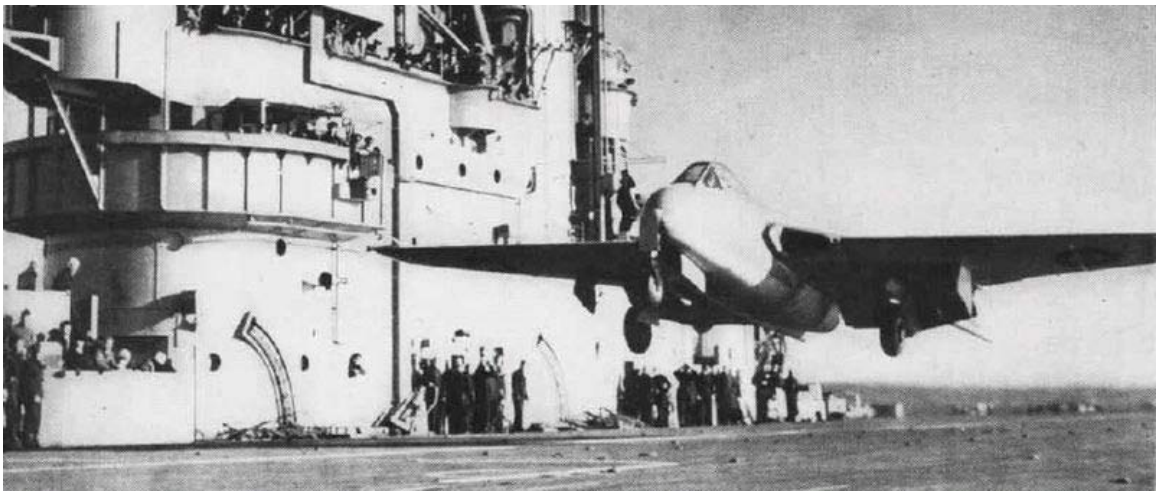
To protect Atlantic convoys, the British developed what they called Merchant Aircraft Carriers, which were merchant ships equipped with a flat deck for six aircraft. These operated with civilian crews, under merchant colors, and carried their normal cargo besides providing air support for the convoy. As there was no lift or hangar, aircraft maintenance was limited and the aircraft spent the entire trip sitting on the deck.

These served as a stop-gap measure until dedicated escort carriers (CVE) could be built in the U.S. About a third of the size of a fleet carrier, they carried between 20 and 30 aircraft, mostly for anti-submarine duties. Over 100 were built or converted from merchantmen. Escort carriers were built in the US from two basic hull designs: one from a merchant ship, and the other from a slightly larger, slightly faster tanker. Besides defending convoys, these were used to transport aircraft across the ocean. Nevertheless, some participated in the battles to liberate the Philippines, notably the Battle off Samar in which six escort carriers and their escorting destroyers briefly took on five Japanese battleships and bluffed them into retreating.

Catapult aircraft merchantmen

As an emergency stop-gap before sufficient merchant aircraft carriers became available, the British provided air cover for convoys using Catapult aircraft merchantman (CAM ships). CAM ships were merchant vessels equipped with an aircraft, usually a battle-weary Hawker Hurricane, launched by a catapult. Once launched, the aircraft could not land back on the deck and had to ditch in the sea if it was not within range of land. In over two years, fewer than 10 launches were ever made, yet these flights did have some success: 6 bombers for the loss of a single pilot.

Post-war developments



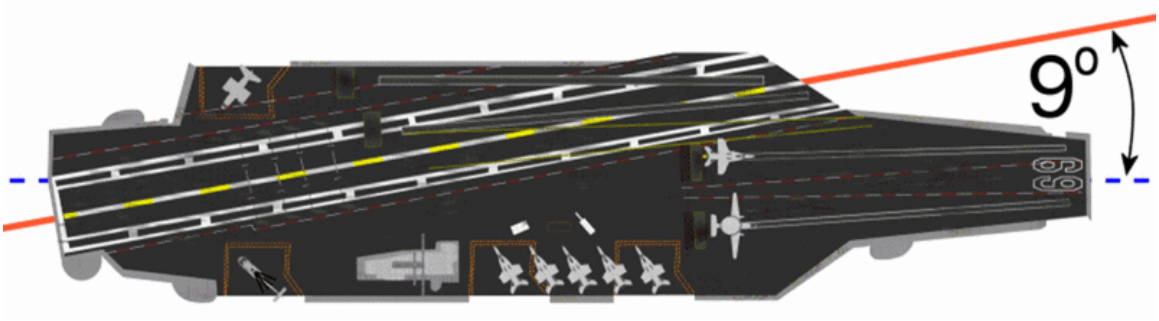
The first carrier landing and take-off of a jet aircraft: Eric "Winkle" Brown landing on HMS *Ocean* in 1945

Three major post-war developments came from the need to improve operations of jet-powered aircraft, which had higher weights and landing speeds than their propeller-powered forebears.

The first jet landing on a carrier was made by Lt Cdr Eric "Winkle" Brown who landed on HMS *Ocean* in the specially modified de Havilland Vampire LZ551/G on 3 December 1945. Brown is also the all-time record holder for the number of carrier landings, at 2,407.

After these successful tests, there were still many misgivings about the suitability of operating jet aircraft routinely from carriers, and LZ551/G was taken to Farnborough to participate in trials of the experimental "rubber deck". Despite significant effort toward developing this idea, and some performance advantages due to the removal of the undercarriage, it was found to be unnecessary; and following the introduction of angled flight decks, jets were operating from carriers by the mid 1950s.

Angled decks



The angled flight deck allows for safe simultaneous launch and recovery of aircraft

During World War II, aircraft would land on the flight deck parallel to the long axis of the ship's hull. Aircraft which had already landed would be parked on the deck at the bow end of the flight deck. A crash barrier was raised behind them to stop any landing aircraft which overshot the landing area because its landing hook missed the arrestor cables. If this happened, it would often cause serious damage or injury and even, if the crash barrier was not strong enough, destruction of parked aircraft.

An important development of the early 1950s was the British invention of the angled flight deck by Capt D.R.F. Campbell RN in conjunction with Lewis Boddington of the Royal Aircraft Establishment at Farnborough. The runway was canted at an angle of a few degrees from the longitudinal axis of the ship. If an aircraft missed the arrestor cables (referred to as a "bolter"), the pilot only needed to increase engine power to maximum to get airborne again, and would not hit the parked aircraft because the angled deck pointed out over the sea.

The angled flight deck was first tested on HMS *Triumph*, by painting angled deck markings onto the centerline flight deck for touch and go landings. This was also tested

on USS *Midway* the same year. In both tests, the arresting gear and barriers remained oriented to the original axis deck. During September through December 1952 the USS Antietam had a rudimentary sponson installed for true angled deck tests, allowing for full arrested landings, which proved during trials to be superior. In 1953 the USS Antietam trained with both US and British naval units, proving the worth of the angled deck concept. The HMS *Centaur* was modified with overhanging angled flight deck in 1954. The U.S. Navy installed the decks as part of the SCB-125 upgrade for the *Essex* class and SCB-110/110A for the *Midway* class. In February 1955, HMS *Ark Royal* became the first carrier to be constructed and launched with the deck, followed in the same year by the lead ships of the British *Majestic* class (HMAS *Melbourne*) and the American *Forrestal* class (USS *Forrestal*).

Steam catapults

The modern steam-powered catapult, powered by steam from the ship's boilers or reactors, was invented by Commander C.C. Mitchell of the Royal Naval Reserve. It was widely adopted following trials on HMS *Perseus* between 1950 and 1952 which showed it to be more powerful and reliable than the hydraulic catapults which had been introduced in the 1940s.

Optical Landing Systems

The first of the Optical Landing Systems was another British innovation, the Mirror Landing Aid invented by Lieutenant Commander H. C. N. Goodhart RN. This was a gyroscopically-controlled concave mirror (in later designs replaced by a Fresnel lens Optical Landing System) on the port side of the deck. On either side of the mirror was a line of green "datum" lights. A bright orange "source" light was directed into the mirror creating the "ball" (or "meatball" in later USN parlance), which could be seen by the aviator who was about to land. The position of the ball compared to the datum lights indicated the aircraft's position in relation to the desired glidepath: if the ball was above the datum, the plane was high; below the datum, the plane was low; between the datum, the plane was on glidepath. The gyro stabilisation compensated for much of the movement of the flight deck due to the sea, giving a constant glidepath. The first trials of a mirror landing sight were conducted on HMS *Illustrious* in 1952. Prior to OLSs, pilots relied on visual flag signals from Landing Signal Officers to help maintain proper glidepath.

Nuclear age

The U.S. Navy attempted to become a strategic nuclear force in parallel with the United States Air Force (USAF) long range bombers with the project to build *United States*, which was termed CVA, with the "A" signifying "atomic". This ship would have carried long range twin-engine bombers, each of which could carry an atomic bomb. The project was canceled under pressure from the newly-created USAF, and the letter "A" was recycled to mean "attack." This only delayed the growth of carriers. Nuclear weapons would be part of the carrier weapons load, despite Air Force objections, beginning in

1955 aboard USS *Forrestal*. By the end of the 1950s the Navy had a series of nuclear-armed attack aircraft.

The U.S. Navy also built the first aircraft carrier to be powered by nuclear reactors. USS *Enterprise* is powered by eight nuclear reactors and was the second surface warship (after USS *Long Beach*) to be powered in this way. Subsequent supercarriers starting with USS *Nimitz* took advantage of this technology to increase their endurance utilizing only two reactors. Other nations operate nuclear powered submarines, but thus far only France has a nuclear-powered carrier, the *Charles de Gaulle*.

Helicopters

The *Tripoli*, a US Navy *Iwo Jima*-class helicopter carrier

The post-war years also saw the development of the helicopter, with a variety of useful roles and mission capability aboard aircraft carriers. Whereas fixed-wing aircraft are suited to air-to-air combat and air-to-surface attack, helicopters are used to transport equipment and personnel and can be used in an anti-submarine warfare (ASW) role, with dipping sonar, air-launched torpedoes, and depth charges; as well as for anti-surface vessel warfare, with air-launched anti-ship missiles.

In the late 1950s and early 1960s, the United Kingdom and the United States converted some older carriers into Commando Carriers or Landing Platform Helicopters (LPH); seagoing helicopter airfields like HMS *Bulwark*. To mitigate the expensive connotations of the term "aircraft carrier", the new *Invincible*-class carriers were originally designated as "through deck cruisers" and were initially to operate as helicopter-only craft escort carriers. The arrival of the Sea Harrier VTOL/STOVL fast jet meant they could carry fixed-wing aircraft, despite their short flight deck.

The United States used some *Essex*-class carriers initially as pure ASW carriers, embarking helicopters and fixed-wing ASW aircraft like the S-2 Tracker. Later, specialized LPH helicopter carriers for the transport of Marine Corps troops and their helicopter transports were developed. These evolved into the Landing Helicopter Assault (LHA) and later into the Landing Helicopter Dock (LHD) classes of amphibious assault ships, which normally also embark a few Harrier aircraft.

Ski-jump ramp

The ski-jump on Royal Navy carrier HMS *Invincible*

Another British innovation was the ski-jump ramp as an alternative to contemporary catapult systems. The ski-jump ramp at the end of a runway or flight deck allows an aircraft which makes a running start to transition a portion of its forward momentum into upward motion. The intent is that the additional altitude and upward angled flight path from the jump provides extra time until the forward airspeed generated by engine thrust is high enough to maintain level flight. V/STOL aircraft will often also use their ability to

direct some of their thrust downwards to give them additional lift until required airspeed is attained.

As the Royal Navy retired or sold the last of its World War II-era carriers, they were replaced with smaller ships designed to operate helicopters and the V/STOVL Sea Harrier jet. The ski-jump gave the Harriers an enhanced STOVL capability, allowing them to take off with heavier payloads. It was subsequently adopted by the navies of several nations such as India, Spain, Italy, Russia, and Thailand.

Post-World War II conflicts

UN carrier operations in the Korean War

The United Nations command began carrier operations against the North Korean Army on July 3, 1950 in response to the invasion of South Korea. Task Force 77 consisted at that time of the carriers USS *Valley Forge* and HMS *Triumph*. Before the armistice of July 27, 1953, twelve U.S. carriers served 27 tours in the Sea of Japan as part of Task Force 77. During periods of intensive air operations as many as four carriers were on the line at the same time, but the norm was two on the line with a third "ready" carrier at Yokosuka able to respond to the Sea of Japan at short notice.

A second carrier unit, Task Force 95, served as a blockade force in the Yellow Sea off the west coast of North Korea. The task force consisted of a Commonwealth light carrier (HMS *Triumph*, *Theseus*, *Glory*, *Ocean*, and HMAS *Sydney*) and usually a U.S. escort carrier (USS *Badoeng Strait*, *Bairoko*, *Point Cruz*, *Rendova*, and *Sicily*).

Over 301,000 carrier sorties were flown during the Korean War: 255,545 by the aircraft of Task Force 77; 25,400 by the Commonwealth aircraft of Task Force 95, and 20,375 by the escort carriers of Task Force 95. United States Navy and Marine Corps carrier-based combat losses were 541 aircraft. The Fleet Air Arm lost 86 aircraft in combat, and the Australian Fleet Air Arm 15.

Post-colonial conflicts

In the period following World War II through the 1960s, the United Kingdom, France, and the Netherlands employed their carriers during decolonization conflicts of former colonies.

France employed the carriers *Dixmude*, *La Fayette*, *Bois Belleau*, and *Arromanches* to conduct operations against the Viet Minh during the 1946–1954 First Indochina War.

The United Kingdom used carrier-based aircraft from HMS *Eagle*, *Albion*, and *Bulwark*, and France from *Arromanches* and *La Fayette*, to attack Egyptian positions during the 1956 Suez Crisis. Royal Navy carriers *HMS Ocean* and *Theseus* acted as floating bases to ferry troops ashore by helicopter in the first ever large-scale helicopter-borne assault.

The Royal Netherlands Navy deployed HNLMS *Karel Doorman* and an escorting battle group to Western New Guinea in 1962 to protect it from Indonesian invasion. This intervention nearly resulted in her being attacked by the Indonesian Air Force using Soviet supplied Tupolev Tu-16KS-1 Badger naval bombers carrying anti-ship missiles. The attack was called off by a last-minute cease fire.

Between 1964 and 1967, the Royal Navy deployed the Far East Fleet carriers HMS *Ark Royal*, *Centaur*, and *Victorious* in support of operations in Borneo during the *Konfrontasi* conflict between Indonesia and Malaysia. HMS *Albion* and *Bulwark* were deployed as commando carriers, and the Australian carrier HMAS *Sydney* served as a troop transport.

Indo-Pakistan War of 1971

During the war, India deployed INS *Vikrant* against Pakistan from its station in Andaman islands for operation against Pakistani forces in the East (present Bangladesh). Hawker Sea Hawk of the carrier successfully choked the Chittagong harbour and put it out of service.

U.S. carrier operations in Southeast Asia

The United States Navy fought "the most protracted, bitter, and costly war" (René Francillon) in the history of naval aviation from August 2, 1964 to August 15, 1973 in the waters of the South China Sea. Operating from two deployment points (Yankee Station and Dixie Station), carrier aircraft supported combat operations in South Vietnam and conducted bombing operations in conjunction with the U.S. Air Force in North Vietnam under Operations Flaming Dart, Rolling Thunder, and Linebacker. The number of carriers on the line varied during differing points of the conflict, but as many as six operated at one time during Operation Linebacker.

Twenty-one aircraft carriers (all operational attack carriers during the era except *John F. Kennedy*) deployed to Task Force 77 of the U.S. Seventh Fleet, conducting 86 war cruises and operating 9,178 total days on the line in the Gulf of Tonkin. 530 aircraft were lost in combat and 329 more in operational accidents, causing the deaths of 377 naval aviators, with 64 others reported missing and 179 taken prisoner-of-war. 205 officers and men of the ship's complements of three carriers (*Forrestal*, *Enterprise*, and *Oriskany*) were killed in major shipboard fires. At times some the carrier groups operated in an excess of 12,000 miles from their home ports.

Falklands War

HMS *Invincible*

During the Falklands War the United Kingdom was able to win a conflict 8,000 miles (13,000 km) from home in large part due to the use of the light fleet carrier HMS *Hermes* and the smaller "through deck cruiser" HMS *Invincible*. The Falklands showed the value of a STOVL aircraft—the Hawker Siddeley Harrier (the RN Sea Harrier and press-ganged RAF Harriers)—in defending the fleet and assault force from shore-based aircraft and in attacking the enemy. Sea Harriers shot down 21 fast-attack jets and suffered no aerial combat losses, although six were lost to accidents and ground fire. Helicopters from the carriers were used to deploy troops and for medevac, Search and rescue and anti-submarine warfare.

An opposite lesson from the Falklands War was the withdrawal of Argentina's aircraft carrier ARA *Veinticinco de Mayo* with her A-4Qs. The sinking of the Argentine cruiser ARA *General Belgrano* by the fast attack submarine HMS *Conqueror* caused the premature home deployment as it showed that capital ships were vulnerable in the nuclear submarines' hunting ground.

