



Imminent controlled crash landing for a French Navy Rafale

Carrier Ops

The nuclear-powered *Charles de Gaulle* is operating from the Indian Ocean some thousand nautical miles (1800 kilometres) from the battlefield, hardly the traditional view of littoral operations, which are usually perceived as taking place off coasts or, perhaps, over continental shelves. The aircraft carrier is an incredibly versatile platform and in the past two decades has participated in high- and low-intensity operations, operations short-of-war and humanitarian missions.

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The presence of a carrier can send a diplomatic signal: the arrival of the *USS John C. Stennis* was widely perceived as underlining Washington's willingness to take military action against Iran over its nuclear activities, but it appears that its deployment had more in common with the *Charles de Gaulle* in support of Nato operations in Afghanistan.

France's deployment of Dassault Rafale F1/F2 fighters (the latter with improved ground-attack capabilities) from the DCNS-built aircraft carrier illustrates an aspect of littoral warfare which is not generally appreciated, especially with the modern surface capital ship.

Navies recognise the value of aircraft carriers; not just to operate aircraft but as command platforms able to exploit on-board and off-board sensors to co-ordinate operations over a wide area. The United States intends to maintain a force of about a dozen, the United Kingdom intends to build two, France will build a second carrier while China is talking of building carriers and is believed to be returning a former Russian ship to operational service. India may extend the life of its former British ship *INS Viraat*, it has purchased the former Russian carrier *Admiral Gorshkov* that is being updated

and is building its own ship, the Indigenous Aircraft Carrier (formerly Air Defence Ship) or IAC. However, the deterioration of the Russian ship means that refurbishment is taking longer than anticipated and there are reports it will not be delivered by August 2008 as planned but at least a year later.

What's In a Name?

Defining an aircraft carrier is not as easy as it might seem. After reducing a Japanese carrier to a blazing hulk an American aviator radioed: «Scratch one flat-top!» But a 'flat-top' is no longer an aircraft carrier, indeed Japan's *IHI Marine*, laid down in May 2006, a 18,000-tonne ship with a flight deck along its whole 197-metre length and a superstructure ('island') offset to starboard, is officially described as a 'future destroyer.' The British *Invincible* class aircraft carriers were officially described as 'through-deck cruisers' for many years while most carriers of the Soviet Navy were described as 'aircraft carrying cruisers.' In addition, there are amphibious assault ships very similar to Japan's future destroyer and, like them, are intended to operate only rotary-wing aircraft, and ironically the *HMS Ark Royal* has now reverted to a similar function.

Aircraft carriers are designed primarily to operate fixed-wing aircraft which

are usually augmented by a rotary-wing complement. The aircraft are stored and maintained in hangers below the flight deck where they can also be refuelled and re-armed. When required the aircraft are moved onto lifts which carry them to the flight deck where they are launched.

There are two types of fixed-wing aircraft for carrier use, Conventional Take-Off and Landing (Ctol) and Short Take-Off, Vertical Landing (Stovl) and each has its advantages. Conventional aircraft have longer ranges and can carry larger amounts of ordnance, but require a catapult to launch and this restricts the number of sorties to about 50 per day. Angled flight decks allow for more catapult installations and for simultaneous landings but the aircraft require an arrestor system of shipborne lines with an aircraft tail hook to restrict movement once landed, and these 'controlled crashes' reduce airframe life.

Stovl aircraft also require assistance to take-off. In theory they are capable of taking-off and landing vertically but they have limited range and load-carrying ability and take-off has to be made by flying up a vertically-angled section of the flight deck or a more sharply inclined 'ski jump' to provide adequate lift, although they are able to operate off amphibious assault ships. With no need to reset catapults after each launch a higher sortie rate of some 70 a day is generated and, because the aircraft can land vertically, they usually fly alongside the ship and then move across the flight deck to the landing spot, therefore do not require either an arrestor system nor an angled flight deck.

