



# Corbett Paper

No 13

The interoperability of future  
UK air power, afloat and ashore:  
a historical analysis

*Tim Benbow and James Bosbotinis*

**KING'S**  
*College*  
**LONDON**

**University of London**

# The interoperability of future UK air power, afloat and ashore: a historical analysis

Dr Tim Benbow and James Bosbotinis

## **Key Points**

- Carrier-based aircraft have on many times successfully operated from bases ashore when this was beneficial; there are relatively very few occasions on which land-based aircraft have operated from carriers. This is due less to the technical modifications to aircraft required for such operation than the specialised training for personnel required to be fully capable (including night operations).
- Sea-basing offers many advantages over operating from land bases, not least in terms of mobility, flexibility and the freedom from dependence on the permission of other states for basing and overflight. It also avoids the significant recurring cost of building or adapting air bases, which is all the more burdensome for the most modern aircraft.
- Of the two models proposed for the air group of the UK's *Queen Elizabeth*-class carriers, the option for a fully worked up force that is routinely deployed with the carrier is vastly preferable to the option where the air group is merely an occasional visitor and configured principally to operate from ashore.
- The reducing number of combat aircraft available to the UK place considerable value on the interoperability of those that remain. In future aircraft procurement decisions, the ability of any proposed system to operate from carriers must be an important factor.

**Dr Tim Benbow** is a Senior Lecturer in the Defence Studies Department, King's College London, at the Defence Academy of the UK. His research interests lie primarily in naval strategy, the recent history of the Royal Navy, and British strategy and defence policy. He is currently writing a book on the Royal Navy and the aircraft carrier question in the post-1945 period.

**James Bosbotinis** is currently reading for a PhD at King's College London on the debate concerning Britain's future aircraft carrier programme and British maritime strategy. His research focuses on British strategy, military and strategic trends, in particular with regard to Russia and China, and maritime strategy.

The analysis, opinions and conclusions expressed or implied in this publication are those of the authors and do not necessarily represent the views of the JSCSC, the UK MOD, The Corbett Centre for Maritime Policy Studies or King's College London.

# **The interoperability of future UK air power, afloat and ashore: a historical analysis**

**Dr Tim Benbow and James Bosbotinis**

## **Part One: Analysis and Deductions**

### ***Introduction***

The aim of this paper is to provide a historically informed analysis of the interoperability of fixed-wing aircraft between bases on land and aircraft carriers. It therefore builds on a previous paper of March 2011, 'Historical Survey of Uses of Carriers and Amphibious Forces, 1945-2010'.<sup>1</sup> That earlier piece sought to provide some empirical and analytical underpinning for the rather inadequate public and political debate about the utility of carriers and amphibious forces.

In contrast, this current paper takes as a starting point the decision to acquire new aircraft carriers and the F-35 aircraft, and examines how the ships and aircraft can be combined to provide the most effective military capability and the best value for money for British defence policy. The study has been confined to fixed-wing aircraft; rotary-wing aircraft are not covered. Further, this paper is limited to considering the pattern for the basing of the future F-35 force; it does not explore whether recent decisions with respect to the specific variant and number of the fixed-wing aircraft to be procured represent the best use of the carrier or sensible choices for British defence policy. These and other issues concerning the complement of the carrier are important questions and worthy of study but are beyond the scope of this paper. Its focus is the assessment of two competing models that have been proposed for the fixed-wing air group of the carriers. The first envisages the aircraft being primarily sea-based, that is, routinely operating as a fully worked-up part of the carrier and habitually deploying with it, though with the ability to use air bases ashore where this should prove useful. The second model would have the aircraft being mainly land-based, either in the UK or deployed overseas, embarking on the carriers for operations only when there was no suitable air base available ashore.

### ***The weight of history***

In conducting the historical research to support this paper a rich and varied spread of experience was available. However, an evidential and hence analytical problem swiftly arose in the shape of a vast imbalance in historical material for the two sides of the question. There were plenty of examples of carrier-based aircraft operating from ashore, across many decades, providing plenty of evidence on which to base the analysis. However, it was notably difficult to identify cases in which aircraft principally organised to deploy from land bases have operated from carriers. Neither extending the historical material back in time, nor broadening the states covered beyond the UK provided a great deal of help.

The fact is that Britain has only rarely operated land-based, fixed-wing aircraft from carriers; the other major operators of aircraft carriers have done so even less frequently, if at all. Moreover, when this has occurred it has either been a temporary expedient rather than a long-term, deliberate policy, or the land-based aircraft have joined a pre-existing cadre of carrier-capable aircraft onto which the additional aircraft could be grafted. This study was unable to find a single case in history from any of the states that have operated carriers, of the ship's air group being designed to be primarily land-based and only deploying to the carrier by exception. Such a clear finding is no less significant for being negative: those who advocate the land-based model find themselves risking institutional and operational failure on the basis of an argument that lacks the assistance of any historical backing.

### ***Land-based aircraft operating from the sea***

The historical evidence could hardly be more clear-cut; the number of cases in which land-based aircraft have successfully operated from carriers is tiny (and vastly outweighed by cases in which carrier-based aircraft have operated with great success from land air bases). Why is this?

One reason is that for most of its history the Royal Air Force has not needed to be expeditionary. During the two World Wars and much of the Cold War period, it was able to rely on plentiful, well founded air bases in the UK, in British colonies or on the territory of NATO allies. These were reasonably secure and access to them could effectively be taken for granted. As the process of decolonisation accelerated, however, the number of air bases available overseas declined rapidly, while

increasing restrictions on overflight rights limited the ability of land-based aircraft to deploy and operate outside Europe. Yet the impact of this process was largely masked by an increasing concentration of British strategy on Europe and the resulting withdrawal from overseas military commitments. As successive British governments turned towards a narrow focus at home, there was an increased reliance on carrier-based air power to support the remaining post-imperial commitments overseas while the bulk of British air power and military power more broadly was concentrated in Europe, based where it would need to fight. Since the early 1990s, however, the serious limitations of this essentially Cold War model of air power have become increasingly apparent. Britain has continued to intervene militarily overseas and has repeatedly encountered serious problems initially with securing access to suitable air bases and then subsequently with putting in position the elaborate and expensive support and logistical infrastructure that such deployment requires. These difficulties, combined with the shrinking size of British air power, places a premium on deployability and versatility, which in turn makes the ability to operate from carriers highly valuable.

A second reason for the paucity of historical material on the use of land-based aircraft from carriers has been the prevailing attitude of the Royal Air Force towards naval aviation. While there have been some honourable exceptions, as a rule the leadership of the RAF has from its inception tended to have a predominantly negative view of naval aviation. On the one hand, it represented a conceptual challenge to the ideal of the 'indivisibility of all air power', which sought to have all air power unified under a single service. On the other, given the constant pressures on British defence spending, naval aviation was a competitor for resources. This attitude frequently led to inter-service clashes, particular during the 1950s and 1960s, which have left a legacy that includes a degree of mutual suspicion between the Royal Navy and the RAF over the issue of naval aviation. However, recent years have seen some more hopeful signs of a spreading awareness of the advantages for British defence policy of having air power that is truly expeditionary; as the benefits of sea basing for British air power become clearer, there is a real opportunity for the two services to set aside the destructive disputes of the past and to work together. Perhaps if this paper were to be revised in 10 years' time, there will be more historical material on which to draw.

A third reason – the most significant in terms of the current policy debate – is that operation from the sea is particularly demanding and requires a range of

specialised skills as well as a shared culture, from air crew, ground crew and those operating the ships. Not all aircraft are able to operate from carriers. The problems that must be resolved include technical ones such as the ability to take off and land, as well as the compatibility of aircraft electronic and weapons systems with shipboard operation. Undertaking the range of technical modifications and trials necessary to certify a particular aircraft type for embarked operations is essential but is only the first step. The more challenging requirement is for the aircrew to become fully qualified for flying from a carrier by day and also by night, and then to maintain currency in these skills, and for the 'ground crew' to become a fully worked up component of the ship's company. These competences require specialised training over an extended period, and then considerable on-going experience and practice. Moreover, the full 'marinisation' of personnel is not merely a matter of achieving a series of competences but also includes an equally demanding cultural aspect, to fully understand and appreciate the maritime environment.<sup>2</sup> Without all of these exacting requirements being met – which is unlikely to be achieved by merely periodic visits – the supposed capability risks becoming largely hollow.

The complexity involved in operating fixed-wing aircraft from a flight deck is truly formidable. It involves mastering several different roles that must be integrated with rotary-wing aircraft and the other operations and activities of the carrier. It also demands a high level of integration with the rest of the task group, which is often multi-national and provides a significant additional layer of complexity beyond the air group and the carrier – not least including the avoidance of 'blue on blue' incidents – especially at night. The implication that this is something that can be 'ad libbed' might be dismissed as laughable if it did not suggest a fundamental lack of understanding of what is required. It is simply not the case that flying from a carrier is just the same as flying from an air base; it is deeply misleading to imply that the only difference is the colour of the runway, tarmac black versus warship grey.

The historical survey in Part Two of this paper covers in some detail two particular examples where land-based aircraft were used with some success from British carriers; first, the deployment of RAF Harriers to reinforce the contingent of Sea Harriers during the Falklands War and, second, the 'Joint Force Harrier' initiative. These two examples demonstrate some of the potential of such activities whilst also drawing attention to the requirements for them to succeed and providing an important warning for contemporary policy. They show that if there is an already existing cadre

of fixed-wing aircraft operating from the carrier to act as a nucleus, land-based aircraft can join them and operate reasonably effectively, albeit subject to some operational constraints (such as being confined to daytime operations). They then become a useful adjunct to the routinely deployed and fully capable air group. It is possible to add an additional piece into an already functioning system, while creating the whole system from scratch would be an entirely different undertaking. However, in addition to having a fully worked up maritime air element, this also requires that the land-based aircrews have the requisite level and currency of training and experience. Without pilots qualified in night operations, for example, which is demanding and time-consuming, it would be little more than a paper capability. The Joint Force Harrier case is instructive in this respect; the inception of this force, which from the perspective of the RAF was predominantly land-based, reduced the capacity for embarked operations – and this capacity steadily diminished as time went on. The initiative was an interesting one and began with good intentions but the results offer a salutary lesson for those designing a truly interoperable force.

### ***Carriers as aircraft ferries***

There have been several uses of carriers as ferries for aircraft. On the one hand, this does provide a useful service, lending the strategic mobility and access enjoyed by ships to aircraft as an alternative to long deployment flights, or when the air routes that would be required are unavailable. However, in these cases the aircraft are not an operating capability of the warship and cannot be used should the need arise, with consequent risk to a precious capital ship as well as to the aircraft it is transporting. Moreover, the carrier used in this role is not available for other uses. Further, the aircraft thus deployed depend utterly on the availability of a secure and adequate base at the other end of the journey. In some ways, setting aside the ability to fly aircraft off the carrier at the destination, it would be just as effective to box up the aircraft concerned and send them in merchant ships; this alternative approach would have two advantages. First, it would not place at risk the aircraft carrier that was thereby disarmed. Second, it would not be possible to depict the transport vessel as having a military capability, hence avoiding the possibility of giving a misleading impression to political leaders, who might be encouraged to believe that the force had greater utility than it actually possessed, or to the tax-payers who were funding it.

In any case, in every one of the historical examples in which carriers were used to transport aircraft from one air base to another one overseas, this use of the carrier was a temporary diversion, taking advantage of an additional benefit conferred by possession of this versatile class of ship. The carriers usually operated with their own, specialised and properly worked up air group. There was never a suggestion that the only role of the carrier should be to lift aircraft between air bases. Ferrying aircraft is a useful additional role, available as a free bonus once you have a carrier, alongside its core capability. It should not be mistaken for the core capability itself.

### ***Carrier-based aircraft and operations from ashore***

Carrier-based aircraft have frequently and successfully demonstrated a capacity to operate from shore bases. The historical survey in Part Two of this paper provides abundant evidence for this proposition; many more cases could be cited but little would be gained by such repetition. A carrier-capable air group can operate from ashore – either as a whole or, as in many historical cases, in part – in those cases where there are operational advantages in doing so. It can, of course, switch back to afloat operation if the balance of advantage changes in what is likely to be a dynamic situation.

Carrier-based aircraft can therefore operate from ashore. What is debatable is the extent to which they need to do so. In discussions of expeditionary air power, the dangerous assumption is occasionally evident that shore-based operation is always inherently preferable and that operating afloat is necessarily the poor cousin, only to be adopted, with the greatest reluctance, when there is absolutely no alternative – and then only for as short a period as possible. This is a wholly distorted depiction of the relative balance of advantage between land-basing and sea-basing.

There are often some significant advantages to shore-basing. First, air bases can generally operate greater numbers of aircraft than a carrier and hence generate a greater number of sorties – although a more distant air base requires more aircraft to generate a given sortie rate, or alternatively more sorties to achieve a given effect, than a carrier operating closer to the theatre of operations. (Sorties from the latter can be more effective due to the lower response time; this shorter reaction time permits more dynamic targeting, especially the ability to attack fleeting targets of opportunity.) Given the planned size of Britain's future air power structure, however, the numbers



issue is becoming a less pressing consideration: it is difficult to conceive many deployments greater than the full capacity of the *Queen Elizabeth* class. A second advantage of shore basing is that the longer runways of air bases in comparison to carriers allow aircraft to carry (and also recover) heavier payloads of weapons and fuel. Third, whilst an air base on land is vulnerable to some threats that would not endanger a carrier (see below), it is not vulnerable to some that would, particularly underwater weapons such as torpedoes or naval mines.