Operations in the Persian Gulf

The U.S. has also made use of carriers in the Persian Gulf and Afghanistan and to protect its interests in the Pacific. During the 2003 invasion of Iraq U.S. aircraft carriers served as the primary base of American air power. Even without the ability to place significant

numbers of aircraft in Middle Eastern airbases, the United States was capable of carrying out significant air attacks from carrier-based squadrons. Recently, U.S. aircraft carriers such as the *Ronald Reagan* provided air support for counter-insurgency operations in Iraq.

Chapter- 3

Flight Deck

Flight deck of USS *John C. Stennis* doing a high speed turn during her acceptance trials

The **flight deck** of an aircraft carrier is the surface from which its aircraft take off and land, essentially a miniature airfield at sea. On smaller naval ships which do not have aviation as a primary mission, the landing area for helicopters and other VTOL aircraft is also referred to as the flight deck. The official U.S. Navy term for these vessels is "aviation capable ships".

Evolution

F/A-18 Hornet landing on *Nimitz*

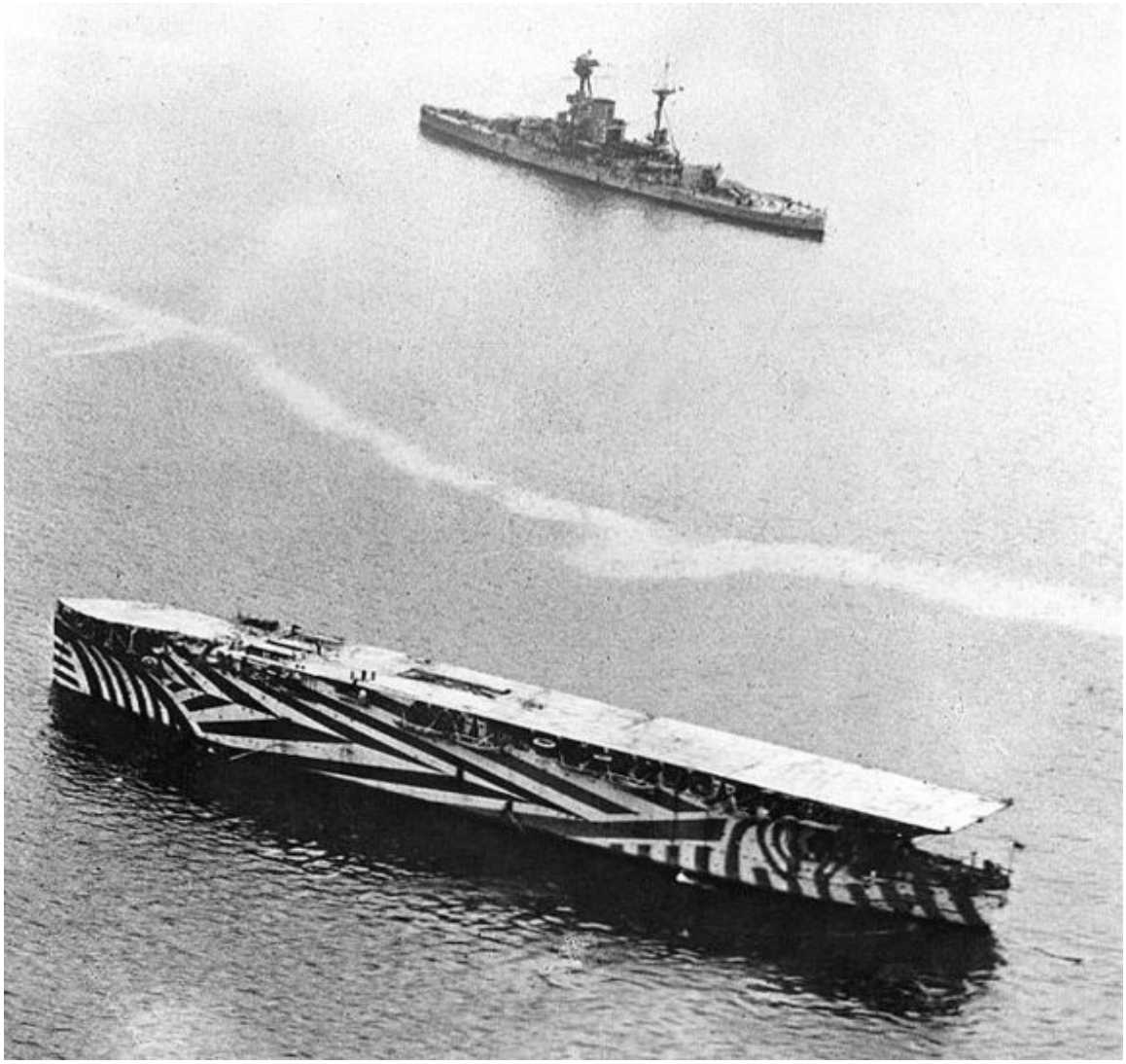
Early flight decks

The first flight decks were inclined wooden ramps built over the forecastle of naval warships. Eugene Ely made the first fixed-wing aircraft take-off from a warship from USS *Birmingham* on 14 November 1910. Two months later, on 18 January 1911, Ely landed his Curtiss pusher plane on a platform on *Pennsylvania* anchored in San Francisco Bay, using the first ever tailhook system, designed and built by circus performer & aviator Hugh Robinson. Ely told a reporter: "It was easy enough. I think the trick could be successfully turned nine times out of ten." On 4 May 1912, Commander Charles Samson became the first man to take off from a ship which was underway when he flew his Short S27 off of HMS *Hibernia*, which was steaming at 10.5 kn (12.1 mph; 19.4 km/h). Because the take-off speed of early aircraft was so low, it was possible for an aircraft to make a very short take off when the launching ship was steaming into the wind. Later, removable "flying-off platforms" appeared on the gun turrets of battleships and battlecruisers, allowing aircraft to be flown off for scouting purposes, although there was no chance of recovery.

On 2 August 1917, while performing trials, Squadron Commander Edwin Dunning landed a Sopwith Pup successfully on board the flying-off platform of HMS *Furious*, becoming the first person to land an aircraft on a moving ship. However, on his third attempt, a tire burst as he attempted to land, causing the aircraft to go over the side,

killing him; thus Dunning also has the dubious distinction of being the first person to die in an aircraft carrier landing accident. The landing arrangements on *Furious* were highly unsatisfactory. In order to land, aircraft had to manoeuvre around the superstructure. *Furious* was therefore returned to dockyard hands to have a 300 ft (91 m) deck added aft for landing, on top of a new hangar. The central superstructure remained, however, and turbulence caused by it badly affected the landing deck.

Full length decks



HMS *Argus* showing the full-length flight deck from bow to stern

The first aircraft carrier that began to show the configuration of the modern vessel was the converted liner HMS *Argus*, which had a large flat wooden deck added over the entire length of the hull, giving a combined landing and take-off deck unobstructed by superstructure turbulence. Because of her unobstructed flight deck, *Argus* had no fixed conning tower and no funnel. Rather, exhaust gases were trunked down the side of the ship and ejected under the fantail of the flight deck (which, despite arrangements to

disperse the gases, gave an unwelcome "lift" to aircraft immediately prior to landing). The lack of a command position and funnel was unsatisfactory, and *Argus* was used to experiment with various ideas to remedy the solution. A photograph in 1917 shows her with a canvas mock-up of a starboard "island" superstructure and funnel. This was placed on the starboard side because the rotary engines of some early aircraft created torque which pulled the nose left, meaning an aircraft naturally yawed to port on take-off; therefore, it was desirable that they turned away from the fixed superstructure. This became the typical aircraft carrier arrangement and was used in the next British carriers, HMS *Hermes* and *Eagle*.

After World War I, battlecruisers that otherwise would have had to have been discarded under the Washington Naval Treaty - such as the British *Furious* and *Glorious*-class and the American USS *Lexington* and *Saratoga*- were converted to carriers along the above lines. Being large and fast they were perfectly suited to this role; the heavy armouring and scantlings and low speed of the converted battleship *Eagle* served to be something of a handicap in practice. Because the military effectiveness of aircraft carriers was then unknown, early ships were typically equipped with cruiser-calibre guns to aid in their defence if surprised by enemy warships. These guns were generally removed during World War II and replaced with anti-aircraft guns, as carrier doctrine developed the "task force" (later called "battle group") model, where the carrier's defence against surface ships would be a combination of escorting warships and its own aircraft.

In ships of this configuration, the hangar deck was the strength deck, and an integral part of the hull, and the hangar and wooden flight deck were considered to be part of the superstructure. Such ships were still being built into the late '40s, classic examples being the U.S. Navy's *Essex* and *Ticonderoga*-class carriers. However, in 1936, the Royal Navy began construction of the *Illustrious*-class. In these ships, the flight deck was now the strength deck, an integral part of the hull, and was heavily armoured to protect the ship and her air complement. Although the armoured carrier concept in this form remained something of a dead end, the flight deck as the strength deck was adopted for later construction. This was necessitated by the ever-increasing size of the ships, from the 13,000 ton USS *Langley* in 1922 to over 100,000 tons in the latest *Nimitz*-class carriers.

Armoured decks

When aircraft carriers supplanted battleships as the primary fleet capital ship, there were two schools of thought on the question of armour protection being included into the flight deck. The addition of armour to the flight deck offered aircraft below some protection against aerial bombs. However, to reduce top-weight the hangar height was reduced and this restricted the types of aircraft that these ships could carry, although the Royal Navy's armoured carriers did carry spare aircraft in the hangar overheads. The armour also reduced the length of the flight deck, reducing the maximum aircraft capacity of the armoured flight deck carrier, however the largest part of the disparity between RN and USN carriers in aircraft capacity was due to the use of a permanent deck park on USN carriers. RN carriers did not use a permanent deck park until 1943.The experience of World War II caused the USN to change their design policy in favour of armoured flight

decks: "*The main armor carried on Enterprise is the heavy armored flight deck. This was to prove a significant factor in the catastrophic fire and explosions that occurred on Enterprise's flight deck in 1969. The US Navy learned its lesson the hard way during World War II when all its carriers had only armored hangar decks. All attack carriers built since the Midway class have had armored flight decks.*"

Landing on flight decks

A barricade is raised on the USS *Ronald Reagan*. Barricade usage is a rare emergency measure.

Landing arrangements were originally primitive, with aircraft simply being "caught" by a team of deck-hands who would run out from the wings of the flight deck and grab a part of the aircraft to slow it down. This dangerous procedure was only possible with early aircraft of low weight and landing speed. Arrangements of nets served to catch the aircraft should the latter fail, although this was likely to cause structural damage.

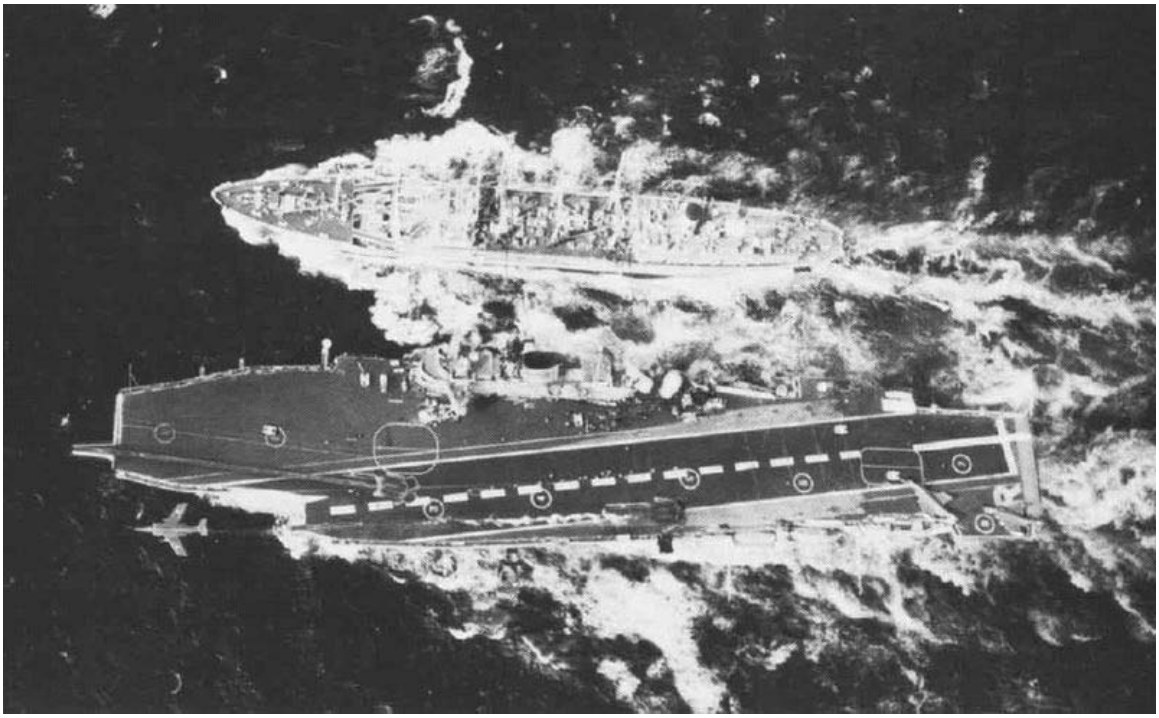
Landing larger and faster aircraft on a flight deck was made possible through the use of arresting cables installed on the flight deck and a tailhook installed on the aircraft. Early carriers had a very large number of arrestor cables or "wires". Current U.S. Navy carriers have three or four steel cables stretched across the deck at 20 ft (6.1 m) intervals which bring a plane, traveling at 150 mph (240 km/h), to a complete stop in about 320 ft (98 m). The cables are set to stop each aircraft at the same place on the deck, regardless of the size or weight of the plane. During World War II, large net barriers would be erected across the flight deck in order that aircraft could be parked on the forward part of the

deck and recovered on the after part. This allowed increased complements, but resulted in lengthened turn-around times as aircraft were shuffled around the carrier to allow take-off or landing operations.

A barricade is an emergency system used if a normal arrestment cannot be made. Barricade webbing engages the wings of the landing aircraft, and momentum is transferred to the arresting engine.

Modern innovations

Angled flight deck



Overhead view of HMS *Ark Royal* showing the angled flight deck

The **angled flight deck** was invented by Royal Navy Captain (later Rear Admiral) Dennis Campbell. With this type of deck, (also referred to as a "skewed deck" or "canted deck" or the "angle"), the aft part of the deck is widened and a separate runway is positioned at an angle from the centreline. The angled flight deck was designed with the higher landing speeds of jet aircraft in mind, which would have required the entire length of a centreline flight deck to stop. The design also allowed for concurrent launch and recovery operations, and allowed aircraft failing to connect with the arrestor cables to abort the landing, accelerate, and relaunch (or "bolter") without risk to other parked or launching aircraft. The redesign allowed for several other design and operational modifications, including the mounting of a larger island (improving both ship-handling and flight control), drastically simplified aircraft recovery and deck movement (aircraft now launched from the bow and re-embarked on the angle, leaving a large open area amidships for arming and fuelling), and damage control. Because of its utility in flight

operations, the angled deck is now a defining feature of STOBAR and CATOBAR equipped aircraft carriers.

The angled flight deck was first tested on HMS *Triumph*, by painting angled deck markings onto the centerline of the flight deck for touch and go landings. This was also tested on the USS *Midway* the same year. It should be noted that in both tests, the arresting gear and barriers remained oriented to the original axis deck. From September–December 1952, the USS *Antietam* had a rudimentary sponson installed for true angle deck tests, allowing for full arrested landings, which proved during trials to be superior. In 1953, *Antietam* trained with both US and British naval units, proving the worth of the angle deck concept. HMS *Centaur* was modified with overhanging angled flight deck in 1954. The U.S. Navy installed the decks as part of the SCB-125 upgrade for the *Essex*-class and SCB-110/110A for the *Midway*-class. In February 1955, HMS *Ark Royal* became the first carrier to be constructed and launched with the deck, followed in the same year by the lead ships of the British *Majestic*-class (HMAS *Melbourne*) and the American *Forrestal*-class (USS *Forrestal*).

Ski-jump ramp

A view of the Russian *Admiral Kuznetsov* showing prominent ski-jump ramp

Another British innovation is the **ski-jump ramp**, which came about as a means of improving take off for the VSTOL BAE Sea Harrier "jump-jet" on the small Invincible class aircraft carriers. They are most common on aircraft carriers supporting STOVL aircraft such as the Harrier, but the Russians also used them with conventional MiG-29s.

The ski jump is a ramp which is curved upwards at its forward end. For STOVL aircraft the aircraft starts by making a conventional rolling takeoff with the jet exhausts set to provide maximum forward thrust. As the plane nears the end of the ramp (the ski jump portion) the jet exhausts are rotated to provide upward lift as well as forward thrust. Rolling over the ski ramp launches the plane both upwards and forwards. As the plane leaves the ski jump ramp it continues to accelerate horizontally until the wings can provide the needed lift.

For conventional aircraft such as the MiG-29 the aircraft just rolls down the runway in the obvious manner. Again, rolling over the ski ramp launches the plane both upwards and forwards.

Such takeoffs allow a larger takeoff weight than a straight vertical launch because the wings provide some lift even at low speeds, and the ski jump ramp provides a vertical impetus when most needed, right at takeoff at the slowest takeoff speed.

