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NAVAL AVIATION
FROM NASCENCY TO GLOBAL PARAMOUNTCY

Writing on the evolution of naval aviation around the globe, Admiral S.N. Kohli,a former Chief of the Naval Staff, had said in 1978: When one considers the aircraft carrier as a weapon system for achieving the primary role of sea control, it emerges as a cost-effective instrument of maritime warfare. Its ability to exercise this control in a wider and more efficacious manner than other less endowed vessels rates it very high in the naval armoury. The possibility of building relatively small carriers, shorn of much of the old launching and arresting equipment, using simple hulls - because V/STOL does not demand high speeds in the carrier vessels - and the developments in miniaturisation and automation, must be seen in this light. As the Indian Navy grows, so will its air arm. The percentage of manpower and resources likely to be utilised in this long arm of the Navy is also likely to increase, because of the changing pattern of warfare at sea. Naval aircraft will continue to be used in our environment for many, many years, till India reaches a stage in technology when satellites will carry out a11 surveillance, and a combination of missile and electronic warfare can meet aJjMhreats. Whether aircraft will operateat all at sea is difficult to foretell. That it will undergo much change and increase in sophistication is, however, beyond doubt. And that it will continue to be one of the most vital elements of warfare at sea in the present century is also a certainty.

Tracing the evolution of warships over the last two millennia, we find that the galley, in its various forms, held sway in the Mediterranean region for over 1,000 years while the Norse longboat, its contemporary, ruled in the northern seas. The development of sailing warships in W.estern Europe gradually drove both these boats into extinction. The sailing warships reigned as sailing 'ships of the battle line' for about 300 to 400 years after which, over a relatively short span of time, they were replaced by ships (armoured with plates of iron) known as ironclads. The era of the heavily armed and armoured centre-line gun battleship was ushered in, by ships of the heavily armed Dreadnought class within the next half century or so. But the Dreadnoughts reigned only for about 40 years and were dethroned by the aircraft carrier during the early stages of World War II. The carrier has now been the capital ship in most of the major navies around the globe for over half a century.

It was George Santayana who wrote, 'He who fails to learn the lessons ofhistory is doomed to repeatthem.' Andthehistoryoftheevolutionof the warship tells us that any dominant weapon system or platform is eventually countered by obsolescence and new developments. 'These dominant weapon systems', avers a specialist in strategic offensive systems/ 'are a form of technology fruition and therefore show the same trends. The process of introduction, acceptance, dominance, obsolescence and demise of weapon systems - notably capital ships - has become progressively shorter/

The Carrier's Pre-eminence at Sea

Since the middle of the 1940s the carrier has successfully reigned supreme as a surface weapon platform. During the post-World War II years its use in the Korean, Vietnamese and Falkland wars and in the eastern theatre of the 1971 Indo-Pak conflict, as well as its deployment in the various oceans as the long arm of the superpowers, have not only displayed its fighting capabilities but have also established its efficacy in continuously maintaining a credible stabilising and deterring presence of the superpowers in the world's more volatile areas.

It is, however, not yet clear what will finally dethrone the carrier and when. Some of the potential challengers to the carrier within the next two or three decades, as prognosticated by today's naval thinkers, are likely to be nuclear- powered submarines, hovercraft or surface effect ships, SWATH (small waterplane area twin hull) ships, land-based long-range aircraft, long-range smart missiles launched from a great variety of platforms and helicopter carrier ships carrying V/STOL aircraft with their rapid deck-cycle capability and, with the concurrent development in surface and sub-surface nuclear propulsion, supersonic jet aircraft and electronic warfare.

History is replete with instances of naval strategists or fleet commanders coming to grief only because they refused to accept the changes that had come about in tactics, ship designs, propulsion technology, weapons and equipment. For instance, when King Philip of Spain decided to send an invasion armada against England, he was wise enough to replace his fleet of Mediterranean galleys with bigger and sturdier sailing ships, but retained two vestiges of the galley that spelt the armada's doom: short-range heavy guns characteristic of galleys which were predominantly manned by soldiers and not by sailors, as was the practice earlier. British seamen firing lighter but longer-range guns from smaller but nimbler English men-of-war easily defeated them and thwarted the invasion.

During the American War of Independence, confidence in conventional weapon platforms led the Union Navy to deploy wooden-hulled ships at Hampton Roads against the Confederate ironclad, *Virginia,* and were being heavily battered when the new MomYor (with two large centre line guns, a new concept at that time), came to their rescue and effectively repulsed an attack launched by ships of the line with 80,100 and even 120 guns each.

Till the beginning of World War I, as stated elsewhere in this volume, Britain had not developed enough confidence in the submarines as a potent weapon platform though some other countries already possessed the new lethal platform for operating on the surface and below the surface. But the sinking of three British armoured cruisers in one hour by a single German U-boat, soon after the beginning of World War I provided enough warning of this new and deadly form of naval warfare - an expensive lesson indeed.

The sinking of two British battleships in quick succession by Japanese aircraft spelt the doom of Singapore, Malaysia and Indonesia during World War II and exposed the weaknesses of this class of warships against air attacks. Besides, the Japanesecarrier assault on Pearl Harbour causing a US battleship disaster and the significant US victory at Midway convinced the Allied forces of the superiority of the aircraft carrier over the battleship in naval warfare and antiaircraft defence.Though the battleship continued for some more time, her role was mainly confined to the artillery-equivalent at sea, viz., carrier air defence and shore bombardment, the carrier having become the most potent surface weapon platform of all major navies of the world.

> The position of the aircraft carrier as the most potent and versatile weaponplatforminany fleethas remainedunassailed during the lastfour decades, and has in fact been reinforced by the performance of carriers and carrier aircraft in Korea, Vietnam, Falklands and Bangladesh, albeit in the absence of any enemy challenge to the carrier itself in these four wars. During this period the carriers have progressed from operating propeller-driven to jet-powered aircraft, from catapults to the V/STOL mode of launching aircraft, from fair to all-weather flying, from steam propulsion to nuclear power, from coastal to global deployment, from antiaircraft guns to surface-to-air missiles, and from hit-and-run to stand-and-fight tactics.

However, the carrier is not going to remain the queenof the sea forever and, as mentioned earlier, is likely to 'yield place to new' within a few decades - as the portents of her replacement are neither expected to be ignored, discredited nor countered for long by the proponents of the 'reigning queens' for, it is hoped, naval strategists have already learned lessons from history.

However, thestudies,simulations,wargames, exercises and analyses of war games that have been conducted by the major navies and naval strategists, planners and thinkers, indicate that the carrier will continue to hold the prime position in naval warfare for at least two more decades. These evaluations incorporate all the current and programmed improvements in naval warfare and indicate an extended lease for the carrier until the first decade of the next century.

Another lesson to learn from the history of naval warfare is that immediately before the demise of a prime weapon system, there is an onset and blossoming of the process of involution - self-analysis - for redesigning the system to render it impregnable. The sole mission then becomes survival and everything else is subordinated to it.

For similar reasons, towards the end of the Mediterranean galley era, several unwieldy multi-tiered galleys - quadriremes with four tiers and even quinquaremes with five tiers of oars - with hundreds of galley-slaves and troops manning them were built but, unfortunately, the days of the galley were, by that time, sadly over and it did not survive. When the ironclads came in, the sailing ships became more and more ornate, elaborate and cumbersome as ships of the line, with 100 to 120 guns and over 1,000 men on board. When the battleships were about to be replaced by aircraft carriers, they were bristling with antiship and antiaircraft guns, had been fitted with virtually impregnable armour and had in some cases a complement of over 3,000. men.

In each of these cases, the weapon system or the weapon platform that reigned supreme for several years fell victim to a longer-range weapon platform with greater lethality. With the growing threat in recent years to today's queen of any naval power, the aircraft carrier, from modern vessels with greater versatility and less vulnerability, this weapon platform is being rendered more and more impregnable and other vessels, specifically designed for the defence of the carriers - cruisers and nuclear submarines - are being built to indicate that involution is about to set in once again.

Nevertheless, this process is likely to take at least two decades - may be even longer in the developing countries - and hence the carrier is most likely to reign supreme for many years to come.

Early History

The honour of flying the first aircraft from the deck of a ship at sea goes to an American civilian pilot, Eugene Ely, who took off in a 50-horse power Model-D Curtiss biplane from a 57-foot wooden platform on the forecastle - the forward upper deck - of the US Navy's light cruiser,*USSBirmingham,* which was anchored offHamptonRoads,VirginiaonNovember14,1910 Theaircraft, designed by Glenn Curtiss, a pioneer designer,builderandflierof aircraft for both civilian and naval use, was the prototype of the all-purpose biplane that occupied the centre-stage of aviation for many years. Ely could reach a height of only 37 feet above sea level and the aircraft's wooden propeller, wheels and float touched the sea, drenching him and damaging the aircraft but he managed to maintain his perilously low altitude and flew a distance of 2.5 miles before landing ashore. It was decided next to attempt landing on a ship-borne platform.

