

Waves and Wings: The Rise of Naval Air Warfare

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INTRODUCTION

The nature of warfare has undergone profound transformations over the centuries, shaped by technological innovation, shifting strategic imperatives, and the dynamic contest for dominance over land, sea, and air. Among the most significant revolutions in the domain of maritime conflict has been the advent and maturation of naval air warfare—a development that redefined traditional sea power in the 20th century and continues to influence global military strategy today. This paper seeks to examine the evolution of naval air power, exploring its roots, and its watershed moments during the two World Wars.

Until the early 20th century, naval supremacy was largely defined by the size and firepower of surface fleets. The transition from wooden sailing ships to steam-powered ironclads in the 19th century marked a major technological leap, culminating in

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the era of the dreadnoughts—a symbol of national might and imperial ambition. Naval engagements like the Battle of Tsushima (1905) underscored the tactical possibilities of long-range artillery and speed at sea.¹ However, despite such advances, naval warfare remained a two-dimensional struggle and was confined largely to surface-to-surface engagements. This pattern began to shift fundamentally with the integration of air power into naval operations. While early 20th century innovations such as radio communications and submarine warfare introduced new variables into maritime strategy, it was the potential of aircraft launched from, and operating over, the sea that truly opened up a third operational dimension.² Initially used for reconnaissance, air platforms soon demonstrated the capacity to strike with unprecedented range, speed, and precision—threatening even the most heavily armoured battleships and rendering traditional naval superiority increasingly obsolete.

The birth of naval aviation is often traced to the experimentation during and immediately after World War I, when aircraft were deployed from modified cruisers and early aircraft carriers.³ Yet it was in the inter-war period that a genuine rethinking of the naval doctrine began to occur. Leading naval powers—especially the United Kingdom, Japan, and the United States—invested in developing carrier-based aviation, culminating in the commissioning of purpose-built aircraft carriers. The theories of

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1. George Hageman, "Battle of Tsushima: The First Naval Battle of the 21st Century", *Naval History and Heritage Command*, August 2022, <https://www.history.navy.mil/get-involved/essay-contest/2020-winners/hageman-cno-essay.html>.
 2. Owen R. Cote, Jr, "The Third Battle: Innovation in the US Navy's Silent Cold War Struggle with Soviet Submarines", *Naval War College*, n.d., <https://www.usni.org/sites/default/files/inline-files/newportpaper16.pdf>.
 3. Adrian O. Van Wyen, "Naval Aviation in WWI", *Chief of Naval Operations*, 1969, <https://www.history.navy.mil/content/dam/nhhc/research/histories/naval-aviation/naval-aviation-in-world-war-i/pdfs/naval-aviation-in-wwi.pdf>.

sea power advanced by Alfred Thayer Mahan were subtly, and eventually profoundly, reinterpreted through the lens of air mobility and aerial reach. Air power, once an auxiliary to fleet operations, was rapidly becoming the centrepiece of maritime force projection.⁴

World War II was the crucible in which naval air warfare truly demonstrated its strategic potential. The devastating Japanese attack on Pearl Harbour in December 1941 showcased the offensive capabilities of carrierborne aircraft in achieving surprise and massed firepower at extended ranges. In battles such as those of the Coral Sea and Midway, the fate of fleets was determined not by surface guns but by aerial torpedoes and dive bombers.⁵ The carrier effectively replaced the battleship as the dominant capital ship of naval warfare—a shift so profound that many post-war naval doctrines were rewritten to reflect this new reality. Notably, it was not just fleet-versus-fleet action that defined naval air power. Carrier groups provided vital air cover for amphibious operations, disrupted supply lines, conducted anti-submarine patrols, and played a central role in both deterrence and coercion strategies throughout the Pacific and Atlantic theatres.

By the end of the war, the aircraft carrier had become a symbol of modern sea power—a floating air base capable of projecting force thousands of miles from home shores. In the Cold War era, this trend only intensified. The geopolitical contest between the United States and the Soviet Union necessitated rapid response and forward deployment capabilities. The supercarriers of the United States became essential tools for power projection, humanitarian

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4. Shekhar Sinha, "Decade of the Maritime Air Power", *SP's Naval Forces*, 2021, <https://www.spsnavalforges.com/story/?id=716&h=Decade-of-the-Maritime-Air-Power>.
 5. Robert Lewis, "The Battle of the Coral Sea", ANZAC Day Commemoration Committee, n.d., <https://anzacday.org.au/ww2-the-battle-of-the-coral-sea>; "Battle of Midway", *Britannica*, <https://www.britannica.com/event/Battle-of-Midway>.

operations, and nuclear deterrence, operating globally without reliance on foreign bases. They also evolved technologically with steam catapults, angled decks, and sophisticated radar and electronic warfare systems, reflecting the growing complexity of joint air-sea operations.