Of course, there are numerous and significant caveats to the putative advantages of basing ashore. First, doing so is entirely dependent on the availability at the right time and in the right place, without the attachment of prohibitive conditions, of an air base that is of sufficient quality to support modern aircraft.<sup>3</sup> (It is worth emphasising that a fifth generation aircraft such as the F-35 requires sophisticated support that would be available on a carrier, which would act as a mobile main operating base, whereas operating from an austere deployed operating base would prevent the aircraft from making the most of its advanced capabilities.) If such a base is not available, as has frequently been the case in British experience across the decades, then the only options are carrier basing or sitting out the conflict. Second, such a base and the forces and personnel stationed there are highly vulnerable due to its static nature, in a known location – which is particularly dangerous in view of modern theatre ballistic missile capabilities. Even if such a base is available, significant damage to the forces occupying it can be achieved by a relatively small number of rogue actors, let alone conventional forces.

Moreover, the deployed air power also needs its significant ground support and huge logistical tail to be reliably in place. The assertion that ‘air power is mobile’ is deeply misleading and is not made any more accurate by repetition. *Aircraft* are indeed mobile (within a certain radius of an adequate base); air *power* comprises not only aircraft and their bases – which as noted above is more of a constraint than is generally acknowledged – but also the vast supporting infrastructure required to fuel, maintain and arm the aircraft, as well as to house, support and supply the ground crews, and to defend the bases, aircraft and personnel. This whole panoply is remarkably ponderous as well as expensive to deploy and, later, to move. Further, the effort to improve, let alone build from scratch, an air base would require a dedicated organisation, which Britain currently lacks and would be expensive to create.

Similarly, it is often stated that aircraft are very much faster than carriers. First, this is only true over tactical distances; in deployments at greater range, carriers are often faster to reach the theatre and also faster to achieve a useful and sustainable military effect, since they arrive on station fully ready for operations. Second, it invites the response that carriers move a great deal faster than air bases.

As so often, the language used is significant. Advocates of the presumption of relocating combat aircraft from a carrier to land bases tend to describe the evolution as 'stepping ashore'. The term suggests an easy translation, with connotations of an airy, carefree jaunt along the lines of Jerome K. Jerome's 'Three Men in a Boat' stopping off for a delightful lunch at a waterside hostelry before resuming their meandering voyage. It conveys little of the reality of identifying a suitably well-equipped base in the right location, negotiating rights to use it and meeting the financial and diplomatic price for this access. There is no hint of the time and cost involved in the essential transportation of large numbers of ground crew who, like the pilots, need to be accommodated and supplied, nor of the huge logistical supporting infrastructure that must be put in place both to facilitate initial operations (which of course imposes an often considerable delay at a time when a pause in operational tempo might not be desirable or even possible) and then to support them on a continuing basis. All of this effort itself imposes huge transportation requirements, either by land (slow, costly, highly demanding in terms of permission from the states through which the traffic must pass), sea (requiring lift, which in turn requires protection) or air (requiring dedicated assets, overflight permission, a safe and fit base to receive it) – or, more likely, some combination of land, sea and air with all the consequent complications. Blithely skated over is the need to protect the aircraft, the base, the personnel and the long logistical tail against attacks both conventional and asymmetric, to say nothing of the huge cost of all this activity – much of which will need to be spent all over again for the next operation.

Of course even if bases are available on land, it is simply not the case that sea-basing is necessarily the inferior option. Carrier-based operation confers important advantages, notably strategic and tactical mobility – for example, the ability to close with a target, to attack from an unexpected direction, to avoid bad weather affecting stationary bases ashore or, most common, to circumvent political restrictions or even refusal of permission to use air bases or overflight, or even to shift, within days, to another theatre of operations entirely at no additional cost. The use of carriers, which

can replace many fixed bases over their service lives, also removes the necessity to spend large amounts of money to establish or improve existing facilities – infrastructure that is subsequently either lost or gifted to another government that may or may not remain friendly – as well as removing many of the most serious vulnerabilities encountered in counterinsurgency and stabilisation operations. Carrier-basing routinely allows aircraft to be operated from far nearer to the target which, by reducing flight time and the need for in-air refuelling, makes it considerably more cost effective,<sup>4</sup> as well as more reactive to dynamic situations. It is often overlooked by the critics of carriers that they are considerably less vulnerable to many forms of attack than air bases, the location of which is easily discernible from Google Earth. It is a matter of fact that no aircraft carrier has been hit by an enemy, let alone sunk, since the later stages of the Second World War; nor has any aircraft been destroyed by enemy action while onboard a carrier during this period, in contrast to the thousands destroyed on bases ashore.<sup>5</sup>

The assumption that it is inherently preferable to operate from bases ashore overlooks the vast and recurring expense, tactical inflexibility and potential vulnerability that this can involve, while underestimating the formidable tactical, operational and strategic advantages of operating from carriers.

### ***Implications for policy: a tale of two models***

The UK government has decided to acquire two aircraft carriers with the F-35 Lightning II as the principal aircraft to operate from them. The next choice to emerge is between two proposed models for their operation. The first is predominantly land-based: the aircraft would generally operate from ashore, only embarking on the carrier intermittently, in response to a particular crisis and then only for as short a time as possible until they can relocate to the shore bases. The second model envisages the air group as first and foremost carrier-based, embarked and operated as an integrated element of the ship but with the ability to deploy or detach ashore where this was advantageous. This paper argues that the first model, in which a land-based force is merely an occasional visitor to the carrier en route to the preferred option of a land base, suffers from several deep flaws.<sup>6</sup>

First, this 'just passing through' approach would not result in a force that was fully capable of operating from the carrier. The risk is that the non-embarked option

essentially becomes indistinguishable from using the carrier as an aircraft ferry, with all of the grave disadvantages of that approach demonstrated by the historical examples discussed below. It might be possible to suitably modify a given aircraft and to undertake trials to confirm that it and its onboard systems and weapons are compatible with carrier operation (a process which can take a remarkably long time, as with clearing the Apache attack helicopter to operate from HMS *Ocean*); these actions are necessary but not sufficient, representing only the first steps in providing capability. Experience shows that long-term embarkation and constant practice are required to produce the ability to undertake complex, integrated operations from a carrier, by day and also by night and in all kinds of weather. This is the standard that is essential and no watering down of it is acceptable.<sup>7</sup> Anyone inclined to question this proposition must consider whether they would accept the deployment of aircraft and personnel to an in-theatre air base that could only operate during daylight and in favourable weather conditions. If they would not, then how can the same limitations be acceptable for a carrier capability? To have the air group acting merely as occasional visitors to the carriers brings with it two major costs: the pilots of the aircraft are prevented from developing and maintaining the full range of skills demanded by afloat operation, while the ships' crews are prevented from refining the equally demanding skills needed to operate aircraft safely and effectively. Developing these skills is possible but this process cannot be completed at short notice.<sup>8</sup> Without a fully worked up capability already in place, readiness would be very low and the British response to any crisis or conflict would be far slower as a result. A future Prime Minister would not be impressed when his request to send a carrier to a trouble spot is greeted with the exclamation, 'this calls for the immediate beginning of a work-up training period'.

The survey was unable to find a single case, historical or contemporary, UK or international, of a scheme envisaging a generally empty carrier to which aircraft might deploy in a crisis. The cases explored in Part Two in which RAF Harriers were able to deploy to carriers and conduct some flying operations were possible only because they were able to slot in to an existing system, with a well worked up carrier air group – which deteriorated after the decommissioning of the Sea Harrier force that had provided the integrated foundation for the capability. This activity was quite different to the proposed model in which aircraft would deploy to an empty carrier forlornly steaming around the sea waiting to welcome them like tourists, and then trying to improvise an effective capability. The gradual reduction in time spent embarked meant

that Joint Force Harrier became a sub-optimal way to operate the *Invincible*-class carriers; carrying forward a similar concept of operations to the new *Queen Elizabeth* class would represent a missed opportunity on a vastly greater scale and would be a staggering waste of resources and potential. It would also broadcast an unwelcome signal of a major national capability being abandoned and hence raise questions about national 'strategic shrinkage' and Britain's self-perception of its role in the world.

For some advocates, an inability to use carriers is not a serious impediment as they believe that relying on air bases ashore is preferable. Yet as argued above, such air bases have often proved to be unavailable in the right place when needed. No doubt there will be scenarios when such bases are available when and where they are needed, without any political restrictions or diplomatic complications, and the risk to the large numbers of people and expensive machinery involved are acceptable. But what about all the other cases in the unpredictable decades to come? The embarked model would provide an alternative and considerable flexibility, and could function effectively in either case; the 'occasional visitor' model could only function in the most favourable scenarios and without access to the right sort of bases, would leave no alternative other than inaction.

The proponents of the ferry/occasional visitor model, assuming land bases as the principal means of deploying air power, must explain how it would function in a crisis or conflict. If fighting has already broken out, there would be considerable risk to the combat aircraft and also their substantial supporting infrastructure during initial deployment and also during the period before the force became ready for operations. Alternatively, if the area considered for operations were still peaceful, their deployment would present diplomatic difficulties for overflight and basing that could well be prohibitive, as they have so often proved to be in the past. Of course, further complications would ensue as a result of the time required to improve the available facilities to the required standard, to say nothing of the expense. Moreover, the overt deployment of the large-scale presence represented by land-based aircraft, their ground support, their force protection and all the logistical tail required is equally likely to prove escalatory and destabilising (not least in offering a valuable and time-limited target for pre-emptive attack) as it is to act as a deterrent. An afloat capability, in contrast, can be deployed without the permission of any other government, can be poised within reach of a crisis zone for extended periods, and can have its presence made as public or as discreet as the diplomatic circumstances warrant. It therefore

offers huge flexibility for deterrence, reassurance and conflict prevention. A land-based force offers the political leadership a binary, on/off choice while an embarked force provides a wide range of options that can be precisely tailored to the needs of the situation. The maritime force also carries its protection with it, has an established system of logistic support and arrives ready for operations.

One further consideration is relevant when choosing between the two options. A UK contribution to a future allied or coalition force is likely to be of a small size relative to the whole. Many allies have large numbers of aircraft capable of deployment to air bases (subject to the usual caveats); a fully capable sea-based contingent of advanced fixed-wing aircraft is rather less commonplace, suggesting that this capability would be a significant contribution conveying real decision-making weight and diplomatic influence. A contribution the size of Britain's future F-35 force that was capable only of land-based operation would be a minor one for a coalition operation, replicating what many others could deploy; the same size force fully capable of day and night, all-weather and fully integrated afloat operations would be a rarer commodity and a lot more valuable to our partners (including in cases when the US were involved, but particularly when it were not), as well as fulfilling national requirements.

## ***Conclusion***

This paper has argued that the case for a predominantly land-based mode of operation for expeditionary air power is deeply flawed. First, there is no compelling reason to believe that operating from bases ashore is inherently preferable to operating from a carrier. Of course, in those situations where it is preferable, carrier-capable aircraft are entirely capable of doing so. Second, historical experience is unambiguous in demonstrating that occasional visits to a carrier do not and cannot provide a full operational capability – either for the air crew or those responsible for air operations on the ship. The land-basing concept would in effect offer little more than the ability to use the carrier as a ferry, which was useful at times in the Second World War for transporting aircraft but came with huge penalties. Both the carrier and the air group would thereby be deprived of their full operational capacity and also made unnecessarily vulnerable by adopting this approach as the permanent scheme for the forces rather than as just a temporary expedient.

Conversely, carrier-based aircraft have a repeatedly proven capacity to deploy or detach ashore and to operate from shore bases on the occasions where this has been necessary or desirable. An air group that is fully worked up for operation from a carrier has an inherent capacity to conduct the less demanding role of operating from ashore; an air group trained in operating ashore cannot operate from afloat without an extended period of additional training and its culture is unlikely to meet the demands of a truly integrated force. This period can be shortened if there is already a fully worked up system in existence on the carrier.

The policy choice comes down to one between on the one hand, an option that provides the ability to operate from suitable and secure land bases alone (or possibly acting as cargo for a carrier to transport to an overseas air base, should that be available) and on the other hand, an option that would offer this ability but also allows for credible integrated operation from afloat – or any combination of the two – depending on the balance of advantage in a particular situation. Understood in this way, the decision has to be that the F-35 force must be fully carrier capable which cannot be achieved by the aircraft doing no more than periodically visiting the ship.<sup>9</sup>

Of course, many of the arguments above were couched in terms of the planned F-35 force, but they apply with equal conviction to other aircraft. However British defence spending evolves over the coming years, for reasons of military effectiveness as well as due to considerations of cost effectiveness, an increasing premium will inevitably be placed on flexibility and agility, not least the ability to operate across domains and environments. The significant investment already committed to the *Queen Elizabeth*-class carriers and the compelling advantages of carrier-based operations for air power mean that the ability to operate from the carrier will be an important attribute for future British air programmes. Indeed, if any future proposed air system, whether manned or unmanned, is incapable of operating from the carriers, this shortcoming should count very heavily, even decisively, against it in any decision on balance of investment and priorities.<sup>10</sup> Having spent so many years paying lip service to interoperability, Britain now has no choice but to embrace it wholeheartedly.

The contemporary operating environment means that Britain can no longer accept a largely static, Cold War continental model for its air power. As the overall size of Britain's armed forces reduces and the degree of redundancy in key capabilities diminishes, flexibility and versatility become all the more important. The country's expeditionary air power requires a carrier capability worthy of the name, that fulfils

what policy-makers expect of it and offers value for money. It must therefore have a fully integrated air group, not one that is merely an occasional visitor.



## **Part Two: Historical Survey**

This historical survey is divided into four sections. The first three focus on particularly significant periods in the British experience of carrier-based aircraft operating from ashore and land-based aircraft operating afloat: the Second World War, the 1982 Falklands War and then the 'Joint Force Harrier' initiative. The fourth section considers some examples, mainly from the case of the United States, of the experience of other states.