A large wooden platform, 120 feet long and 32 feet wide, was built on the quarterdeck of the cruiser, *USS Pennsylvania,* with a ramp with a slope of 30 degrees and extending to 15 feet at the rear end of the platform, to prevent the aircraft from crashing into the stern. A canvas barrier was erected at the forward end of the platform to stop, the aircraft from hitting the cruiser's superstructure incaseit overshot the makeshift'runway',and wooden guard-rails were built on the sides of the platform to prevent it from falling

into the sea. Twenty two manila ropes were stretched across the platform at a height of one foot from the deck, each one of which was attached to a 50-pound sandbag on either side. The tail assembly of the aircraft was fitted with three hooks, one of which was expected to engage one of the manila ropes and the aircraft, while moving over the deck, would continue to pick up an additional 100-pound drag every three feet, thus experiencing andincreasingbrakingeffort and being brought to a stop after travelling only a little more than half the length of the 120-foot platform. This arrangement was the precursor to the present-day arrester gear, the only difference between the two being the replacement of ropes by wires and the sandbags by hydraulic brakes.

Two months after the historic take-off of his aircraft from the deck of carriers since it was introduced in this ship -an elevator on the flight deck which helped in stowing aircraft, which would normally be positioned on the flight deck, inahangerspacebelow.Theadvantagewas three-fold-the carrying capacity of the aircraft carrier was increased, more space was available on the flight-deck for conducting flying operations, and repair and maintenance of aircraft could be carried out in the enclosed hangar space.

Catapult launching of aircraft was also tried out in 1912, when in November, an experimental catapult built at Annapolis, Maryland, suc cessfully launched a plane, piloted by T.G. EUyson. In 1915, Commander H.C. Mustin of the US Navy became the first person to make a catapult flight from a ship when he was launched from the *North Carolina* in a Curtiss AB-2 flying boat. Two US cruisers, the *Seattle* and the *Huntington,* were fitted with catapults to launch twin-float R-6 torpedo planes.

In 1912 a Short biplane was used to drop 100- pound bombs onselected targets and 1.5-pounder guns were fitted on these aircraft for strafin g ground targets. By 1914 Short biplanes had made a successful torpedo drop with a 14-inch 810-pound torpedo and had been equipped with wireless equipment for communication with ground stations and ships at sea. The three main roles assigned to naval aircraft at this time were fighter operations for home defence, spotter operations for reconnaissance and shipborne aircraft for operations at sea.

These seaplanes were by now being equipped with 50-pound bombs and torpedoes, which was an indication of naval planners being seized of the potential for offensive uses of ship-borne planes, and it was this future of supplying wings to the navy to carry bombs and torpedoes to targets hundreds of miles away, which eventually made the aircraft carrier one of the most potent weapon platforms in the course of the following decades. The first aircraft for the French Navy, a British Maurice Farman seaplane, was acquired in September 1910 for training pilots, and in 1912 an old 6086-ton torpedo boat carrier, *Foudre,* was converted into a seaplane carrier, with two seaplanes which were hoisted on board after they took off from and landed back on the sea. She was later equipped with a launching platform, from which an aircraft successfully took off, on May 8,1914.

Three Lieutena nts of the Japanese Navy were sent to France and two to the USA for training in flying

in 1912. Two Maurice Farman seaplanes from Britain and one Curtiss biplane from the USA were thereafter acquired for the Japanese Navy and in November 1912 Japanese naval aviators started flying their aircraft from a shore base. *Wakamiya Maru,* a 7,600-ton naval transport, was converted in 1913 into a seaplane tender with a carrying capacity of four seaplanes. By September 1914, the Wakamiya Maru had started operating against the Germans by successfully using her seaplanes to bomb and sink a minelayer in Kiaochao Bay, off the Chinese coast.

In 1907 an officer of the Italian Navy, Lieutenant Mario Calderara, succeeded in flying a seaplane glider which was towed and launched by the destroyer *Lanciere.* Italian naval aviators received training in France and Calderara was the first to earn his flying licence in 1909. The first lot of seaplanes were acquired from Britain, France and the USA.

By the time the first World War started on August 04,1914, The Royal Navy had 71 aircraft, CzaristRussiahad50,theItalianNavyhad30and the US Navy 12. The role of a reconnaissance picket at sea had been transferred from the scout frigate and scout cruiser to the new long-range 'eye-in-the-sky' launched from ships of the fleet

.**Carriers in World War I**

The first World War saw fairly extensive use of ship-bome aircraft. These planes were used for air reconnaissance, carrying out attacks on ships, submarines, Zeppelins, shore bases and installations and for the protection of fleets from air attacks.

Three British carriers, the *Empress, Engadine* and *Riviera,* each with three seaplanes on board, and escorted by a screen of two light cruisers, 10 destroyers and 10 submarines, carried out an attack in December 1914 on the Zeppelins' sheds near the German North Sea base at Cuxhaven. Bad weather, however, prevented the planes from causing any serious damage to the German installations and poor visibility caused the loss of seven planes, though the crews of the planes, which had ditched, were picked up by ships and submarines. Though this attack was not much of a success, it was the first true naval air operation with the attack being launched from carriers at sea with screens of ships and submarines and with the over-the-horizon targets, well outside the range of the ship's guns or shore-based planes.

The British carrier fleet was soon enla rged with the conversion of three steamers, the *Ben-My-Chree, Manmax* and *Vindex,* into carriers but lost the *Hermes,* the first ship to have been converted into a carrier, in October 1914 when she was torpedoed by a U-boat (Undersee boot - under-sea boat, German submarine) in the English Channel.

In September 1914 the German 3,400-ton light cruiser *Konisberg* took refuge in the delta of the Rufigi river in Tanganyika. *Chatham,* which had been chasing the German ship from Zanzibar after the latter had sunk the British ship *Pegasus,* could not move up the Rufigi river because of her greater draught (depth of water drawn). In July 1915, two monitors -s allow-draught warships of heavy gunpower - and six cruisers were engine and then being hauled down with the help of rope toggles. On August7whenDunningmadehis third attemptto land, the aircraft stalled, rolled over the side and fell into the sea, killing him. The *Furious* was thereafter modified and fitted with a primitive form of arrester gear consisting of longitudinal arrester wires and transverse rope attached to sandbags, both of which were engaged by spring clip hooks on the axle ofthe aircraft.

The first flat-top, i.e., the first true aircraft carrier of the world with a flush flight-deck with no superstructure and vents discharging exhaust gasesover the stern, Argus, was completedinl918,and in October thatyear, history wasmade when Wing Commander Richard Bell Davis tookoff from itsdeckinaSopwithl.5 Strutter andlandedback safely without evenusing the arrester gear.The *Furious* soon embarked a squadron of the first aircraft designed to carry torpedoes, the Sopwith Cuckoo.

About this time the Royal Navy carried out trials on another method of launching of aircraft. Lighters with decks of 30 feet length and 16 feet width were towedby destroyers at speeds of over 30 knots, and the aircraft tookoff from the lighters. InMay 1918, Wing Commander Swanson safely took off fromatowedlighterina Sopwith Camel, and on July31the same year Lieutenant Culley shot down a Zeppelin, after taking off in a Sopwith Camel from a towed lighter.

Argus, the first true aircraft carrier to be built, was still in fighting trim whenWorld War I ended onNovember 11,1918. The others had either been lost, decommissioned or converted for use in different roles.

During the war the US Navy and Marine Corps had concentrated mainly on antisubmarine operations, using the Curtiss H12 and H16 Flying Boats,each one of whkhhadbeen equipped with four machine-guns or two 230-pound bombs or depth charges. These aircraft operated from shore bases in Europe, attacked 25 U-boats and sank or severely damaged 12 of them. Actual operations of planes launched from US Navy ships during World Warl were of little importance. As mentioned earlier, the US cruisers *HuntingtonandSeattlewere*equipped withcatapults,andcarried planes for providing antisubmarine protection to convoys plying across the Pacific, but these never saw action. The main reason for the limited development of ship-launched aviation in the US Navy was the short duration of its involvement- only 19 months -asit had joined the fray only on April 6,1917. When the Royal Air Force came into being on April 1,1918, over 3,000 aircraft of the Royal Naval Air Service were merged with the Royal Flying Corps to create an air wing independent of the Army and the Navy, and adopted the rank structure of the RNAS with certain minor

modifications, with officers of the Fleet Air Arm reverting to the naval rank structure in 1924.

