SIXTH EUROPEAN ROTORCRAFT AND POWERED LIFT AIRCRAFT FORUM

Paper 1

OPENING ADDRESS

by

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ABSTRACT

The Admiral reviews the impact of the rotorcraft on Naval operations from its adoption during the latter stages of World War II. He describes the developing roles of the helicopter and, following the demise of the large aircraft carrier, the emergence of VSTOL.

The address concludes with some views on development needs for the future.

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INTRODUCTION

1. Chairman, Ladies and Gentlemen, I am honoured to be asked to give the opening keynote address to this important assembly. I am, however, well aware that your invitation is not due to your finding anything particularly attractive in the sound of my voice but rather because you appreciate the role the Royal Navy has played and is playing in developing the use of helicopters and VSTOL aircraft at sea.

2. The Royal Navy has been in the forefront of maritime helicopter activity for many years, and much of what we have learnt from experience is now applied, not only in other navies, but also in the rapidly expanding employment of helicopters in connection with off-shore oil, rescue at sea, coastguard and sea-lane patrols. Maritime commercial helicopter operations will continue to expand as the resources of the oceans and the minerals beneath them are progressively exploited. Maritime use of VSTOL is just starting but again the Royal Navy is in the forefront.

3. Much of what I am going to say is already known to many of you. So please expect no startling revelations. I am engaged more in reminding us all of how the situation has developed so far, what it is today, and a look into what the future may hold. I shall deal separately with rotorcraft and with VSTOL aircraft because their uses have many differences at the present time. It is worth remembering, though, that whereas the maritime use of helicopters is some 40 years old, that of VSTOL is, as I have said, in its infancy and there could well be a greater encroachment on traditional maritime rotorcraft roles by VSTOL aircraft as naval experience with them grows.

NAVAL HELICOPTER HISTORY

4. The first step in the Royal Navy's use of helicopters occurred in the early 1940s during World War II. The Board of Admiralty had recognised their likely potential and saw advantage in encouraging a similar interest in the United States Navy. A trial and demonstration were set up in 1942 in a British merchant ship, the Empire Mersey, fitted with a landing platform. A Pitcairn PA 39 helicopter carried out successful landings and take-offs. Among those witnessing the trials was a man named Igor Sikorsky.

5. Helicopters were seen as having convoy protection possibilities and 24 Sikorsky R4's, then coming into production, were ordered for the British Services and 50 for the United States. Further trials took place and, for the first time operationally, two R4's were embarked in another British merchant ship, the Dagheston. The R4's weather limitations soon became apparent and the United Kingdom and the United States came to the joint conclusion that the helicopter had no use as an anti-submarine weapon; but they added the important rider that development should continue. The Royal Navy kept its R4's but cancelled an order that had been placed for R5's.

6. After World War II, in 1947, the Board of Admiralty approved the formation of 705 Squadron with a complement of 7 Sikorsky Hoverflies, at Gosport aerodrome near Portsmouth. The squadron duties were to train pilots, aircrewmen and maintainers, evaluate new equipment, develop new techniques, provide helicopters for special

trials and also to provide helicopters for the Fleet, without any particular fleet roles being specified. All this with 7 Hoverflies. The main activity during the first two years was in fact to keep the Hoverflies flying but in 1949 the Westland Sikorsky Dragonfly appeared and started to replace the Hoverfly.

SEARCH AND RESCUE (SAR) AND CASUALTY EVACUATION

7. The following two years saw 705 Squadron responding to many emergency calls, including a search in the Channel for the missing submarine AFFRAY, and in 1951 the Admiralty announced that the Royal Navy was adopting the helicopter for air sea rescue and for communication between ships. So, just under 30 years ago we had our first official roles for naval helicopters. The Search and Rescue role quickly bore fruit. The Korean war was upon us and a helicopter unit in HMS GLORY rapidly proved its worth in plucking downed aircrew, not only from the sea, but also from enemy territory. During the Korean war a staggering 25,000 wounded were evacuated by helicopter forces. Thus the Casualty Evacuation role, as well as the SAR role, became firmly established. The Royal Navy, however, receives no royalties from the long running television series "M.A.S.H."

COMMANDO ROLE

8. In August 1952 the new S55 Whirlwind began to arrive in 705 Squadron and a second squadron also was formed two months later. Because the Army and Royal Air Force had at that time too few helicopters and these mainly of old types, the new naval squadron, to be known as 848 Squadron, was to serve ashore in the then Malaya in support of the security forces campaign against communist terrorists. So, in January 1953, Royal Naval Helicopters attained the additional role of troop carriers. The experience gained in these activities convinced the Naval Staff that helicopters could provide flexibility and mobility in amphibious operations. Three years later, at the Suez landing in 1956, the Royal Navy first used helicopters in the tactical assault role, putting ashore 415 Royal Marine Commandos and 23 tons of stores in 90 minutes from two light fleet carriers, an achievement which it would be difficult to better, even today.