### **(1) Second World War**

The early stages of the Second World War provide a warning from history regarding the results of a failure to understand the unique nature and requirements of air operations from afloat. The Fleet Air Arm was only restored to the Navy shortly before the war, having been part of the Royal Air Force since 1918.<sup>11</sup> During the interwar period, the specialist expertise of embarked carrier aviation was submerged in a general air force for which operations from the sea were at best a minor concern. Much knowledge and capability was lost and had to be slowly and painfully relearned at the beginning of the war.<sup>12</sup>

During the war the Fleet Air Arm contributed extensively to operations both from aircraft carriers and from land bases, including providing squadrons and personnel to serve ashore in the Norwegian campaign, the Battle of Britain, the Battle of the Atlantic and the campaigns in North Africa, the Middle East and Mediterranean, Western Europe and the Far East. The principal role of the Royal Air Force was (and remains) the provision of land-based airpower; it did however also utilise the Royal Navy's aircraft carriers during the Second World War, in particular during the first half of the conflict, to permit deployments of airpower overseas which would not otherwise have been possible. The use of carriers in the aircraft ferrying role was particularly significant in the Norwegian campaign and in the reinforcement of Malta.

#### ***Carriers in the ferrying role***

**Norway, 1940:** A temporary air station was established at Lake Lesjaskog, 23/24 April, with RAF Gladiators deployed from HMS *Glorious*.<sup>13</sup> The detachment consisted of one squadron (No.263) and 'was chosen because its obsolescent Gladiator

biplanes could operate from small landing grounds'.<sup>14</sup> The squadron was destroyed within three days of its deployment to Norway, with the last pilots being evacuated via cargo ship on 26 April and arriving at Scapa Flow on 1 May.<sup>15</sup> No.263 Squadron was again deployed to Norway (to Bardufoss) with fresh Gladiators on 21 May, having sailed aboard *Furious* on 14 May. Due to adverse weather conditions, the 21 May attempt was aborted after two of the aircraft crashed; the remaining Gladiators managed to land back on *Furious* and the deployment was completed the following day.<sup>16</sup> The RAF deployed Hurricanes (from 46 Squadron) to Norway via *Glorious* on 26 May. The aircraft were 'hoisted aboard from lighters' following unsuccessful tests of landing the aircraft on *Glorious* during the transit to Norway.<sup>17</sup> These tests also underpinned the decision to destroy the Hurricanes at Bardufoss when withdrawal became necessary rather than attempt to evacuate the aircraft; the commanding officer of 46 Squadron appealed against this decision and successfully led ten Hurricanes to land aboard *Glorious* on 7 June.<sup>18</sup> The Hurricane was not a naval aircraft and thus lacked an arrester hook for deck landings (a navalised Sea Hurricane was developed later in the war). The successful recovery to *Glorious* and its significance, is described by Till thus: 'This very gallant act by pilots quite untrained in the skills of deck-landing in aircraft unfitted for it demonstrated once and for all that carriers could operate high-performance fighters'.<sup>19</sup> However, these land-based aircraft were not capable of operating from the carrier, which therefore lacked its core weapons system with the result that she was helpless when attacked by the German battleships *Scharnhorst* and *Gneisenau* on the journey home. In the words of Winston Churchill: 'unfortunately, when attacked by enemy battleships, the fact that HMS *Glorious* was carrying RAF fighters that could not operate from the sea meant that she could not fly off her own torpedo-bombers; defenceless, she was sunk'.<sup>20</sup>

**Egypt, 1940:** 73 Squadron, consisting of 34 Hurricanes, was ordered to Egypt on 6 November. The aircraft were to be transported by HMS *Furious* and the ground personnel via cruiser through the Mediterranean. *Furious* reached Takoradi, Ghana, on 27 November and flew off all but one aircraft successfully (the other one crashed into the sea). The aircraft were then to stage across Africa to Heliopolis in Egypt with a Blenheim serving as a guide aircraft. Eventually 27 aircraft reached Egypt; the squadron became fully operational at the end of December.<sup>21</sup>

**Malta, 1940-1942:** The defence of Malta depended on external support and reinforcement of the very limited forces on the island. Carriers operating in the ferry role made possible the successful defence of Malta by transferring large numbers of fighters (initially Hurricanes, later Spitfires) to the island:

- 2 August 1940: 12 Hurricanes were flown off *Argus* with ground staff and stores arriving via submarine.<sup>22</sup>
- 17 November 1940: 12 Hurricanes were flown off *Argus* from 450 miles west of Malta, at a greater distance than anticipated due to Italian fleet movements. However, due to lack of planning, the pilots not having long-range flying experience and the observer in the guiding Skua being fresh out of training, only four of the Hurricanes arrived at Malta, the others ditching en route.<sup>23</sup>
- 27 April 1941: additional Hurricanes arrived having flown off HMS *Ark Royal*.<sup>24</sup>
- 20 April 1942: 47 Spitfires were flown off USS *Wasp* but the guns and radios of many of the aircraft were not in optimal condition and thus required immediate attention by the ground crews. Further, German air attacks had by the following evening reduced the number of serviceable aircraft to 17.<sup>25</sup>
- 9 May 1942: 64 Spitfires were flown off HMS *Eagle* and USS *Wasp* of which 62 reached Malta.<sup>26</sup> Between 10 and 24 May, 63 additional Spitfires were flown off *Eagle*, 59 of which reach Malta.<sup>27</sup>
- In 1941 alone, the carriers *Ark Royal*, *Furious* and *Victorious* undertook 15 such ferrying trips to Malta.<sup>28</sup>

In all the above cases, the RAF aircraft were only being launched from the carrier – as opposed to operating over the sea and then returning to her – with a Fleet Air Arm guide aircraft (typically a Skua) to aid in over-sea navigation. Flying operations remained under naval control.

**Mediterranean, May 1941:** Admiral Sir Dudley Pound, the First Sea Lord, sought approval from the War Cabinet to have one of the carriers ferrying RAF aircraft reinforcements to the Mediterranean and Middle East released from this diversion: ‘When *Victorious* had carried her present load of Hurricanes to the Mediterranean they felt it was essential that she should return to her proper role as an offensive weapon against enemy raiders.’<sup>29</sup> The very day that this request was made, the German battleship *Bismarck* (widely regarded as the single most powerful warship in the world) was sunk by Royal Navy warships after being slowed by an air strike launched from

HMS *Ark Royal* – which at the time the German ship put to sea ‘was 1,500 miles away ferrying aircraft to Malta’.<sup>30</sup> Thankfully she was able to switch between roles in time.

**Murmansk, Soviet Union, 1941:** The first British convoy to Murmansk, which sailed 21 August 1941, included the carrier HMS *Argus* with 39 Hurricanes on-board (15 were dismantled) constituting No.151 Wing.<sup>31</sup> 24 Hurricanes were flown off successfully to Vaenga airfield, outside Murmansk; due to German air attack, *Argus* diverted to Archangel with the remaining 15 crated aircraft, which were disembarked and made operational before flying on to Vaenga.<sup>32</sup>

**Sri Lanka and Malaya:** HMS *Indomitable* arrived off Sumatra on 26 January 1942 with 48 Hurricanes embarked; 15 flew off to Singapore, the rest to Palembang on the Malay Peninsula (five crashed on landing at the latter). The aircraft were delayed in becoming operational due to their gun armament being choked with anti-corrosion grease applied to protect the guns during transit on the carrier.<sup>33</sup> During February 1942, the US aircraft carrier *Langley* attempted to transport P-40 fighters to Java; she was intercepted by Japanese land-based aircraft flying out of the southern Philippines and was sunk.<sup>34</sup> On 6-7 March 1942, HMS *Indomitable* transported Hurricane Mk 1 and II aircraft belonging to 30 and 261 Squadrons to Sri Lanka from the Middle East.<sup>35</sup>

### ***Selected examples of Fleet Air Arm units operating from ashore***<sup>36</sup>

**10 April 1940:** Operating from Hatston in the Orkneys, 15 Skuas of 800 and 803 squadrons launched a strike on Bergen, Norway, a round trip of 560 miles. The German light cruiser *Konigsberg*, alongside at Bergen, was sunk for the loss of a single Skua.<sup>37</sup>

**21 June 1940:** Six Swordfish, also flying from Hatston, launched a torpedo strike (unsuccessfully) against the German battleship *Scharnhorst*.<sup>38</sup>

**The Battle of Britain:** 804 squadron operating Sea Gladiators and the American-made Grumman Martlet, based at Hatston, and 808 squadron operating Fulmars from Wick, served under RAF Fighter Command control in the dockyard defence role.<sup>39</sup> 23

Fleet Air Arm pilots also served with RAF Hurricane and Spitfire squadrons, including three who served under Douglas Bader in 242 Squadron.<sup>40</sup>

**October 1940:** 14 Swordfish from *Illustrious* and *Eagle* temporarily deployed to Fuka Satellite airfield for mining operations against Tobruk harbour.<sup>41</sup>

**Battle of Cape Matapan:** Fleet Air Arm Swordfish and Albacores operated from the carrier *Formidable* and also from ashore in Maleme, Crete alongside RAF aircraft (also flying from Maleme and Greece) to find, fix and strike the Italian fleet in order to enable Admiral Cunningham's Mediterranean Fleet to close and engage the Italians in a surface action.<sup>42</sup>

**March-April 1941:** Albacore and Swordfish conducted operations in Greece and Syria.<sup>43</sup>

**21 December 1941:** Swordfish operating from Gibraltar achieved the first night-time sinking of a U-boat by aircraft. The Swordfish were previously part of the *Ark Royal* air group until her sinking by U-boat on 14 November 1941.<sup>44</sup>

**April 1942:** Six Fulmars of 873 Squadron deployed ashore from HMS *Hermes* to aid in the defence of Sri Lanka.<sup>45</sup>

**Summer 1942:** 60 aircraft (including Martlet, Swordfish, Fulmar and Albacore) from five Fleet Air Arm squadrons operated in the Western Desert as part of the Desert Air Force; a notable contribution was the use of Albacores as night-time pathfinders for RAF Wellington bombers.<sup>46</sup>

**1942:** 823 Naval Air Squadron Albacores deployed to RAF Tangmere.

**1943:** 'One squadron equipped with the latter type of aircraft [Albacore] had been lent by the Admiralty to the RAF, and worked under Fighter Command throughout nearly the whole of 1943'.<sup>47</sup>

**May 1944:** 'Night patrols against E-boats, for which a comparatively slow aircraft was the most suitable, were generally made by the Albacores which the Admiralty had transferred to the RAF. In May, two Fleet Air Arm squadrons, equipped with Swordfish and Avengers, came to the RAF station at Manston in Kent to join in the offensive, thus adding yet one more arm to the many-sided campaign for control of the coastal waters'.<sup>48</sup>

**June 1944:** Two Fleet Air Arm fighter squadrons deployed ashore, one in Northern Ireland and one in Peterhead, to provide fighter protection for northern areas of the country, allowing RAF Fighter Command to concentrate in the south in support of D-Day. The Chief of the Air Staff thanked the First Sea Lord: 'Your assistance did much to remove the anxiety we felt at having to uncover so much of the country to surprise air attacks while the bulk of our forces were engaged in the South.'<sup>49</sup>

**1944-45:** Four Fleet Air Arm squadrons (808, 885, 886 and 897) equipped with Seafires, served as part of the Air Spotting Pool of the Second Tactical Air Force.<sup>50</sup>

### **Observations**

Naval airpower functioned effectively from both sea and land bases; land-based aircraft, conversely, only operated from carriers in the non-combat, ferry role (or additionally in the case of *Glorious* in the Norwegian campaign, in an ad-hoc evacuation role). The land-based aircraft were typically lifted aboard the carrier and were not capable of combat operations off the deck (see the example above of Hurricanes being ferried to the Malay Peninsula aboard *Indomitable* with their guns choked). Thus, whilst operating the ferrying role, a carrier would be potentially vulnerable to attack, as in the incidents mentioned above relating to HMS *Glorious* and the USS *Langley*. In all cases during the Second World War (and subsequently), land-based aircraft, when operating from a carrier, were doing so under naval control, and typically required direct navigational support from an accompanying naval aircraft. This approach indicated the importance of being familiar with, and proficient in operating in the maritime environment.

## **(2) The Falklands War, 1982**

Initially eight Sea Harrier FRS1 (801 NAS) were embarked aboard HMS *Invincible* and 12 Sea Harrier (800 NAS augmented with aircraft from 899 NAS, the Sea Harrier training unit) aboard HMS *Hermes*.<sup>51</sup>

‘Operation “Corporate” saw the first operational use of land-based Royal Air Force aircraft from an aircraft carrier since World War II’.<sup>52</sup> This innovation was made possible by the advent of vertical/short take-off and landing aircraft in the form of the Harrier. After entry into RAF service in 1969, Harriers undertook vertical take-off tests from the cruiser *Blake* and short take-off tests from *Eagle*, leading to official approval for RAF Harriers to operate at sea. No.1(F) Squadron RAF conducted further trials in 1971 aboard *Ark Royal* to test the concept of operating from carriers.<sup>53</sup>

### ***RAF Harrier deployment***<sup>54</sup>

No.1(F) Squadron RAF equipped with the Harrier GR3 received its first signal from the Ministry of Defence regarding potential deployment to the South Atlantic on 8 April; a further signal was received on 10 April warning of a possible deployment. On the same day, the merchant vessel *Atlantic Conveyor* commenced modification for deployment as a ‘Ship taken up from trade’; the vessel was checked on 13 April to ascertain whether Harriers and helicopters could be embarked. RAF Wittering received tasking on 16 April to deploy up to 12 Harriers circa 26 April. On 18 April, a signal confirming deployment of No.1(F) Squadron was received – nine aircraft were to deploy to Ascension on 26-28 April with six to join the Task Force and three to be retained for air defence at Ascension. The initial concept for GR3 operations was discussed on 21 April and is described in Air Chief Marshal Sir Peter Squire’s diary:

I attend a meeting at HQ 18 Gp chaired by the Chief of Staff. We are briefed on the concept of an amphibious assault followed by the building of a Harrier site ashore. The concept for GR3 employment is still uncertain but we are given the following assumptions:-

- sustained period of operations in cold climate from bare base
- fuel/comms/ATC [Air Traffic Control]/catering provided
- re-supply within 22 days

- 12 aircraft in AD [Air Defence] role armed with guns and AIM-9
- initial weapons provision 48 AAMs plus 5,760 rounds 30mm
- sortie length 45 mins
- 8 sorties per day.