Carriers range from the Navantia-built Thai *HTMS Chakri Naruebet*, which displaces 11,485 tonnes and is 182 metres



A composite picture of Spain's two carriers as they will appear at the beginning of the next decade. On the left is the Principe de Asturias and on the right the Juan Carlos I, which is actually a helicopter carrier rather than an aircraft carrier. (Navantia)

long, to the US Navy's mighty Nimitz class whose later vessels have a displacement of 102,000 tonnes, are 317 metres long and built by Newport News. The larger the ship the larger the air group, but air group size is also shaped by the problem of congestion on the flight deck. Spain's SPS *Principe de Asturias* can theoretically embark up to 29 aircraft, of which a dozen (possibly even 20) would have to remain on deck exposed to the elements. But, in these circumstances, moving aircraft to and from the hanger would be extremely difficult, severely restricting sortie levels, so the carrier typically has an air group of up to ten Harrier Stovl aircraft and up to nine helicopters.

The Royal Navy has the largest Stovl carriers, the 20,600-tonne *Invincibles*, which carry a typical air group of some 24 aircraft. These were originally mixed-role

Harrier FRS with a radar for air-to-air operations, but these have been withdrawn and area air defence is increasingly left to anti-air warfare destroyers or land-based aircraft. All the Harriers are now dedicated to ground support missions and carry a variety of air-to-surface and air-to-air ordnance augmented by pods for reconnaissance or to support 'smart' munitions. The fixed-wing aircraft are augmented by Merlin HM Mk 1 anti-submarine helicopters, which can also be used in the anti-surface warfare role with Skua air-to-surface missiles, and by Sea King Asac Mk 7 airborne surveillance and control aircraft, which help extend the radar range.

Similar air groups are to be found in Fincantieri's *Giuseppe Garibaldi*, Navantia's *Principe de Asturias* and Thailand's carrier, as well as the *INS Viraat*, although

the latter is a converted Ctol ship. India's new generation of carriers will revert to Ctol but will follow the Russian Short Take-Off and Barrier Assisted Recovery (Stobar) philosophy, which does not use catapults but an angled deck to provide 'lift'. The Russian Navy's sole carrier, the 58,500-tonne *Admiral Kuznetsov*, operates 18 Sukhoi Su-33 'Flanker D' air defence fighters and four Su-25 'Frogfoot' ground attack aircraft augmented by 15 Kamov Ka-27 'Helix' anti-submarine and two Ka-31 'Helix' airborne early warning aircraft. The Indian ship will operate twelve MiG-29 mixed role aircraft and half-a-dozen 'Helix' and, like the *Admiral Kuznetsov*, will feature an angled flight deck with arrestor wires to recover the fixed-wing aircraft. The 37,500-tonne IAC will adopt the same philosophy but will have double the helicopter complement.

Stovl aircraft can operate from amphibious assault ships and it is interesting to note that in augmenting their conventional carriers both Italy, with the *Cavour*, and Spain, with the *Juan Carlos I*, are combining the roles. Both ships have a displacement in excess of 27,000 tonnes, incorporate an angled deck or 'ski jump' to launch fixed-wing aircraft but are predominantly helicopter carriers designed to land expeditionary forces with armour; indeed the Spanish ship will be a landing platform dock with four landing craft. She will be able to embark only a dozen aircraft but the Italian ship will embark about 20 aircraft.

The majority of Stovl ships are powered by gas turbines, while most Ctol ships are nuclear powered. France's *Charles de Gaulle* is a 42,000-tonne ship which can carry a dozen Rafales, a couple of E-2C Hawkeye airborne early warning and command aircraft together with some helicopters for search-and-rescue. For anti-submarine protection these ships rely upon anti-submarine warfare destroyers or frigates.