These takeoffs use less runway than a takeoff over a flat surface because the plane takes off at a lower speed, using both the ski jump ramp's vertical impetus and the deflected jet engines to generate lift.

Ski-jump flight deck of the Royal Navy's *Invincible* class, HMS *Ark Royal*

Ski jump ramp takeoffs are considered safer than takeoffs over a flat top carrier. When a Harrier launches from an American LHA (Landing Helicopter Assault) it might finish its takeoff roll and begin flight at 60 ft (18 m) above the water. It might not have a positive rate of climb, especially if the ship had pitched nose down during the takeoff roll. Using a ski jump ramp the plane will certainly launch with a positive rate of climb and its momentum will carry it to 150 to 200 ft (46 to 61 m) above the water.

For example, an AV-8B Harrier with a gross weight of 29,000 lb (13,000 kg) on a 59 °F (15 °C) day and a 35 kn (40 mph; 65 km/h) wind over the deck would require 400 ft (120 m) to takeoff using a 12° ski jump ramp designed as on the *Principe de Asturias*, but 750 ft (230 m) without the ski jump ramp.

For a MiG-29 launching over the ski jump ramp on the *Tbilisi*, takeoff speed is reduced from about 140 kn (160 mph; 260 km/h) to about 70 kn (81 mph; 130 km/h) (depending on many factors such a gross weight).

Carriers using STOVL aircraft and a ski jump ramp do not need catapults nor arresting gear.

With the exception of the United States and France, every navy in the world that operates STOVL naval aircraft uses ski jump ramps.

Flexible decks

An idea tested but never taken to completion was the "flexible deck". In the early jet age it was seen that by eliminating the landing gear for carrier borne aircraft the inflight performance/range would be improved. This led to the concept of a deck that would absorb the energy of landing, the risk of damaging propellers no longer being an issue though take off would require some sort of launching cradle. Test were carried out with a Sea Vampire on the rubber deck fitted to HMS *Warrior*, and Supermarine designed their Type 508 for rubber deck landing, and the flexible deck idea was found to be technically feasible in tests but was nevertheless abandoned. The Supermarine Type 508 was subsequently developed into a 'normal' carrier aircraft, the Scimitar.

Chapter- 4

Anti-submarine Warfare Carrier

USS *Yorktown* (CVS-10) at sea off Hawaii, circa the early 1960s

Royal Navy light carrier HMS *Invincible*, lead ship of the *Invincible*-class aircraft carriers

Three SH-3A Sea Kings from HS-6 flying over the aircraft carrier USS *Kearsarge* (CVS-33), circa 1962–1964

An S-2E ready for launching from the USS *Bennington* (CVS-20)

An **ASW carrier** (**Anti-Submarine Warfare carrier**) is a type of small aircraft carrier whose primary role is to hunt and destroy submarines. This type of ship came into existence during the Cold War as a development of the escort carriers used in the ASW role in the North Atlantic during World War II.

Role

After World War II, the main naval threat to most western nations was confrontation with the Soviet Union. The Soviets ended the war with a small navy and took the route of asymmetric confrontation against western surface ship superiority by investing heavily in submarines both for attack and later fielding submarine launched missiles. Several nations who purchased British and US surplus light carriers were most easily able to accommodate slow moving, less expensive, and easy to land antisubmarine aircraft from the 1960s forward such as the S-2 Tracker which flew from the decks of US, Canadian, Australian, Dutch, Argentine, and Brazilian carriers or Alizé which flew from French and Indian ships and still remain useful especially in the framework of NATO even as newer fighter and strike aircraft were becoming too heavy for the equipment designed for WW-II aircraft.

Improvement in long range shore based patrol and conventional ship based ASW helicopter capability combined with the increasing difficulty maintaining surplus WW-II carriers lead to most of these ships to be retired or docked by smaller nations from the

1970s to the mid 1980's. This trend in ASW force draw down only accelerated with the massive reduction in the operational Soviet/Russian submarine fleet which rarely went to sea in large numbers in the 1990s. Ships that could be called dedicated ASW carriers are now only found with the Japanese navy which operates helicopters and no fixed wing carrier based aircraft of any kind. Even the United States Navy, the last nation to regularly operate a dedicated fixed wing carrier based ASW aircraft, the S-3 Viking, on its mixed role super carriers had already removed most ASW equipment in the 1990s from this aircraft and has now removed this type from service as of January 2009 without replacement. Interestingly the Argentine Navy currently without much hope of a replacement CATOBAR carrier its own still trains several times a year landing S-2 Turbo Trackers aboard the Brazilian carrier São Paulo.

Much easier to operate from small decks than fixed wing aircraft were ASW helicopters which flew from the decks of nearly all allied conventional carriers to this day and most LPH or STOVL carriers operated by the Soviet, Spanish, Italian, Japanese, British, and Thai navies. Since the only navy currently building new ASW though-deck helicopter-only ships is Japan, who terms their vessels as helicopter destroyers instead of ASW carriers, it is disputable if a ASW helicopter only vessel is best defined as a ASW carrier or perhaps a new designation.

List of ASW carriers

Aircraft carriers and helicopter carriers that had primary ASW duties from the mid 1960's onward.

ASW aircraft carriers

Argentine Navy

- ARA *Independencia* - one ship (ex-Colossus-class) ASW (retired/scrapped) Fixed Wing CATOBAR S-2 and Helicopters
- ARA *Veinticinco de Mayo* - one ship (ex-Colossus-class) ASW (retired/scrapped) Fixed Wing CATOBAR S-2 and Helicopters

Brazilian Navy

- NAeL *Minas Gerais* - one ship (ex-Colossus-class) ASW (retired/scrapped) Fixed Wing CATOBAR and Helicopters

French Navy

- *Arromanches* - one ship (ex-Colossus-class) ASW (retired/scrapped) Fixed Wing CATOBAR and Helicopters

Italian Navy

- *Giuseppe Garibaldi* one ship, ASW helicopter carrier 1985-1988, STOVL fighters and ASW Helicopters carrier 1988-current.

Hyūga class, ASW helicopter carrier

Japan Maritime Self-Defense Force

- *Hyūga* class, the *Hyūga* was commissioned Wednesday, March 18, 2009. It will be stationed in Yokosuka port, near Tokyo. Another ship of this class to be named the *Ise* was launched 21 August 2009, two more are planned but require approval for a total of four ships in this class. ASW, utility, and sea mine clearing helicopters

Spanish Navy

- *Dédalo* - one ship (ex-Independence class) ASW helicopter carrier 1967-1976, STOVL carrier 1976-1989. Strike/ASW (retired/scrapped) STOVL and Helicopters
- *Principe de Asturias* one ship STOVL fighters and Helicopters

Royal Navy

- HMS *Bulwark* Centaur class aircraft carrier In 1979 recommissioned from reserve as a helicopter ASW carrier, due to delays with Invincible. (retired/scrapped)
- HMS *Hermes* Centaur class aircraft carrier Converted to helicopter ASW in 1976. (sold to India, renamed INS Viraat)
- Invincible class - three ships Strike/ASW/Amphibious Assault STOVL and Helicopters

The three ships of the *Invincible* class, were originally designed as through deck cruisers for the ASW role, but ended up also equipped with Harrier STOVL fighters. Following

the Falklands War, however, the role of these ships was reconsidered, and they were used as conventional, albeit light, fleet aircraft carriers, in the power projection role.

Royal Australian Navy

- HMAS *Melbourne* - one ship (Majestic-class) Strike/ASW (retired/scrapped) Fixed Wing CATOBAR and Helicopters

Royal Canadian Navy

- HMCS *Bonaventure* - one ship (ex-Majestic-class) ASW (retired/scrapped) Fixed Wing CATOBAR and Helicopters

Royal Netherlands Navy

- HNLMS *Karel Doorman* - one ship (ex-Colossus-class) ASW (retired/sold) Fixed Wing CATOBAR and Helicopters

Soviet/Russian Navy

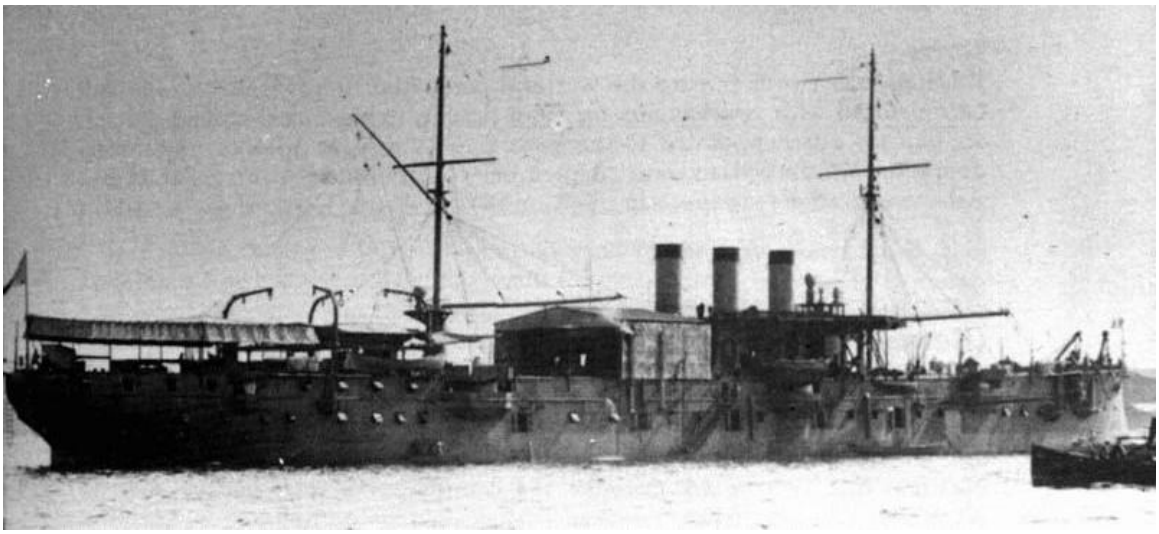
- *Moskva* class ASW helicopter support ship, large rear deck landing pad and hangar for 18 helicopters(retired/scrapped) Helicopters only
- *Kiev Class* Cruiser/Carrier Guided Missile Cruiser/Limited Air Defense/ASW(retired/sold) STOVL and Helicopters

United States Navy

- *Essex* class during their careers ships fitted and assigned the CVS designation were ASW carriers with Fixed wing and helicopter anti-submarine aircraft and AEW aircraft, although for a short time some also carried an A-4 Skyhawk squadron for daytime combat air patrol(retired/scrapped) Fixed Wing CATOBAR and Helicopters
- *Wasp* class, *Tarawa* Class, and the now retired LPH Amphibious assault ships were given secondary roles of Sea Control meaning they would deploy with a modified air compliment consisting of Helicopters for ASW coverage and a larger STOVL fighter group for air defense and even limited strike missions.

Chapter- 5

Seaplane Tender



The first seaplane carrier, the French *Foudre* in 1912, with plane hangar and cranes

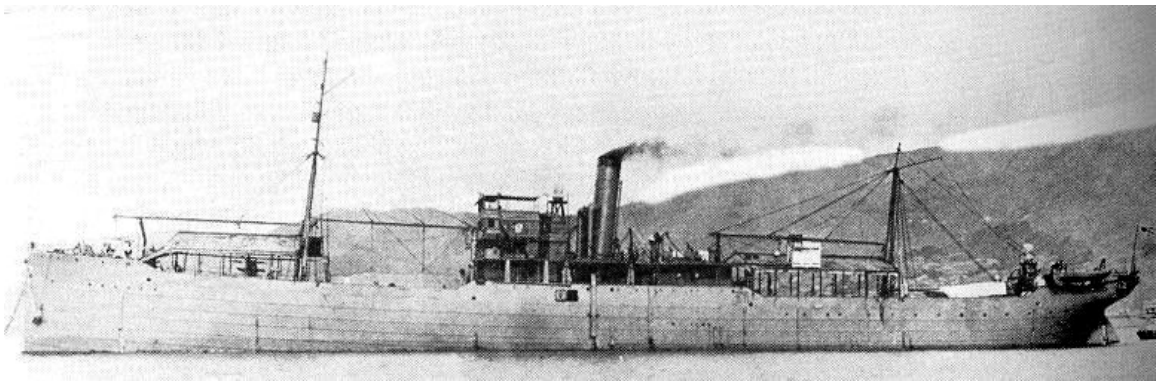
A **seaplane tender** (or *seaplane carrier*) is a ship that provides facilities for operating seaplanes. These ships were the first aircraft carriers and appeared just before the First World War.

History

a scoutplane being hoisted onboard the USS *Philadelphia*

The first seaplane tender appeared in 1911 with the French Navy *La Foudre*, following the invention of the seaplane in 1910 with the French *Le Canard*. *La Foudre* carried float-equipped planes under hangars on the main deck, from where they were lowered on the sea with a crane. *La Foudre* was further modified in November 1913 with a 10 meter-long flat deck to launch her seaplanes. Another early seaplane carrier was HMS *Hermes*, an old cruiser converted and commissioned with a flying-off deck in mid 1913.

World War I



The Japanese seaplane carrier *Wakamiya* conducted the world's first naval-launched air raids in September 1914.

In the Battle of Tsingtao, from September 5, 1914 the Imperial Japanese Navy seaplane carrier *Wakamiya* conducted the world's first naval-launched air raids from Kiaochow Bay. The four Maurice Farman seaplanes bombarded German-held land targets (communication centers and command centers) and damaged a German minelayer in the Tsingtao peninsula from September to November 6, 1914 when the Germans surrendered. On Christmas Day 1914 the British carried out the Cuxhaven Raid - seaplanes carried within range of their targets attacked German naval targets in the Heligoland Bight.

These carriers had hangars for storing and maintaining the aircraft, but no flight deck as in a true aircraft carrier. Instead they used cranes to lower the aircraft into the sea for takeoff and to recover them after landing. The ships were normally converted merchant vessels rather than specially constructed for the task. As aircraft improved the problems of using seaplanes became more of a handicap. The aircraft could only be operated in a smooth sea and the ship had to stop for launching or recovery, both of which would take around 20 minutes. The tender was often stationed ten miles or so in front of the main battle fleet with the cruiser screen so that it would not fall hopelessly behind when it launched its aircraft. Seaplanes also had poorer performance than other aircraft because of the drag and weight of the floats. Seaplane tenders had largely been superseded by aircraft carriers in the battle fleet by the end of the First World War, although aircraft were still of minor importance compared to the firepower of naval artillery. The British *Ark Royal* was a seaplane tender with a flying-off deck. Seaplanes could be recovered while the ship was under way through the "Hein Mat" - a sheet towed behind the vessel, once the aircraft was on the mat it was effectively stationary with respect to the ship and could be hoisted aboard.

The Australian seaplane tender HMAS *Albatross* with one of her aircraft overhead (AWM 300122)

In the inter-war years, it was common for cruisers and battleships to be equipped with catapult-launched reconnaissance seaplanes. A few navies, especially those which lacked true aircraft carriers, also acquired catapult-equipped seaplane carriers for fleet reconnaissance purposes.

World War II

USS *Timbalier* with two Martin PBM Mariner flying boats shortly after World War II

During the Second World War both the United States Navy and the Imperial Japanese Navy built a number of seaplane tenders to supplement their aircraft carrier fleets; however these ships often had their catapults removed, and were used usually as support vessels which operated seaplanes from harbours rather than in a seaway. These aircraft were generally for long range reconnaissance patrols. The tenders allowed the aircraft to be rapidly deployed to new bases because their runways did not have to be constructed, and support facilities were mobile much like supply ships for submarines or destroyers.

Seaplane tenders became obsolete at the end of the Second World War. A few remained in service after the war but by the late-1950s most had been scrapped or converted to other uses such as helicopter repair ships.