We are tasked to provide detailed UASTs [Urgent Air Staff Targets] and estimate of peak sortie rate.

Notwithstanding the AD employment, I ask for the provisions of LGBs.<sup>55</sup>

**Sunday 24 April:** 'Deployment date delayed until at least 1 May. This thankfully will give more time before [sic] to complete the modification programme which is enormously manpower intensive. The whole of Engineering Wing is working round the clock to modify an initial batch of 12 aircraft in order to get 9 to Ascension Island.'<sup>56</sup>

The Harrier GR3 required some modification to enable it to operate from aircraft carriers. These included tie-down rings being fitted to the outrigger legs, changes to the steering and nozzle control mechanisms and measures to protect against salt water corrosions.<sup>57</sup> In addition, work was required to develop a means of aligning the aircraft's inertial navigation system whilst on a moving flight deck. Despite the efforts of British Aerospace and Ferranti to develop a trolley-mounted device which could be plugged into the aircraft, success was not achieved and the pilots of 1(F) Squadron had to rely on visual methods of navigation in the South Atlantic.<sup>58</sup> A number of modifications to the Harrier's weapons fit were also undertaken, including the provision of an air-to-air missile capability via the integration of the AIM-9 Sidewinder, and the integration of Fleet Air Arm rocket pods on the aircraft. The latter was required due to the RAF's own SNEB rocket pods being unsuitable for carrier operations as the pods were not insulated against the high electromagnetic forces aboard a ship.<sup>59</sup>

**18 May:** Four Harrier GR3s cross-decked from *Atlantic Conveyor* to *Hermes* (the other two aircraft were unserviceable and joined *Hermes* subsequently).<sup>60</sup> On 19 May, four additional Harrier GR3s deployed to *Hermes* with the aid of air-to-air refuelling, bringing the number of Harriers aboard *Hermes* to ten, alongside 14 Sea Harriers.<sup>61</sup>



Three of the pilots from 1(F) Squadron had prior experience of landing on ship; Squadron Leaders Bob Iveson, Peter Harris and Tim Smith had previous experience via the US Marine Corps.<sup>62</sup> The Squadron had prior to its deployment undertaken some ski jump training at Royal Naval Air Station Yeovilton and, whilst embarked on *Atlantic Conveyor*, joint ground training with personnel from 809 NAS.<sup>63</sup>

For the most part, no major problems were encountered with integrating 1(F) Squadron aboard HMS *Hermes*. This was because the Squadron:

...joined a well-founded airfield that was experienced in the safe operation of Harriers in poor weather and with a fully worked up Air Department optimised for the environment. They were supported and trained by the existing carrier system. They also had the benefit of dovetailing with the RN's 800 Sqn, who provided deck briefings and an intensive work-up package. Their minds were firmly focussed upon the dangers of operating from a ship.<sup>64</sup>

### ***The Forward Operating Base, Port San Carlos***

A forward operating base (FOB) for Harriers and helicopters was established at San Carlos on 28 May with the first helicopters refuelling at the site the same day. Four aircraft could be parked but not armed. The base opened on 2 June and was used immediately by two GR3s with two Sea Harriers utilising it on 3 June. The base was useful for Sea Harrier operations as it enabled more time on combat air patrol (CAP) station as Woodward kept the carriers eastward to minimise the threat from Argentine air attack.<sup>65</sup>

The strip was 850ft long and constructed of 10ft by 2ft aluminium planking. There were also refuelling facilities, a vertical landing pad and two taxiing loops at one end (one for refuelling and the other for parking). It had been built on a slight incline which aided take-offs but, of course was nothing like as effective as a ski-jump. One of the taxi loops was later removed (after 8 June).<sup>66</sup>

Lieutenant Commander Andy Auld DSC, RN (officer commanding 800 NAS during the Falklands campaign) states that the FOB could operate up to six Harriers at any one time.<sup>67</sup> Goose Green was also considered for a FOB but 'could not be defended because of a lack of spare Rapier, fuel supplies were problematic and the airfield itself was littered with debris'.<sup>68</sup>

'The advantage of the FOB was that it enabled the Sea Harriers to respond more quickly to attack and air defence taskings and increased the CAP on-station time by a factor of almost three'.<sup>69</sup>

'Pilots encountered no problems in translating from ship to shore operations and back again'.<sup>70</sup>

'On one day we supported 18 to 19 Harrier and Sea Harrier movements on the small base'.<sup>71</sup>

'8 June was another fine day and, once again, it was intended that air defence Sea Harriers and ground support GR3s would make full use of the FOB... A detachment of GR3s was sent to the FOB from *Hermes* (positioned about 250 east of the Falkland Islands) to support British ground forces as and when needed. Upon arrival at Port San Carlos at about 1500Z, one of the Harriers (flown by OC 1(F) Sqdn) suffered a malfunction and crash-landed across the strip, effectively putting the FOB out of action for a few hours. Whether denial of access to the FOB during the afternoon was crucial or not to later events that day [the air attacks on *Sir Tristram* and *Sir Galahad*] is purely conjecture, but it meant that for a while all CAP cover by 800 and 801 Sqdns had to originate from the carriers with a corresponding reduction in continuous CAP cover and patrol loiter time'.<sup>72</sup>

**11 June:** Officer commanding 801 NAS, Lt Cdr 'Sharkey' Ward staged out of the FOB in an attempt to intercept Argentine C-130 flights flying daily missions transporting supplies to Argentine ground forces.<sup>73</sup>

Summary of No.1(F) Squadron's contribution: 'A total of 150 sorties were flown from "Hermes" and the Port San Carlos FOB between 18 May and 14 June, of which 126 were operational tasked sorties over the Falkland Islands'.<sup>74</sup>

Due to a shortage of Sea Harriers until *Hermes* and her air group returned to the UK, 899 NAS hosted a detachment of eight Harrier GR3s from 4(F) Squadron to enable completion of the final work-up phase of HMS *Illustrious* ahead of deploying to the South Atlantic to relieve *Invincible*.<sup>75</sup> *Illustrious* departed Portsmouth on 2 August with seven Sea Harriers embarked (an eighth joined the next day). *Illustrious* relieved *Invincible* off the Falklands on 28 August with a total of ten Sea Harriers embarked (two joining from *Invincible*); this enabled two Sea Harriers to be permanently detached ashore to RAF Stanley.<sup>76</sup> *Illustrious* provided a Sea Harrier presence ashore and afloat in the Falklands until the second half of October 1982 when work to lengthen the runway at RAF Stanley was complete, thus enabling the deployment of RAF Phantoms to the South Atlantic.<sup>77</sup>

### **Observations**

'...the greatest effect was achieved where incoming Joint augmentee units reinforced *pre-existing and properly worked-up organisations*. Examples of this are the integration of 2 and 3 Para into 3 Commando Brigade and 1 Sqn within the Air Group and Air Department of *HMS Hermes*'.<sup>78</sup> The successful integration of 1(F) Sqn aboard *Hermes*, as with the embarking of land-based aircraft on carriers during the Second World War, was reliant on the existence of an already worked-up and proficient naval interface. This was essential in order to provide 'the professional and physical basis for effective operations in an unfamiliar environment'.<sup>79</sup>

The Harrier GR3 was successfully integrated into operating from HMS *Hermes*, albeit only by daylight (due to limited embarked training and experience), despite not being designed for naval operations; this did however require some modification to the aircraft in order to ensure compatibility with the maritime environment. Some of those modifications would subsequently be repeated on RAF Harrier GR7s in the 1990s (see below). Conversely, aircraft designed for naval use did not require modification

for land-based operations as was demonstrated with Sea Harrier operations from both carriers and the FOB in Operation 'Corporate', and subsequently from RAF Stanley.

### **(3) Joint Force Harrier**

#### ***The Genesis of Joint Force Harrier***

The opportunity to continue development of joint Harrier operations post-Falklands was missed. Rear Admiral Ian Henderson states in this regard: 'My only regret is that, in the wake of 1982, when we had Air Force Harriers operating from *HERMES*, it would have been really good news to have seen some sort of joint force coming into being. We missed a huge trick then...'<sup>80</sup>

There was renewed interest in the early 1990s in reconstituting a maritime RAF Harrier capability following the entry into service of the GR7. On 27 June 1994, three GR7s from Strike/Attack Operational Evaluation Unit deployed to HMS *Illustrious* for:

three weeks of trials and to lay down the basic Standard Operational Procedures (SOPs) for future deployments... The trials established the operational flying limitations and deck interface requirements for the new GR7. This included checking for electromagnetic interference and the integration of the RAF Harrier within carrier's hangar decks and aircraft lifts etc. One of the earlier priorities of the trial was to overcome problems with the pre-flight alignment of the GR7's FIN1075 Inertial Navigation System (INS) while on a pitching and moving carrier deck.<sup>81</sup>

**Operation 'Jural', March 1997:** During this operation, held under the auspices of the 'Ocean Wave 97' deployment, 1(F) Squadron RAF Harrier GR7s embarked on *Illustrious*, building on the experience of the 1994 trials. Joint operations involving Sea Harrier FA2s and the GR7s were undertaken contributing to Operation 'Southern Watch', the no-fly zone over southern Iraq. The 1(F) Squadron detachment remained on *Illustrious* for one month.<sup>82</sup> Prior to the 'Jural' deployment, pilots from 1(F)

Squadron undertook training at Royal Naval Air Station Yeovilton, including two day and two night practice ski jump take-offs.<sup>83</sup> Whilst embarked on *Illustrious*, pilots were 'due to fly around 20 hours on various training missions, including undertaking and expanding their Night Vision Goggle (NVG) deck landing aboard the carrier';<sup>84</sup> though this latter capability did not materialise due to lack of deck lighting NVG compatibility, which would take nearly a decade to rectify.

**September 1997:** HMS *Invincible* departed Portsmouth on 2 September and whilst in the Channel embarked her carrier air group comprising Sea Harrier FA2s of 800 NAS and five Harrier GR7s from 1(F) Squadron RAF.<sup>85</sup>

**Operation 'Bolton' was initiated on 14 November 1997:** Following an increase in tensions with Iraq due to its refusal to comply with United Nations Security Council resolutions concerning disarmament, the decision was taken to commence a military build-up in the Gulf. The initial plan had been to deploy RAF Tornados to the region but overflight rights were not granted by certain countries, thus necessitating the despatch of a Royal Navy task force.<sup>86</sup> HMS *Invincible*, then off Barbados, was ordered to make a high-speed transit across the Atlantic to Gibraltar. On 20 November, *Invincible* departed Gibraltar and embarked seven Harrier GR7s from 1(F) Squadron and proceeded east into the Mediterranean.<sup>87</sup> The carrier air group was eventually to achieve a peak strength of eight Sea Harrier FA2s, eight Harrier GR7s and six Sea Kings (four airborne early warning and two anti-submarine variants).<sup>88</sup> Whilst en route to the Middle East, the embarked Sea Harriers and Harriers contributed to Operation 'Deliberate Guard' over the Former Yugoslavia and once on-station in the Gulf, contributed to Operation 'Southern Watch'.<sup>89</sup> A major challenge, in particular for the Harrier GR7s, was fitting into the maritime air contribution to the overall Air Tasking Order. Captain Burnell-Nugent described the issue thus:

In the first few weeks within the Gulf, *Invincible's* 800 Naval Air Squadron and 1(F) Squadron RAF had to achieve this high degree of cooperation, both in planning and in the air, with *USS George Washington*, *USS Nimitz* and *USS Independence* as well as with the RAF and USAF ashore. This was particularly demanding for the GR7s who, through no fault of their own, had very little previous experience

of this high degree of integration of maritime air assets. Note the implications for readiness.<sup>90</sup>

**January 1998:** HMS *Illustrious* was despatched to the Mediterranean to work up in case it was required to relieve *Invincible* on-station in the Gulf. The *Illustrious* air group consisted of Sea Harrier FA2s (801 NAS) and RAF Harrier GR7s; *Illustrious* relieved *Invincible* in the Gulf in early March and remained in the region until 17 April. The Sea Harriers and Harriers conducted operations in support of Operation 'Southern Watch'.<sup>91</sup>

**Operation 'Bolton II':** *Invincible* departed for the Gulf on 9 January 1999 and embarked Sea Harriers from 800 NAS 'but sadly none of the hoped-for RAF GR7 Harriers'.<sup>92</sup>

### ***The Experience of Joint Force Harrier***

The 1998 Strategic Defence Review declared that:

The operational potential of a joint carrier air wing was graphically shown earlier this year in the Gulf, when the deployment of Royal Air Force Harrier GR7s alongside the Royal Navy Sea Harriers on HMS INVINCIBLE made an important contribution to the multinational force applying pressure on Iraq to comply with UN resolutions. Total integration of current Harrier aircraft into a single force is impracticable. The two Harrier variants share only around 10% of their airframe and avionics, and they have quite different primary operational roles. But closer harmonization between the existing Harrier forces could pave the way towards a truly joint force for the future. Capitalising on the success of current joint Harrier operations, we propose to develop a Joint Force 2000, which could eventually involve the replacement of all Harriers with a common aircraft type. There are several options for the new aircraft (which would be capable of operating from ashore and afloat). For the Joint Force 2000 concept to work successfully, we will need a common aircraft, common

operating procedures, common maintenance practice and a common support organisation. Further study will begin shortly to determine the best way to realise the potential which the concept offers to provide a flexible and deployable joint force, able to operate either from land bases or aircraft carriers.<sup>93</sup>

The mission statement of Joint Force 2000 was: 'To provide a force, able to deploy from land and sea, capable of precision attack of sea, land and air targets, able to undertake timely reconnaissance, and air escort of joint and allied assets to the Joint Commander's Directive in pursuit of UK Defence aims across the spectrum of peace, crisis and conflict.'<sup>94</sup>

**1 April 2000:** 'Joint Force 2000' became 'Joint Force Harrier' within a wider Maritime Group – 3 Group, which also included the Nimrod force – within RAF Strike Command. The Group came under the command of Flag Officer Naval Aviation, Rear Admiral Iain Henderson, who became Flag Officer Maritime Aviation.<sup>95</sup>

**Operation 'Palliser', May 2000:** HMS *Illustrious* was diverted from Exercise 'Linked Seas' in the Bay of Biscay to Sierra Leone to join a wider British intervention operation, the first use of the Joint Rapid Reaction Force.<sup>96</sup> The *Illustrious* air group comprised eight Sea Harriers of 801 NAS and five Harrier GR7s of 3(F) Squadron.<sup>97</sup> None of the pilots of 3(F) Squadron had embarked on a carrier previously but all managed to quickly become day qualified<sup>98</sup> – though none achieved night qualification during the period in which they were embarked. After the arrival of *Illustrious* off Sierra Leone on 11 May, the first operational GR7 sorties were conducted on 17 May; the GR7s conducted a total of 48 sorties in three weeks, did not expend any weapons and conducted low level 'Presence' runs for deterrence purposes,<sup>99</sup> amounting to a third of fast jet sorties. However, the Squadron was not worked up for night flying, had not embarked key equipment such as the Thermal Imaging Airborne Laser Designator (TIALD) pod and saw the deployment only as a training evolution. It was therefore not well prepared for operations.<sup>100</sup> Nevertheless, the deployment was seen to be a success: 'The valuable contribution of the Sea Harrier FA2s and Harriers [sic] GR7s to the Joint Force Commander included over-the-horizon power projection and a range of capabilities from reconnaissance to close air support to both UK and UN forces on

the ground'.<sup>101</sup> Commodore Bill Covington Royal Navy also described the role of Joint Force Harrier Operation *Palliser* in positive terms:

The latter [Sierra Leone] was a particularly good example of JFH elements: No 3 Sqn and No 801 NAS, working together in an extremely successful operation where the desired effect was produced by noise and the mere 'presence' of air power, plus the limited but, as it happened, critical recce capability represented by the Sea Harrier's side-facing F95 camera.<sup>102</sup>

**Exercise 'Saif Sareea II' and Operation 'Oracle', autumn 2001:** HMS *Illustrious* departed Portsmouth on 3 September 2001 and embarked a joint air group including Sea Harriers and a detachment of Harrier GR7s from 4(F) Squadron RAF. Whilst en route to the Middle East, the attacks of 11 September 2001 were conducted in the United States. The British government decided to proceed with the exercise (to take place in Oman) in order to demonstrate a presence in the region and to be capable of responding to emerging operational taskings. The Royal Navy task group component of 'Saif Sareea II' shifted to an operational posture under the codename 'Operation Oracle'.<sup>103</sup> This saw HMS *Illustrious* switch to a helicopter carrier role with RAF Chinook helicopters embarked alongside Special Forces.<sup>104</sup> The 4(F) Squadron Harriers had spent a month embarked on *Illustrious* before deploying to Masirah, Oman; this was the 'longest period that the Sqn had spent on a carrier since the Chanak crisis over 80 years previously'.<sup>105</sup>

**'Marstrike 05':** HMS *Invincible* left Portsmouth on 17 January 2005 to lead a task group deployment to the Mediterranean and Gulf over a three month period.<sup>106</sup> The most significant component of the deployment was Exercise 'Magic Carpet'; a combined exercise with French, Omani, US and UK air assets over southern Oman.<sup>107</sup> This involved the embarking of a joint air group on *Invincible* comprising seven Sea Harrier FA2s from 801 NAS and eight Harrier GR7s from IV(AC [army cooperation]) Squadron RAF.<sup>108</sup> The exercise included the use of *Invincible* as a strike carrier, including the first use from a UK carrier of the Enhanced Paveway II 1,000 lb. munition, and the IV Squadron Harriers deploying ashore to a Forward Arming and



Refuelling Point.<sup>109</sup> The Harrier GR7s deployed from *Invincible* at the end of Exercise 'Magic Carpet' to Kandahar Airfield, Afghanistan, to support Operation 'Herrick'.<sup>110</sup>

2006 saw the evolution of Joint Force Harrier from a two-aircraft fleet (Sea Harrier FA2 and Harrier GR7) to a single Harrier GR7/9-based force. The Sea Harrier FA2 was withdrawn from service in 2006 and the two fixed-wing Fleet Air Arm squadrons (800 and 801) converted to the GR7.<sup>111</sup> This move marked a major shift in focus for the Fleet Air Arm away from air defence of the fleet to providing close air support and ground attack capabilities.<sup>112</sup>

**October 2006-January 2007:** 800 NAS (equipped with Harrier GR7) deployed to Kandahar Airfield, relieving IV(AC) Squadron.<sup>113</sup>

In 2007, the fixed-wing component of the Fleet Air Arm was further reorganised with the formation of the Naval Strike Wing, subsuming 800 and 801 NAS.<sup>114</sup> The Naval Strike Wing constituted one of three squadrons (the other two being RAF) forming Joint Force Harrier.<sup>115</sup>

**Exercise 'Neptune Warrior 071', April-May 2007:** Harrier GR7s and 9s of the Naval Strike Wing were embarked on *Illustrious* for the exercise off Scotland, after which *Illustrious*, with the Naval Strike Wing still embarked, participated in Exercise 'Noble Mariner'. This major NATO exercise, held in May and June 2007, tested the NATO Response Force.<sup>116</sup>

**October 2007-February 2008:** The Naval Strike Wing undertook another deployment in support of Operation 'Herrick', operating from Kandahar Airfield.<sup>117</sup>

**Exercise 'Hajjar Osprey', March-April 2008:** On 19 March, four Harrier GR7s and GR9s from the Naval Strike Wing deployed to HMS *Illustrious* off Oman having staged from RAF Cottesmore via Cyprus.<sup>118</sup> The aircraft conducted training missions covering strikes against inland targets and the air defence capabilities of the 'Orion 08' Task Group; the Harriers departed *Illustrious* on 11 April to return to the UK and prepare for deployment to Afghanistan.<sup>119</sup>

**July-December 2008:** The Naval Strike Wing undertook a further deployment to Kandahar Airfield. The deployment included the first operational use of the Paveway IV precision guided bomb.<sup>120</sup>

Between December 2008 and April 2009, IV Squadron RAF was responsible for the Harrier detachment at Kandahar Airfield. The Harrier deployment to Afghanistan, the last operational deployment by the type, ended in June 2009.<sup>121</sup>

**June 2009, Exercise 'Loyal Arrow':** Four Harriers of the Naval Strike Wing embarked on HMS *Illustrious* participated in the exercise, which was designed to train elements of the NATO Response Force Joint Force Air Component Headquarters in the conduct of air operations and involved NATO and non-NATO Partnership for Peace members.<sup>122</sup>

Joint Force Harrier moved into a regeneration phase following the completion of its deployment in Afghanistan.<sup>123</sup>

**1 April 2010:** Naval Strike Wing reverted to the identity of 800 NAS.<sup>124</sup>

**Summer 2010, Exercise 'Auriga 10':** HMS *Ark Royal* left Portsmouth on 5 April 2010 to participate in the joint and combined Exercise 'Auriga 10'.<sup>125</sup> The ship initially embarked 800 NAS, before hosting 12 AV-8Bs and 143 personnel of the US Marine Corps and subsequently, six Harrier GR9s of 1(F) Squadron were embarked.<sup>126</sup> It is interesting to note that 116 RAF personnel were embarked to support the six Harriers of 1(F) Squadron<sup>127</sup> in contrast to the 143 US Marine Corps personnel required to support their detachment of 12 aircraft. 1(F) Squadron despatched advanced elements, comprising the squadron's engineers, operations staff and a few pilots, to the ship on 2 June before the aircraft arrived on 4 June.<sup>128</sup>

**November-December 2010:** Four Harriers from 1(F) and 4 Squadrons RAF and 800 NAS embarked on *Ark Royal* for the final time ahead of the withdrawal from service of both Joint Force Harrier and *Ark Royal* following the Strategic Defence and Security Review.<sup>129</sup>

Following the retirement of the Sea Harrier FA2, embarked activity dropped significantly, impacting the training and number of night-qualified pilots as well as flight deck safety, efficiency and the carriers' warfighting potential. For example, at the time of the Sea Harrier retirement, 50 per cent of pilots were night capable: at the time of the withdrawal of the GR9, only four to five per cent of pilots were night-capable and they were mostly former Sea Harrier pilots.<sup>130</sup> This reduction in capability can be attributed to the decline in embarked activity, as illustrated by Exercise 'Hajjar Osprey', where only four Harriers were embarked on *Illustrious* for a period of approximately three weeks. Attaining full day and night deck qualification would typically require at least 18 months front line service.<sup>131</sup> Moreover, a lack of embarked activity would have a detrimental effect not only on the operational capability of the pilots but also on the wider ship-air interface. The credibility of the ship-air interface is critical to achieving interoperability with allies and to enable joint assets to operate from the ship; for example, although 1(F) Squadron performed admirably in the Falklands War, it could not have done so had there not been a fully worked-up and proficient ship-air interface on *Hermes* with which the Squadron could connect.<sup>132</sup>

### ***Exercise Bold Step***

Quite separate from Joint Force Harrier, Exercise 'Bold Step' took place in July 2007: This was a Joint Task Force Exercise designed to develop interoperability between US and coalition forces, centring on two US Navy Carrier Strike Groups – the *Eisenhower* and *Truman* groups (both *Nimitz*-class aircraft carriers) – and HMS *Illustrious*; up to 30 ships and 15,000 sailors and marines participated from five nations.<sup>133</sup> The exercise involved the embarkation on-board *Illustrious* of 14 US Marine Corps Harriers for two and a half weeks. This was based on a mutual training requirement emerging from the Marines having little access to enough large amphibious ships for training on, and the Royal Navy having too few aircraft to train with, and too infrequently due to the small size of Joint Force Harrier and its frequent commitment on land. During the deployment, approximately 30 pilots were qualified for embarked operations, albeit only by day. The majority of the pilots did not have sufficient consolidated embarked day experience, nor was there sufficient time available, to progress to night flying. The embarked US Marine Corps squadron demonstrated a flexibility and enthusiasm for, and were culturally wedded to, the

concept of supporting whichever capability or Command required it, and thus contributed to all roles of maritime and air warfare for which their radar-equipped AV-8Bs were suitable. Further, it demonstrated that generating an interoperable capability whereby one nation's aircraft could operate from another nation's carrier was feasible, 'if approached in a safe manner and controlled by subject matter experts with decades of corporate experience'.<sup>134</sup> That is, 'Bold Step' demonstrated that a sea-based equivalent to the close cooperation developed by NATO and other coalition forces operating from land bases such as Incirlik, Turkey, and Gioia del Colle, Italy, could be attained. The experience of 'Bold Step' emphasised that maintaining the capability to operate at sea also confers the ability to operate from a land base. The alternative, generating a sea-based capability from a land-based force, even one with a latent maritime expeditionary capability such as the US Marines, requires significantly longer. Many of the Marine pilots who embarked on *Illustrious* for 'Bold Step' were operational from land but only achieved a very basic daytime capability from the carrier in the two-and-a-half week deployment, and would require months to obtain the necessary experience to progress to a safe level of proficiency in night flying.<sup>135</sup> (The US Marine Corps approach to aviation is discussed further below.)

### **Observations**

The ability of RAF Harrier GR7s/9s to deploy on-board *Invincible*-class carriers, as with the Second World War and Falklands cases discussed above, was dependent on the existence of a fully worked-up and proficient naval-controlled ship-air interface, in particular as (again reflecting previous experience) most RAF pilots had no prior experience of embarked operations.

The irregular frequency and brief periods spent embarked at sea by RAF Harriers indicated that the level of capability that could be provided in the maritime environment by the RAF Joint Force Harrier squadrons would be limited. This is not unexpected as the RAF considered the Harrier force to be primarily a land-based capability. The demands of operations in Iraq and especially Afghanistan further reduced the time that RAF Harrier units – and after the withdrawal of the Sea Harrier, all Harrier units – spent embarked at sea. The figure from 2005 onwards of six weeks per year

embarked indicates a most basic daytime capability, with serious limits to its military credibility and hence political utility.

The decline in the number of pilots night-qualified for embarked flying, the lack of embarked experience and the focus on operations in Afghanistan turned Joint Force Harrier in its latter stages into a predominantly land-based force, despite the original intention of a more versatile, interoperable capability.