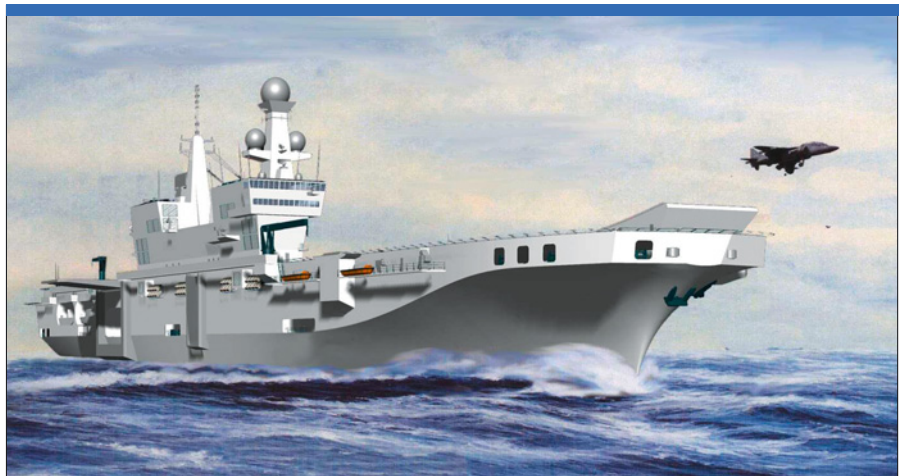


Models of the new European carriers for which contracts are eagerly anticipated. On the left is the British CVF and on the right is the French PA 2. (Armada/EHB)



The very latest version of the Hawkeye, the E-2D was rolled out on 30 April 2007. On 9 July 2007, Northrop Grumman received a \$ 408 million contract for pilot production. The aircraft should have made its maiden flight by the time these lines are printed. (Northrop Grumman)

The US Navy has been able to raise its sortie rates through re-structuring the air wing in the mid 1990s, aided by a change in doctrine allowing the ships to approach closer to the coast because of the improved efficiency of the anti-air warfare escort vessels and reduced combat air patrols. A typical air group consists of 48 F/A-18 Hornet multi-role strike fighters, four Hawkeyes, four EA-6B prowler electronic warfare aircraft and up to nine Seahawk helicopters used primarily for anti-submarine warfare but increasingly configured as the multi-role MH-60R; capable also of search-and-rescue as well as anti-surface warfare. The fixed-wing aircraft can be launched at the rate of one every 20 seconds but the size of the air group means only half can be accommodated in the hangers.



The Italian Navy Cavour in the artist impression seen here and the Spanish Juan Carlos I both have a displacement of more than 27,000 tonnes. (Fincantieri)



The 700-tonne 'island' as it was being carried onto the last of the Nimitz class carriers, the USS George H.W. Bush, on 8 July 2006. (Newport News)

The US Navy is using the last of the Nimitz class, the USS *George H.W. Bush* (CVN 77) as an evolutionary stepping-stone to the next generation of carriers known generically as CVN-21, of which the first will be the USS *Gerald Ford* (CVN 78). The former is to be commissioned in April 2008 and the latter in 2015 with her sister ship following in 2019. With the commissioning of the USS *George H.W. Bush* the last fossil-fuelled carrier in the US Navy, the 47-year-old USS *Kitty Hawk* (CV 63), will be paid off.

The last of the Nimitz class will feature a bulbous bow design to improve hull efficiency and reduce drag, an idea incorporated in her predecessor the USS *Ronald Reagan* (CVN 76), and a smaller 'island' with integrated arrays. This will reduce electronic interference between emitters and the ship's overall superstructure as well as providing more flight deck space.

The flight deck will also be re-organised to provide mini service centres, known as 'pit stops', on the outside edges for routine maintenance together with semi-automated refuelling and re-arming. This will be aided by improved ordnance loading systems, which will dimin-

ish the need to strike down the aircraft to hangers except for major repairs.

These changes will help generate an increase in sortie rates with a target of 20% more than was possible with the earlier Nimitz class. An electro-magnetic catapult and a new jet blast deflector system will aid this process, the latter replacing water-cooled systems with one incorporating heat-dissipating ceramic tiles, similar to those used on the space shuttle. The reduction in costs is a major consideration in new carrier design and features include re-arranging internal spaces, the introduction of condition-based maintenance systems including zonal electrical distribution systems which will make isolating problems easier. There will be greater automation in material movement as well as damage control, which will also help reduce both crew and costs.