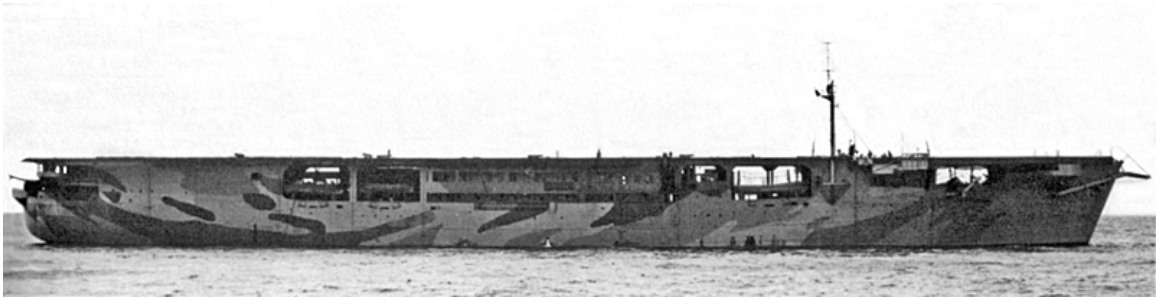
List of examples

Examples of seaplane tenders included:

- HMAS *Albatross* (Australia, 1928)
- *La Foudre* (France, converted into the world's first seaplane tender in 1911-13)
- Japanese aircraft carrier *Chitose*
- *Commandant Teste* (France, 1932)
- *Giuseppe Miraglia* (Italy, converted from merchant vessel *Citta de Messina* in 1927)
- *Dédalo* (Spain, converted from German merchant vessel *Neuenfels* in 1922)
- HMS *Ark Royal* (UK, 1914, renamed *Pegasus* in 1934)
- HMS *Ben-my-chree* (UK, a ferry converted in 1915 used in WWI)
- HMS *Engadine* (UK, 1911, another converted ferry present at the Battle of Jutland)
- HMS *Campania* (UK)
- HMS *Riviera* (UK, sister ship of *Engadine*)
- USS *Langley* (CV-1) (USA's first aircraft carrier, but converted into a seaplane tender in 1937)
- USS *Mississippi* (USA, an obsolete battleship used as a seaplane tender in 1914)
- USS *Curtiss* (AV-4) (USA WWII Pearl Harbor to Okinawa)
- USS *Currituck* and USS *Pine Island* (USA WWII-era seaplane tender, both later participated in Operation *Highjump*, a 1947 mission to Antarctica)
- USS *Norton Sound* (Began service as Currituck-class seaplane tender AV-11, later converted to AVM-1 - first US guided-missile ship)
- USS *Tangier* (USA, a cargo ship converted to a seaplane tender during World War II)
- USS *Timbalier* (tended Martin PBM Mariner flying boats until 1954)

Chapter- 6

Escort Carrier



Escort Carrier HMS *Audacity* (D10)

The **escort aircraft carrier** or **escort carrier**, also called a "jeep carrier" or "baby flattop" in the USN or "Woolworth Carrier" by the RN, was a small and slow type of aircraft carrier used by the British Royal Navy (RN), the Imperial Japanese Navy and Imperial Japanese Army Air Force, and the United States Navy (USN) in World War II. They were typically half the length and one-third the displacement of the larger fleet carriers. While they were slower, less armed and armored, and carried fewer planes, they were less expensive and could be built in less time. This was their principal advantage, as escort carriers could be completed in greater numbers as a stop-gap when fleet carriers were scarce. However, the lack of protection made escort carriers particularly vulnerable and several were sunk with great loss of life. The light carrier (hull classification symbol CVL) was a similar concept to escort carriers in most respects, however they were intended for higher speeds to be deployed alongside fleet carriers.

Escort carriers were too slow to keep up with the main forces consisting of fleet carriers, battleships, and cruisers. Instead, they were used to defend convoys from enemy threats such as submarines and planes. In the invasions of mainland Europe and Pacific islands, escort carriers provided air support to ground forces during amphibious operations. Escort carriers also served as backup aircraft transports for fleet carriers, and ferried aircraft of all military services to points of delivery.

In the Atlantic, the escort carriers were used to protect convoys against U-boats. Initially escort carriers accompanied the merchant ships and fended off attacks from aircraft and submarines. Later in the war, escort carriers centered hunter-killer groups which sought out submarines instead of being attached to a particular convoy.

During the Leyte Campaign, at the Battle off Samar, the Japanese Center Force of cruisers and battleships, including *Yamato*, the largest battleship ever built met the US task force of escort carriers and destroyers known as "Taffy 3". The escort carriers and destroyers were not expected to put up much of a fight against major big-gun warships. Nonetheless, the Japanese were turned back by furious defence put up by "Taffy 3", with the Wildcat and Avenger planes playing a key role against the Japanese who had no air cover, as well as the US destroyers who made torpedo runs. The US sunk three Japanese cruisers in that engagement, at the cost of one escort carrier and three destroyers.

Of the 151 aircraft carriers built in the United States during WWII, 122 were escort carriers. Though no examples survive to this day, the *Casablanca* class holds the distinction of being the most numerous single class of aircraft carrier ever built, with 50 having been launched. The *Bogue* class escort carrier comes in a close second, with 45 launched.

Development

The Washington Naval Treaty imposed limits on the maximum size and total tonnage of aircraft carriers for the five main naval powers. Later treaties largely kept these provisions. As a result construction between the World Wars had been insufficient to meet operational needs for aircraft carriers as the Second World War expanded from Europe. Too few fleet carriers were available to simultaneously transport aircraft to distant bases, support amphibious invasions, offer carrier landing training for replacement pilots, conduct anti-submarine patrols, and provide defensive air cover for deployed battleships and cruisers. The foregoing mission requirements limited use of fleet carriers' unique offensive strike capability demonstrated at the Battle of Taranto and the Attack on Pearl Harbor. Conversion of existing ships (and hulls under construction for other purposes) provided additional aircraft carriers until new construction became available.

Conversions of cruisers, passenger liners, and fleet oilers with speed similar to fleet carriers were identified by the United States as "light aircraft carriers" (hull classification symbol CVL) able to operate at battle fleet speeds. Slower conversions were classified as "escort carriers" and were considered naval auxiliaries suitable for pilot training and transport of aircraft to distant bases.

The Royal Navy had recognized a need for carriers to defend its trade routes in the 1930s. No construction was undertaken until HMS *Audacity* (D10) was converted from the captured German merchant ship MV *Hannover* and commissioned in July 1941. For defence from German aircraft, convoys were supplied first with Fighter catapult ships and CAM Ships which could carry a single (disposable) fighter. In the interim, before escort carriers could be supplied, they also brought in Merchant aircraft carriers which could operate 4 aircraft.

In 1940, Admiral William Halsey recommended construction of naval auxiliaries for pilot training. On 1 February 1941, the United States Chief of Naval Operations gave priority to construction of naval auxiliaries for aircraft transport. United States ships built to meet

these needs were initially referred to as **auxiliary aircraft escort vessels** (**AVG**) in February 1942 and then **auxiliary aircraft carrier** (**ACV**) on 5 August 1942. The first United States example of the type was USS *Long Island* (AVG-1). Operation Torch and North Atlantic anti-submarine warfare proved these ships capable aircraft carriers for ship formations moving at the speed of trade or amphibious invasion convoys. United States classification revision to **escort aircraft carrier** (**CVE**) on 15 July 1943 reflected upgraded status from auxiliary to combatant. They were informally known as "Jeep carriers" or "baby flattops." It was quickly found that the escort carriers had better performance than light carriers, which tended to pitch badly in moderate to high seas. The *Commencement Bay* class was designed to incorporate the best features of American CVLs on a more stable hull with a less expensive propulsion system.

Amongst their crews, CVE was sarcastically said to stand for "Combustible, Vulnerable, and Expendable". Magazine protection was minimal in comparison to fleet aircraft carriers. HMS *Avenger* was sunk within minutes by a single torpedo, and HMS *Dasher* (D37) exploded from undetermined causes with very heavy loss of life. Three escort carriers—USS *St. Lo* (CVE-63), *Ommaney Bay* (CVE-79) and *Bismarck Sea* (CVE-95)—were destroyed by kamikazes, the largest ships to meet such a fate.

Allied escort carriers were typically around 500 ft (150 m) long, not much more than half the length of the almost 900 ft (300 m) fleet carriers of the same era, but were less than one-third of the weight. A typical escort carrier displaced about 8,000 tons, as compared to almost 30,000 tons for a full-size fleet carrier. The aircraft hangar typically ran only a third of the way under the flight deck and housed a combination of 24 to 30 fighters and bombers organized into one single "composite squadron". By comparison a late *Essex*-class fleet carrier could carry a total of 103 aircraft organized into separate fighter, bomber and torpedo-bomber squadrons.

The island on these ships was small and cramped, and located well forward of the funnels (unlike on a normal-sized carrier where the funnels were integrated into the island). Although the first escort carriers had only one aircraft elevator, two elevators, one fore and one aft, quickly became standard, so did the one aircraft catapult. The carriers employed the same system of arresting cables and tailhooks as on the big carriers, and procedures for launch and recovery were the same as well.

The crew size was less than a third of that of a large carrier, but this was still a bigger complement than most naval vessels. It was large enough to justify the existence of facilities such as a permanent canteen or snack bar, called a gedunk bar, in addition to the mess. The bar was open for longer hours than the mess and sold several flavors of ice cream, along with cigarettes and other consumables. There were also several vending machines, which made a "gedunk" sound when operated.

In all, 130 Allied escort carriers were launched or converted during the war. Of these, six were British conversions of merchant ships: HMS *Audacity* (D10), *Nairana* (D05), *Campania* (D48), *Activity* (D94), *Pretoria Castle* F61) and *Vindex* (D15). The remaining escort carriers were US-built. Like the British, the first US escort carriers were converted

merchant vessels (or in the *Sangamon* class, converted military oilers). The *Bogue* class carriers were based on the hull of the Type C3 cargo ship. The last 69 escort carriers of the *Casablanca* and *Commencement Bay* classes were purpose-designed and purpose-built carriers drawing on the experience gained with the previous classes.

Royal Navy

Originally developed at the behest of the United Kingdom to operate as part of a North Atlantic convoy escort rather than as part of a naval strike force, many of the escort carriers produced were assigned to the Royal Navy for the duration of the war under the Lend-lease act. They supplemented and then replaced the converted merchant aircraft carriers which were put into service by the British and Dutch as an emergency measure until the escort carriers became available. As convoy escorts, they were used by the Royal Navy to provide air scouting, to ward off enemy long-range scouting aircraft and, increasingly, to spot and hunt submarines. Often additional escort carriers also joined convoys, not as fighting ships but as transporters, ferrying aircraft from the US to Britain. In this case the aircraft cargo could be doubled by storing aircraft on the flight deck as well as in the hangar.

The ships sent to the Royal Navy were slightly modified, partly to suit the traditions of that service. Among other things the ice cream making machines were removed, since they were considered unnecessary luxuries on ships, which served grog and other alcoholic beverages. The heavy duty washing machines of the laundry room were also removed since "all a British sailor needs to keep clean is a bucket and a bar of soap" (quoted from Warrilow).

Other modifications were due to the need for a completely enclosed hangar when operating in the North Atlantic and in support of the Arctic convoys.

US Navy Service

Meanwhile the US discovered their own use for the escort carriers. In the North Atlantic, they supplemented the escorting destroyers by providing air support for their anti-submarine warfare. One of these escort carriers, the USS *Guadalcanal* (CVE-60), was instrumental in the capture of the German submarine (U-boat) U-505 off North Africa in 1944. The *Guadalcanal* and her task force were commanded by Captain (later Admiral) Daniel V. Gallery. In 1955 the U-505 was moved to Chicago, restored, and made a permanent exhibit at the Chicago Museum of Science and Industry.

In the Pacific theatre, escort carriers lacked the speed to sail with fast carrier attack groups, so were often tasked to escort the landing ships and troop carriers during the island-hopping campaign. In this role they provided air cover for the troopships and flew the first wave of attacks on beach fortifications in amphibious landing operations. On occasion they even escorted the large carriers, serving as emergency airstrips and providing fighter cover for their larger sisters while these were busy readying or refueling

their own planes. They also transported aircraft and spare parts from the US to remote island airstrips.

Battle off Samar

USS *Gambier Bay*, burning from earlier gunfire damage, is bracketed by a salvo from a Japanese cruiser (faintly visible in the background, center-right) shortly before sinking during the Battle off Samar.

Perhaps the finest moment for these escort carriers was the relatively little known Battle of Leyte Gulf's Battle off Samar, where aircraft of three escort carrier groups (many unarmed or armed only for harassment), along with their hopelessly outmatched escorting destroyers not only fended off but turned back the battleship *Yamato* and the Japanese Combined Fleet, allowing General Douglas MacArthur's Army to complete the liberation of Leyte. In this battle, the slow ships could not hope to outrun 30-knot cruisers, nevertheless they launched their aircraft, and maneuvered out of the way of shellfire for over an hour. They then endured dozens of hits, mostly from ineffective armor-piercing shots, with the USS *Gambier Bay* (CVE-73) the only US carrier lost to surface fire in the war. The carriers carried only a single 5-inch anti-aircraft gun as a stinger, but to land accurate hits, pursuing Japanese cruisers had to close within range of the carriers' own guns. One of the guns caused critical damage to the burning Japanese cruiser *Chokai* and

a subsequent bomb dropped from one of the task force's aircraft hit the forward machinery room on Chokai, leaving her dead in the water. Several kamikaze aircraft were shot down by carrier gunners, with only the *St Lo* lost to air attack. In the costly victory, the small task force had suffered a number of ships and men lost comparable to the Battle of Coral Sea and Battle of Midway combined.

USN escort carrier Division Commanders in World War II

- Vice Admiral George R. Henderson
- Vice Admiral Ralph A. Ofstie
- Rear Admiral William Sample
- Vice Admiral Clifton A. F. Sprague
- Vice Admiral Thomas L. Sprague
- Admiral Felix B. Stump

Escort carrier tactics when escorting convoys

There are three basic tactics for operating an escort carrier in defence of a convoy:

- **Within the convoy**, which gives it the protection of the convoy's escort but limits the space to turn into the wind to operate aircraft.
- **Near the convoy**, which gives the carrier freedom of manoeuvre, but puts it outside the screen provided by the convoy's escort, making it necessary for the carrier to have its own separate escort. The carrier is also likely to be spotted by enemy forces approaching the convoy, making it vulnerable to attack.
- **Some distance away from the convoy**. This increases the time required for aircraft to reach the convoy but reduces the risk of being spotted by forces attacking the convoy.

HMS *Audacity* was sunk while operating in the second position which was later banned by the Admiralty as too risky.

The ships

Many escort carriers were Lend-Leased to the United Kingdom, this list specifies the breakdown in service to each navy.

- *Long Island* class: Two ships, one in USN service (USS *Long Island* (CVE-1)) and one in British service (HMS *Archer* (D78)).
- *Charger* class: Four ships, one mainly in USN service (USS *Charger* (CVE-30)), three in British service as *Avenger* class.
- *Sangamon* class: Four ships, all in USN service.
- *Bogue* class: 45 ships, 11 in USN service, 34 in British service as *Attacker* class (first batch) and *Ameer* class (second batch).
- *Casablanca* class: 50 ships, all in USN service.

- *Commencement Bay* class: 19 ships, all in USN service, including two which were accepted but not commissioned and laid up for many years after the war. Four more units were canceled and scrapped on the building slips. The *Commencement Bay* class ships were seen as the finest escort carriers ever built, and several units continued in service after the war as training carriers, aircraft ferries and other auxiliary uses.

In addition, six escort carriers were produced by the British during the war (all converted from other vessels).

The table below lists escort carriers and similar ships performing the same missions. The first four were built as early fleet aircraft carriers. Merchant aircraft carriers (MAC) carried trade cargo in addition to operating aircraft. Aircraft transports carried larger numbers of planes by eliminating accommodation for operating personnel and storage of fuel and ammunition.

Name	Date	Nation	Displacement	Speed	Aircraft	Notes
HMS *Argus* (I49)	1918	UK	14,000 tons (net)	20 knots	18	converted liner
USS *Langley* (CV-1)	1922	United States	11,500 tons	15 knots	30	converted collier
Hōshō	1923	Japan	7,500 tons (standard)	25 knots	12	early fleet carrier
HMS *Hermes* (95)	1924	UK	10,850 tons (standard)	25 knots	12	early fleet carrier
HMS *Audacity* (D10)	1941	UK	5,500 tons	15 knots	6	merchant conversion
USS *Long Island* (CVE-1), HMS *Archer* (D78)	1941	United States and UK	9000 tons	17 knots	15–21	merchant conversions
HMS *Avenger* (D14), HMS *Biter* (D97), HMS *Dasher* (D37), USS *Charger* (CVE-30)	1941	United States and UK	8,200 tons	17 knots	15–21	merchant conversions
Taiyō, *Unyō*, *Chūyō*	1941	Japan	17,830 tons (standard)	21 knots	27	converted liners
USS *Kitty Hawk* (APV-1), USS *Hammondsport* (APV-2), USS *Lakehurst* (APV-3)	1941	United States	8,100 tons	17 knots		merchant conversion aircraft ferries
HMS *Activity* (D94)	1942	UK	11,800 tons (standard)	18 knots	10–15	merchant conversion
Bogue class	1942	United	9,800 tons	18	15–21	45

		States and UK		knots		conversions of C-3 merchant hulls
USS *Sangamon* (CVE-26), USS *Suwanee* (CVE-27), USS *Chenango* (CVE-28), USS *Santee* (CVE-29)	1942	United States	11,400 tons (standard)	18 knots	31	converted oilers
HMS *Campania* (D48)	1943	UK	12,400 tons (standard)	18 knots	18	merchant conversion
HMS *Vindex* (D15)	1943	UK	13,400 tons (standard)	16 knots	15–20	merchant conversion
HMS *Nairana* (D05)	1943	UK	14,000 tons (standard)	16 knots	15–20	merchant conversion
Rapana class (*Acavus*, *Adula*, *Alexia*, *Amastra*, *Ancylus*, *Gadila*, *Macoma*, *Miralda*, *Rapana*)	1943	UK	12,000 tons	12 knots	3	tankers converted to Merchant aircraft carriers
Casablanca class	1943	United States	7,800 tons	19 knots	28	50 built as escort aircraft carriers
Kaiyō	1943	Japan	13,600 tons (standard)	23 knots	24	converted liner
HMS *Pretoria Castle* (F61)	1943	UK	17400 tons (standard)	18 knots	21	merchant conversion
Empire MacAlpine, *Empire MacAndrew*, *Empire MacRae*, *Empire MacKendrick*, *Empire MacCallum*, *Empire MacDermott*	1943	UK	8,000 tons (gross)	12 knots	4	grain carrying Merchant aircraft carriers
Empire MacCabe, *Empire MacKay*, *Empire MacMahon*, *Empire MacColl*	1943	UK	9,000 tons (gross)	11 knots	3	tanker Merchant aircraft carriers
Commencement Bay class	1944	United States	10,900 tons	19 knots	34	19 built as escort aircraft carriers
Shinyō	1944	Japan	17,500 tons	22 knots	33	converted liner

Relative carrier sizes in World War II

Relative carrier sizes

	***Bogue* class Escort carrier**	***Independence* class light carrier**	***Essex* class fleet carrier**	***Illustrious* class carrier**
Length:	151 m	190 m	266 m	205 m
Beam:	21 m	22 m	28 m	29 m
Displacement:	9,800 t	11,000 t	27,100 t	23,000 t
Armament	1x 127 mm, light AA	light AA	8x 127 mm, light AA	16x 114 mm
Armor	None	50-125 mm	150-200 mm	75 mm deck
Aircraft:	24	33	90	72
Speed:	17 knots (32 km/h)	31 knots (58 km/h)	33 knots (61 km/h)	30 knots
Crew:	850	1,569	3,448	817 + 390

Post World War II

The years following World War II brought many revolutionary new technologies to the navy, most notably the helicopter and the jet fighter, and with this a complete rethinking of its strategies and ships' tasks. Although several of the latest *Commencement Bay*-class CVE were deployed as floating airfields during the Korean war, the main reasons for the development of the escort carrier had disappeared or could be dealt with better by newer weapons. The emergence of the helicopter meant that helicopter-deck equipped frigates could now take over the CVE's role in a convoy while also performing their own traditional role as submarine hunters. Ship-mounted guided missile launchers took over much of the aircraft protection role, and in-flight refueling abolished the need for floating stopover points for transport or patrol aircraft. As a result, after the *Commencement Bay* class, no new escort carriers were designed, and with every downsizing of the navy, the CVEs were the first to be mothballed.