The evolution of naval air warfare also necessitated the development of integrated battle groups, where destroyers, submarines, and surveillance platforms coordinated with carriers to ensure layered defence and offence. The synergy between air assets and surface vessels created a holistic maritime operational doctrine, emphasising flexibility, rapid deployment, and sustained combat operations—attributes particularly critical in the era of limited wars and regional contingencies. The importance of air-sea integration continued into conflicts such as the Korean War, Vietnam War, and Gulf War, where naval aviation was instrumental in precision strikes, close air support, and maritime interdiction.

In more recent decades, the nature of naval air warfare has evolved further to incorporate Unmanned Aerial Vehicles (UAVs), long-range strike platforms, stealth technology, and Artificial Intelligence (AI)-enhanced surveillance and targeting systems. As powers like China and India expand their carrier capabilities, and as naval competition resurfaces in regions like the Indo-Pacific, the strategic value of seaborne air power has only intensified. Questions about the survivability of large carriers in a hypersonic and satellite-targeted era continue to spark debate, but their symbolic and operational utility remains potent. From the fragile biplanes of World War I to the nuclear-powered supercarriers of today, naval aviation has not only shaped the outcomes of past conflicts but continues to influence the strategic calculus of emerging powers. In doing so, it has redefined what it means to control the seas—not just through presence, but through the capacity to dominate the air above them.

NAVAL AIR POWER: THE THIRD DIMENSION

With the naval battles now being fought from the surface by battleships as well as from the underwater domain by U-boats, the sky was indeed the limit. The Wright Brothers, in the early 1900s, had paved the way for modern day aviation⁶ by launching the powered manned aircraft. This led to militaries transitioning to a completely new domain that was created in the battlespace. The Royal Navy, US Navy and French Navy to name a few, started their plans of using air power at sea, either from ships, or from the shore. Mobility, flexibility and reach, some of the main attributes of air power were now new entrants in the maritime domain. While naval aviation was still at its nascent stage during World War I, the inter-war period saw the development of the naval air arm⁷ in a novel form, with the newfound focus on aircraft carriers (the ability to launch aircraft from ships at sea was discovered). The USA, Britain, Japan were in the spree of induction of these potent platforms. The induction of aircraft carriers gave the flexibility to a tactical commander to launch his air assets for an effective scout mission or an attack with ease. Of course, there were weather conditions, ship design, management of aircraft on deck, training of pilots and many other related complexities that came along with this platform. Table 1 below depicts the types and details of aircraft carriers operated by various countries during Word War II.

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6. Michael G. Dodson and David S. Miklosovic, "An Historical and Applied Aerodynamics Study of Wright Brothers," *ASME*, October 13, 2008, <https://apps.dtic.mil/sti/pdfs/ADA437187.pdf>.
 7. Philip D. Mayer, "Incubate Innovation: Aviation Lessons from the Interwar Period," *US Naval Institute Proceedings*, Vol. 33, No. 6 (2019), <https://www.usni.org/magazines/naval-history-magazine/2019/december/incubate-innovation-aviation-lessons-interwar-period>.

Table 1: Types and Details of Aircraft Carriers Operated by Various Countries During World War II⁸

Country	Fleet (1)	Light (2)	Escort (3)	MAC (4)	Total
USA	24	9	78	0	111
Britain	12	8	44	19	83
Japan	13	7	5	0	25
France	1	0	0	0	1
Total	50	24	127	19	220
Total sunk	19	7	15	0	41
Sunk percentage	38%	29%	12%	0%	19%

Source: "Aircraft Carrier Operations During World War II", https://ww2db.com/other.php?other_id=49

Note:

1. Fleet Aircraft Carrier: operates with the main fleet.
2. Light Aircraft Carrier: smaller in size than the fleet aircraft carrier.
3. Escort: A small and slower type of aircraft carrier.
4. MAC: Merchant Aircraft Carrier, with the Merchant Marine, modified to carry aircraft.

From the above table one can visualise the change in warfighting that occurred with these platforms. The deployment philosophy of naval forces changed with this superior technology being made available to a tactical commander at sea. The aircraft carriers also played a significant role in the naval campaigns during World War II, aiding in scouting, and destruction of enemy warships, indirectly or directly aiding in the safety of the Merchant Marine, amphibious operations and power projection to name a few. The Pacific campaign in World War II saw one of the most power packed battles of the aircraft carriers of the navies of the United States and Japan. The significant contribution of aircraft carriers is still relevant till date in modern day navies. The Battles of Midway, Coral Sea and Philippine Sea are some

8. Bob Bryant, "Aircraft Carrier Operations During WW2," *World War II Database*, https://ww2db.com/other.php?other_id=49.

of the battles of World War II in which aircraft carriers played a crucial role.