The Inter-War Years

In the Royal Navy, carrier operations practically came to a standstill after WorldWar I, with most ofitsaircraft having been transferred to the Royal Air Force and the *Furious* having been decommissioned. The only aircraft carrier still in operation was *Argus* which had been fitted with an experimental arresting device. This device caused considerable damage to the aircraft' undercarriages when they landed and hence was later removed. *Courageous* was fitted in 1931 with transverse wires, with friction brake-drums providing the arresting effort and an electrical system resetting the wires. The electrical system was soon replaced with a hydraulic system which proved to be more efficient and fail-safe. The retractable hook suspended below the axle of the aircraft's undercarriage was now shifted to the rear of the fuselage and this prevented the aircraft from tipping forward on being arrested and thus avoided damaging the propeller, as was the case earlier.

While the US Navy had been experimenting with catapults for launchingaircraftas early as 1915 and had equipped a number of ships with catapults, itwas tried out in Britain for the first time in 1917 when the steam hopper *Slinger* successfully launched a Fairey 9 seaplane from its forward deck with a catapult. It took the Royal Navy another eight years to introduce this launching system, when a Fairey HID seaplane, piloted by Wing Commander Burling, was launched by a catapult from the deck of *Vindictive* in October 1925. Initially the catapults used a hydro-pneumatic mechanism which was later replaced with the more efficient steam-powered mechanism. The earlier version of the steam catapult, known as anaccelerator,hadbeen developed during the earlieryearsof the 1930s but was not considered very safe and was used only as a last resort, when the ship's speed and the prevailing wind could not produce a relative wind strong enough for the aircraft to take of f on its own. Another innovation for the accelerator catapult launch was a strop, a collar of spliced wire, engaging the aircraft to a projection on the launcher, which fell off immediately after the aircraft was airborne.

On April 13,1920, the second British flush-deck carrier, *Eagle,* with a flight deck measuring 625 feet in length and 96 feet in width and a speed of 24 knots, displacing 22,600 tons and operating 24 aircraft, was commissioned. Its superstructure, known in naval aviation parlance as an 'island' which houses the bridge, mast and funnels, was on the starboard side of the flight-deck, as is the convention eventoday,and itwas equipped with longitudinal wires to arrest landing aircraft.

On February 6, 1922, the Naval Armament Limitation Treaty was signed at Washington, stipulating the ratio of 5:5:3 regarding the total tonnage for navies maintained by the United States, Britain and Japan. So far as the aircraft carriers of the three major naval powers were concerned, the United States and Britain were permitted a maximum gross tonnage of 135,000 tons and the ceiling for Japan was 81,000 tons.

Britain's Fleet Air Arm continued to expand. Two battle cruisers, the *Courageous* and the *Glorious,* were converted into aircraft carriers with flight-decks of size 570 feet by 110 feet and a carrying capacity of 48 aircraft each, in 1928 and 1930 respectively.The first ship to havebeen designed and built as an aircraft carrier, the 27,000 ton *Ark Royal* with a flight-deck of length 720 feet and width 95 feet, aspeedashigh as31.75 knots, and for the first time using a crash barrier to prevent landing aircraft from hitting and damaging other aircraft parked on the deck, was completed in 1938. Four aircraft carriers of the *Illustrious* class, each displacing 23,000 tons and a speed of 31 knots, were laid down during the period. Of these, the *Illustrious* and *theFormidable* were commissioned in 1940 and the *Victorious* and the *Indomitable* were commissioned in 1941. Each one of these carriers had a carrying capacity of 36 aircraft each but could carry a maximum of 60 aircraft, the additional 24 aircraft being parked on the flight- deck. These four carriers were soon followed by two more carriers, the *Implacable and* the *Indefatigable,* which were similar to the *Illustrious* class but had a speed of 32 knots and two hangar-decks which increased their aircra ft carrier capacity to 72. Another light fleet carrier, the *Unicorn,* which also served as a supply and repair ship and carried 35 aircraft, was commissioned in 1943.

As regards aircraft for these carriers, the biplane fighter, *Hawker Nimrod,* was used for eight years from 1931 to 1939. The biplane fighter, *Gloster Sea Gladiator,* was introduced in 1939, the two-seater biplane, the *Hawker Osprey,* having already been introduced in 1932. The strike role during the war was, however, assigned to the torpedo-carrying biplane, *Fairey Siuordfish,* and the two-seater monoplane dive bomber, the *BlackburnSkua.*

The first American aircraft carrier was the *Langley,* commissioned in 1922 with a flight-deck of length 534 feet, width 64 feet and a speed of 14 knots. This was followed by two large aircraft carriers, the *Saratoga* and the *Lexington,* each witha displacement of 33,000 tons, a speed of 33.5 knots and a 880-foot flight-deck, commissioned in 1927. In 1934 the 14,500-ton *Ranger* was commissioned, with a speed of 29 knots and an aircra ft complement of 75. By 1938, two more 19,900-ton carriers, the *Yorktown* and the *Enterprise,* each with a speed of 30 knots and aircraft complement of 80 aircraft, had been added to the US Fleet.

The Naval Armament Limitation Treaty permitted one more carrier to the US Navy and the 19,000-ton *Wasp,* a 30-knot carrier with a capacity of 84 aircraft, was commissioned in 1940. She was soon followed, after the termination of the Treaty, by the *Hornet,* which was a modified version *of* the *Yorktown.*

The first monoplane to operate from US carriers was the BT-2 which was introduced in 1940. It carried a 1000-pound load of bombs and was embarked in the *Yorktown* and *Enterprise.* Soon the successful dive bomber, *fhe Douglas Dauntless, was* developed and used in the Battle of Midway. The *Vaught Vindicator,* a scout/dive-bomber monoplane equipped with folding wings, was used till 1942 and the *Douglas Devastator,* another monoplane carrying a 21-inch torpedo, saw service till after Midway. In 1938 the *Grumman F3F*

fighter began opera ting from the UScarriers and was replaced in 1940 by the *Grumman F4F-3,* better known as the *Wildcat,* which was armed with machine guns and bombs.

It was on board the *Langley* that the development of the 'batsman' technique for providing guidance to landingaircraft and the 'crash barrier' for the prevention of landing aircraft from colliding with other flight-deck aircraft and the acceleration of the frequency of landing took place in 1926. The 'batsman', known as the Landing Signals Officer in the US Navy, positioned himself on the port side of the flight-deck and used a special arm signal code to safely guide landing aircraft down to the flight-deck at an approachangle that would ensure the engagement of the arrester wires. He raised his arm to indicate that the approach was too high, kept it in a horizontal position to indicate a correct approach, lowered it if the aircraft was too low and signalled instructions to the pilot to switch off his engine when the aircraft was close enough the deck. This system was introduced in the Royal Navy in 1936, but was discontinued in all navies when mirror landing sights were introduce^ after World War II.

During flying operations in 1926, an aircraft had failed to engage the arresterwires onboard *the Langley andhit a* numberofaircraft onherdeck, damaging 14 of them. The ship decided to rig thick manila hawsers across the deck during landing operations and effectively prevented such damage to aircraft. The manila hawsers were soon replaced by steel wire ropes which were hydraulicaily raised before landing an aircraft and lowered thereafter to enable the landed a ircraft to be parked ahead of the barrier. The crash barriers ceased to be used as a regular safety measure in 1953, when the carriers began to use angled decks.

Japan, after flying some Sopwith Pups from the seaplane tender, *Wakamiya,* and from the battleship, *Yamashiro,* commissioned a flush-deck aircraft carrier in 1922, *theHosho,* which displaced 7,470 tons andhad a 550-foot flight-deck. Her speed was 25 knots and her aircraft complement was 21. In 1927 the 26,900-ton *Akagi* with a 632-foot flight-deck, a speed of 31 knots and 60 aircraft was commissioned, and in 1928, a battleship under construction, the *Kaga,* was completed as a carrier with a displacement of 29,600 tons, length 783 feet and a speed of 27.5 knots.

In 1929, Japanbuilt the 10,600-ton *Ryujo* whichhad a speedof 29 knots, length 591 feet and carried 36 aircraft. She then decided to disregard the restriction to tonnage imposed by the Naval Armament Limitation Treaty and went ahead to build the 18,800-ton *Soryu* in 1937, and the 21,150-ton *Hiryu* in 1939, both ships being capable of a maximum speed of 34 knots and operating with 60 aircraft each, operating from flight-decks 711 feet long and 85 feet wide, the *Hiryu* being the only aircraft carrier built with an island on the port side. Two more carriers, displacing *25,675* tons and operating 80 aircraft each and having a speed of 35 knots, the *Shokaku* and the *Zuikaku,* were commissioned in 1941.

As regards aircraft, Japan produced the first carrier-borne monoplane, the *Nakajima Type 97,* well before the commencement of World War II. This aircraft had an impressive range of 1,238 miles and could carry

machine-guns and torpedoes or a bomb load of 1,760 pounds. But Japan's most successfulaircra ft was the A6MMi£SHfttsfa' *Zero Sen* which wasdeveloped in 1939 and achieved great success during World War II.