Several escort carriers were pressed back into service during the first years of the Vietnam War because of their ability to carry large numbers of aircraft. Redesignated AKV (air transport auxiliary), they were manned by a civilian crew and used to ferry whole aircraft and spare parts from the United States to Army, Air Force and Marine bases in South Vietnam. However, CVEs were only useful in this role for a limited period. Once all major aircraft were equipped with refueling probes, instead of shipping a plane overseas to its pilot, it became much easier to fly the aircraft directly to its base.

The last chapter in the saga of the escort carriers consisted out of two conversions: As an experiment, the USS *Thetis Bay* (CVE-90) was converted from an aircraft carrier into a pure helicopter carrier (CVHA-1) and used by the Marine Corps to carry assault helicopters for the first wave of amphibious warfare operations. Later, the *Thetis Bay* became a full amphibious assault ship (LHP-6). Although in service only from 1955 (the

year of her conversion) to 1964, the experience gained in her training exercises greatly influenced the design of today's amphibious assault ships.

In the second conversion, in 1961, the USS *Gilbert Islands* (CVE-107) had all her aircraft handling equipment removed and four tall radio antennas installed on her long, flat deck. In lieu of aircraft, the hangar deck now had no less than 24 military radio transmitter trucks bolted to its floor. Rechristened USS *Annapolis* (AGMR-1), the ship was used as a communication relay ship and served dutifully through the Vietnam War as a floating radio station, relaying transmissions between the forces on the ground and the command centers back home. Like the *Thetis Bay*, the experience gained before she was stricken in 1976 helped develop today's purpose-built amphibious command ships of the *Blue Ridge* class.

Unlike almost all other major classes of ships and patrol boats from World War II, most of which can be found in a museum or port, no escort carrier or American light carrier has survived: all were destroyed during the war or broken up in the following decades. The last escort carrier, USS *Gilbert Islands*, was broken up for scrap starting in 1976. The last American light carrier (the escort carrier's faster sister type) was the USS *Cabot* (CVL-28), which was broken up in 2002 after a decade-long attempt to preserve the vessel.

The United States designed the Sea Control Ship to serve a similar role, whilst none where actually built the Spanish aircraft carrier Principe de Asturias and HTMS Chakri Naruebet are all based on the concept.

Chapter- 7

French Aircraft Carrier Charles de Gaulle (R91)

Career (France)	
Name:	*Charles de Gaulle* (R91)
Namesake:	Charles de Gaulle
Ordered:	3 February 1986
Builder:	DCNS
Laid down:	14 April 1989
Launched:	7 May 1994
Commissioned:	18 May 2001
In service:	18 May 2001
Renamed:	Laid down as *Richelieu*, renamed *Charles de Gaulle* in 1987
Homeport:	Toulon, France
Nickname:	CDG
Honours and awards:	Jack with the colours of the Free French Forces (front) and the ribbon of the *Ordre*

	de la Libération (back)
Fate:	Active in service as of March 2010
	General characteristics
Class and type:	Unique aircraft carrier
Displacement:	37,085 tonnes (standard) 42,000 tonnes (full load)
Length:	261.5 metres (858 ft) overall
Beam:	64.36 metres (211.2 ft) overall
Draught:	9.43 metres (30.9 ft)
Propulsion:	2 × K15 pressurised water reactors (PWR), 150 MW each 4 × diesel-electric 2 × shafts
Speed:	27 knots (50 km/h)
Range:	Essentially unlimited distance; 20 years
Endurance:	45 days of food
Capacity:	800 commandos, 500 tonnes of ammunitions
Complement:	Ship's company: 1,350 Air wing: 600
Sensors and processing systems:	DRBJ 11 B tridimensional air search radar DRBV 26D air search radar DRBV 15C low altitude air search radar Arabel target acquisition radar
Electronic warfare and decoys:	ARBR 21 Detector ARBB 33 Countermeasures suite ARBG2 MAIGRET Interceptor 4 × Sagaie decoys launcher SLAT (*Système de lutte anti-torpille*) torpedo countermeasures
Armament:	4 × 8 cell SYLVER launchers carrying the MBDA Aster 15 surface to air missile. 2 × 6 cell Sadral launchers carrying Mistral short range missiles 8 × Giat 20F2 20 mm cannons.
Aircraft carried:	28 - 35 aircraft, including *Rafale *Super Étendard *E-2C Hawkeye *SA365 Dauphin helicopters

Charles de Gaulle **(R91)** is the only serving French aircraft carrier and is the flagship of the French Navy (*Marine Nationale*). She is the tenth French aircraft carrier, the first French nuclear-powered surface vessel, and the first and only nuclear-powered carrier

built outside of the United States Navy. She is named after French statesman and general Charles de Gaulle.

The ship carries a complement of Dassault-Breguet Super Étendard, Dassault Rafale M and E-2C Hawkeye aircraft, as well as modern electronics and Aster missiles. She is the second largest European carrier, after the *Admiral Kuznetsov*. She is a CATOBAR-type carrier that uses a shorter version of the catapult system than that installed on the US *Nimitz* class carriers, the 75 m C13-3 steam catapult.

Development

Construction

The carrier replaced *Foch*, a conventionally-powered aircraft carrier, in 2001. *Clemenceau* and *Foch* were completed in 1961 and 1963 respectively; the requirement for a replacement was identified in the mid-1970s.

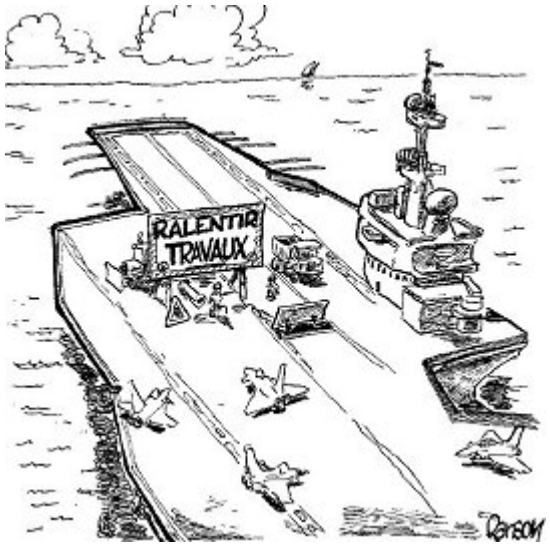
The hull was laid down in April 1989 at the DCNS Brest naval shipyard. The carrier was completed in May 1994 and at 35,500 tonnes was the largest warship launched in Western Europe since 1951. She was to be named *Richelieu* in 1986 by the French president at the time, François Mitterrand, after the famous French politician Armand-Jean du Plessis, Cardinal and Duc de Richelieu (following a traditional name for capital ships in the French Navy). On 7 February 1987, however, after a ferocious row, the name of the ship was changed to *Charles de Gaulle* by the Gaullist Prime Minister at the time, Jacques Chirac.

Construction quickly fell behind schedule as the project was starved of funding, which was worsened by the economic recession in the early 1990s. Total costs for the vessel would top €3 billion. Work on the ship was suspended altogether on four occasions: 1990, 1991, 1993 and 1995. The ship was commissioned on 18 May 2001, five years behind the projected deadline.

Spying incident

In 1993, it was alleged by *The Guardian* that a group of engineers inspecting the vessel during her construction were MI6 operatives, believed to have been evaluating the method of shielding the nuclear reactors, amongst other technical details. However, the newspaper published a denial by both the British government and the *Direction de la Surveillance du Territoire* that there had been any incident.

Trials and technical problems



Satirical strip of *Le Parisien* newspaper. The sign reads: "Work in progress, slow down".

Charles de Gaulle entered sea trials in 1999. These identified the need to extend the flight deck to safely operate the E-2C Hawkeye. This operation sparked negative publicity, however, as the same tests had been conducted on both *Foch* and *Clemenceau* when the F-8E(FN) Crusader fighter had been introduced. The 5 million francs for the extension was 0.025% of the total budget for *Charles de Gaulle* project.

On 28 February 2000, a nuclear reactor trial triggered the combustion of additional isolation elements, producing a smoke incident.

During the night of 9 November 2000, in the Western Atlantic while en route toward Norfolk, Virginia, the port propeller broke and the ship had to return to Toulon to replace the faulty unit. The investigations that followed showed similar structural faults in the other propeller and in the spare propellers: bubbles in the one-piece copper-aluminium alloy propellers near the centre. The fault was blamed on the supplier, Atlantic Industries, which had already gone bankrupt. To make matters worse, all documents relating to the design and fabrication of the propellers had been lost in a fire. As a temporary solution, the less advanced spare propellers of *Clemenceau* and *Foch* were used, limiting the maximum speed to 24 knots (44 km/h) instead of the contractual 27 knots (50 km/h).

On 5 March 2001, *Charles de Gaulle* went back to sea with two older propellers and sailed 25.2 knots (47 km/h) on her trials. Between July and October, *Charles de Gaulle* had to be refitted once more due to abnormal noises, as loud as 100 dB, near the starboard propeller, which had rendered the aft part of the ship uninhabitable.

On 8 November 2001, a sailor performing a routine maintenance task lost consciousness due to a toxic gas leak. A non-commissioned officer attempted to rescue him and collapsed as well. They were rescued by the on-board medical team and sent to Toulon Hospital. Both survived.

Active service

Refitting

Command bridge of *Charles de Gaulle*

On 16 September 2001, the French press reported slightly higher than acceptable radioactivity levels aboard *Charles de Gaulle*, thought to be caused by a faulty isolation element. It was later discovered that the radioactivity levels were normal, but that the regulations concerning acceptable radioactivity levels had changed. While the United States was preparing its response to the September 11, 2001 attacks in the form of Operation Enduring Freedom, the media complained about the lack of deployable French military power. At the same time, the Defence Commission reported the maintenance of the Fleet to be substandard. In this context, *Charles de Gaulle*, then under repairs, was again an object of criticism, with former President Valéry Giscard d'Estaing describing it as a "half-aircraft-carrier".

Link 16

On 11 October 2001, the frigate *Cassard*, four AWACS aircraft and *Charles de Gaulle* were involved in a successful trial of the Link 16 high-bandwidth secure data network. The network allows real-time monitoring of the airspace from the South of England to the Mediterranean Sea. The collected data were also transmitted in real time to the *Jean Bart* through the older Link 11 system.

Afghanistan

A rare occurrence of a 5-country multinational fleet of the NATO countries, the Netherlands, France, the United States, Italy, and the United Kingdom, during Operation Enduring Freedom in the Oman Sea

On 21 November 2001, France decided to send *Charles de Gaulle* to the Indian Ocean in support of Operation Enduring Freedom against Taliban-controlled Afghanistan. Task Force 473, with 2,900 men under the command of Contre-Amiral François Cluzel, sailed on 1 December. The task force was composed of *Charles de Gaulle*, frigates *La Motte-Picquet*, *Jean de Vienne* and *Jean Bart*, the nuclear attack submarine *Rubis*, the tanker *Meuse* and the aviso *Commandant Ducuing*.

Embarked air power comprised sixteen Super Étendards, one E-2C Hawkeye, two Rafale Ms and several helicopters. The Super Étendards carried out their first missions above Afghanistan on 19 December, executing reconnaissance and bombing missions, covering over 3,000 kilometres. Overall they carried out 140 missions, averaging 12 every day.

USS *Enterprise* (left), the first nuclear-powered aircraft carrier, and *Charles de Gaulle* (right), at the time the latest nuclear carrier.

On 18 February 2002, a Helios observation satellite spotted abnormal activities near Gardez. The next day, after American Special Forces in the region confirmed these observations, *Charles de Gaulle* launched two reconnaissance Super Étendards. On 20 February, British and US forces entered the valley and Operation Anaconda began in early March.

In March, Super Étendards and six Mirage 2000 aircraft carried out airstrikes against targets claimed to be al Qaeda. A few targets suggested by US forces were denied out of fear of hitting civilians. Nevertheless, French involvement was complimented on 11 March 2002 by US President George W. Bush, who mentioned "our good ally, France, has deployed nearly one-fourth of its navy to support Operation Enduring Freedom". At this point, the French air complement had been increased to 16 Super Étendards, 6 Mirage 2000 D, 5 Rafales, and two Hawkeye AWACS. From February, the air wings of *Charles de Gaulle* and USS *John C. Stennis* landed on each other's decks as a means of strengthening the ties between the allies.

On 2 May, *Charles de Gaulle* arrived in Singapore for relief and returned to Oman on 18 May.

Indian-Pakistani crisis

In June 2002 while *Charles de Gaulle* was in the Arabian Sea, armed Rafale fighters operated combat air-patrols with the United States Navy off the coast of India and Pakistan, marking a significant point in the Rafale M's operational career and its integration with the carrier.

Rescue mission

On 9 October, the *CrossMed* (The Regional Operational Centre for Monitoring and Rescue in the Mediterranean Sea) received a distress call from the 8-metre *Babolin*, whose hull was leaking. *Charles de Gaulle*, on manoeuvres in the region, sent a helicopter that airlifted the three-man crew, despite 35-knot (65 km/h) wind, troubled sea, and bad visibility.

Continuing operations

Charles de Gaulle participated in further actions as part of Operation Enduring Freedom in 2005. She returned to Southwest Asia in May 2006 and shortly after supported coalition efforts over Afghanistan. The aircraft carrier regularly participates in the annual bilateral naval exercises between the Indian and French navies called 'Varuna'.

First major overhaul

Charles de Gaulle refitting in the southwestern dock of Vauban industrial zone in 2008

Charles de Gaulle's first major overhaul began in September 2007. The highlight of this 15-month refit was the refueling of the nuclear power plant, a necessary step after six years in service, during which *Charles de Gaulle* sailed the equivalent of 12 times around the world, spent 900 days at sea, and performed 19,000 catapult launches. Several improvements will also be made, including the installation of new propellers. These will allow the *Charles de Gaulle* to reach her design speed of 27 knots, replacing the vintage propellers used as a stop-gap since 2001. Aircraft maintenance and weapons stores will also be upgraded to allow operation of new Rafale F3 fighters armed with ASMP-A nuclear missiles and SCALP EG cruise missiles, and satellite communications bandwidth will be increased tenfold. The refit was completed in December 2008 but following technical problems in March 2009 the carrier is back in Toulon for repairs. An intensive work-up period is planned to bring the *Charles de Gaulle* and her airgroup back to operational status.

On 14 October 2010, a four month cruise was cut down to a single day when the ship suffered an electrical fault in its propulsion system.

Fifth overseas deployment

A French naval task group led by the *Charles de Gaulle* departed Toulon on 30 October 2010 for a four-month deployment to the Mediterranean Sea, Red Sea, Indian Ocean. and Persian Gulf. The task group also included the frigates *Forbin* and *Tourville*; a nuclear attack submarine *Améthyste*; a replenishment oiler *Meuse*, 3,000 sailors, and an Embarked Aviation Group (EAG) consiting of 12 Super-Étendard attack aircraft, 10 Rafale multi-role fighters, and two E-2C Hawkeye 2000 AEW aircraft. The task group commander, Rear Admiral Jean-Louis Kerignard, defined force's mission as follows:

With USS *Abraham Lincoln*

The force would help allied navies fight piracy off the coast of Somalia and send jets to support NATO in the skies above Afghanistan."