The Japanese air raids in the early morning hours of December 7, 1941 on Pearl Harbour at Hawaii which also resulted in the United States joining the war, is testimony to the reach and surprise that air power at, or from, the sea can achieve. The use of air power at sea by an aircraft carrier or also a shore-based strike on an adversary at sea is till date one of the important considerations a tactical commander at sea needs to be conscious about while planning campaigns.⁹ Air power also played a crucial role in detecting and prosecuting submarines and surface ships during the various battles that ensued. Technological advancements in the carrierborne fighters of today as compared to the ones of World War II vintage have further complicated the battlespace at sea.

THE RADAR: TO DETECT TARGETS BEYOND VISUAL RANGES

While we had the battleships, U-boats, SONARS (Sound Navigation and Ranging), mines, torpedoes, big guns and naval aviation taking centre-stage in technological advancements in naval warfare, the detection of an enemy in the expanded battlespace at sea was still dependent on visual aspects, until the invention of one of the major technological advancements in naval warfare: the radar. The radar (Acronym for Radio Aided Detection and Ranging) used electromagnetic waves which were sent out in the form of transmissions. Once these transmissions impacted on an object, the sent waves used to reflect back and be received onboard the transmitting platform. The time taken from the transmitted to the received pulse would then determine the range of the object.

9. Gurpreet S. Khurana, "Indian Navy Updates Indian Maritime Doctrine 2009" National Maritime Foundation, March 2016, <https://maritimeindia.org/indian-navy-updates-indian-maritime-doctrine-2009/>.

The United States Navy researched on this in the 1930s and then the first American radar, the XAF, was installed on the USS *New York* (BB-34) in 1938.¹⁰ When the Japanese launched their attack on Pearl Harbour in December 1941, about 20 radar units had already been installed on certain ships of the US Navy. The UK and Germany too had their own technology being developed during this period.¹¹ These radar systems played a crucial role in various battles during World War II, including the Battles of the Coral Sea, Midway, and Guadalcanal. Fitted on ships and later on aircraft, radars changed the concept of battles, as early detection of an enemy fleet beyond visual range became the primary objective to gain a decisive advantage in the campaign. By the end of World War II, each of the above technological inventions kept getting upgraded with greater ranges and more firepower. The period after World War II has seen several aspects of technology coming to the fore at various stages, which include missile technology, advancements in anti-submarine warfare and air defence at sea, superior submarines, etc.

CONTEMPORARY SCENARIO

In 1976, the Indian Air Force (IAF) formally transferred the responsibility of Long-Range Maritime Patrol (LRMP) operations to the Indian Navy by handing over the Super Constellation aircraft.¹² This marked a significant milestone in naval aviation,

10. "Radar and Sonar," Naval History and Heritage Command, November 30, 2023, <https://www.history.navy.mil/browse-by-topic/exploration-and-innovation/radar-sonar.html>.

11. Raymond C. Watson, *Radar Origins Worldwide: History of Its Evolution in 13 Nations through World War II* (Indiana: Trafford Publishing, 2009), https://books.google.co.in/books/about/Radar_Origins_Worldwide.html?id=g-rQQgAACAAJ&redir_esc=y.

12. Shekhar Sinha, "A Walk Through the History of Indian Navy's Maritime Air Power", Indus International Research Foundation, March 2021, <https://indusresearch.in/a-walk-through-the-history-of-indian-navys-maritime-air-power-vice-admiral-shekhar-sinha-rettd/>.

as it was the navy's first experience in operating four-engine, long-endurance aircraft. The naval aircrew had to quickly adapt to evolving operational demands, including flying extended missions from shore-based air stations, maintaining continuous surveillance, manually relaying data to the Maritime Operations Centres (MOCs), and navigating across multiple flight information regions. These missions frequently brought them into contact with advanced US Navy fighter aircraft while operating near international airspace. This transition led to the development of new operational competencies within the navy, extending its surveillance capability beyond what had previously been achieved using carrier-based Alizé aircraft, which were primarily adequate for localised domain awareness around carrier task groups.¹³

The induction of the Super Constellation, thus, heralded a new era in maritime domain awareness, expanding the navy's reach across the Indian Ocean Region (IOR). Concurrently, Maritime Operations Centres were upgraded to process larger volumes of intelligence over a much broader expanse. This transformation also enabled closer coordination between shore-based anti-ship strike assets of the IAF and naval maritime patrol aircraft. Consequently, carrier task forces were relieved from close-in surveillance duties and were free to project power further from the Indian Exclusive Economic Zone (EEZ), including delivering maritime influence and strategic reach into distant littoral zones—paving the way for India's emergence as a blue-water navy. Nevertheless, challenges in coordinating shipborne and shore-based airborne Anti-Submarine Warfare (ASW) capabilities remained unresolved.