#### **(4) International Experiences**

**Argentina:** During the 1982 Falklands Conflict, Argentine Navy A-4 Skyhawks and S-2 Trackers initially operated from the Argentine Navy aircraft carrier *25 de Mayo* and subsequently operated from land bases. This followed the Argentine Navy's withdrawal to territorial waters after the sinking of the cruiser *General Belgrano*.<sup>136</sup>

**Brazil:** From 1960 to 1996, the Brazilian Navy's sole aircraft carrier, the *Minas Gerais* (a former UK *Colossus*-class ship), operated a joint air group comprising Air Force and Naval assets. The Brazilian Air Force was responsible for the operation of all military aircraft in the country at the time of the carrier's acquisition (1960); however, the Brazilian Navy also established its first operational fixed-wing unit (equipped with T-28 Trojans) to embark on the carrier.<sup>137</sup> Due to the hostility of the Brazilian Air Force to the Navy's attempts to expand its fixed-wing component, the Brazilian government in 1965 issued an edict declaring that all fixed-wing aircraft would be operated by the Air Force. From 1965 to 1996, the *Minas Gerais* embarked Air Force-operated S-2 Trackers (in the anti-submarine role) along with Navy helicopters; between 1961 and 1965, the carrier had operated the Trackers but under Naval control.<sup>138</sup> The *Minas Gerais* was retired in 2001 following the delivery of the former French *Foch* (*Clemenceau*-class) aircraft carrier. The new carrier, *Sao Paulo*, would embark fixed-wing aircraft, including fast jets with the acquisition of former Kuwaiti Air Force A-4 Skyhawks (the Skyhawk being a 1950s design originally developed for the US Navy and Marines and thus carrier-capable). The Brazilian government passed legislation in 1998 allowing the Brazilian Naval Air Arm to re-establish a fixed-wing component.<sup>139</sup>

## ***The United States***

The following is a small selection of particularly notable examples.

### Land-based aircraft operating from carriers

**The Doolittle Raid:** On 18 April 1942, 16 US Army Air Force B-25 Mitchell medium bombers launched an air raid on Tokyo. The aircraft were lifted by crane onto and were flown off the US Navy aircraft carrier *Hornet* for the operation. The mission was a one-off and one-way; the B-25s could not recover aboard the *Hornet* and were to fly on to China.<sup>140</sup>

**Central Intelligence Agency U-2 Trials/Operations from Carriers:** During the 1960s (in particular 1963 and 1969), the CIA and US Navy undertook trials of the U-2A and U-2R surveillance aircraft on-board the USS *Ranger* and *America* (*Forrestal* and *Kitty Hawk*-class carriers respectively). The purpose of the trials was to test the suitability of the aircraft for operations from Navy carriers for CIA use and also due to US Navy interest in the aircraft. The 1963 trials were principally driven by the CIA, which wanted to undertake surveillance of French nuclear tests on the Muroroa atoll. A cadre of five CIA pilots were worked-up and qualified for carrier operations. In 1969, trials were again conducted and five pilots qualified for carrier operations; however, due to the U-2's long range and in-flight refuelling capability, little use of the capability was made.<sup>141</sup>

**October-November 1963:** The US Navy considered a variant of the C-130 Hercules for the Carrier On-board Delivery role. A US Marine Corps KC-130 (tanker variant) was loaned to the Navy and undertook trials from the USS *Forrestal*; the C-2 Greyhound was eventually selected as the US Navy's dedicated aircraft for this role.<sup>142</sup>

**1972:** The US Chief of Naval Operations, Admiral Elmo Zumwalt, pursued an initiative to qualify US Air Force units on US Navy carriers; it was aborted due to there being little enthusiasm in either service.<sup>143</sup>

### Carrier-based aircraft operating ashore

**The Battle of Guadalcanal (7 August 1942 to 9 February 1943):** The initial stages of the campaign and its ultimate success depended to a significant extent on the possession by the Americans of the airfield on the island, Henderson Airfield.<sup>144</sup> The campaign began with the seizure of an incomplete Japanese airfield on Guadalcanal, which was completed by US forces and after two weeks hosted the first US combat aircraft deployed to the island. On 21 August, 19 F-4F Wildcat fighters and 12 SBD-3 Dauntless dive bombers launched from the escort carrier *Long Island* and landed at Henderson.<sup>145</sup> On 24 August, 11 dive-bombers (probably SBD-3s), short on fuel, flew in from the USS *Enterprise*.<sup>146</sup> Also on the 24<sup>th</sup>, 30 aircraft from the USS *Saratoga* deployed to Henderson after a Japanese torpedo damaged the carrier. By this time, there was a growing presence of US Navy, Marine and Army Air Force aircraft on Guadalcanal.<sup>147</sup> On 12 September, 18 F-4F Wildcats were flown off the USS *Wasp* to Henderson.<sup>148</sup> On 26 October the USS *Enterprise* was damaged during the Battle of the Santa Cruz Islands and her air group deployed ashore to Henderson Airfield.<sup>149</sup>

**From 1997:** Following the retirement of the US Air Force EF-111A *Raven* electronic warfare aircraft, the US Navy/US Marine Corps EA-6B Prowler became the only US tactical airborne electronic attack aircraft. A joint force was developed to operate from both land bases and aircraft carriers (the Prowler was already used in this manner) with the US Air Force providing some crews, including for operations from carriers.<sup>150</sup>

**1997, Exercise 'Infinite Acclaim':** Aircraft from the USS *John F. Kennedy* deployed to King Faisal Air Base, Jordan, to participate in the exercise. The detachment, comprising ten aircraft and 125 personnel including a full cadre of maintenance and support equipment, 'proved the Navy could provide the wide range of capabilities historically associated with the expeditionary operations of the Marine Corps and Air Force'.<sup>151</sup>

**March to June 1999:** During Operation 'Allied Force', the US Army deployed to Albania 'Task Force Hawk', a force of 24 AH-64 Apache attack helicopters, one Multiple Launch Rocket System battalion, two infantry battalions, one signal battalion

plus headquarters, command and control, and logistics support.<sup>152</sup> This force had a total footprint of 55 aircraft and 5,000 personnel. Due to a variety of logistical and doctrinal issues, combined with the fact that the units comprising Task Force Hawk had not habitually operated together, it contributed very little to Operation 'Allied Force'.<sup>153</sup> In contrast, the US Marine Corps deployed a detachment of 24 F/A18 Hornet fast jets to Hungary in 14 days (from initial order to deploy to undertaking combat operations), with a total of 800 Marines, including force protection – despite being only 40 miles from the Yugoslav border.<sup>154</sup> This episode suggests the value of an expeditionary mind-set.

**17 September 2005:** A detachment from VAQ-141 (a US Navy electronic attack squadron operating EA-6B Prowlers), embarked on USS *Theodore Roosevelt*, deployed to Al Asad Air Base in Iraq for a three-week period, marking the first time that carrier-based aircraft had deployed ashore to support Operation 'Iraqi Freedom'.<sup>155</sup> The deployment, originally intended as a temporary operation, became a permanent detachment over the course of the six-month deployment of the *Roosevelt* in the region, with two aircraft forward deployed to Iraq. In addition, during a port call in the United Arab Emirates, a number of F/A-18C Hornets from the carrier also deployed ashore to support operations in Iraq.<sup>156</sup>

**September-October 2006:** The USS *Enterprise* simultaneously supported Operations 'Iraqi Freedom' and 'Enduring Freedom' by detaching a number of aircraft, aircrew and maintenance personnel to Al Asad Air Base before deploying into the Gulf of Oman to provide sea-based support to operations over Afghanistan.<sup>157</sup> The detachment to Al Asad comprised nine F/A-18s together with 18 aircrew from a US Marine Corps squadron attached to the *Enterprise* air group.<sup>158</sup> The detachment of carrier aircraft ashore yielded significant operational benefits, in particular with regard to reduced reliance on air-to-air refuelling and increasing time on-station.<sup>159</sup> However, Knepper also noted that the advantages of expeditionary detachments are contingent on the availability of existing potential Forward Operating Bases, and cited the costs of using the Manas Airbase in Kyrgyzstan: "the costs have skyrocketed, tripling to more than \$60 million, which does not include \$66 million for capital improvements to the airfield." A startup [sic] effort would be cost-prohibitive and would negate any efficiencies gained by the expeditionary detachment'.<sup>160</sup>



### ***The US Marine Corps approach to air power***

US Marine Corps doctrine describes its approach to air power as follows:

Marine aviation is an integral part of the Marine air-ground task force (MAGTF). It provides the MAGTF with a complete spectrum of operational capabilities and is a flexible instrument of the MAGTF's combat power. The aviation combat element (ACE) is a powerful and versatile part of the MAGTF's combined-arms team, complementing the MAGTF's ground combat element (GCE) and combat service support element (CSSE), while functioning in consonance with the Marine Corps' doctrinal philosophy of maneuver [sic] warfare. ... Marine aviation's expeditionary character sets it apart from all other aviation organizations. The ACE's role is to project combat power, conduct air operations, and contribute to battlespace dominance in support of the MAGTF's mission, and it organizes, trains, and equips for that role. Marine aviation can operate from amphibious platforms, forward operating bases (FOBs), forward expeditionary land bases, carriers (as an integral part of carrier air groups), or any combination thereof.<sup>161</sup>

The rationale of the Marine Corps is to provide an 'expeditionary force in readiness',<sup>162</sup> configured to operate as a versatile maritime combined-arms force. Its aviation capability reflects this, consisting of both land- and sea-based fixed- and rotary-wing aircraft with the aim to 'readily transition between sea and land bases without loss of capability'.<sup>163</sup> (It is worth noting that the Corps' ability to shift from sea to land is facilitated by their significant strength in rotary-wing aircraft and also by the broader US investment in strategic lift, which are both capabilities vastly in excess of anything that the UK armed forces enjoy.) The focus on littoral manoeuvre can however result in the perception for Marine Harrier pilots embarked on the large amphibious assault ships that fixed-wing operations are secondary to amphibious and helicopter operations.<sup>164</sup> Deployment at sea, in particular on-board US Navy carriers, can be

irregular and infrequent and requires a 'complex and intense training period prior to deployment.'<sup>165</sup> This can involve a 'minimum of 3 months prior to the ship's/CVW's refresher training (RefTra) or 3 months prior to initial embarkation aboard ship for type training.'<sup>166</sup>

It is worth emphasising that the US Marine Corps is able to place greater emphasis on operating ashore precisely because they can rely on the larger and more specialist capabilities of the US Navy to deliver carrier strike in all of its roles. The picture would be quite different if the Marine Corps provided the entirety of the expeditionary air power of the United States.<sup>167</sup>

**Navy-Marine Corps Tactical Air Integration:** Since 2004, the US Department of the Navy has been developing plans to integrate US Navy and Marine tactical aviation, effectively creating a force akin to a common pool of strike fighters, enabled by the common acquisition of the F-35C, alongside the Marines F-35Bs.<sup>168</sup> A key aspect of the plan will be the assigning of Navy strike-fighter squadrons to Marine units and Marine squadrons embarking on US Navy carriers, in order to engender familiarisation between the two organisations.<sup>169</sup> Bolkcom and O'Rourke identify a potentially significant issue with the integration plan:

Marine Corps pilots are trained as infantrymen before they become pilots, so that they will better understand the battlefield needs of ground forces. As pilots, they then receive extensive training in close air support (CAS) – the mission of supporting friendly troops on the ground by attacking nearby enemy ground forces. Navy pilot training, in contrast, has traditionally focused more on air-to-air combat and on interdiction – the mission of attacking enemy forces and assets in locations away from friendly ground forces.<sup>170</sup>

**Taliban attack on Camp Bastion, Afghanistan:** The Taliban attack on the airfield at Camp Bastion on 14 September 2012 marked the 'greatest loss of US combat aircraft in a single day since the Vietnam War'.<sup>171</sup> The attack destroyed six AV-8B Harriers on the ground and significantly damaged two more – approximately six per cent of the US Marine Corps' AV-8B fleet.<sup>172</sup> The aircraft were from VMA-211, a squadron with

extensive combat experience both from land bases and from amphibious assault ships.<sup>173</sup>

### **Observations**

No country other than the UK has sought to deploy as a joint force, a maritime fixed-wing combat air capability. The Brazilian case is noteworthy as a joint air group that endured for approximately 30 years but although under Air Force ownership, the original cadre of Brazilian carrier aircrew were of a naval background. Moreover, in order to develop a carrier-borne fast jet capability, the Brazilian Navy was later granted responsibility.

The United States has consistently maintained a naval-controlled and thus proficient and agile carrier-based capability. The resources available to the US have enabled it to develop two distinct maritime air capabilities – the carrier-based aviation of the US Navy and the expeditionary capabilities of the US Marine Corps. The complementary capabilities of the US Navy and Marine Corps have formed the basis for recent US Navy interest in expeditionary detachments. The expeditionary mind-set of the Marine Corps has aided in the deployability of its forces (for example, see the ‘Allied Force’ cases).

The ability of the *Enterprise* air group to contribute effectively to two concurrent operations indicates the potential cost effectiveness of a larger carrier air group that has sufficient mass to enable expeditionary detachments. In addition, as noted with regard to the Second World War and Falklands examples, a sea-based air capability is also operational from land at no additional cost.

---

<sup>1</sup> This paper was published as Tim Benbow, *Corbett Paper No.9: British Uses of Aircraft Carriers and Amphibious Ships 1945-2010* (Corbett Centre for Maritime Policy Studies, March 2012); it is available online:

<http://www.kcl.ac.uk/sspp/departments/dsd/research/researchgroups/corbett/corbettpaper9.pdf>

<sup>2</sup> Evidence for this argument can be found in the Second World War, in the poor performance of Bomber Command aircraft that were temporarily switched to maritime roles, in comparison with the dedicated and specialised forces of Coastal Command.

<sup>3</sup> An abundance of recent historical examples of cases where land bases were not available, overflight was denied, and carriers were particularly useful, can be found in *Corbett Paper No.9*, cited above.

