



**ROYAL  
AERONAUTICAL  
SOCIETY**  
Loughborough Branch

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5th Elfyn Richards Lecture  
**QE Class Aircraft Carrier  
– Flagship of the Future**  
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Defence Equipment and Support

In recent years the Branch programme has included a presentation about airports: this proved to be partially comparable - but so different too. In stages that carried information seamlessly through several stages we were delivered much about the specification, evolution and commissioning of a new and very unique breed of aircraft carrier.

It was inevitable to start with a glance back in time – a comment that some 57 aircraft carriers were in the Royal Navy in 1945 was connected to the fact that we have had none for a decade or so, and will have only two when the new class is fully commissioned. However, this was an introduction to more than the simple numbers that the press use often ignominiously. It proved to be a declaration of the breadth and depth of what is involved in specifying the role of such a new capability, and carried us through the processes involved in creating, constructing and commissioning the fleet, its systems, and its complement of air-vehicles.

Formal record of work commencing on the specification of the new class was some 20 years ago. We learned that configurations from 30,000 tonnes to over double that size were assessed, and it was a 65,000 tonnes concept that became the focus of design studies. In simple figures it is 280m (918ft) long, and has a maximum deck width of 73m (239ft). The waterline beam is much less than the deck width (but still considerable – 39m (128ft) - and the significance of that was made when it was shown that during construction there was only 20cm (8ins) of lateral leeway between the bilge keels and dock walls. Draught is around 10m (33ft) – and that we were informed led to a 3.5million ton dredging operation in Portsmouth Harbour and the dock area.

The deck overhangs the hull and uses side-mounted lifts between the hangars and deck (Royal Navy carriers of the past used centreline lifts). We were talked through a number of potential deck layouts, and the prevarications that took many a headline a decade or so ago, when the prime aircraft type was specified, then changed in a cost-cutting exercise - then changed back to the original aircraft. The eventual configuration was not to be an angle-deck with catapults (as has been used on all preceding Royal Navy carriers of high-performance aircraft), but to be a straight deck, without catapults. It still incorporates the ski-jump foredeck, introduced on Invincible Class carriers, a concept that arose from Sea Harrier operations as it allows a short-take-off and landing (STOVL) aircraft to carry an enhanced payload. With the new generation STOVL (the F35B Lightning) a high-temperature exhaust is inevitable during the landing, and the deck has to be protected with heat-resistant skin that includes aluminium and titanium particles. Trials have been taking place in recent weeks, and will continue, with aircraft operations.

The ship's most distinctive physical feature is the double superstructure on the flight deck: the fore dedicated to all aspects of the maritime operations, and the aft being the aviation-related control centre. These are built as modules and provide segregation of the teams, although clearly they do have to be coordinated.

The whole ship is based on modular construction. In 2007 the Aircraft Carrier Alliance (ACA) had been awarded the contract to build the two carriers. The consortium comprises BAE Systems, Thales, MoD (Ministry of Defence) and Babcock and they arranged that the build work would take place at Appledore, Birkenhead, Govan, Portsmouth, Rosyth and Tyne, with components taken by barge to Rosyth where the final assembly took place.



HMS Queen Elizabeth

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Although first sight might suggest it is just another large aircraft carrier, the internal configuration is not so conventional, and much of this has been possible by harnessing opportunities that reflect 21<sup>st</sup> Century technology. A traditional engine room is no longer necessary. The carrier has a hybrid propulsion system with two Rolls-Royce Marine Trent MT30 36 MW (48,000 hp) gas turbine generator units and four Wärtsilä diesel generator sets (two 9 MW or 12,000 hp and two 11 MW or 15,000 hp). The six sources feed power through high (11KV) voltage cabling to four GE Power Conversion's 20 MW Advanced Induction Motor (two per shaft) electric propulsion unit that drive the twin 5-blade fixed-pitch (each 33-tonne) propellers. The propellers are effective when rotated forward or in reverse.

Another unique feature is the 'Highly Mechanised Weapon Handling System' (HMWHS) that is an on-board logistics system with all the technology of a modern mechanised warehouse, but in this case the goods involved are ordnance – conveying between magazine and operational posts the armament for vessel-protection and for carriage by aircraft. This synthesis of technology and operations requires a crew (almost 700) - more akin to that of a much smaller vessel – and there is room allocated for the carriage of over 900 other personnel when the carrier is used to support land-based operations.

The selection of the Lockheed-Martin F35B (STOVL capable), around 2007, was crucial to the design, but some expansion of the programme timescale was inevitable when the change of government in 2010 led to the F35C, a conventional take-off/landing (CTOL) variant, and then the reversion to the STOVL F35B. It was 2012 before the Royal Navy was allowed to designate the F35B. Even so, work had begun on construction of the aircraft carriers in 2008, but changes were largely in deck-related zones and there was little impact on the programme overall. By 2014 the first example 'HMS Queen Elizabeth' was already a recognisable assembly at Rosyth and the naming ceremony took place on the 4th July. There was still a substantial amount of fitting-out. The carrier conducted trials on the way to Portsmouth, arriving on 16 August 2017, and was commissioned on 7 Dec 2017. Initial operational trials have been underway and at the time of the presentation, trials using the F35B had commenced. The target for full entry to service is 2019-20. The second example 'HMS Prince of Wales' is following a similar programme about two years after the sister ship. Delivery of F35B aircraft is expected to pass 24 examples (12 per ship) by 2024.

The prime role takes top place in a description, but the speaker also highlighted the diversity of the aircraft that will complement the nominal fleet of 36 F35Bs, with specialist rotary-wing based support. These will include:

- Merlin (Leonardo AW101) – this helicopter can carry up to 24 troops into battle zones, or provide medical-support, with up to 16 stretcher patient. An anti-submarine variant can operate more locally and dip or dispense sonar equipment to support defensive duties. Up to 9 Merlins will be assigned to each carrier.
- Wildcat (Leonardo AW159) is a Lynx-derivative that will provide support to the larger Merlin, and performing a similar range of roles.
- Crowsnest was mentioned, and this is a bolt-on sensor package that can be carried by any Merlin. The pod is based on the Sea King's Searchwater 2000 radar, already used by the Royal Navy, and will provide airborne early warning and control. Five Merlins with this system are planned to be on each carrier.
- Chinook and Apache can use the ship as a base in joint operations.

Overall, the full complement of therefore 26-36 fixed-wing, and a rotary-wing fleet of 4 -14 Merlin/Crowsnest and additional Wildcat helicopters.

This wide-ranging presentation raised a host of questions from the audience, ranging from asking why it wasn't nuclear-powered? ... what support fleet was expected when in combat operations? ... why such simple (non-variable pitch) propellers were used? ... and what was the cost of operating the fleet? Pro and cons expressed, without embellishment, these were admirably answered, and the session overall was well received, with no qualms about an essentially maritime project having been the centre of attention to an aviation-orientated audience of about 180 who felt they had learned and benefitted greatly from the evening's session.

*Lecture notes by Mike Hirst*