CVN 21 will take this process further and will incorporate the dual-band



CVN 78 will be the first of the CVN 21 new generation US Navy carriers. It will be named after former President Gerald Ford. The most noticeable feature is the greatly reduced size of the island. (Newport News)

been adapted by the French to meet their Ctol PA 2 requirement. This will operate up to 32 Rafales, three Northrop Grumman Hawkeyes and five NH Industries NH 90 helicopters.

It had been hoped to begin these carrier programmes this year but there have been problems agreeing on budgets. An added complication in the United Kingdom is the Government's determination to see the naval construction industry rationalised before authorising CVF to proceed and with the French desperate to have begun before the presidential elections in May there was the distinct possibility that Paris would sail alone leaving London to catch up as, and when, it could.

It now appears that a Main Gate decision (production approval) will be made some time this year either in the summer (after rationalisation of the warship building industry) or in the late autumn (following a treasury financial review). The Royal Navy wants the first of its carriers, reportedly named the *Queen Elizabeth*, to be commissioned in 2013 and her sister ship in 2016 to replace the *Invincibles*. Paris wants the PA 2 to be commissioned in 2014 to augment the *Charles de Gaulle*.

Aircraft carriers to date have operated only manned aircraft but the prospect exists not only of them operating unmanned aerial vehicles (UAV) for reconnaissance but even of unmanned combat air vehicles (Ucav). Unmanned aircraft obviously offer considerable advantages in that they may be despatched to high-risk environments in order to reduce aircrew exposure but the distaff side is now becoming more apparent. Command and control remains a major issue, especially for Ucavs, and the ability of unmanned aircraft to survive long enough to complete their missions in a hostile environment of surface-to-air weapons and aerial opponents remains unproven. □

AN/SPY-3 radar scheduled for the Zumwalt (DDG 1000) class destroyers. The traditional steam catapult, which has created corrosion problems and been relatively slow, will be replaced by electromagnetic units, there will be three rather than four lifts and an advanced weapon elevator. The new carrier, the first of which will be laid down next year, will feature an integrated warfare system, new arrestor gear and a new nuclear power plant which, with new electrical generation and distribution systems, will see a 250 to 300% increase in the amount of electrical power generated compared with the Nimitz class. This will help in the distributed architecture computer system for the ship and, in the long term, may make possible the provision of directed energy weapons and some form of shield for protection.

Compared with the 4660-strong crew of the Nimitz class it is hoped to reduce the CVN 21 complement by 500 to 900 people and to increase sortie levels by 25%. The flexible, open architecture system will allow the command centre to support multiple missions simultaneously and this would not be confined to the traditional sword and shield operations but through network centric systems and would also include joint/coalition operations as well as special forces missions.

Some of the philosophies employed in the USS *George H.W. Bush* and the USS *Gerald Ford* will also be used in the major European carrier project known as the Future Aircraft Carrier (CVF) and Porte-Avions 2 (PA 2). While influenced by the United States, CVF/PA 2 will be a British design with integrated full electrical propulsion based upon gas turbine alternators and diesel generators. It will incorporate the 'pit stop' concept but flight deck space has been increased by creating two

mini-islands on the starboard side with one of the two deck-edge lifts in between. But most noticeably it will feature two small islands to improve airflow over the flight deck and ease air operations.

The CVF will be a 65,000-tonne Stovl design carrying up to 40 aircraft based upon the Joint Combat Aircraft or F-35 Lightning II, of which there will usually be about 30 augmented by six Merlin anti-submarine helicopters and four rotary-wing Maritime Airborne Surveillance & Control aircraft. It will feature a 'ski jump' but it can be adapted in the future to accept catapults and an arrestor system, which means that the design has



The nuclear-powered carrier Charles de Gaulle is a unique European ship, but its running costs mean that the new PA 2 carrier will have conventional propulsion. (DCNS)