<sup>4</sup> According to Tobias Ellwood, whose study drew on unpublished material from the Ministry of Defence, forward basing of aircraft during the Libya campaign cost the UK as much as £100 million. In comparison, the *annual* cost of running one of the *Queen Elizabeth*-class carriers will be £65 million

(which he compares favourably to the £144 million annual cost of running a single air base, RAF Marham). He also cites MoD evidence that at a distance of 600 miles, land-based air costs four times as much as carrier-based air. Tobias Ellwood MP, *Leveraging UK Carrier Capability: A Study into the Preparation for and Use of the Queen Elizabeth-Class Carriers*, RUSI Occasional Paper (London: RUSI, September 2013), pp.3-4, 23. Available at:

<http://www.rusi.org/publications/occasionalpapers/ref:O522DC005BE8DC/>.

<sup>5</sup> It is a revealing sign of desperation when the carrier sceptic suggests that the ship would be vulnerable in a total war against China. While true, if adopted as a general criterion for military capabilities, very few would pass muster – certainly not static air bases stationed within range of China's air power or ballistic missiles.

<sup>6</sup> The Secretary of State for Defence, in a speech in November 2012, stressed the ability of the carrier 'to deliver a joint force that can operate from land bases in the UK, from the carriers when they are at sea, and from forward operating bases when deployed abroad.' Yet he also gave a strong indication that British policy is leaning towards the carrier-based model, adding: 'When deployed outside home waters, the new Carrier will routinely have Lightning II jets embarked with personnel from both Services.' Secretary of State for Defence, keynote speech at the RUSI Chief of the Air Staff Air Power Conference, 2 November 2012, emphasis original; available at:

<http://www.rusi.org/events/past/ref:E4FD1FBD632AE1/info:public/infoID:E50928BCE62C1D/#.UJMSY46BjvY>

<sup>7</sup> It is also the minimum standard expected of close allies with whom the UK is likely to become increasingly interoperable – which is becoming more demanding in what it entails, going well beyond mere deconfliction, if seamlessly integrated operation is to be achieved and if the full potential benefits are to be realised.

<sup>8</sup> It is sometimes suggested that afloat basing can erode the wider combat air skills of the air crews. First, historical and contemporary performance of carrier-based aircraft versus that of land-based aircraft provides no empirical support for this contention. Second, it is easier for a carrier-capable air group to maintain these broader skills than for a land-based air group to become proficient in operations afloat.

<sup>9</sup> A recent research paper by an MP strongly recommended that 'the carrier-based F-35 capability (including training, doctrinal development and manpower support) will be provided by a single service (the Royal Navy).' He also urged that both of the carriers should be commissioned and operated, rather than seeing one of the brand new ships immediately mothballed. Ellwood, *Leveraging UK Carrier Capability*, p.31. The author was previously Parliamentary Private Secretary to the previous defence secretary, Liam Fox and is a former Army officer (still serving in the reserves).

<sup>10</sup> The Ellwood paper cited above makes a convincing case that any future batch of F-35 aircraft should also be the B-variant, to maximise the force capable of operation from the carriers, rather than the land-based A-variant. Ellwood, *Leveraging UK Carrier Capability*, p.19. Moreover, in addition to needlessly reducing flexibility, given its limited commonality with the B-variant, any purchase of the A-variant would expensively add an additional aircraft type to the UK fleet, thus violating one of the principles turned against the Harrier in the 2010 SDSR.

<sup>11</sup> For this period, see Geoffrey Till, *Air Power and the Royal Navy 1914-1945* (London: Janes, 1979); also S.W. Roskill, *Naval Policy Between the Wars, Volume I: The Period of Anglo-American Antagonism 1919-1929* (London: Collins, 1968) and *Naval Policy Between the Wars, Volume II: The Period of Reluctant Rearmament 1930-39* (London: Collins, 1976).

<sup>12</sup> For an excellent account of the problems caused by the split control system – which had a serious detrimental effect on the capabilities of RAF Coastal Command as well as those of the Fleet Air Arm – see Christina M. Goulter, *A Forgotten Offensive: Royal Air Force Coastal Command's Anti-Shipping Campaign, 1940-1945* (London: Frank Cass, 1995).

<sup>13</sup> Till, *Air Power and the Royal Navy*, p.20.

<sup>14</sup> Denis Richards, *Royal Air Force 1939-1945, Volume 1: The Fight At Odds* (London: Her Majesty's Stationery Office, 1953), p.89. On this occasion 18 Gladiators flew off *Glorious*, with a Fleet Air Arm Skua leading; *Ibid.*, p.91.

<sup>15</sup> *Ibid.*, p.92.

<sup>16</sup> *Ibid.*, pp.98-99.

<sup>17</sup> *Ibid.*, p.103.

<sup>18</sup> *Ibid.*, pp.103-104.

<sup>19</sup> Till, *Air Power and the Royal Navy*, p.26.

<sup>20</sup> Winston S. Churchill, *The Second World War, Volume I: The Gathering Storm* (London: Cassell, 1948), pp.586-92.

<sup>21</sup> Richards, *Royal Air Force, Vol.1*, pp.267-268.

---

<sup>22</sup> *Ibid.*, p.263.

<sup>23</sup> *Ibid.*, p.264.

<sup>24</sup> *Ibid.*, p.306. The source does not disclose the number of aircraft flown off in this case but does state it allowed an additional squadron to be established. It also refers to the arrival earlier in the month of another 12 Hurricanes but does not state whether those were flown off a carrier.

<sup>25</sup> Denis Richards and Hilary St. George Saunders, *Royal Air Force 1939-1945, Volume II: The Fight Avails* (London: Her Majesty's Stationery Office, 1954), p.194.

<sup>26</sup> *Ibid.*, p.196.

<sup>27</sup> *Ibid.*, p.204.

<sup>28</sup> Ben Jones, 'The Fleet Air Arm and the Struggle for the Mediterranean, 1940-44' in Tim Benbow (ed.), *British Naval Aviation: The First 100 Years* (Farnham: Ashgate, 2011), p.86.

<sup>29</sup> The National Archives, Kew: DO(41)35<sup>th</sup> Meeting, 27 May 1941, CAB69/2.

<sup>30</sup> Till, *Air Power and the Royal Navy*, p.177.

<sup>31</sup> Richards and St. George Saunders, *Royal Air Force, Vol.II*, p.78.

<sup>32</sup> *Ibid.*

<sup>33</sup> *Ibid.*, pp.43-44.

<sup>34</sup> *Ibid.*, p.49.

<sup>35</sup> *Ibid.*, pp.70-71.

<sup>36</sup> This list only includes aircraft that were carrier-capable, e.g. Swordfish, Albacore.

<sup>37</sup> Till, *Air Power and the Royal Navy*, p.16.

<sup>38</sup> *Ibid.*, pp.27-28.

<sup>39</sup> 'Fleet Air Arm in the Battle of Britain', fact sheet published by the Fleet Air Arm Officers' Association (2009); available online at <http://fleetairarmoa.org/Content/sites/FLEET AIR ARMOA/pages/178/FLEET AIR ARM amp BoB.PDF>.

<sup>40</sup> *Ibid.*

<sup>41</sup> Jones, 'The Fleet Air Arm and the Struggle for the Mediterranean', p.90.

<sup>42</sup> See *Ibid.*, p.84; and Correlli Barnett, *Engage the Enemy More Closely: The Royal Navy in the Second World War* (London: Penguin Books, 2001), pp.334-345 for an account of the Battle of Cape Matapan and p.352 for Fleet Air Arm and RAF aircraft based at Maleme.

<sup>43</sup> See Jones, 'The Fleet Air Arm and the Struggle for the Mediterranean', p.92 for a useful summary.

<sup>44</sup> 'Fleet Air Arm History', Fleet Air Arm Officers' Association, <http://fleetairarmoa.org/fleet-air-arm-history-timeline>, accessed 17 September 2012.

<sup>45</sup> Richards and St. George Saunders, *Royal Air Force, Vol.II*, p.74.

<sup>46</sup> Jones, 'The Fleet Air Arm and the Struggle for the Mediterranean', p.91.

<sup>47</sup> Stephen Roskill, *The War at Sea 1939-1945, Vol.III Part 1* (London: HMSO, 1960), p.93.

<sup>48</sup> *Ibid.*, p.287.

<sup>49</sup> The National Archives, Kew: Chief of the Air Staff to First Sea Lord, 21 June 1944, AIR8/1458.

<sup>50</sup> Hilary St. George Saunders, *Royal Air Force 1939-1945, Volume III: The Fight is Won* (London: Her Majesty's Stationery Office, 1954), p.413.

<sup>51</sup> Eric Grove, *Vanguard to Trident: British Naval Policy Since World War II* (London: The Bodley Head, 1987), p.362.

<sup>52</sup> Rodney A. Burden et al., *Falklands: The Air War* (London: Arms and Armour Press, 1986), p.371.

<sup>53</sup> Grove, *Vanguard to Trident*, p.319.

<sup>54</sup> The data that follow are taken from the diary of Air Chief Marshal Sir Peter Squire (then Wing Commander and officer commanding No. 1. Squadron), 'The Harrier Goes to War', available online at <http://www.raf.mod.uk/history/TheHarrierGoestoWar.cfm>, and specifically 'Harrier Diary 1', <http://www.raf.mod.uk/history/HarrierDiary1.cfm>.

<sup>55</sup> *Ibid.*

<sup>56</sup> *Ibid.*

<sup>57</sup> Burden et al., p.372.

<sup>58</sup> See *Ibid.*, also Squires, 'Harrier Diary 1', <http://www.raf.mod.uk/history/HarrierDiary1.cfm>.

<sup>59</sup> Burden et al., p.372.

<sup>60</sup> Air Chief Marshal Sir Peter Squire, 'Harrier Diary 3', <http://www.raf.mod.uk/history/HarrierDiary3.cfm>.

<sup>61</sup> Grove, *Vanguard to Trident*, p.372.

<sup>62</sup> Squire, 'Harrier Diary 2'.

<sup>63</sup> Squire, 'The Harrier Goes to War'.

<sup>64</sup> DCDC, 'Joint Operations – Lessons from the Falklands Campaign', 20 January 2009, p.3.

<sup>65</sup> Paragraph based on Lawrence Freedman, *The Official History of the Falklands Campaign, Volume II: War and Diplomacy* (Abingdon: Routledge, 2005), p.540.

<sup>66</sup> Burden et al., p.202.

- 
- <sup>67</sup> 'Andy Auld' in John Godden (ed.), *Harrier: Ski-jump to Victory* (Oxford: Brassey's Defence Publishers, 1983), p.61.
- <sup>68</sup> *Ibid.*
- <sup>69</sup> Burden et al., p.202.
- <sup>70</sup> 'Andy Auld', pp.61-62.
- <sup>71</sup> *Ibid.*, p.89.
- <sup>72</sup> Burden et. al., p.204.
- <sup>73</sup> See Commander 'Sharkey' Ward, *Sea Harrier over the Falklands* (London: Cassell, 2000), pp.323-325.
- <sup>74</sup> Burden et al., p.380.
- <sup>75</sup> *Ibid.*, pp.228-229.
- <sup>76</sup> *Ibid.*, p.227.
- <sup>77</sup> *Ibid.*
- <sup>78</sup> DCDC, 'Joint Operations – Lessons from the Falklands Campaign', p.6; emphasis added.
- <sup>79</sup> *Ibid.*
- <sup>80</sup> Rear Admiral Sir Iain Henderson CBE, 'My Jobs: Joint Force Harrier Commander', *The RUSI Journal*, Vol.145 No.3 (June 2001), pp.21-27.
- <sup>81</sup> Patrick Allen, 'Air Ex: Ocean Wave 97', *Air Forces Monthly*, No.110 (May 1997), pp.15-19.
- <sup>82</sup> John Roberts, *Safeguarding the Nation: The Story of the Modern Royal Navy* (Barnsley: Seaforth Publishing, 2009), p.240. Also see Roy Clare, 'The UK CVSG in Joint Operations – Up-Front, Up-Tempo and Up to Date', *The Naval Review*, Vol.85 No.4 (October 1997), pp.318-321.
- <sup>83</sup> Allen, 'Air Ex: Ocean Wave 97', p.19.
- <sup>84</sup> *Ibid.*
- <sup>85</sup> Roberts, *Safeguarding the Nation*, p.244.
- <sup>86</sup> *Ibid.*, pp.244-245.
- <sup>87</sup> *Ibid.*, p.245.
- <sup>88</sup> Captain James Burnell-Nugent Royal Navy, 'HMS *Invincible* and Operation Bolton – A Modern Capability for a Modern Crisis', *The RUSI Journal*, Vol.143 No.4 (August 1998), pp.19-26.
- <sup>89</sup> *Ibid.*
- <sup>90</sup> *Ibid.*
- <sup>91</sup> Roberts, *Safeguarding the Nation*, p.246.
- <sup>92</sup> *Ibid.*, p.258.
- <sup>93</sup> 'Joint Operations', *Supporting Essay Eight* in Ministry of Defence, *The Strategic Defence Review*, Cm 3999 (London: The Stationery Office, 1998), p.199.
- <sup>94</sup> Flight Lieutenant Will Dole RAF, 'Joint Force 2000 – Making it Happen', *Warship World*, Vol.6 No.10 (Spring 2000), p.8.
- <sup>95</sup> See *Ibid.*, and Henderson, 'My Jobs: Joint Force Harrier Commander'.
- <sup>96</sup> Roberts, *Safeguarding the Nation*, p.260.
- <sup>97</sup> Richard Scott, 'Flexing Joint Muscle', *Jane's Defence Weekly*, Vol.34 No.6 (9 August 2000), pp.24-27.
- <sup>98</sup> *Ibid.*
- <sup>99</sup> Group Captain Andy Gollege, 'Operations in the Harrier GR7', *RAF Historical Society Journal* (No. 35A, 'The Harrier Story', 2006), pp. 93-100, available online: <http://www.rafmuseum.org.uk/documents/Research/RAF-Historical-Society-Journals/Journal-35A-Seminar-the-RAF-Harrier-Story.pdf>.
- <sup>100</sup> Interview with Commander Henry Mitchell Royal Navy, 1 August 2012. At the time of Operation *Palliser*, Commander Mitchell was commanding officer of 801 NAS.
- <sup>101</sup> Rear Admiral Iain Henderson CBE, 'Britain's Harriers Join Forces', *Defence Management Journal*, Vol.3 No.4 (Summer 2001), pp.28-30.
- <sup>102</sup> Commodore Bill Covington, 'The Joint Force Harrier Concept', *RAF Historical Society Journal* (No. 35A, 'The Harrier Story', 2006), p. 100-106. Cdre Covington held a number of positions, including commanding officer of 801 NAS, Commander (Air) on HMS *Illustrious*, Commodore Joint Force 2000 and Senior Naval Officer at HQ Strike Command.
- <sup>103</sup> Roberts, *Safeguarding the Nation*, p.265.
- <sup>104</sup> Nick Childs, *The Age of Invincible: The Ship that Defined the Modern Royal Navy* (Barnsley: Pen & Sword Maritime, 2009), p.152.
- <sup>105</sup> RAF 4 Squadron, <http://www.raf.mod.uk/organisation/4squadron.cfm>.
- <sup>106</sup> Richard Scott, 'Striking Back', *Jane's Defence Weekly*, Vol.42 No.11 (16 March 2005), pp.28-30.
- <sup>107</sup> *Ibid.*
- <sup>108</sup> *Ibid.*



<sup>109</sup> *Ibid.*

<sup>110</sup> Roberts, *Safeguarding the Nation*, p.298.