The only aircraft carrier that France built during the inter-war years was the *Beam* which was built on the hull of a battleship and commissioned as a 21,800-ton carrier in 1927. She had a speed of 21.5 knots and operated 40 aircraft from a flight-deck 595 feet long.

The Australian light cruiser, *Brisbane,* operated a Sopwith Pup in 1917 for a few months and, seven years later, the *Geranium* had a *Fairey HID* for a short period. A seaplane carrier, *Albatross,* was commissioned in 1920 but was transferred to Britain in 1938. Five Australian cruisers were thereafter equipped with catapult-launched reconnaissance planes which were effectively used during World War II.

Due to their land-oriented strategic thinking, the Soviet Union decided to build aircraft carriers only during the 1930s but Stalin's views against a third dimension in naval warfare put paid to the Russian Navy's hopes of acquiring the integral air element for its fleets, and thus all its operations during World War II were confined to the surface and sub-surface.When the second global conflict reached its flash-point on September 01,1939, the United States had five aircraft carriers with a total tonnage of 120,300 carrying 380 aircraft with two additional carriers totalling 39,000 tons and a carrying capacity of 141 aircraft under construction; Britain had seven carriers with a total tonnage of 138,225, carrying 202 aircraft, with six more carriers totalling 102,000 tons and a combined aircraft complement of 384 aircraft under construction; Japan had six aircraft carriers with a total tonnage of 125,970 carrying 395 aircraft with two additional carriers totalling 53,350 tons, with a combined carrying capacity of 172 aircraft under construction, but Germany had no aircraft carriers.

World War II - Evolution of Carrier Strategy and Tactics

At the beginning of World War II, naval strategists had assigned two roles to aircraft carriers: as a fast striking force and as an escort force. These two functions being widely different, they were to be performed by different classes of carriers.The fast carriers were primarily offensive weapon platforms and were to be used for offensive as well as defensive operations, observation of enemy fleet and shipping movements, and strikes against 'beach-head targets'. Built to provide mobility and flexibility of operations, along with a strong air strike capability and heavy defensive armament, they were to take aerial control of large sea areas and to harass and destroy enemy forces which were likely to threaten friendly naval forces, coastal regions, amphibious operations or merchant shipping.

The mobility and tremendous striking power of a fast carrier strike force, comprising several task groups, each consisting of three to five carriers carryingfighter,divebomber and torpedo bomber squadrons,and supported by several battleships, cruisers and destroyers, was demonstrated most effectively during World War II. In September 1944 the first air assault by the Allied forces on the Philippines included 730 carrier aircraft, the task force supporting the landing at Leyte in October the same

year used l,060aircraft and the task force raiding the Japanese home islands in February 1945 used as many as 1,220 aircraft.

The escort carriers, which were slower and smaller platforms, carrying a few squadrons of fighters and torpedo bombers, when organised as a force, provided adequate air and antisubmarine defence for invasion convoys and beach-head areas, and aerial support for invasion troops until such time as conditions permitted the employment of land-based aircraft. These carriers, escorted by destroyers, provided aerial support to amphibious operations and also operated individually in escort duties and antisubmarine warfare.

Since the first step in winning control of a sea area is to take control of the air space above it, this task, it was thought, was best carried out by the carrier which, with its high mobility, permitted itself to be quickly placed in the area where control of the air space was desired, while its offensive power, reckoned in terms of its aircraft, i.e.,itsair strike capability, enabled it to take control of the air space, in the face of the most persistent and continued opposition.

As early as 1941,anexampleoftheimportance of airspace controlover a specified area was provided when the presence of the two carriers, *Victorious* and *Ark Royal* enabled the British to launch sufficient aircraft to slow the formidable German battleship, the *Bismarck,* to the point where battle ships could close in for the kill. Later in the same year, Britain lost the *Prince of Wales* and the *Repulse* in the South China Sea in an engagement lasting only two hours, because of lack of adequate air space control. Another example of the importance of air space control was the inability of the British forces to sink three German ships, the *Gneisenau, Scharnhorst* and the *Prinz Eugen,* in the Straits of Dover, despite the availability of land-based aircraft of the Royal Air Force, because the Germans had already deployed a very large number of aircraft and had effectively maintained air space control over the area.

The tactical effectiveness of aircra ft carriers is best exemplified by the shipping losses suffered by Japan during the War. Taking into account only vessels drawing 500 tons and above,the US forces, during the 44 months of their involvement in the War, sank a total of 2,728 ships with a tonnage of 9,736,068, and out of these as many as 520 ships with a tonnage of 2,101,477 were sunk by carrier aircraft themselves, and another 35 ships with a tonnage of 210,085 in combination with other aircraft and ships.

Immediately following the commencement of hostilities in the Atlantic theatre, *Courageous* was lost whilehunting for U-boats along with *the Ark Royal* and the *Hermes* but within months aircraft catapulted from the *Ajax* spotted the German battleship *Graf Spee* in the South Atlantic and a concerted action by the *Ajax, Exeter* and *Achilles* (later *INS Delhi)* led to the scuttling of the *Graf Spee* outside Montivideo harbour in Uruguay. In April 1940, the German cruiser, *Konisherg,* was attacked and sunk, while she was berthed alongside at Bergen, Norway, by 16 *Skua* aircraft of the *Ark Royal.* In June 1940, *Glorious* was intercepted and sunk by the German battle cruisers *Gneisenau* and *Scharnhorst* because she had stowed all her aircraft in the hangar and, once the attack commenced, hoisting, marshalling and launching aircraft even for self-

defence had become impossible.

In July 1940, aircraft from the *Ark Royal,* along with some surface units, attacked the French fleet, which had already capitulated to Germany, at Oranand destroyed or disabled most of the ships, including the only French aircraft carrier, the *Beam.*

The two British carriers, the *Illustrious* and the *Eagle,* soon proceeded to the Mediterranean, and on November 11, 1940, torpedo and dive bombers launched by these carriers attacked six Italian battleships at Taranto, sinking one battleship, damaging two battleships, three cruisers and one destroyer and losing only two aircraft and four men. Only 20 Swordfish aircraft had accomplished in less than an hour, what the Grand Fleet had done at Jutland during World War I, at the loss of 6,000 men and 14 ships.

On March 28, 1941, aircraft from the carrier *Formidable* located and shadowed the Italian Fleet in the Mediterranean and a torpedo strike virtually immobilised the battleship, *Vittorio Veneto,* reducing its speed to 8 knots, and crippled the cruiser *Pola.* This led to the sinking of three Italian heavy cruisers and two destroyers, reducing the Italian Navy to an insignificant force within the span of a day.

Having been detected by a Royal Naval aircraft on May 23,1941, the German battleship *Bismarck* and the heavy cruiser *Prinz Eugen* sailed out of the Polish port of Gdynia and entered the North Atlantic, where they sank the battle cruiser, *Hood,* and damaged the battleship, the *Prince of Wales* but while the *Prinz Eugen* escaped, the *Bismarck* was hit and damaged and was slowed down from 30 knots to 28 knots. On the night of May 24/25, aircraft from the aircraft carriers *Victorious* and *Ark Royal* attacked the *Bismarck,* but because of foul weather the damage caused was minimal. On May 26, ' several aerial attacks were launched by Swordfish aircraft from the *Ark* Koi/fl/, immobilising the German battleship,andthecoupdegrace was soon delivered by the cruiser *Devonshire.* The sinking of the legendary battleship signified the end of the battleship era.

In November and December 1941, the Royal Navy suffered two major losses - the aircraft carrier *Ark Royal,* while ferrying RAF aircraft from Gibraltar to Malta, was torpedoed and sunk on November 14, and on December 21 the escort carrier *Audacity,* while escorting a convoy of merchantmen from Gibraltar to Britain, was torpedoed and sunk by U-Boats.

The spectacular Japanese carrier-borne attack on Pearl Harbour has now become a part of legend. On December 7,1941, in a brilliantly planned and executed move, Japan caught the USA by complete surprise and virtually devastated the US naval units at Pearl Harbour. Six Japanese carriers, the *Akagt, Kaga, Hiryu, Soryu, Zuikaku* and *Shokaku,* carrying 132 *Zero Sen fighters,* 129 *Aichi* dive bombers and 143 *Kate* torpedo bombers, supported by two battleships, three cruisers, nine destroyers, three submarines and a few auxiliary craft, (some of which carried another 450 aircraft), attacked Pearl Harbour, which had eight battleships, eight cruisers, 29 destroyers, five submarines and 20 other combat vessels at anchor or alongside, at dawn on that Sunday. In less than two hours of death and destruction the raid was

over, the savage assault leaving seven out of the eight battleships - the *US West Virginia, Arizona, California, Oklahoma, Nevada, Maryland, Tennessee* and *Pennsylvania* - either sunk or badly crippled and three cruisers and three destroyers severely damaged; 188 US aircraft out of a totalof 394 destroyed,and another 159 damaged,2403 Americans killed and 1178 wounded; the Japanese lost only one full-sized submarine, five midget subniarines, 29 aircraft and 100 pilots. As is well-known, the attack onPearlHarbourwasawatershedinthecourseofoperationsduring

War II, drawing the US into the Warand Japan herself to ultimate disaster.