ANTI-SUBMARINE WARFARE (ASW)

9. Meanwhile, in 1953, another development was taking place. From World War II experience it was known that convoys, with aircraft overhead, had remained virtually free from submarine attack. Submarines were forced to submerge and, in those days, their low underwater speed enabled the convoy to move or stay beyond torpedo range. The Whirlwind helicopter could undertake this role as effectively as had fixed wing aircraft and did not need an aircraft carrier from which to operate.

10. In addition to flying over the convoy to keep submarines down, the helicopter could detect submarines by hovering and lowering an active sonar transducer into the water. It could also attack with depth charges. If a large enough number of helicopters were available they could provide a complete screen around a convoy. Escort carriers were then needed to provide support, maintenance, command and control facilities. This reasoning led to the first anti-submarine helicopter squadron being formed towards the end of 1953.

SURVEY ROLE

11. The next year, in 1954, an S51 Hiller helicopter was embarked for the first time in a survey ship to assist in charting and particularly in landing survey teams in otherwise inaccessible positions. This work rapidly became established and for over a quarter of a century helicopters have been embarked in survey ships, notably for the annual Antarctic survey season in HMS ENDURANCE and her predecessor HMS PROTECTOR. A particular task for the helicopter in the survey ship HMS VIDAL, was the annexation in 1955 of the aptly named island, Rockall. The significance of the annexation is now becoming apparent in offshore rights and fishing zones.

HELICOPTERS IN SMALL SHIPS

12. Returning to anti-submarine warfare, small ships, frigates and destroyers, were now being fitted with sonar equipments having enhanced detection ranges and a complementary longer range or stand-off weapon was needed to exploit this advantage. Submarine performance and that of their weapons had also improved and it was becoming increasingly hazardous for a small ship to approach a submarine close enough for a short range attack. The concept of using a helicopter, launched from a frigate or destroyer and constantly fed with updated ship's sonar information, to carry the weapon to the submarine, led to the development of the Wasp. This was the first helicopter to be specifically and successfully designed for small ship operations. It was armed with homing torpedoes.

13. Two other roles have since been developed for small ship helicopters. They are surface search as an extension of the parent ship's visual and radar horizon, and surface attack, in which either the helicopter attacks with air to surface missiles or helicopter sensors are used to provide over-the-horizon targetting for the ship's surface-to-surface weapon systems. These two methods give additional fire power and range. In small ships therefore the helicopter had become an integrated part of the ship's anti-submarine and anti-surface ship weapon systems, while additionally providing communications and rescue facilities.

THE LARGER ASW HELICOPTERS

14. Within the same period, here in the United Kingdom, gas turbines were also being fitted to the larger anti-submarine helicopters. The better power-to-weight ratio allowed more fuel to be carried thus increasing endurance. Equally if not more important, was the new flight control system which automatically took the aircraft from cruise flight to a 30 ft hover over the sea, thus permitting both night and bad weather operations to be undertaken. The gas turbine-driven Wessex helicopter was deployed in our fleet carriers where its longer operating cycles fitted well with fixed wing operations.

15. The next step was to incorporate a radar and tactical display system, which was achieved in the Wessex 3, coming into service in 1963. This enabled the helicopter to operate autonomously and to direct the anti-submarine activities of fixed wing aircraft, ships and other helicopters as well; a far cry from the anti-submarine Whirlwind of ten years earlier. A twin engined version, the Wessex 5 was introduced for troop carrying and support. It carries 15 troops or 3000 lbs of stores.

REPLENISHMENT AT SEA

16. In order for warships to operate for lengthy periods away from their bases it is necessary to supply them at sea from stores ships and fuel tankers of the Royal Fleet Auxilliary Service. Liquids can be pumped across quite quickly but the transfer by jackstay of heavy and bulky stores and ammunition involves difficult handling tasks to and from the jackstay points in both the supplying and the receiving ship. Much of this is greatly eased and accelerated by the use of helicopters with underslung loads. This role is known as vertical replenishment at sea or VERTREP for short.

SUMMARY OF ROLES

17. So we have seen the development of the following roles:

a. Communications

b. Search and rescue

c. Casualty evacuation

d. Troop carrying

e. Tactical assault

f. Anti-submarine weapon carrier

g. Autonomous anti-submarine warfare and direction of other units

h. Surface search

i. Surface attack

j. Survey work

k. Vertical replenishment

HELICOPTER TYPES IN THE ROYAL NAVY

18. I have mentioned the Wasp and the Wessex. Other helicopters in our present inventory include the more modern Lynx and Sea King.