<sup>111</sup> *Ibid.*, pp.293, 312.

<sup>112</sup> Commander Ade Orchard Royal Navy with James Barrington, *Joint Force Harrier* (London: Penguin Books, 2009), p.16.

<sup>113</sup> An account of this deployment, from the perspective of the officer commanding 800 NAS, can be found in *Ibid.*

<sup>114</sup> Roberts, *Safeguarding the Nation*, p.316.

<sup>115</sup> Orchard, *Joint Force Harrier*, p.286.

<sup>116</sup> Roberts, *Safeguarding the Nation*, pp.324-325.

<sup>117</sup> Orchard, *Joint Force Harrier*, p.285.

<sup>118</sup> Roberts, *Safeguarding the Nation*, p.329.

<sup>119</sup> *Ibid.*, pp.329-330.

<sup>120</sup> 'Harrier Drops Paveway IV in Afghanistan...' *Air Forces Monthly*, No.251 (February 2009), p.5.

<sup>121</sup> RAF IV Squadron, [http://www.raf.mod.uk/organisation/IVSquadron\(R\).cfm](http://www.raf.mod.uk/organisation/IVSquadron(R).cfm), accessed 21 September 2012; also Gareth Jennings, 'UK Harrier Fleet Retires Four Months Early', *Jane's Defence Weekly*, Vol.47, No.51 (22 December 2010), p.32.

<sup>122</sup> Swedish Armed Forces, 'A Floating Air Base', 13 June 2009, <http://www.forsvarsmakten.se/en/About-the-Armed-Forces/Exercises/Completed-exercises-and-events/Loyal-Arrow-20092/News/More-than-a-floating-runway/>, accessed 21 September 2012; also Swedish Armed Forces, 'About Loyal Arrow', <http://www.forsvarsmakten.se/en/About-the-Armed-Forces/Exercises/Completed-exercises-and-events/Loyal-Arrow-20092/More-about-Loyal-Arrow/>, accessed 21 September 2012.

<sup>123</sup> Sqn Ldr Paula Willmot, 'Harriers and Auriga', *Key.Aero*, 23 July 2010, [http://www.key.aero/view\\_feature.asp?ID=61&thisSection=military](http://www.key.aero/view_feature.asp?ID=61&thisSection=military), accessed 21 September 2012.

<sup>124</sup> <http://fleetairmoa.org/fleet-air-arm-history-timeline>

<sup>125</sup> Ministry of Defence, 'HMS Ark Royal sets sail for Atlantic exercises', 8 April 2010, <http://www.mod.uk/DefenceInternet/DefenceNews/TrainingAndAdventure/HmsArkRoyalSetsSailForAtlanticExercises.htm>, accessed 21 September 2012.

<sup>126</sup> 'HMS Ark Royal Welcomes 1(F) Joint Force Harrier Squadron to Auriga Task Group', [http://webarchive.nationalarchives.gov.uk/20101208171809/http://www.royalnavy.mod.uk/operations-and-support/surface-fleet/type-23-frigates/hms-sutherland/news/hms-ark-royal-welcomes-1\(f\)-joint-force-harrier-squadron-to-auriga-task-group/index.htm](http://webarchive.nationalarchives.gov.uk/20101208171809/http://www.royalnavy.mod.uk/operations-and-support/surface-fleet/type-23-frigates/hms-sutherland/news/hms-ark-royal-welcomes-1(f)-joint-force-harrier-squadron-to-auriga-task-group/index.htm), accessed 21 September 2012.

<sup>127</sup> *Ibid.*

<sup>128</sup> Willmot, 'Harriers and Auriga'.

<sup>129</sup> David Oliver, 'UK Harriers Make Last Flights off Ark Royal', *Jane's Defence Weekly*, Vol.47 No.48 (1 December 2010), p.32.

<sup>130</sup> Interview with Commander Mitchell.

<sup>131</sup> Rear Admiral Scott Lidbetter, 'Joint Force 2000 – On Track or Coming off the Rails?', *The Naval Review*, Vol.91 No.4 (November 2003), pp.349-353.

<sup>132</sup> DCDC, 'Joint Operations –Lessons from the Falklands Campaign', p.3.

<sup>133</sup> 'JTFEX 07-02 "Operation Bold Step" Proves Interoperability', 1 August 2007, [http://www.navy.mil/submit/display.asp?story\\_id=30900](http://www.navy.mil/submit/display.asp?story_id=30900), accessed 21 September 2012.

<sup>134</sup> Interview with Commander Mitchell.

<sup>135</sup> Much of this paragraph is based on the observations of Commander Henry Mitchell, who was Commander (Air) on HMS *Illustrious* during Exercise *Bold Step*.

<sup>136</sup> See Burden et al., pp.39-43 and 49-50 for discussion of Argentine Navy A-4 and S-2 operations during the Falklands War.

<sup>137</sup> Thomas Newdick, *Carrier Aircraft: 1917-Present* (London: Amber Books, 2011), p.63.

<sup>138</sup> *Ibid.*, pp.64-65.

<sup>139</sup> *Ibid.*, p.152.

<sup>140</sup> Frank Uhlig, Jr., *How Navies Fight: The U.S. Navy and Its Allies* (Annapolis: Naval Institute Press, 1994), p.206; and United States Naval History and Heritage Command, 'Doolittle Raid on Japan, 18 April 1942', <http://www.history.navy.mil/photos/events/wwii-pac/misc-42/dooltl.htm>, accessed 25 September 2012.

<sup>141</sup> The above paragraph is based on the account in Jay Miller, *Lockheed Martin's Skunk Works: The Official History* (Leicester: Midland Publishing, 1995), pp.87, 93-94 and 100.

<sup>142</sup> Patuxent River Naval Air Museum Association, 'C-130 Carrier Trials in 1963', <http://paxmuseum.com/video/c130-hercules-carrier-trials>, accessed 25 September 2012.

- 
- <sup>143</sup> Peter M. Swartz with Karin Duggan, 'U.S. Navy-U.S. Air Force Relationships 1970-2010', (CNA, MISC D0024022.A4/1Rev, June 2011), p.30. Available online via the Defense Technical Information Center, [www.dtic.mil](http://www.dtic.mil).
- <sup>144</sup> *Ibid.*, p.374.
- <sup>145</sup> Colin Bruce, 'Guadalcanal: Operation WATCHTOWER, August 1942', in Lt Cdr Tristan Lovering Royal Navy, *Amphibious Assault: Manoeuvre from the Sea* (Royal Navy, 2006), pp.145-158.
- <sup>146</sup> Uhlig, *How Navies Fight*, p.216.
- <sup>147</sup> *Ibid.*, p.217.
- <sup>148</sup> *Ibid.*
- <sup>149</sup> Bruce, 'Guadalcanal: Operation WATCHTOWER, August 1942', pp.155-156.
- <sup>150</sup> *Ibid.*, p.63.
- <sup>151</sup> Commander Gregory D Knepper United States Navy, 'Breaking the Paradigm of Carrier Based Operations: Carrier Air Wing Expeditionary Detachments in Support of Phase IV Stabilization and Phase V Enabling Civil Authorities', (Research Paper, Department of Joint Military Operations, Naval War College, Rhode Island, 2010) [Available online via [www.dtic.mil](http://www.dtic.mil)], p.3.
- <sup>152</sup> Colonel Gary P. Shaw United States Marine Corps, 'Operation Allied Force: Case Studies in Expeditionary Aviation – USAF, USA, USN, and USMC', (US Army War College Strategy Research Project, 2002), p.12.
- <sup>153</sup> *Ibid.*, pp.13 and 16.
- <sup>154</sup> *Ibid.*, p.15.
- <sup>155</sup> Knepper, 'Breaking the Paradigm of Carrier Based Operations', p.1.
- <sup>156</sup> *Ibid.*
- <sup>157</sup> *Ibid.*, p.4.
- <sup>158</sup> Lieutenant Commander Richard M. Kelly United States Navy, 'Naval Expeditionary Air Power, A Justified Capability', (Research Paper, Department of Joint Military Operations, Naval War College, Rhode Island, 2007) [Available via [www.dtic.mil](http://www.dtic.mil)], p.6.
- <sup>159</sup> See Knepper, 'Breaking the Paradigm of Carrier Based Operations', pp.8-12.
- <sup>160</sup> *Ibid.*, p.13.
- <sup>161</sup> US Marine Corps, *Aviation Operations*, MCWP 3-2, p.1-1.
- <sup>162</sup> *Ibid.*, Foreword.
- <sup>163</sup> *Ibid.*, pp.2-15.
- <sup>164</sup> Vago Muradian, "'Lusty" is a refined carrier, U.S. pilots say', *Navy Times*, 5 August 2007, [http://www.navytimes.com/news/2007/08/navy\\_lustymain\\_070805/](http://www.navytimes.com/news/2007/08/navy_lustymain_070805/), accessed 25 September 2012.
- <sup>165</sup> Headquarters United States Marine Corps, 'Deployment of Marine Corps Aviation Units on Aircraft Carriers; Preparation for', MCO 3500.18 W/CH 1, 20 August 2004 (originally promulgated 27 February 1984), p. 1, available online: <http://www.marines.mil/news/publications/Documents/MCO%203500.18%20W%20CH%201%20AND%20ERRATUM.pdf>.
- <sup>166</sup> *Ibid.*, p. 3.
- <sup>167</sup> This argument suggests the main flaw in the suggestion that is occasionally made that the UK armed forces should model themselves on the US Marine Corps. While this institution is an admirable one and capable of conducting independently a wide range of operations, its design, structure, capabilities and equipment are all predicated on the fact that it is one among four services, not the only one, and relies for many capabilities and complementary assets on the US Navy, US Army and US Air Force.
- <sup>168</sup> See Christopher Bolkcom and Ronald O'Rourke, 'Navy-Marine Corps Tactical Air Integration Plan: Background and Issues for Congress', *CRS Report for Congress* RS21488, 10 April 2003; and Chinara Lucas, 'SECNAV, CNO, CMC Sign MOU to Join Navy, Marine Corps Forces', *Navy.mil*, 14 March 2011, [http://www.navy.mil/Submit/display.asp?story\\_id=59083](http://www.navy.mil/Submit/display.asp?story_id=59083), accessed 25 September 2012.
- <sup>169</sup> Bolkcom and O'Rourke, 'Navy-Marine Corps Tactical Air Integration Plan', p.2.
- <sup>170</sup> *Ibid.*, p.4.
- <sup>171</sup> Peter Felstead, 'Bastion Attack Leaves ISAF Rethinking Security', *Jane's Defence Weekly*, Vol.49 No.39 (26 September 2012), p.4.
- <sup>172</sup> *Ibid.*
- <sup>173</sup> 'Marine Attack Squadron 211', <http://www.3maw.usmc.mil/external/3dmaw/mag13/vma211/history/history.jsp>, accessed 25 September 2012.



*The Corbett Centre for Maritime Policy Studies  
aims to promote the understanding and analysis of  
maritime history and policy and to provide a forum  
for the interaction of academics, policy-makers  
and practitioners.*

**Corbett Papers**

Series Editor  
Dr Martin Robson

Editorial Assistant  
James Bosbotinis

**Editorial Board**

Professor Geoff Till  
Professor Greg Kennedy  
Dr Jon Robb-Webb  
Dr Tim Benbow  
Dr Andrew Gordon

The Corbett Centre for Maritime Policy Studies  
Defence Studies Department  
Joint Services Command and Staff College  
Defence Academy of the United Kingdom,  
Shrivenham, Swindon, SN6 8LA, United Kingdom

**Email:** [corbettcentre.jscsc@defenceacademy.mod.uk](mailto:corbettcentre.jscsc@defenceacademy.mod.uk)

**Copies of previous Corbett Papers are available from:**  
[www.kcl.ac.uk/schools/sspp/ws/research/groups/ccmps](http://www.kcl.ac.uk/schools/sspp/ws/research/groups/ccmps)