Once on station, the *Charles de Gaulle* carrier task group joined two U.S. Navy carrier strike groups led by the Nimitz class aircraft carrier aircraft carriers USS *Abraham Lincoln* (CVN-72) and USS *Harry S. Truman* (CVN-75) operating in the Persian Gulf (*pictured*). On 28 November 2010, according to an Associated Press dispatch, the French Ministry of Defense announced that a French Rafale fighter jet crashed near the *Charles de Gaulle* which was operating 60 miles (100 kilometres) off the coast of Pakistan in the Arabian Sea in support of coaltion forces in Afghanistan. The pilot parachuted to safety and was picked up by helicopter, and the cause of the crash was under investigation.

In December 2010, during its deployment to the Persian Gulf, the British Type 22 frigate *Cumberland* rotated from its maritime security patrol to escort *Charles de Gaulle* in support of coalition military operations in Afghanistan. This represented an example of interoperability pursuant to the recently-ratified Anglo-Franco defence cooperation treaty. Between 7–14 January 2011, the French carrier task group led by the *Charles de Gaulle* participated with bilateral naval exercise, code named Varuna 10, with the Indian Navy. Indian naval units participating in Varuna 10 included the aircraft carrier *Viraat*, the frigates *Godavari* and *Ganga*; and the diesel-electric submarine *Shalki*. Varuna 10 was a two-phase naval exercise, with the harbor phase taking place between 7–11 January and the sea phase between 11–14 January in the Arabian Sea.

Integration in the future navy

The French Navy is theoretically a two-carrier navy, mainly to ensure that at least one ship is operational at all times even if the other is under repair. This scheme requires another aircraft carrier to be built though, as the *Charles de Gaulle* is the only aircraft carrier currently serving.

Cost considerations have made equipment standardization a necessity. In this context, there is a possibility of collaboration with Britain for future aircraft carriers and Thales made the design for the *Queen Elizabeth*-class aircraft carrier, which may be modified as the Future French aircraft carrier. Steps have been taken by both countries to make such a scenario possible: the new carrier had to be conventionally propelled to meet the requirements of the Royal Navy. France favours nuclear propulsion, and a study is being conducted to see if it is more cost efficient than gas turbines.

Chapter- 8

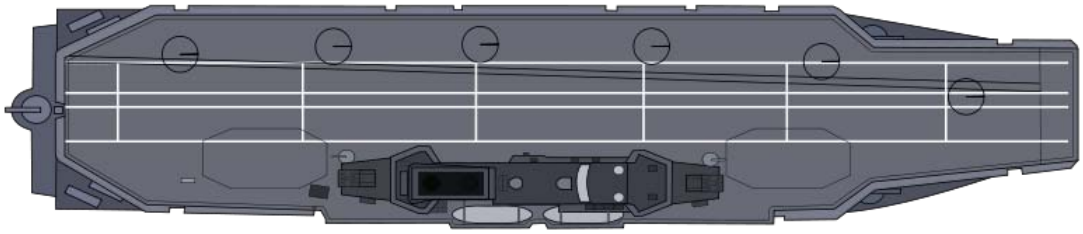
Italian Aircraft Carrier Giuseppe Garibaldi (551)

Career (Italy)	
Name:	Giuseppe Garibaldi
Builder:	Fincantieri
Laid down:	March 1981
Launched:	11 June 1983
Commissioned:	30 September 1985
Homeport:	Taranto
Motto:	"Obbedisco"
Status:	in active service, as of 2011
General characteristics	
Type:	CVS aircraft carrier
Displacement:	10,000 tons (standard) 13,850 tons (loaded)
Length:	180.2 m
Beam:	30.4 m

Draught:	8.2 m
Propulsion:	4 × General Electric/Avio LM2500 gas turbines providing 82,000 hp 6 × Diesel generators (9.360 KW)
Speed:	30+ knots
Range:	7,000 nautical miles (13,000 km) at 20 knots (37 km/h)
Complement:	630 Crew 100 Fleet Air Arm 100 C^4 staff
Sensors and processing systems:	MM/SPS-768 (RAN 3L) long-range radar SPS-774 (RAN-10S) early warning radar AN/SPS-52C early warning radar SPS-702 CORA surface search radar SPN-749 navigation radar SPN-728 approach radar RTN-30 fire control radar RTN-10X fire control radar DE 1160 LF hull sonar
Electronic warfare and decoys:	SLQ-732 jamming system SCLAR decoy launcher SLAT anti-torpedo system SLQ-25 Nixie towed torpedo decoy
Armament:	2 × Mk.29 octuple launcher for Sea Sparrow/Selenia Aspide SAM 3 × Oto Melara Twin 40L70 DARDO 2 × 324 mm triple torpedo tubes 4 × Otomat Mk 2 SSMs (removed)
Aircraft carried:	AV-8B Harrier II fighter/bombers Augusta SH-3D or AgustaWestland EH101 helicopters (ASW, ASH and AEW)
Notes:	Pennant 551

Giuseppe Garibaldi **(551)** is an Italian aircraft carrier. She is named after the Italian general Giuseppe Garibaldi.

Giuseppe Garibaldi and the US aircraft carrier *USS Harry S. Truman (CVN-75)* operate near each other in the Atlantic Ocean while participating in Majestic Eagle 2004, a multinational war exercise conducted off the coast of Morocco.



Giuseppe Garibaldi's deck layout

SH-3 Sea King on deck

Built by Fincantieri (Italcantieri) at the Monfalcone shipyards in the Gulf of Trieste, she was laid down in March 1981, launched in 1983 and commissioned on 30 September 1985. *Garibaldi* is classed as a CVS–ASW or Anti-Submarine Warfare Aircraft Carrier and is based in Taranto.

The ship is powered by four Fiat COGAG gas turbines built under license from GE, offering a sustained power of 81,000 hp (60 MW). Driving two shafts the ship has a maximum speed of 30 knots (56 km/h) and can travel for 7,000 nautical miles (13,000 km) at around 20 knots (37 km/h).

The ship was equipped with four Otomat Mk2 long range surface to surface missile system installed at the stern of the ship (removed in 2003 to improve the flight deck and satellite communications) and two ILAS three triple tube torpedo launchers. Defences are provided by two eight-cell SAM launchers firing the SARH *Aspide* missile, additional defences are offered by three Oto Melara Twin 40L70 DARDO CIWS.

The ship also has many countermeasures include two SCLAR twenty-barrel launchers for chaff, decoy, flares, or jammers, the SLQ-25 Nixie and SLAT anti-torpedo systems and ECM systems.

Her air-arm consists of either a maximum sixteen AV-8B Harrier IIs, or eighteen Agusta helicopters or a mix of helicopters and fighters. The flight-deck is the characteristic off-axis design with 4 degrees ski-jump for STOL aircraft, it is 174 m long and 30.4 m wide.

The WWII peace treaty banned Italy from having an aircraft carrier, and therefore at the time of her launch she did not receive her Harriers and classed as *Incrociatore portaeromobili* (Italian for *Aircraft carrying cruiser*). Until 1988 only Italian helicopters landed on her deck, as well as RN Sea Harriers during NATO joint maneuvers. The ban was eventually lifted and in 1989 the Italian Navy obtained fixed wing aircraft to operate from *Garibaldi*.

In 2009 *Garibaldi* has been joined as the flagship of the Italian navy by the new and larger carrier *Cavour*.

Other ships with the same name

Giuseppe Garibaldi (551) is the fourth ship of the Italian Navy named after the 19th century Italian General Giuseppe Garibaldi. Previous ships with the same name are:

- a frigate (1861)
- an armoured cruiser (1901)
- a light cruiser (1936), extensively re-built in 1961

All the five ships included the missile cruiser, together with an image of Garibaldi, are depicted in the crest.

Chapter- 9

Russian Aircraft Carrier Admiral Kuznetsov

Career (Soviet Union / Russia)	
Name:	*Admiral Kuznetsov* (Russian: Адмирал Кузнецов)
Namesake:	Nikolai Gerasimovich Kuznetsov
Ordered:	March 3, 1981
Builder:	Nikolayev South *Designer:* Nevskoye Planning and Design Bureau
Laid down:	February 22, 1983
Launched:	December 5, 1985
Commissioned:	January 21, 1991 Fully operational in 1995
Status:	in active service, as of 2011
General characteristics	
Class and type:	*Admiral Kuznetsov*-class aircraft carrier

Displacement:	• 43,000-tons (Standard-load) • 55,000-tons (Full-load) • 58,600-tons (Max-load)
Length:	1,005.5 ft (306.5 m) o/a 900 ft (270 m) w/l
Beam:	237.2 ft (72.3 m) o/a 125 ft (38 m) w/l
Draft:	29.9 ft (9.1 m)
Propulsion:	Steam turbines, 8 turbo-pressurised boilers, 4 shafts, 200,000 hp (150 MW) 2 × 50,000 hp (37 MW) turbines 9 × 2,011 hp (1,500 kW) turbogenerators 6 × 2,011 hp (1,500 kW) diesel generators 4 × fixed pitch propellers
Speed:	32 knots (37 mph; 59 km/h)
Range:	8,500 nmi (15,700 km) at 18 kn (21 mph; 33 km/h)
Endurance:	45 days
Complement:	1,993 (total); 1,960 ship's crew 626 air group 40 flag staff 3,857 rooms
Armament:	• 8 × AK-630 AA guns (6×30 mm, 6,000 round/min/mount, 24,000 rounds) • 8 × CADS-N-1 Kashtan CIWS (each 2 × 30 mm Gatling AA plus 32 3K87 *Kortik* SAM) • 12 × P-700 *Granit* SSM • 18 × 8-cell 3K95 *Kinzhal* SAM VLS (192 missiles; 1 missile per 3 seconds) • RBU-12000 UDAV-1 ASW rocket launchers (60 rockets)

Aircraft carried:	41-52
	• Fixed Wing;
	  ○ 12 × Sukhoi Su-33 fighters
	  ○ 5 × Sukhoi Su-25UTG/UBP

aircraft
- Rotary Wing;
  - 4 × Kamov Ka-27LD32 helicopters
  - 18 × Kamov Ka-27PLO helicopters
  - 2 × Kamov Ka-27S helicopters

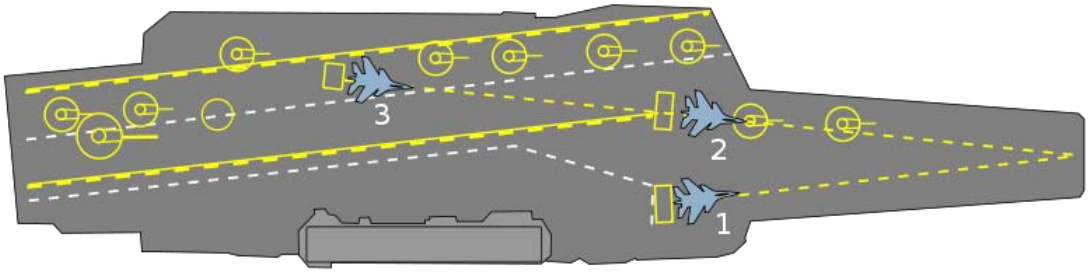
Admiral Flota Sovetskovo Soyuza Kuznetsov (Russian: Адмирал флота Советского Союза Кузнецов) ***Fleet Admiral of the Soviet Union Kuznetsov***, (originally named *Riga*, renamed *Leonid Brezhnev* then *Tbilisi*) is an aircraft cruiser (heavy aircraft carrying cruiser (TAKR or TAVKR) in Russian classification) serving as the flagship of the Russian Navy. She was originally commissioned in the Soviet Navy, and was intended to be the lead ship of her class, but the only other ship of her class, *Varyag*, was never commissioned and was sold to the People's Republic of China by Ukraine under the condition she would never be refitted for combat. *Kuznetsov* was named after the Admiral of the Fleet of the Soviet Union Nikolai Gerasimovich Kuznetsov.

Role

While designated an aircraft carrier by the West, the design of the *Admiral Kuznetsov'* class implies a mission different from that of either the United States Navy's carriers or those of the Royal Navy. The term used by her builders to describe the Russian ships is *tyazholyy avianesushchiy kreyser* (TAKR or TAVKR) - "heavy aircraft-carrying cruiser" - intended to support and defend strategic missile-carrying submarines, surface ships, and naval missile-carrying aircraft of the Russian Navy. The Montreux Convention, which deals with ships passing the Dardanelles and the Bosphorus between the Mediterranean and the Black Sea does not prohibit the transit of any warships of the Black Sea states. Limitations are placed on warships of non-Black Sea states.

Адмирал флота
Советского Союза
Кузнецов

Admiral Flota
Sovetskogo Soyuza
Kuznetsov



The deck configuration has three launch positions for fixed-wing aircraft

The *Admiral Kuznetsov*'s main fixed-wing aircraft is the multirole Sukhoi Su-33. It can perform air superiority, fleet defense, and air support missions and can also be used for reconnaissance and searching for naval mines. It is augmented by the twin seat Su-33UB, which is also used for pilot training along with the Su-25UTG. The carrier also carries the Kamov Ka-27 and Kamov Ka-27S helicopters for anti-submarine warfare, search and rescue, and small transport.

For take-off of the fixed wing aircraft, the *Admiral Kuznetsov* uses a ski-jump at the end of its deck. On take-off aircraft accelerate toward and up the ski-jump using their afterburners. This results in the aircraft leaving the deck at a higher angle and elevation than on an aircraft carrier with a flat deck and catapults. The ski-jump take-off is less demanding on the pilot, since the acceleration is lower, but on the other hand results in a clearance speed of only 120–140 km/h (75-85 mph) requiring an aircraft design which will not stall at those speeds.

The *cruiser* role is facilitated by the *Kuznetsov's* complement of 12 long-range surface-to-surface anti-ship Granit (SS-N-19) (NATO name SHIPWRECK) cruise missiles. This armament justifies the ship's Russian type designator "heavy aircraft carrying cruiser".

History and current status

Admiral Flota Sovetskovo Soyuza Kuznetsov, constructed at Nikolayev South Shipyard in Nikolayev, Ukrainian SSR, was launched in 1985, and became fully operational in 1995.

An official ceremony marking the start of construction took place on September 1, 1982; in fact she was laid down in 1983. The vessel was first named *Riga*, but in November 1982 the name was changed to *Leonid Brezhnev*, in August 1987 to *Tbilisi*, and finally on October 4, 1990 to *Admiral Flota Sovetskovo Soyuza Kuznetsov*, referred to in short as *Admiral Kuznetsov*. The ship was 71% complete by mid-1989. In November 1989 she undertook her first aircraft operation trials. In December 1991, she sailed from the Black Sea to join the Northern Fleet. Only from 1993 on did she receive aircraft.

Kuznetsov made a Mediterranean cruise early in 1996, marking the 300th anniversary of the Russian Navy. During that period the carrier laid at anchor at sea off the Syrian harbor of Tartus and its aircraft, mainly Su-33 fighters, made flights close to the Israeli shore line and were intercepted by Israeli F-16s. At the end of 1997 she remained immobilized in a Northern Fleet shipyard, awaiting funding for major repairs, which were halted when they were only 20% complete. The overhaul was completed in July 1998, and the ship returned to active service in the Northern fleet on November 3, 1998. The Kuznetsov apparently remained in port for about two years before participating in operations related to the rescue and salvage of the *Kursk* submarine in late 2000. Plans for further operations were postponed or cancelled. In late 2003 and early 2004, the Kuznetsov went to sea for inspection and trials. In late October 2004, she participated in a fleet exercise of the Russian Navy in the Atlantic Ocean, and again in September 2005. During the 2005 exercise, one of her Su-33 fighters was involved in an accident, and fell from the carrier into the Atlantic Ocean.

Although financial and technical problems have resulted in limited operations for the ship, it is expected that *Admiral Kuznetsov* will remain in active duty until at least 2030.

On September 27, 2006 it was announced that *Admiral Kuznetsov* will return to the Northern Fleet by the end of the year. The ship will undergo another modernization refit, in an attempt to correct some of its many technical issues. Admiral Vladimir Masorin, Commander-in-Chief of the Russian Navy, also stated that several Su-33 fighters assigned to the aircraft carrier would return to the ship after undergoing maintenance and refits of their own.

On December 11, 2007, *Admiral Kuznetsov* passed by Norwegian oil platforms in the North Sea, 60 nautical miles (110 km) outside Bergen, Norway. Su-33 fighters and Kamov helicopters were launched from the carrier while it was in the area of the rigs. The incident caused the Norwegian helicopter service to stop its flights out to the rigs, due to a risk of collision with Russian aircraft operating from the carrier. The Russian carrier was in international waters during the maneuver.

The *Admiral Kuznetsov* then proceeded to the Mediterranean Sea, where it participated in an exercise together with 11 other Russian Navy surface ships and 47 aircraft. It performed 3 tactical training missions, using live and simulated missile launches with both air and surface missiles.

The aircraft carrier arrived back in Severomorsk on February 3, 2008 along with Udaloy I Class anti-submarine destroyers Admiral Chabanenko and Admiral Levchenko.