19. The Lynx is now replacing the Wasp in small ships. Employing advanced British technology its greater speed and longer endurance are accompanied by twin engine reliability and excellent deck landing characteristics using a harpoon restraint device engaging a deck grid. Sea Spray radar and a sophisticated navigation system equip it well for anti-submarine warfare and surface surveillance. It carries homing torpedoes and depth charges and will shortly be equipped with Sea Skua missiles for surface attack.

20. The anti-submarine Sea King Mark 2 uses similar flight control system, sonar, radar and doppler, to those of the Wessex 3 but has much greater endurance. A passive sonobuoy system to complement the active dunking sonar is being fitted to all our Mark 2s.

21. The Sea King Mark 4 is a troop carrying version now supplementing our Wessex Mark 5s. It can carry 27 troops or an underslung load of 7,500 lbs and has already proved its worth in Royal Marine winter exercises in northern Norway, NATO's important northern flank.

22. In the Royal Navy today, all ships larger than minesweepers carry helicopters or are equipped to operate them. Helicopters are also carried in a number of the Royal Fleet Auxilliary supply ships.

VSTOL AIRCRAFT IN THE ROYAL NAVY

23. Turning now to VSTOL aircraft in the Royal Navy the history is much shorter. You may recall that the Board of Admiralty, again seeing the potential of new technology, initiated, at the beginning of the 1960s, the P1154 project. In 1963, unfortunately, it had to be discarded to make way for more pressing requirements. The decision, 2 years later, to build no more large aircraft carriers for the Royal Navy, put a time limit to our capability to operate conventional fixed wing aircraft at sea. As you know HMS ARK ROYAL, the last of our large carriers, paid off last year.

24. Fortunately, the Royal Air Force were developing the Harrier, also to be taken up by the United States Marine Corps, as the AV8A, and by the Spanish Navy as the Matador. But these were strike and ground support aircraft whereas the Royal Navy's main need was for a high level interceptor with reconnaissance and attack or strike capabilities. So we developed the Sea Harrier FRS Mark 1 from the Harrier GR Mark 3. Among other things this involved fitting air intercept radar and electronic warfare equipments, and replacing a simple avionic and navigation system with one more suitable to the maritime environment.

25. The great advantage that the Sea Harrier enjoys over previous generations of fixed wing aircraft at sea is that it does not require catapult or arresting gear for launch and recovery. This reverses the trend towards larger and more expensive ships to meet the demands of heavier and higher performance aircraft. The Sea Harrier can be embarked in medium sized ships at much lower costs in terms of money, manpower and ship's space. Ship's space is a subject I shall return to later. Another major advantage is that a ship operating VSTOL aircraft does not need to turn into wind or to build up speed to obtain wind across the deck. The saving in fuel is obvious, with a welcome increase in the time the ship can operate before replenishment becomes necessary. It also means that aircraft can be launched without having to wait for ship's speed to reach the desired level and that the ship's vulnerability to attack is reduced because there is no longer a need to maintain course and speed for a predictable time, so much appreciated by submariners. There is also a significant reduction in wear and tear on ships propulsion machinery due to not having to operate at maximum speed.

26. If vertical take-off is employed there is no need to re-spot the deck as with conventional aircraft.

27. Aircraft can be recovered from abeam as well as from astern and at least one recovery has already been made from over the bows with the ship steaming into wind. While cross-wind and even down-wind launches and recoveries can be made, maximum mission effectiveness,

in terms of endurance and payload, can be achieved by a rolling take-off into wind. Here, the introduction of the ski-jump, providing vertical as well as horizontal momentum at the point of separation, and therefore greater take-off weights or lower take-off speeds, provides even more flexibility in trade off of deck run, launch weight and ship's speed. An example might be that the Command may choose a low ships speed in order to minimise acoustic signature through the water. The most frequent method of operation is seen as being STOVL, short take off (with the added advantage that ski-jump gives) and vertical landing.

28. It is worth pausing here for a moment to consider the pilot's workload during recovery to the ship. With conventional fixed wing aircraft he has to get his attitude, height, course and speed right, up to the moment when his hook catches an arrestor wire. In a VSTOL aircraft he has to go through the transition from cruise speed to the forward speed of the ship, and keep correct attitude, course and height, but there is an additional dimension, vertical speed. This total activity probably represents the biggest pilot workload yet. When you add to it the difficulties of bad weather with ship motions in pitch, roll and yaw, you begin to appreciate the picture, and the picture itself disappears or becomes very different when you do it at night.