On December 10,1941 a task force designated Force Z, comprising the British35,000-tonbattIeshipPn«ceo/Wfl/£[i]sandthe32,000-tonbattle-cruiser *Repulse* (the third capital ship, the aircraft carrier, *Indomitable,* was still to join the Force as she had run aground whilst working up in the West Indies), were patrolling off the east coast of Malaya, 200 miles north of Singapore, in defence of the trade routes in the Indian Ocean. The absence of air cover had prompted Admiral Sir Tom Philips, the Force Commander, to ask for air reconnaissance and a combat air patrol from the RAF base at Singapore, but this had been denied. At about 1100 hours on that day, Japanese Navy torpedo and dive bombers launched a fierce assault on these two ships sinking them in two hours. Admiral Philips and 840 officers and men lost their lives.

Within a week of the attack on Pearl Harbour, Japanese forces made a landing attempt on Wake Island but were repulsed. But the Japanese persisted and after a two-day three-element assault by ships, submarines, assault troops and aircraft from the *Hiryu* and *Soryu,* the island fell to the Japanese on December 23, 1941.

During the Battle of the Java Sea which led to the Japanese capture of Java Island in March 1942, strikes from the carriers *Soryu* and *Ryujo* demolished all resistance after a long-drawn-out battle, during which the US aircraft carrier *Langley* and a large number of Allied ships, including three cruisers, four destroyers, one oiler and 20 smaller ships were sunk.

On April 5 the same year, 125 aircraft from a powerful Japanese strike force comprising the six aircraft carriers, *Akagi, Shokaku, Zuikaku, Hiryu, Soryu* and *Ryujo,* four battleships, three cruisers and eight destroyers attacked Colombo and sank a few ships, besides shooting down 16 RAF aircraft against the loss of only seven Japanese aircraft, while the British Eastern Fleet consisting of the aircraft carriers *Formidable, Indomitable* and *Hermes,* five battleships, seven cruisers, 16 destroyers and several submarines, was fuelling at Maldives. During the attack on Sri Lanka, Japanese aircraft spotted two British cruisers 300 miles southwest of Colombo and sank them. This was followed by an attack on Trincomalee during which the British carrier *Hermes* and an Australian destroyer escorting her were sighted south of Trincomalee and were sunk, along with a British corvette and two oilers.

During the Battle of the Coral Sea, three Japanese carriers, the *Zuikaku, Shokaku* and *Shoho,* constituted the invasion force for Port Morseby in New Guinea onMay *7,* 1941. A task force comprising the two carriers, *Yorktown* and *Lexington,* five heavy cruisers and 13 destroyers opposed the Japanese landing and sank the *Shoho.* On the following day, a strike of 82 aircraft from these two carriers attacked the Japanese carrier force, which was 200 miles away, and damaged the *Shokaku,* while a Japanese air strike of 69 aircraft set the *Yorktown* on fire and fatally damaged the *Lexington,* which was later sunk by a US destroyer. Though only one Japanese carrier had been sunk at the cost of a larger carrier, the first carrier, *Shokaku,* had been damaged, leading to the cancellation of the invasion of Port Morseby. For the first time in the history of naval warfare, a major naval battle had been fought with the two opposing forces not sighting each other even once.

The turning point in the war at sea, was the Battle of Midway, which resulted in the sinking of four Japanese carriers at the cost of one US carrier. The success was attributed to the breaking of the Japanese signal code by US crypto- analysts and the absence of radar on the Japanese ships. On June 3,1942, aircraft from two Japanese carriers, the *Ryujo,* and *Junyo,* made a diversionary attack on the US bases in the Aleutian Islands and on June 4, an occupation force, comprising four Japanese carriers, *Akagi, Kaga, Hiryu* and *Soryu,* a large number of heavy surface ships and 16 transport vessels with 2,500 occupation troops, launched an attack on Midway, 1500 miles south of the Aleutians. Unknown to the Japanese force commander, two US taskforces, the first comprising the carriers *Enterprise* and *Hornet,* five cruisers and nine destroyers and the second consisting of the carrier *Yorktown,* two cruisers and five destroyers, were assigned the task of defending Midway.

On June4, the Japanese force launcheda strike of lOOaircraftwhilestill 230 miles from Midway, and caused severe damage to the US base, despite a large number of US fighters from Midway intercepting them. Soona strike of 108 aircraft was launched by the two carriers *Enterprise* and *Hornet* but an alteration of course by the Japanese force, on the basis of an intelligence report, saved the Japanese carriers from the air strike. A large number of aircraftof this air strike were forced to ditchas they ran out of fuel, returning to their mother ships. A second strike from the US carriers *Enterprise* and *Yorktown* located the Japanese force but could not cause much damage. A few hours later on the same day,anair strike of 55 aircraft from the *Enterprise* and *Yorktown* caught the Japanese force by surprise and carried out a coordinated attack. As a result of this massive attack, the *Kaga* was set on fire and blew up before sinking, the *Akagi* was set ablaze and later scuttled by Japanese destroyers, and the *Soryu* had an explosion in thehangar, exploded and sank. The *Hiryu,* which had escaped the attack, launched a counterattack on the *Yorktown,* with 24 aircraft, followed, a few hours later, by another strike with 16 aircraft, causing fatal damage to the US carrier. Meanwhile the *Enterprise* and *Hornet* launched a strike against the *Hiryu,* setting the Japanese carrier ablaze; it went down after the entire hulk had been reduced to a smouldering skeleton.

In the Battle of Midway, which was a decisive American victory, Japan lost four carriers, one heavy cruiser, 253 aircraft and 2,300 men, while the US lost one carrier, one destroyer, 147 aircraft and 307 men. This defeat was Japan's first naval defeat since 1592, when the Koreans, in history's first ironclad ships, drove the Japanese fleet from Chinhae Bay. And with the defeat in the Battle of Midway, the Japanese initiative was wrested by the US who, to use the terms used by the Commander-in-Chief, US Fleet, moved forward from the 'defensive-offensive to the 'offensive-defensive'. Admiral CW. Nimitz, Commander-in-Chief of the Pacific Fleet, summed it up thus, "Pearl Harbour has now been partially avenged— Perhaps we will be forgiven if we claim that we are about midway to reducing Japanese sea power to impotence." How right he was!

August 1942 saw another carrier battle, this time in the East Solomons. In an attempt to dislodge Guadalcanal from the US forces, the Japanese deployed the carrier *Ryitjo* to provideair cover to the troop

carriers, with the S/wtafcuandZmM»providingdistantaircover.OnAugust24,anairstrike of 30 aircraft, launched by the *Saratoga,* attacked the *Ryu jo,* scoring several hits, setting her ablaze, and later sinking her. The *Shokaku* and the *Zuikaku* launched anattack on the carriers *Enterprise* and *Wasp* and could causeonly minor damage, but about a week later they were both torpedoed by Japanese submarines forcing the *Enterprise* to retire to Pearl Harbour and causing the *Wasp* to be abandoned and scuttled.

In October 1942 another attempt was made by the Japanese to take the portion of Guadalcanal under US occupation. For this operation they deployed four carriers, the *Shokaku, Suikaku, Junyo* and *Zuiho,* four battle ships, 10 cruisers and 30 destroyers. The opposing American force had two carriers, the *Enterprises* and the *Hornet,* two battleships, nine cruisers, and 20 destroyers. During the indecisive battle that took place off Santa Cruz island on October 26 and 27, the *Hornet* was torpedoed by an air strike from the Junyo and had to be scuttled; and the *Enterprise* suffered some minor damage. Between January 27 and 30, 1943, another battle was fought between these two forces, off Rennel Island, in which the US forces scored a decisive victory and the Japanese finally abandoned Guadalcanal. During the battles for Guadalcanal, the US Navy lost two carriers, eight cruisers, 14 destroyers and 6,000 men, while the Japanese lost one carrier, two battleships, four cruisers, 11 destroyers, six submarines and 900 operational aircraft.