After a maintenance period she was back at sea on October 11, 2008 where drills were held in the Barents Sea. Russian President and Supreme Commander-in-Chief Dmitriy Medvedev visited the ship on October 12, 2008 during the Stability-2008 strategic exercises.

On December 5, 2008 the aircraft carrier and several other vessels left Severomorsk heading for the Atlantic on a tour which was announced would be lasting several months and which would include combat training including joint drills with Russia's Black Sea Fleet and visits to several ports in the Mediterranean. On this tour while the *Admiral Kuznetsov* anchored off Turkey on January 7, 2009 a small fire broke out on the ship. One crewmember was killed by carbon monoxide poisoning. The fire was caused by a short-circuit.

On February 16, 2009, the *Admiral Kuznetsov*, along with other Russian naval vessels was involved in a large oil spill while it refueled off the south coast of Ireland.

On March 2, 2009 the *Admiral Kuznetsov* returned to her main base in Severomorsk after a three-month voyage in the Northern Atlantic and the Mediterranean waters.

In September 2010 the *Admiral Kuznetsov* left a dry dock after scheduled repairs and is getting ready for a training mission in the Barents Sea at the end of that month.

MiG-29K for the *Admiral Kuznetsov*

MiG-29KUB jet at Zhukovskiy LII air field

According to the newspaper "Bulletin Reports," the Russian Navy expects to buy the Mikoyan MiG-29K for the *Admiral Kuznetsov* by 2011, according to an informed source in the Defense Ministry of Russia, noting that the contract may be concluded in the next two years. Information was confirmed by the general designer of one of the defense enterprises, which produces subassemblies for these aircraft, while the MiG corporation refrained from comment.

Currently, according to a companion publication by the Ministry of Defence, the Navy has a fleet of 19 carrier-based Su-33 fighters, a resource which will expire by 2015. The production of new Su-33 is possible, but not cost-effective for such small volumes. At the same time, the MiG-29K in this respect are more convenient, because the Indian Navy has already ordered 16 aircraft and plans to buy at least 30 planes. As noted by Konstantin Makienko, it lessens the series article cost and allows Russia to save on development. India has paid 730 million dollars for the development and delivery of 16 fighters, while the 24 planes for Russia's fleet would cost about $1 billion.

Mid-life refit

In the early April 2010 it was announced that by the end of 2012 the ship will enter Severodvinsk Sevmash shipyard for a major refit and modernisation. The report states that the refit will include upgrades to the obsolete electronics and sensor equipment, installation of the new anti-aircraft system and increase of the air wing by the removal of the P-700 Granit antiship missiles. Upgrades might also include exchanging the troublesome steam powerplant to the gas-turbine or even nuclear propulsion and installation of catapults to the angled deck. Modifications to accommodate the naval variant of PAK-FA are also possible.

Chapter- 10

USS Enterprise (CVN-65)

USS *Enterprise* underway in the Atlantic Ocean

Class overview	
Name:	*Enterprise*-class aircraft carrier
Builders:	Newport News Shipbuilding
Operators:	United States Navy
Preceded by:	*Kitty Hawk*-class
Succeeded by:	*Nimitz*-class
In commission:	25 November 1961
Planned:	6
Completed:	1
Active:	1
Career (United States)	
Name:	USS *Enterprise*
Ordered:	15 November 1957
Builder:	Newport News Shipbuilding and Drydock Company
Cost:	$451.3 million

Laid down:	4 February 1958
Launched:	24 September 1960
Christened:	24 September 1960
Acquired:	29 October 1961
Commissioned:	25 November 1961
Decommissioned:	Scheduled for 2013
In service:	12 January 1962 (maiden voyage)
Reclassified:	CVN-65
Homeport:	NAVSTA Norfolk
Status:	in active service, as of 2011

General characteristics	
Class and type:	*Enterprise*-class aircraft carrier
Displacement:	93,284 long tons (94,781 t) Full Load
Length:	1,123 ft (342 m)
Beam:	132.8 ft (40.5 m) (waterline) 257.2 ft (78.4 m) (extreme)
Draft:	39 ft (12 m)
Propulsion:	8 × Westinghouse A2W nuclear reactors four sets Westinghouse geared steam turbines, 4 × shafts 280,000 shp (210 MW)
Speed:	33.6 kn (38.7 mph; 62.2 km/h)
Range:	Essentially unlimited distance; 20 years
Complement:	5,828 (maximum) Ship's company: 3,000 (2,700 Sailors, 150 Chiefs, 150 Officers) Air wing: 1,800 (250 Pilots, and 1,550 Support personnel)
Sensors and processing systems:	AN/SPS-48 3D air search radar AN/SPS-49 2D air search radar
Electronic warfare and decoys:	AN/SLQ-32 Mark 36 SRBOC
Armament:	• 2 × NATO Sea Sparrow launchers • 2 × 20 mm Phalanx CIWS mounts • 2 RAM launchers
Armor:	8 in (20 cm) aluminum belt (equivalent to 4 in (10 cm) rolled homogeneous steel armor)
Aircraft carried:	Hold up to 90 70 (normally)

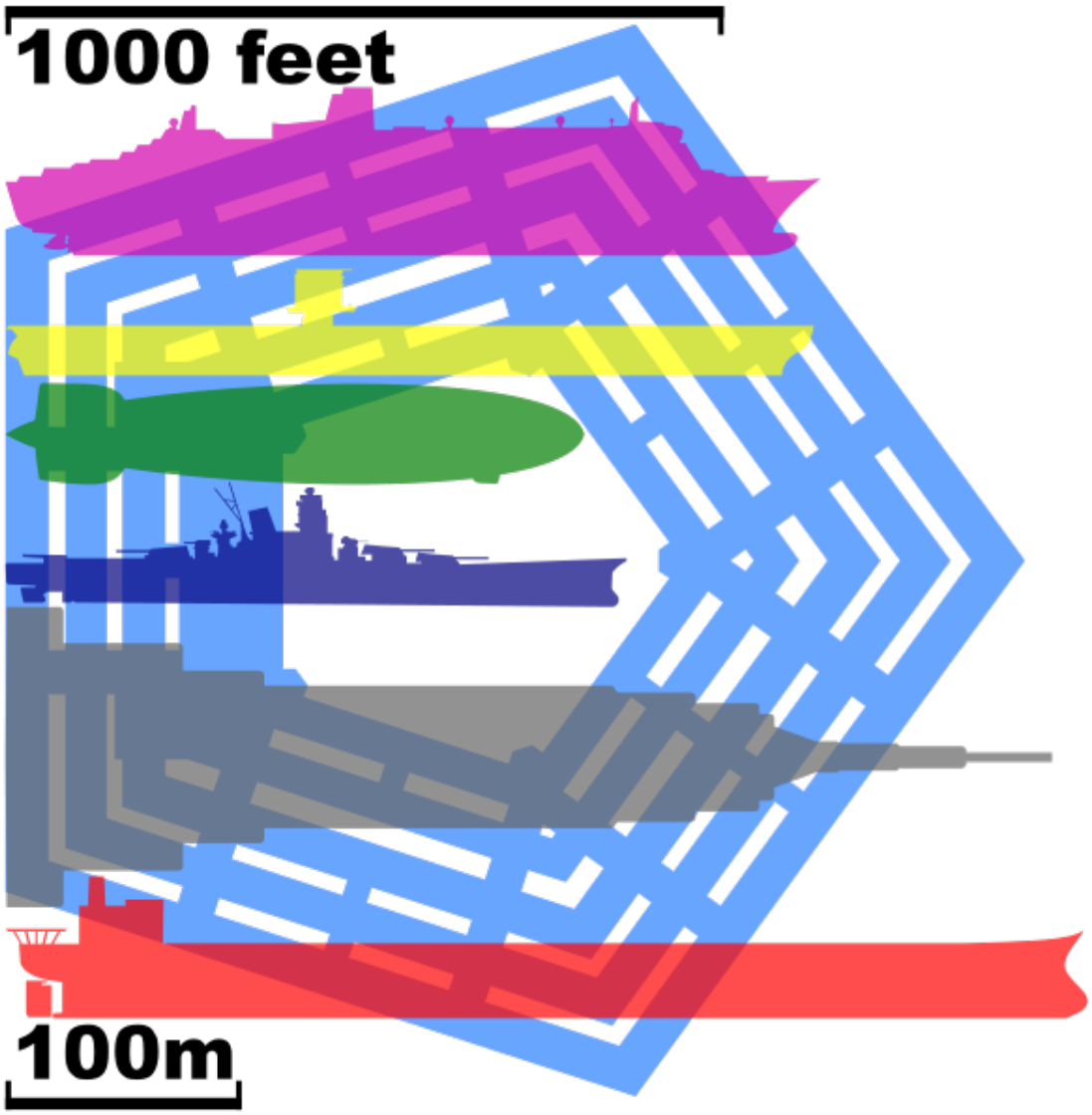
Aviation facilities:	Flight deck: 1,123 ft (342 m)
Motto:	*Ready on Arrival;* *The First, the Finest;* *Eight Reactors, None Faster*
Nickname:	"Big E",
Notes:	915 engineers designed the ship. They made 16,100 drawings and 2,400 blueprints. The ship has about 625 mi (1,000 km) of electrical cables and 37 mi (60 km) of ventilation ducts. The ship has 4 steam powered catapults.
Badge:	

USS *Enterprise* (CVN-65), formerly CVA(N)-65, is the world's first nuclear-powered aircraft carrier and the eighth US naval vessel to bear the name. Like her predecessor of World War II fame, she is nicknamed the "*Big E*". At 1,123 ft (342 m), she is the longest naval vessel in the world. Her 93,284 long tons (94,781 t) displacement ranks her as the 11th-heaviest supercarrier, after the 10 carriers of the *Nimitz* class.

The only ship of her class, *Enterprise* is the second-oldest vessel in commission in the United States Navy, after the wooden-hulled, three-masted frigate USS *Constitution*. She was originally scheduled for decommissioning in 2014 or 2015, depending on the life of her reactors and completion of her replacement, USS *Gerald R. Ford*. But the National Defense Authorization Act for Fiscal Year 2010 slated the ship's retirement for 2013, when she will have served for 51 consecutive years, the most of any U.S. aircraft carrier.

As of September 2010, *Enterprise*'s home port is at Naval Station Norfolk, Virginia. She has one more deployment before her decommissioning. The 22nd and current commanding officer of *Enterprise* is Capt. Dee Mewbourne, who assumed command on January 4, 2011, from Capt. O. P. Honors who was relieved of command by Adm. John C. Harvey Jr., Commander, United States Fleet Forces Command (USFFC), for "demonstrating poor judgment while serving as executive officer of that ship."

Design



Enterprise compared to large ships and buildings:
USS *Enterprise*, 342 m
The Pentagon, 431 m
RMS *Queen Mary 2*, 345 m
Hindenburg, 245 m
Yamato, 263 m
Empire State Building, 443 m
Knock Nevis, ex-Seawise Giant, 458 m

Enterprise was meant to be the first of a class of six, but construction costs ballooned and the remaining vessels were never laid down.

Because of the huge cost of her construction, *Enterprise* was launched and commissioned without the planned Terrier missile launchers. These were never installed and the ship's self-defense suite instead consisted of three shorter-range RIM-7 Sea Sparrow, Basic Point Defense Missile System (BPDMS) launchers. Later upgrades added two NATO Sea Sparrow (NSSM) and three Mk 15 Phalanx CIWS gun mounts. One CIWS mount was later removed and two 21-cell RIM-116 Rolling Airframe Missile launchers were added.

Enterprise is also the only aircraft carrier to house more than two nuclear reactors. Her eight-reactor propulsion design was rather conservative, with each A2W reactor taking the place of one of the conventional boilers in earlier designs. She is the only carrier with four rudders, two more than other classes, and features a more cruiser-like hull.

Enterprise also had a phased array radar system designed to be better at tracking multiple airborne targets than conventional rotating antenna radars. These early phased arrays, which were replaced around 1980, were responsible for the distinctive square-looking island.

History

Commissioning and trials

In 1958, *Enterprise*'s keel was laid at Newport News Shipbuilding and Drydock Company. On 24 September 1960, the ship was launched, sponsored by Mrs. W. B. Franke, wife of the former Secretary of the Navy. On 25 November 1961, *Enterprise* was commissioned, with Captain Vincent P. De Poix, formerly of Fighting Squadron 6 on USS *Enterprise* (CV-6), in command. On 12 January 1962, the ship made her maiden voyage conducting a three-month shakedown cruise and a lengthy series of tests and training exercises designed to determine the full capabilities of the nuclear-powered aircraft carrier.

1960s

On 20 February 1962, *Enterprise* was a tracking and measuring station for the flight of *Friendship 7*, the Project Mercury space capsule in which Lieutenant Colonel John H. Glenn, Jr. made the first American orbital spaceflight. In August, the carrier joined the 6th Fleet in the Mediterranean sea, returning to Norfolk, Virginia in October.

1962 Cuban Missile Crisis

In October, 1962, *Enterprise* was dispatched to her first international crisis. Following revelations that the Soviet Union was constructing nuclear missile launch sites on Cuba, President John F. Kennedy began to prepare for action, moving several military units to Florida and adjacent waters. On 24 October, President Kennedy ordered a naval and air "quarantine" (blockade) on shipment of offensive military equipment to Cuba, and demanded the Soviets dismantle the missile sites there. *Enterprise*, supported by the carriers *Independence*, *Essex*, and *Randolph* and backed by shore-based aircraft,

participated in the blockade as part of the 2nd Fleet. By 28 October, the crisis was averted.

Second/third deployments

Task Force One, the world's first nuclear-powered task force. *Enterprise*, *Long Beach* and *Bainbridge* in formation in the Mediterranean, 18 June 1964. *Enterprise* crew members are spelling out Einstein's mass-energy equivalence formula $E=mc^2$ on the flight deck. Note the distinctive phased array radars in the superstructures of *Enterprise* and *Long Beach*.

On 19 December 1962, a E-2 Hawkeye was aircraft catapulted off *Enterprise* in the first shipboard test of a nose-wheel launch bar designed to replace the catapult bridle. Minutes later, a second launch with a launch bar was made by an A-6A, demonstrating one of the primary design goals of reducing launch intervals.

In 1963-1964, *Enterprise* made her second and third deployment to the Mediterranean, respectively. Also during the third Mediterranean deployment, the carrier was part of Operation Sea Orbit, the world's first nuclear-powered task force with the cruisers *Long Beach* and *Bainbridge*, which joined to sail around the world. In October 1964, *Enterprise* returned to Newport News Shipbuilding and Dry Dock Company for her first refueling and overhaul.

Southeast Asia deployments

In November 1965, the *Big E* was transferred to the Pacific Seventh Fleet, home-porting at NAS Alameda California. The following month, on 2 December, she became the first nuclear-powered ship to engage in combat when she launched aircraft against the Viet Cong near Bien Hoa. *Enterprise* launched 125 sorties on the first day, unleashing 167 short tons (151 t) of bombs and rockets on the enemy's supply lines. On 3 December, she set a record of 165 strike sorties in a single day.

View of *Enterprise*'s stern during the fire of 1969

In January 1968, the capture of *Pueblo* by a North Korean patrol boat led to a diplomatic crisis. *Enterprise* was ordered to operate near South Korean waters for almost a month.

In the morning of 14 January 1969, a MK-32 Zuni rocket loaded on a parked F-4 Phantom exploded due to ordnance cook off after being overheated by an aircraft start unit mounted to a tow tractor. The explosion set off fires and additional explosions across the flight deck. The fires were brought under control relatively quickly (when compared with previous carrier flight deck fires), but 27 lives were lost and an additional 314 people were injured. The fire destroyed 15 aircraft, and the resulting damage forced

Enterprise to put in for repairs, primarily to repair the flight deck's armored plating. She was towed into Pearl Harbor by the fleet tug USS *Hitchiti* (ATF-103). In early March 1969, repairs to the ship were completed at Pearl Harbor, Hawaii and the ship proceeded on her deployment to Vietnam and the Tonkin Gulf.

Sailors aboard *Enterprise* battle a massive ordnance fire triggered by a Zuni rocket. January 14, 1969

On 14 April 1969, tensions with North Korea flared up again as a North Korean aircraft shot down an unarmed EC-121 Constellation which was on a routine reconnaissance patrol over the East Japan Sea from its base at Atsugi, Japan. The entire 31-man crew was killed. The U.S. responded by activating Task Force 71 (TF 71) to protect such flights over those international waters in the future. Initially, the Task Force consisted of *Enterprise*, *Ticonderoga*, *Ranger* and *Hornet*, with a screen of cruisers and destroyers. The ships for TF 71 were drawn mostly from Southeast Asia duty. This deployment became one of the largest shows of force in the area since the Korean War.

In all, *Enterprise* made six combat deployments to Southeast Asia from 1965 to 1975.

1970s

In 1969-1970, *Enterprise* returned to Newport News Shipbuilding and went through an overhaul and her second refitting. In January 1971, she completed sea trials with her

newly designed nuclear reactor cores which contained enough energy for 10 years. *Enterprise* then set sail for Vietnam, again to provide air support for American and South Vietnamese units.