29. To clarify one aspect of the problem, consider the final stage of a landing aboard ship at night. The pilot has got his aircraft into the right position in the small window from which he can make his relatively vertical landing. I say "relatively vertical" because both ship and aircraft will be moving ahead at ship's speed. The area of deck on which he is to land is illuminated and the final stage is visual. If the ship rolls, the pilot's normal reaction in the absence of horizon cues would be to roll the aircraft so that aircraft and ship relative attitudes remain the same. But, as soon as a VSTOL aircraft rolls it will move laterally away from the "wing-up" side and out of the landing window.

30. Some may think that the helicopter pilot will have the same problems but the helicopter is much more stable in the hover and also more responsive to controls. Any power the VSTOL pilot uses for attitude control purposes reduces the main thrust available to him and the increased control activity likely at night in rough sea conditions will further erode the margin available for control of vertical descent.

31. Aids such as MADGE, Microwave automatic digital guidance equipment, and CCA, carrier controlled approach, with its additional psychological boost of a friendly voice in the pilot's ear, can be of considerable assistance but we must not lose sight of the problem.

THE OPERATIONAL WAY AHEAD, MARITIME HELICOPTERS AND VSTOL

32. Looking into the future at naval operational roles for both helicopters and VSTOL it is important again to recall that we have many years experience with helicopters. Here no great change in helicopter roles is envisaged although it will be necessary to enhance capabilities to meet the growing threat. Submarines are likely to become faster and quieter and dive deeper. They may be given anechoic protection. They will probably have longer range weapons at their disposal. The performance of anti-submarine helicopters and their equipments will need at least to keep in step.

33. With VSTOL at sea we are only just beginning, in what might be termed the early post-Wright brothers stage, and the future will hold many options. The ski-jump has already given us a major increase in performance. I do not know where the next break-through will come although wide-ranging studies are being undertaken. It may be the forward deployment to small ships in much the same way as the Royal Air Force use forward operating bases. It may be that VSTOL has an anti-submarine role, possibly in laying sonobuoy screens more rapidly than can be done by helicopters at anything other than short ranges. I cannot be specific, but if helicopter history is anything to go by I think you will agree that an interesting period lies ahead.

ADVANCED TECHNOLOGY

34. As far as technology is concerned we live in an era of very rapid and still accelerating advance. A glance through your programme of topics to be discussed in the next few days is illustrative of the many fields in which progress is being made. While I cannot unfortunately remain with you throughout the forum I shall look forward to reading the papers with great interest. The use of composite materials for optimised helicopter rotor aerofoils, cambered and twisted; for hingeless rotor hubs and lighter fuselages; higher ratio conformal gears with harder, nitrided, steels; skeletal gear box casings and the use of phospor compounds in lubricating oils for higher temperature working; are only a few of the ways in which performance and power to weight ratio may be improved. Perhaps less exciting but an important area for early work is the need to improve structural efficiency and reduce costs of ownership associated with fatigue. Smaller, more reliable electronics, and the use of microprocessors allied to digital highways can be important steps towards battle survivability. Digital engine control, very high speed light weight electrical generators, landing guidance systems, full de-icing and anti-icing, all hold promise.

35. I have mentioned only a small part of what must be a very long list and there are many present far better qualified than I to comment on them. It is difficult not to wax enthusiastic but I must add that we shall, as always, be limited in what we can afford to pay for and that the expenditure of our resources has to be governed by relative priorities across the whole defence spectrum. Most of you will have heard words to that effect before, probably more than once, but I did warn you not to expect any startling revelations.

CONCLUSION

36. In conclusion there are three points concerning naval aircraft which I see as of paramount importance. While improved performance and endurance makes each sortie more cost effective in reducing the proportion of non-productive transit time to total sortie time, pilot and aircrew fatigue can become the limiting factor. The first point therefore is the need to ease and simplify pilot and aircrew workload and improve their environment.

37. The second point stems from the fact of life that space in a warship is finite and at a premium. Every man onboard needs living accommodation which has to be lit, heated and airconditioned. He has to have bathroom and laundry facilities. He eats food which has to be kept in refrigerated storage and then prepared and cooked in a galley by other men. He uses fresh water which has to be distilled, cooled and stored, or, in our newer ships, recycled. I have heard

that, in designs for ships of frigate or destroyer size, each additional man in the complement adds 18 inches to the ship's length. You can imagine what it does to the cost. Naval aircraft and equipments must be designed for minimum maintenance because maintenance needs men. The spares and workshops they use also compete for space and designs need to be optimised to keep the need for these to a minimum too.

38. The last of my three points is an obvious one but no less vital on that account. It is that the more it costs, in through-life as well as initial costs, the fewer we shall be able to afford; and we may not be able to afford it at all.

39. Thank you very much for listening to me. I would just ask that, in your very interesting discussions this week you bear in mind those three points, to minimise

a. Aircrew workload

b. Maintenance

c. Costs of ownership