In order to pin Japan down to the sea areas contiguous to the Japanese islands, before enforcing her final surrender, the Allied strategy adopted was to launch a series of air strikes and amphibious assaults to occupy the Central Pacific islands which had now become Japanese bases. The operations for the capture of the islands began in November 1943, when the Japanese bases on Wake Island and Rabaul in New Britain Island were subjected to heavy strafing and bombing, for which a concentration of six fleet carriers and five light fleet carriers with 700 aircraft, six battleships, six cruisers and 21 destroyers (the largest naval task force ever used during World War II), was deployed, causing severe damage and the destruction ofalargenumberofaircraftfromtheSftofaffew,Zw!fcflfew,andZ[/(7zo at Rabaul. OnNovember 18,air strikes on the Gilbert Islands were launched from the carriers *Essex, Bunker Hill* and *Independence,* and on November 24, the Japanese forces surrendered, but not before sinking the escort carrier, the *Liscomb Bay,* and damaging another, the *Independence.* Between December 1943 and February 1944, the Japanese naval base at Kwajalein in the Marshall Archipelago fell to the Allied forces, followed by the Roi and Bambeer islands and the other Japanese pockets in the same group. Truk atoll, a powerful Japanese base in the Caroline Islands, was also annexed, soon after a strike by aircraft from the *Enterprise, Yorktotvn, Essex, Lexington, Intrepid* and several escort carriers. The US task force lost only 25 aircraft and the Intrepid was damaged but the Japanese lost several hundred aircraft, one cruiser, three destroyers and 200,000 tons of merchant shipping, besides a large number of merchant ships damaged.

About this time the British Eastern Fleet at Trincomalee decided to launch an offensive in the Indian Ocean, in conjunction with some US naval units. Accordingly, the British carrier, *Illustrious* and the US carrier,

Saratoga, escorted by several ships, attacked Sabang on the northern tip of Sumatra with a combined strike of 90 aircraft on April 19, 1944 and caught the Japanese by complete surprise, destroying 24 Japanese aircraft and neutralising the Sourabaya Naval Base in Java.

War in the Pacific theatre continued unabated and the American forces continued to score a series of successes. In June 1944, they fought the greatestcarrier battleof the Pacific Warduring the Battleof Marianas for the occupation of three major islands in the Mariana group - Saipan, Guamand Tinian. The American task force for this operation comprised seven large carriers and eight light fleet carriers with about 1,000 aircraft and a large number of support ships while the opposing Japanese First Mobile Fleet had nineaircraft carriers with450aircraft, five battleships, eight cruisers and 18 destroyers. On June 11, a number of air strikes launched by the Allied carriers destroyed 150 Japanese aircraft in Saipan and within four days the US marines occupied the island. On June 19 the Japanese Fleet launched a massive air strike on the US Fleet, the latter countering by launching 200 aircraft to intercept the strike. During the air battle that followed, (the biggest single air battle in history until that time and laterreferred to as "The Marianas Turkey Shoot'), 300 US aircraft continued for several hours to thwart the Japaneseaircraftfromestablishingairsuperiorityandb the end ofthedayhadshotdown243Japaneseaircraftatthecostofonly30aircraft

Earlier in the morning, an American air strike on Guam in the Marianas had been intercepted by Japanese aircraft from the Caroline Islands and in the ensuing battle a large number of Japanese aircraft had been destroyed. The US submarines, which were waiting for a suitable moment to launch an attack, struck. The US submarine, *Albacore* scored one torpedo hit on the Japanese carrier *Taiho* and the *Cavalla* hit the *Shokaku* with three torpedoes. Both carriers soon sank, followed the next day by the third carrier *Hiyo,* which was torpedoed by US aircraft after a fierce air battle, during which 24 Japanese aircraft were shot downat a cost of 20 US aircraft. Having lost three carriers and hundreds of aircraft, the Japanese fleet withdrew, bringing to an end the greatest carrier battle of- the Pacific war.

The greatest naval battle in history involving 282 warships, 30 more than in the Battle of Jutland, were the battles for Leyte Gulf, fought from October 23 to 25,1944. In an effort to cap ture Leyte in the Philippines, before clearing the archipelago and launchingan attack from there on the Japanese islands, 17 carriers from the US Third Fleet carried out massive air strikes on Luzon, Formosa, Okinawa and some other islands on October 10 and destroyed 804 aircraft at the loss of only 48 US aircraft. This was soon followed by the US Sixth Army, led by General MacArthur, landing on Leyte island under air cover provided by 18 aircraft carriers.

In an attempt to dislodge the US foothold in Leyte, the Japanese decided to launch a massive attack with a force comprising four aircraft carriers with 116 aircraft, 9 battleships, 10 cruisers, 31 destroyers and a large number of support ships. The US force deployed in defence was the 7th fleet which also had a seizable force comprising as many as nine fleet carriers, six light fleet carriers and 18 escort carriers. In addition, there

were six battleships and a large number of cruisers and destroyers supported by over 400 transport, cargo and landing ships. The air support was provided by 18 escort carriers with the main strike element, the 3rd Fleet, comprising nine fleet carriers, six light fleet carriers and a number of battleships, cruisers and destroyers.

The Leyte campaign began with the Battle of the Sibuyan Sea on October 23, 1944 when two US submarines sank two Japanese heavy cruisers and damaged a third, off Palwan Island. This was followed by the US carriers torpedoing two Japanese battleships and damaging a heavy cruiser. The Japanese carriers in the region retaliated and sank one US light fleet carrier with 46 aircraft and shot down 28 aircraft.

The Battle of the Sibuyan Sea was followed by the Battle of the Surigai Strait on October 24, when aircraft from two US carriers attacked a Japanese force which was trying to enter the Leyte Gulf via the Surigao Strait, and damaged a battleship and a destroyer. As night fell a US force comprising 39 motor torpedo boats, a squadron of destroyers, eight cruisersand six battleships attacked the Japanese force, as the latter was entering the Surigao Strait. In this battle which saw the last confrontation between battleships, two Japanese battleships and two cruisers were sunk and one heavy cruiserand one destroyerwere damaged. The US forcelosta number of motor torpedo boats and one destroyer was damaged. Later, one more Japanese cruiser was sunk by the US carriers.

la the BattleofSamar fought on October 25,1944,ajapaneseforcewith four battleships and a number of smaller ships attacked a US force of five escort carriers and their escorts, with three other US carriers providing distant support. While three Japanese cruisers were damaged, two US destroyers were sunk and five badly damaged. This was followed by the sinking of the US escort carrier, with three escort carriers suffering damage. Further damage could have been caused to the US force, but for a tactical blunder on the part of the Japanese force commander, which allowed the US force a little breathing time, during which they regrouped themselves and closed in on the Japanese force. In desperation the Japanese started attacking the US carriers with Kflmtaeaircraft,i.e., aircraft carrying heavy bomb loads, diving and crashing on the US ships, causing severe damage, but losing both aircraft and pilot in the process. One US carrier was sunk in this manner by eight *Kamikaze* aircraft.

The last phase of the Battle for the Leyte Gulf was the Battle of Cape Engano, the last carrier versus carrier battle in the Pacific. On October 25, 1944,a Japanese taskforce comprising four carriers, two battleships, three cruisers and eight destroyers approached Cape Engano with the intention of creatingadiversion,so that the ma in Japanese forcecouldattack US ships in the Leyte region. Since the Japanese forces air cover consisted of only 30 aircraft flown by inexperienced pilots, it suffered considerable casualties -three Japanese carriers, including the *Zuikaku* of Pearl Harbour fame, one cruiser and one destroyer were sunk; one carrier and two light cruisers were damaged and the rest of the Japanese force scattered. By the time this battle ended on October 26,1944, the Japanese hadlost four carriers,22other ships and 1,000 aircraft in the battles for the Leyte Gulf. The Japanese Navy had, for all practical purposes, been

neutralised, and consequently had ceased to be a threat to the US Navy.

The last battle that the US Navy fought in the Pacific was against the forces of nature on December 18,1944 when, within the course of a single day, a typhoon sank three destroyers and damaged four light fleet carriers and several other ships. One hundred and forty six aircraft were lost or severely damaged and over 800 sailors were drowned.

The Battle of the Atlantic and the Mediterranean

So far as containing the German forces and assuring an Allied victory in the Atlantic region was concerned, the Battle of the Atlantic assumed greater significance than in other theatres of the War, for an uninterrupted flow of food, munitions and other supplies from the USA was of vital importance to the Allied forces in Europe. The British losses were mounting rapidly -432 ships with a total tonnage of two million had been lost in 1941, followed by another six million tons lost in 1942. The ASDIC, a device developed by the Anti-Submarine Detection and Investigation Committee, for detecting andhunting enemysubmarineshadnotprovedtobeeffective enough,and radarhadjust been invented, but because of its bulk and weightitwasbeing used only on board ships. Soon aircraft began to be fitted with lighter and smaller radars, which considerably increased the detection range, with its much wider area of surveillance and with its ability to detect not only ships and surfaced submarines, but also snorting submarines, i.e., submerged submarines with only their snorts - air inlet pipes - projected above the sea surface. These aircraft covered a large area on both sides of the Atlantic but left a fairly wide gap in the mid-Atlantic, where the submarine continued to reign supreme.