Southeast Asia

In Vietnam, *Enterprise*, *Oriskany* and *Midway* launched a total of 2,001 strike sorties by 30 July 1971. Strike operations in July were disrupted when the carriers on station evaded three typhoons: Harriet, Kim and Jean. A slight increase in South Vietnam strike sorties occurred during the month. These were mainly visual strikes against enemy troop positions and in support of U.S. helicopter operations. From August-November 1971, *Enterprise* was in operations on Yankee Station.

In December 1971 during the Indo-Pakistani War of 1971, *Enterprise* was deployed to the Bay of Bengal as a show of strength against India's naval blockade by INS *Vikrant*. A Soviet Navy submarine was also trailing the US task force. A confrontation was averted when the Americans moved towards South East Asia, away from the Indian Ocean.

In October 1972, the U.S. ended tactical air sorties into North Vietnam above the 20th parallel and brought Linebacker I operations to a close, a goodwill gesture designed to promote peace negotiations being held in Paris. *Enterprise* and the other carriers had flown a total of 23,652 tactical air attack sorties into North Vietnam from May-October and U.S. tactical air sorties during Linebacker I operations helped to stem the flow of supplies into North Vietnam, thereby limiting the operating capabilities of the North Vietnamese Army.

From October to December, *Enterprise* alternated with other carriers on Yankee Station during the bombing halt and remained on station. As a result of the bombing halt above the 20th parallel in North Vietnam, no MiG kills or U.S. aircraft losses were recorded during this time.

On 18 December 1972, the U.S. resumed bombing campaigns above the 20th parallel under the name Linebacker II. During Linebacker II operations, *Enterprise* and other carriers on station reseeded the mine fields in Haiphong harbor and conducted concentrated strikes against surface-to-air missile and anti-aircraft artillery sites, enemy army barracks, petroleum storage areas, Haiphong naval and shipyard areas, and railroad and truck stations. Navy tactical air attack sorties under Linebacker II were centered in the coastal areas around Hanoi and Haiphong. There were 705 Navy sorties in this area during Linebacker II. Between 18 December and 22 December the Navy conducted 119 Linebacker II strikes in North Vietnam, with the main limiting factor on airstrikes being bad weather.

In December 1972, the North Vietnamese returned to the peace table and Linebacker II ended. In January 1973, the Vietnam cease fire was announced and American carriers ceased all combat sorties into North and South Vietnam.

From 28 January 1973, aircraft from *Enterprise* and *Ranger* flew 81 combat sorties against lines-of-communication targets in Laos. The corridor for overflights was between Huế and Da Nang in South Vietnam. These combat support sorties were flown in support of the Laotian government which had requested this assistance. Laos had no relationship with the cease-fire in Vietnam.

Post-Vietnam

After the cease-fire in Vietnam in 1973, *Enterprise* proceeded to the Puget Sound Naval Shipyard, Bremerton, Washington, where the carrier was altered and refitted to support the Navy's newest fighter aircraft — the F-14 Tomcat. Two of four jet blast deflectors were enlarged to accommodate the Tomcat. The No. 4 propulsion shaft was replaced; it had been bent when its screw became fouled in a discarded arresting gear cable.

In the 1970s, *Enterprise* was refitted to handle F-14 Tomcats, which operated from the ship from 1974 to 2001.

On 18 March 1974, the first operational Tomcats of VF-1 Wolfpack and VF-2 Bounty Hunters made their maiden takeoffs and landings from the carrier. In September 1974, *Enterprise* became the first carrier to deploy with the new fighter plane when she made her seventh western Pacific (WESTPAC) deployment.

In February 1975, Typhoon Gervaise struck the island nation of Mauritius, and *Enterprise* was ordered to provide disaster relief. Arriving at Port Louis, carrier personnel spent more than 10,000 man-hours rendering such assistance as restoring water, power and telephone systems, clearing roads and debris, and providing helicopter, medical, food and drinkable water support to the stricken area.

Operation Frequent Wind

In April 1975, *Enterprise*, *Midway*, *Coral Sea*, *Hancock*, and *Okinawa* were deployed to waters off Vietnam for possible evacuation contingencies as North Vietnam, in violation of the Paris Peace Accords, launched a conventional invasion of South Vietnam. On 29 April, Operation Frequent Wind was carried out by US Navy and Marine Corps helicopters from the 7th Fleet. The Operation involved the evacuation of American citizens and "at-risk' Vietnamese from Saigon, the capital of South Vietnam under heavy attack from the invading forces of North Vietnam.

President Gerald Ford ordered helicopter evacuation when PAVN shelling forced the cessation of fixed-wing evacuation from Tan Son Nhut airport. With fighter cover provided by carrier aircraft, the helicopters landed at the US Embassy, Saigon and the DAO Compound to pick up evacuees. The last helicopter lifted off the roof of the US Embassy, Saigon at 07:53 on 30 April 1975 carrying the last 11 Marine Security Guards. During Operation Frequent Wind, aircraft from *Enterprise* flew 95 sorties.

Eighth and ninth deployments

In July 1976 *Enterprise* began her eighth WESTPAC deployment.

In February 1977, Idi Amin, the President of Uganda, made derogatory remarks against the United States in public and Americans in Uganda were taken hostage. This was several months after the Israeli raid at Entebbe airport. *Enterprise* and her escort ships, having just left Mombasa after a port call, were directed to remain in the area and operated off the east African coast for about one week. At that point the ships were scheduled to transit home after a seven-month deployment. The ship's Marine detachment and air wing prepared for a possible mission to rescue and evacuate the Americans, but Amin eventually released all the hostages. The ships then steamed across the Indian Ocean at high speed to make a previously scheduled final port call at NAS Cubi Point in the Philippines before returning to NAS Alameda.

In 1978, *Enterprise* underwent her ninth WESTPAC deployment, including port calls in Hong Kong, Perth, Australia, and Singapore. In January 1979, the carrier sailed into Puget Sound Naval Shipyard for a 30-month comprehensive overhaul. During this

overhaul, the ship's superstructure was modified, removing the SCANFAR radars and the unique inverted cone-shaped top section which was three stories high. During the lengthy overhaul, *Enterprise* was referred to as "Building 65" by Navy and shipyard personnel.

1980s

In 1982, the carrier underwent her 10th WESTPAC deployment. In April 1983, *Enterprise* ran aground on a sandbar in San Francisco Bay while returning from deployment and remained stuck there for several hours. Coincidentally, George Takei, who played Mr. Sulu, helmsman of the fictional starship *Enterprise* was aboard at the time as a Distinguished Visitor of the Navy. Even though groundings and collisions are usually career-enders for U.S. warship captains, the captain at the time, Robert J. Kelly, who had already been selected for promotion to commodore, eventually became a four-star admiral and commander in chief of the U.S. Pacific Fleet.

In 1984, the carrier underwent her 11th WESTPAC deployment. On 2 November 1985, she struck Bishops Rock on the Cortes Bank during exercises, damaging the outer hull and propeller. She continued operations and later went to drydock for repairs.

In 1986, the carrier made her 12th WESTPAC deployment. On 28 April 1986, *Enterprise* became the first nuclear-powered aircraft carrier to transit the Suez Canal. She went from the Red Sea to the Mediterranean to relieve *Coral Sea*, on station with *America* off the coast of Libya. *Enterprise* entered the Mediterranean to support "Operation Eldorado Canyon", the U.S. bombing of Libya. It was the ship's first visit to the Mediterranean in more than 22 years.

In April 1988, *Enterprise* underwent her 13th deployment and was assigned to Operation Earnest Will, escorting reflagged Kuwaiti oil tankers in the Persian Gulf. On April 14, another Earnest Will ship, *Samuel B. Roberts*, struck an Iranian mine in international waters. In response, the U.S. launched Operation Praying Mantis against Iranian targets, starting with two Iranian oil platforms that were being used as support bases for Iranian attacks on merchant shipping. Aircraft from *Enterprise's* CVW-11 bombed two Iranian frigates, helping to sink one, and provided other air support for the strike.

In September 1989, *Enterprise* left Alameda and began her 14th overseas deployment, an around-the-world cruise that would end at the ship's new homeport of Naval Station Norfolk, Virginia. In early December 1989, *Enterprise* and *Midway* participated in Operation Classic Resolve, President George H.W. Bush's response to Philippine President Corazon Aquino's request for air support during the rebel coup attempt. *Enterprise* remained on station conducting flight operations in the waters outside Manila Bay until the situation subsided.

1990s

In March 1990, *Enterprise* completed her around-the-world deployment, arriving in Norfolk, Virginia, after having steamed more than 43,000 mi (69,000 km). In October,

the carrier moved to Newport News Shipbuilding for refueling and the Navy's largest complex overhaul refit ever attempted. During this overhaul, the Navy extended the carrier's length from 1,101 ft (336 m) to 1,123 ft (342 m), as well as other modifications to extend her service life.

On 27 September 1994, *Enterprise* returned to sea for sea trials, during which she performed an extended full power run as fast as when she was new.

It is rumored that the TV series "Star Trek" star ship was named after the Navy's flag ship and Star Trek memorabilia as well as models of Starfleet ships remain on display throughout the carrier to this day.

On 28 June 1996, *Enterprise* began her 15th overseas deployment. The carrier enforced no-fly zones in Bosnia as part of Operation Joint Endeavor and over Iraq as part of Operation Southern Watch. The deployment ended in December 1996, which also marked the end of active service for the A-6 Intruder from the Navy. In February 1997, *Enterprise* entered Newport News Shipbuilding for an extended selective restrictive availability lasting four-and-a-half months.

In November 1998, following workups, *Enterprise* departed on her 16th overseas deployment, with CVW-3 embarked. On the night of 8 November, shortly after the start of the deployment, a EA-6B Prowler crashed into an S-3 Viking on the carrier's flight deck. The mishap occurred as the EA-6B was landing during night carrier qualifications, striking the folded wings of the S-3, which had not yet cleared the landing area of the flight deck. The four crew of the EA-6B perished when the aircraft hit the water, but the two crew members of the S-3 ejected. A fire broke out on the flight deck, but was quickly extinguished by the flight deck crew. Three of the four members of the Prowler crew were lost at sea, and the remains of the fourth were recovered shortly after the crash. The crew of the Viking were rushed to the Naval Medical Center Portsmouth (Portsmouth, Virginia). There were no other significant injuries. An exhaustive search for three missing EA-6B Prowler crew members was suspended after nearly 24 hours.

On 23 November 1998, *Enterprise* relieved *Dwight D. Eisenhower* in the Persian Gulf. During a port call in Jebel Ali, United Arab Emirates, the carrier hosted former President George H.W. Bush and a live concert by Grammy Award-winning rock group Hootie and the Blowfish. In December 1998, *Enterprise* battlegroup spearheaded Operation Desert Fox, destroying Iraqi military targets with more than 300 Tomahawk land attack missiles and 691,000 lb (346 ST; 313 t) of ordnance. The 70-hour assault was carried out by *Enterprise*, *Gettysburg*, *Stout*, *Nicholson* and *Miami*.

Enterprise patrols the Persian Gulf in support of Operation Desert Fox

Shortly after the Racak massacre and failure of Yugoslavian peace talks in Rambouillet, France, *Enterprise* quickly left a port visit in Cannes, France to return to the Adriatic.

In early March 1999, *Enterprise* returned to the Persian Gulf to relieve *Carl Vinson* in support of Operation Southern Watch, returning to Norfolk in May 1999.

During the 1998-1999 deployment, *Enterprise* steamed more than 50,000 nmi (93,000 km; 58,000 mi) and spent 151 days underway. *Enterprise* Battle Group was the first to deploy with IT-21, which allowed unprecedented internal and external communication capabilities, including commercial internet, email, and television.

2000s

Enterprise, the world's first nuclear-powered carrier (background) with what was then the newest: French carrier *Charles De Gaulle*, 16 May 2001

On 25 April 2001, *Enterprise* began her 17th overseas deployment with CVW-8. From 18–28 June, the carrier and four escorts participated in an exercise with the British Royal Navy in a joint and combined warfare training exercise in the North Sea, near the Hebrides Islands and in Scotland.

Enterprise was beginning her voyage home from the Persian Gulf when the September 11 attacks were carried out. Without orders, the carrier returned at flank speed to the waters off Southwest Asia near the Persian Gulf, outrunning her escorts. In October 2001, the United States launched air attacks against Al Qaeda training camps and Taliban military installations in Afghanistan. The actions were designed to disrupt the use of Afghanistan as a base for terrorist operations and to attack the military capability of the Taliban regime. Over three weeks, aircraft from *Enterprise* flew nearly 700 missions and dropped large amounts of ordnance over Afghanistan. On 10 November, the carrier arrived at her home port of Norfolk, Virginia, 16 days later than originally planned. During her last day at sea, the ship hosted a live two-hour broadcast of ABC's *Good Morning America.* Garth Brooks performed a concert with Jewel from *Enterprise* on 21 November while she was docked in Norfolk, Virginia. The concert was carried live on CBS.

In January 2002, *Enterprise* entered the Norfolk Naval Shipyard, Portsmouth, Virginia for a scheduled one-year Extended Dry Docking Selected Restricted Availability.

Operation Iraqi Freedom

In 2003-2004, the carrier provided air support for Operation Iraqi Freedom. In 2004, the ship participated in Summer Surge 2004 and several multinational exercises.

In May 2006, *Enterprise* departed for a six-month deployment, operating in the 6th, 5th and 7th Fleet areas, and supported both Operations Iraqi and Enduring Freedom. She returned to Norfolk 18 November 2006.

On 19 December 2007, the carrier returned home after a six-month deployment in the Persian Gulf.

In April 2008, *Enterprise* entered the Northrop-Grumman Newport News shipyard for a scheduled 18 month Extended Docking Selected Restricted Availability, with a projected completion date of September 2009. As maintenance was performed, costs continued to rise above projections and the completion date repeatedly slid. *Enterprise*, the oldest active combat vessel in the Navy, was scheduled to be decommissioned as late as 2014. On April 6, 2009, Admiral Gary Roughead, Chief of Naval Operations, stated that he was seeking a congressional dispensation to speed up the process to decommission *Enterprise*. Under this new timetable, the ship would complete one final deployment before being decommissioned in late 2012 or early 2013. This would temporarily reduce the U.S. Navy to having only ten active aircraft carriers through the launch of the *Gerald R. Ford* in 2015. In October 2009, the House and Senate Armed Services Committees agreed with the recommendation, approving the decommissioning of *Enterprise* in 2013 after 51 years of service.

2010s

In April 2010, the Navy announced that the cost of refurbishing the carrier had risen to $655 million and was scheduled to be completed the same month. On April 19, 2010, *Enterprise* left the Northrop Grumman shipyard to conduct sea trials in preparation for return to the fleet. The total cost of refurbishing the carrier was $662 million, which was 46% over budget and took eight months longer than originally scheduled. The Navy stated that it planned to use the carrier for two six-month deployments before her scheduled decommissioning date in 2013.

On 1 January 2011, the Virginian-Pilot leaked highlights from the final video of a set entitled "XO Movie Night" that was filmed on the USS Enterprise and aired via closed circuit television on select Saturday evenings. The videos, which were not meant to be released outside of the command, were produced by Capt. Owen Honors when he was executive officer (XO) of the ship in the 2006-2007 timeframe and included profanity, anti-gay slurs, and sexually suggestive scenes. Capt. Honors received public support from Navy personnel. On 4 January 2011, Adm. John C. Harvey Jr., the commander of the

United States Fleet Forces Command in Norfolk, said in a statement that Captain Honors was removed for demonstrating poor judgment--

“The responsibility of the commanding officer for his or her command is absolute,” Admiral Harvey said in the statement. “ While Captain Honors’ performance as commanding officer of U.S.S. Enterprise has been without incident, his profound lack of good judgment and professionalism while previously serving as executive officer on Enterprise calls into question his character and completely undermines his credibility to continue to serve effectively in command.” Capt. Dee Mewbourne was appointed as replacement commander.

The carrier and its strike group were set to deploy as scheduled on January 13, 2011. Accompyaning the carrier on the cruise to the Persian Gulf and Mediterranean are Carrier Air Wing One, Destroyer Squadron 2, guided missile cruiser *Leyte Gulf*, and guided missile destroyers *Barry*, *Bulkeley*, and *Mason*.

Future prospects

Enterprise will be the first nuclear-powered aircraft carrier to be decommissioned by the United States Navy. In August 2009, an Internet-based petition began circulating to convert *Enterprise* into a museum ship after she is decommissioned. The costs of doing so regarding her nuclear reactors has yet to be calculated by the United States Department of Defense. A petition has also been set up for the CVN-79 to be named as the ninth USS *Enterprise*.

Northrop Grumman's facility at Newport News, Virginia will deactivate and de-fuel the ship after its decommissioning. Using the fates of previous U.S. Navy aircraft carriers as a guide, once the ship's nuclear fuel and reactor machinery has been removed and disposed of, petitioners and naval enthusiasts want the ship to become a museum, however that may not be possible. Once the Navy dismantles and recycles the ships' reactors, there will be nothing left to turn into a museum; virtually everything two decks below the hangar bay would have to be cut apart. *Enterprise* may also enter the Ship-Submarine Recycling Program. Afterward the ship's island could be removed and used as a memorial.