The Super Constellation was eventually replaced by the more advanced IL-38 aircraft, capable of both maritime reconnaissance and ASW missions at extended ranges. With its turboprop engines, enhanced avionics, and onboard armament—including

13. M Doraibabu and Amrut Dilip Godbole, *Signalling Power and Partnerships* (Harper Collins, 2023).

torpedoes and depth charges—the IL-38 significantly improved the navy’s ability to detect and engage submarines, particularly at chokepoints critical to regional maritime security. While it lacked very long endurance and anti-ship strike capability in its original form, the navy modified the platform to integrate Sea Eagle missiles, expanding its strike envelope. Additionally, concepts were developed to guide shore-based fighter aircraft to conduct coordinated anti-ship strikes, effectively pushing adversarial forces further from India’s strategic areas of interest.¹⁴

To bolster its long-range patrol capability, the Indian Navy inducted a squadron of Tu-142M aircraft from the former Soviet Union. With exceptional endurance and the distinction of being the fastest turboprop aircraft in the world, the Tu-142—nicknamed the “Bear”—enabled rapid ingress to, and egress from, patrol zones. Its survivability and reach made it a formidable asset in distant surveillance and deterrence roles.¹⁵ The navy developed “gambit tactics” using this platform, designed to preempt adversarial threats by forcing them to remain within their own territorial waters, well away from Indian fleet movements or carrier groups. With sophisticated sonobuoy systems, the Tu-142 enhanced submarine detection capabilities, particularly against nuclear-powered submarines that required persistent and accurate localisation. Its long endurance meant vast stretches of the IOR could be consistently monitored.

The simultaneous operation of Sea Harrier fighter jets from the aircraft carriers INS *Vikrant* and INS *Viraat* gave the Indian Navy an integrated offensive and defensive aerial capability. These aircraft could intercept enemy maritime patrol and strike aircraft,

14. Angad Singh, “IL-38’s Retirement Brings An Indian Maritime Patrol Era To An End”, *The War Zone*, November 2023, <https://www.twz.com/il-38s-retirement-brings-an-indian-maritime-patrol-era-to-an-end>.

15. V. Narayan, “Indian Naval Aviation - Air Arm and its Carriers”, *Team BHP*, <https://www.team-bhp.com/forum/commercial-vehicles/163578-indian-naval-aviation-air-arm-its-carriers.html>.

conduct deep penetration raids into adversarial territory, and escort anti-ship strike missions beyond the reach of shore-based fighters. This triad—comprising long-range patrol platforms, carrier-based air power, and strike coordination with land-based assets—transformed the Indian Navy into a formidable maritime force capable of dominating the IOR. Over these three decades, the navy's capability matured to the extent that it began fulfilling the role of a net security provider across the region. With improved reach, surveillance, and deterrence capabilities, the Indian Navy was frequently requested by regional nations for assistance with EEZ patrols, escort operations, and maritime security missions. The integration of naval aviation, both shipborne and shore-based, marked the consolidation of India's maritime power projection and established its strategic presence across the Indian Ocean littorals.

CONCLUSION

The evolution of naval air warfare has profoundly transformed maritime strategy, reshaping both the character and conduct of naval operations across the 20th and 21st centuries. From its modest origins in World War I reconnaissance missions to its pivotal role in World War II engagements, naval aviation has evolved into a decisive instrument of sea control, power projection, and strategic deterrence. The aircraft carrier—emerging as the dominant capital ship—symbolised a fundamental shift from surface-gunnery-based tactics to three-dimensional warfare, where reach, flexibility, and rapid response became the cornerstones of naval superiority. The technological strides made in radar, airborne early warning, and integrated carrier battle group operations further consolidated the relevance of naval air power in Cold War and post-Cold War theatres. Notably, air-sea synergy enabled the maritime forces to respond more swiftly to crises, support amphibious operations, interdict enemy logistics, and establish persistent surveillance in

contested waters. In the contemporary era, innovations in stealth, unmanned aerial systems, and long-range strike capabilities continue to redefine the parameters of naval warfare, raising both strategic possibilities and vulnerabilities—particularly as adversaries develop Anti-Access/Area Denial (A2/AD) systems.

India's experience exemplifies the global trajectory of naval air power. From modest beginnings with carrier-based *Alizé* aircraft and shore-based patrols, the Indian Navy has matured into a blue-water force wielding integrated air, surface, and sub-surface capabilities. The induction of long-range platforms like the IL-38 and Tu-142, along with the operationalisation of Sea Harriers and modern carriers, enabled India to assert its maritime presence across the IOR. This triad of shore-based surveillance, carrier air operations, and coordinated strike capability remains central to India's maritime doctrine and regional security role. Ultimately, naval air power has redefined sea control—not merely as domination of the surface, but as command over the expansive and dynamic battlespace that spans air, sea, and undersea domains.