The solution to this problem was sought by arming merchant ships with catapults (this class of ships was referred to by the acronym CAM -Catapult-Armed Merchantmen). It could launch aircraft at sea which, after carrying out surveillance at sea, the pilot either landed at an airfield, if within range, or bailed out at the end of the mission after abandoning the aircraft. These aircraft also provided adequate protection against German long-range bomber aircraft, which had been wreaking havoc on Allied shipping in the Atlantic, by either bombing the ships themselves or by guiding German submarines to these convoys. Between December 1940 and June 1942, four Royal Navy ships, each carrying one Sea Hurricane, were fitted with catapults and deployed. They shot down only one German aircraft but proved to be a fairly effective deterrent at sea. Between May 1941 and August 1943,35 ships were assigned the CAM role and fitted with catapults, each ship carrying one Sea Hurricane; their effectiveness as convoy escorts led to the development of escort carriers, with the specific role of escorting convoys across the seas contiguous to Europe and the Atlantic Ocean.

In July 1941, the Royal Navy commissioned the first escort carrier, *Audacity,wifiha* 460- foot flight-deck with two arrester wires, a crash barrier and a complement of eight Martlet-II aircraft. Within her lifespan of only six months (she was sunk by a U-Boat in December 1941) the *Audacity* aircraft had shot down five

German bombers, damaged four and sighted nine U- boats against the loss of only two aircraft. Escort carriers soon began to be built on merchant ship hulls, the British built four during the War, while the USA built as many as 77 out of which they supplied 38 to Britain. Not only did these carriers escort convoys, provide air cover for shore bombardment and ferry aircraft and other material, they also very effectively carried out hunter-killer operations against German submarines and escorted military convoys to the USSR, sinking 24 U-Boats and shooting down 40 German aircraft in the process.

One of the major operations in the Mediterranean during the war was the supply mission of aircra ft, fuel, ammunition and other stores to Malta, which was being subjected to heavy bombing by German and Italian aircraft until July 1942. A convoy of 14 ships loaded with supplies and escorted by two battleships, seven cruisers, 20 destroyers and four carriers, sailed early in August 1942 and entered the Mediterranean on August 10. A day later, 38 Spitfire aircraft from one of the carriers took off for Malta. Soon one of the carriers was torpedoed and sunk. The other ships of the Allied force continued to be attacked by German and Italian aircraft, U-boats and fast German motor boats known as E-boats (Enemy boats) causing considerable damage. Two cruisers were lost and two carriers which suffered damagehadtowithdraw.OnAugustl3,onlyfive ships of the convoy reached Malta but they succeeded in saving the island from falling into the hands of the Axis powers.

In November 1942, the Allied forces launched an assault on North Africa. A task force of 102 vessels, carrying 35,000 US troops and escorted by four US carriers, sailed for Casablanca and landed the troops on November 10, after neutralising one enemy carrier. British forces landed at Oran and Algiers, with three carriers and three escort carriers of the Royal Navy. During the landing operations, one carrier was sunk and another damaged by torpedoes fired by U-boats.

As 1944 came to an end, carriers continued in their role as the cutting edge of the Allied naval forces. On December 30,13 US carriers put to sea in three groups, for carrying out attacks on Formosa, Okinawa and Luzon in the Philippines, as a prelude to launching landing operations at Luzon, later. The attack on Luzon proved expensive, as several US ships, including six escort carriers, were damaged in *Kamikaze* attacks.

The US forces also sought to establish a base at Iwo Jima, halfway between the Marianas and Tokyo, and launched a landing operation on February 19,1945 after a month-long battle, in which they lost 5,500 men. Oneescortcarrierwas sunk, one damaged and severalother ships were put out of action.

The largest amphibious operation in the Pacific theatre during World War II was the assault on Okinawa, which is halfway between Formosa (now Taiwan) and Japan. It involved 318 combat ships, 1,139 amphibious and auxiliary ships, a few hundred landing craft and 16 carriers. It was launched on March 18, 1945, and the landings began on April 1, after overcoming fierce Japanese resistance, including several *Kamikaze* attacks. Eight US fleet carriers and one escort carrier were damaged, and several other ships were immobilised, but the Japanese defence was eventually neutralised.

Four British armoured carriers took part in the assault on Okinawa and continued to operate till May 25.

One noteworthy feature of British carrier operations was that the armoured flight-decks and armoured hangars of these carriers could withstand the impact of *Kamikaze* attacks, while similar attacks put US carriers out of action. Armouring the vital parts of British carriers had reduced their carrying capacity, but had considerably enhanced their invincibility.

The largest battleship in the world at that time was the Japanese *Yamato,* which had seen action in the Leyte Gulf operations. She sailed on April 6,1945, to carry out an attack on the US forces, off Okinawa, and was escorted by one cruiser and six destroyers. A day later, she was sighted by US carrier aircraft and a massive attack was launched; she was soonhit with 10 torpedoes and five bombs, and sank. With the sinking of the Yamato the Japanese Navy, virtually became emasculated.

Strikes on the Japanese islands continued to be launched from US and British carriers, until Hiroshima and Nagasaki became the targets of US nuclear attacks, killing 150,000 people, and compelling Japan to surrender in August 1945. For six longyears during World War II, aircraft carriers dominated all operations at sea, and it was evident that they would continue to do so for several decades, as the capital ships of all major navies of the world.

When the guns fell silent on August 14, 1945 the US Navy had 34 aircraft carriers and 78 escort carriers in commission or under construction. The Royal Navy had built up its carrier fleet from 7 in 1939, to 62 in 1945, which included 35 escort carriers transferred fromtheUSAbutbyJuly 1946, the carrier wings of both navies had been considerably whittled down; the US Navy was left with only 23 carriers and the Royal Navy with only 16 carriers. At the end of the War, the only Axis 'Aircraft carrier nation', Japan, had nine carriers, besides a few escort carriers. Two of them were assigned the task of repatriatingjapanese troops after the War and by 1946-47 all Japanese carriers, including the ones under construction, had been scrapped.

Post-World War II Developments in Aircraft Carriers

Four important developments took place in carrier operations within thefirst decade of the cessation of hostilities in August 1945 - introduction of jetpropulsionfornavalaircrafttheangleddeck,thesteamcatapultand the mirror landing sight. , , . - , „ , ¦ *¦

Less than a year before the end of the War, a new era in naval aviation was ushered in when a Royal Navy Pilot, Lieutenant Commander E.M. Brown made the first jet landing on an aircraft carrier at sea inhis *Vampire* jet aircraft The aircraft was successfully 'arrested' on the flight-deck of the Roval Navy carrier, *Ocean,* on December 3,1945. And with that began a major evolution in the techniques of launching and recovering aircraft atsea So long as propeller-driven aircraft, with their slower speed, operated from aircraft carriers, the flight-deck used to be roughly divided into two distinct areas - the forward thirdbeing used for parking operational aircraft and launching them with catapults, and the remaining two-thirds for

landing aircraft under the guidance of batsmen; the two areas being divided by a crash barrier which was erected during landing operations. But the advent of the jet age presented two problems - the much higher speed of jet aircraft and the sluggish throttle response of jet engines.

The crash barrier could stop the slower propeller-driven piston-engined aircraft, whenever they missed the arrester wires, without causing any damage to the aircraft, but it caused considerable damage to the much faster jet aircraft. It was Captain D.R.F. Campbell of the Royal Navy who devised a way out of this veritable impasse. He suggested the angling of the flight-deck by only eight to ten degrees to the port sideof the carrier's centre line, and the discontinuation of the use of crash barriers, so that any aircraft that failed to engage the arrester wires, could open their throttle, take off once more and make another attempt to land, while the forward starboard side of the flight-deck could be used for parking and launching aircraft. With this modification the angled deck would enable the carrier to simultaneously launch and recover aircraft, thus reducing their 'turnaround' time and considerably improving the carriers' versatility and operational efficiency. Early in 1952, two carriers, one British and one American, had the angled layout painted on their decks and successfully conducted jet 'roller' (landing and taking off without arresting) operations at sea. The first carrier to be fitted with an angled deck, the *Antietam,* was equipped with a flight-deck angled at 8 degrees to the port, and was soon followed*byCentaur*of theRoyalNavy.Withthesuccessof thisnew design, the angled deck became the permanent feature of aircraft carriers around the globe.

The launching speed of a propeller-driven aircraft was slow enough to be built up by a combination of wind speed, the speed of the carrier and the acceleration that the aircraft's engine could produce while moving

forward on the flight-deck with full throttle, but with the advent of the jet age, entailing higher take-off speed and sluggish engine response, that was no longer possible. A platform, therefore, had to be devised for launching the aircraft into the air, after building up the air speed required for the aircraft to be airborne, with the support of the ship's speed and the prevailing wind. Once again it was an officer of the Royal Navy, Commander C.C Mitchell, who developed the steam catapult which, when fitted at the forward starboard end of the flight-deck, could accelerate the aircraft to the launching speed within a distance of about 100 feet. Soon the steam catapult was also to become standard equipment on aircraft carriers around the globe.

The fourth development that found universal adoption by all navies vvas the landing device, knowna s the mirror landingsightwhich, yet again, was the invention of an officer of the Royal Navy, Commander H.C.N. Goodhart. The propeller-drivenpiston-engined aircraft had a slower landing speed and, therefore, could approach the flight-deck at a steep descending angle, at a speed very close to its stalling speed, and when in position over the landing site, could cut the engine and touch down comfortably. But the jet aircraft, with its higher speed, had to make a much flatter and more precise approach and could cut the engine only after the aircraft was arrested. This rendered the landing of a jet aircraft on the flight-deck of a

carrier, especially during night operations and in adverse weather conditions, considerably hazardous. The mirror landing sight came as a boon to the naval jet pilots of the 1950s. This device consisted of an oblong concave mirror fitted on the port side of the flight-deck which reflected a few white lights positioned on the ship's stern. On the side of the mirror were fitted some green datum lights. While approaching the flight-deckforlanding, the pilot had to keep the white lights aligned with the greenlights to ensure that he was on the right glide path and that the altitude of the aircraft was correct. The mirror angle was adjusted for different types of aircraft and it had an airspeed indicator which produced an audible note in the cockpit, to indicate the speed of the aircraft. In order to neutralise the effects of the carrier's roll and pitch, the mirror was stabilised.

Jet-propelled carrier aircraft were used in combat for the first time during the Korean War. On July 3, 1950, aircraft from two US carriers attacked the North Korean capital, Pyongyang, and destroyed 11 aircraft and several runways and fuel dumps. They also kept at bay, the North Korean aircraft, of Chinese andRussianorigin, all of which were propeller-driven and hence much slower; thus, they encountered virtually no opposition in the air. A few days later, these carrier aircraft attacked and destroyed a number of North Korean refineries, airfields, railway tracks and industrial installations. Three more carriers soon joined the strike force and continued to strafe and bomb vital installations. Prior to General Mac Arthur's amphibious assault on Inchon on September 15,1950, aircraft from six US carriers escortinga 280-ship assault force carried out softening-up operations. The US troops continued to move northward, with the carrier force supplementing the US Air Force air support, and on October 19, US forces occupied Pyongyang. Carrier aircraft continued to pound Chinese forces across the Yalu river, and in November started bombing Chinese troops whose strength in the area had by now gone up to 250,000.

Soon, however, the US forces had to withdraw against stiff opposition from the overwhelming Chinese forces. In April 1951, in orderto thwart the Chinese attack, the US forces decided to flood a large number of South Korean Rivers fed from the Howchon reservoir. This task was effectively carried out by Skyraider aircraft from a US carrier, as the 'dam busters' succeeded in bursting the reservoir dam and inundating a large area. Throughout the Korean War, which finally ended on July 27,1953, aircraft carriers continued to play a significant role in neutralising North Korean aircraft, ships and shore targets.

During the Suez War in 1956, the British deployed five carriers with an aircraft strength of 166 fixed-wing aircraft and helicopters. On October 31, 1956,40 aircraft from the carriers launched an attack on Egyptian MIG and IL-28 aircraft. On November 6, paratroopers were dropped by helicopters from a helicopter carrier, with air support provided by carrier aircraft, the first vertical assault in the history of naval aviation. With effective air cover provided by these aircraft, the British and French forces continued to advance rapidly but the operations were halted on November 6 at the insistence of the United Nations.

Vietnam too saw extensive use of carriers. When the French left the area early in the 1950s, the Americans

moved in and brought with them a large number of helicopters on board two carriers. In August 1964, North Vietnamese motor torpedo boats attempted a torpedo attack on a US destroyer and in retaliation, four aircraft from a US carrier, strafed and damaged the motor torpedo boa ts. Soon massive opera tions were launched against North Vietnamese ships and naval bases by US carriers, and 25 motor torpedo boats were destroyed or put out of action and their naval bases damaged. Before long three more carriers joined the fray. In retaliation for a massive Viet Cong attack on US fuel clumps, airstrips and personnel, a number of aircraft from three US carriers bombed a large military base of North Vietnam. Within a few months three more US carriers joined in and continued operations till the end of 1965, when they were replaced by the nuclear-powered carrier *Enterprise.* By January 1966, the US carriers had flown a total of 238,000 sorties, nearly ten times the number of sorties flown during the Korean War. In June 1966, there was further escalationin the War and US carriers continued to operate their Phantom fighters, shooting down MIG 21s with sidewinder missiles. The intensity of the War thereafter went down, especially after President Nixon withdrew nearly 500,000 US troops from the area by 1970. In November 1970 operations were again stepped up and two US carriers carried out strikes against North Vietnam. In 1972 another carrier launched operations in the area, staging attacks against Viet Cong aircraft in the Haiphong area and mining North Vietnamese harbours; it was soon joined by three more carriers. The war continued for another year and a peace treaty was signed finally in January 1973.

The Global'CarrierClub'

Before World War II only four countries - Britain, France, Japan and the US - had acquired carriers for their navies. By the end of the War, Japan had ceased to be a member of the 'Carrier Club' but during the years following, several other countries realised the importanceof what is known as 'integral air' at sea and have acquired air arms for their navies.

Out of the fourteen carriers that the Royal Navy had at the endof World War II, only eight - one fleet class, two light fleet class, four escort class and one maintenance carrier -were retained and the rest were scrapped. During the period from 1954 to 1955 three new 27,800-ton carriers joined the British fleet, besides the existing carriers. In 1957, the four escort carriers were scrapped and in 1960 and 1962, two carriers were converted into Commando carriers. On February 8,1963 the first vertical take off and landing aircraft (VTOL), the *Hawker P-1127,* which was to later develop into the *Sea Harrier,* made a vertical landing on the *Ark Royal,* the first such landing on a carrier. And with that the concept of 'through-deck cruisers', the new nomenclature for aircraft carriers without catapults or arrester gears, and designed to operate antisubmarine helicopters and vertical and short take off and landing aircraft, was formalised.

The US Navy scrapped most of the carriers of World War II vintage and started a massive programme

of building nuclear-powered aircraft carriers, beginning with the 75,700-ton Enterprise which commissioned in 1961. Conventional carriers of 70,000 tons displacement continued to be built and the US Navy continued to be the prime aircraft carrier nation of the world.

In 1945, France had only one aircraft carrier which was soon relegated to the status of a barracks ship. In 1945 and 1946 France acquired an escort carrier and a light fleet carrier from Britain, and in 1951 obtained two light fleet carriers on loan from the US Navy. The French built two 22,000-ton carriers in 1961 and 1963, and returned the American carriers to the US Navy.

The Soviets had no carriers during World War II and were firm detractors of the carrier concept for many years thereafter, but by the 1960s they too started thinking in terms of adding the third dimension to their navy and began the construction of two 'large antisubmarine cruisers', as they were described by the Russian planners, which were a cross between missile cruisers and helicopter carriers. The first of these was commissioned in 1967 and the second in 1969.

The Canadian Navy acquired a carrier on loan from Britain in 1946 and this was soon replaced by another carrier in 1948. In 1952 a light fleet carrier was acquired from Britain and the carrier loaned earlier, returned. The new carrier was soon equipped with an angled deck and steam catapult and commissioned as a full-fledged modern carrier in 1957.

During World War II the Australian Navy operated catapult-launched aircraft from its cruisers. A British light fleet carrier was acquired in 1948 to be followed by another in 1955.

A British escort carrier was acquired on loan by the Netherlands in 1946 and operated till 1948 when she was replaced by another light fleet carrier. Between 1955 and 1958 she was equipped with an angled deck, steam catapult and mirror landing sight, and continued to operate till 1968, when she was transferred to Argentina. This carrier underwent extensive refit in the Netherlands and joined the Argentine Navy in 1969 as the sister ship of a light fleet carrier which had been obtained from Britain in 1958. The first aircraft carrier nation in South America was Brazil which had acquired a British light fleet carrier in 1956. This carrier was earlier being operated by the Australian Navy and was commissioned into the Brazilian Navy in 1960, after extensive modernisation.

Spain's lone carrier, a light fleet carrier from the USA, was acquired in 1947 and was soon converted into an antisubmarine carrier.

Italy did not acquire any carrier during this period but in 1964 commissioned two cruisers which carried four helicopters each.

As is well-known, the first post-World War II aircraft carrier nation in Asia, India, acquired her first carrier, *Vikrant,* in 1961.