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The Royal Air Force *Air Power Review* is published under the auspices of the Director of Defence Studies (RAF) and has the sponsorship of the Assistant Chief of the Air Staff. It is intended to provide an open forum for study, which stimulates discussion and thought on air power in its broadest context. This publication is also intended to support the British armed forces in general and the Royal Air Force in particular with respect to the development and application of air power.

Contributions from both Service and civilian authors are sought which will contribute to existing knowledge and understanding of the subject. Any topic will be considered by the Air Power Review Management Board and a payment of £200 will be made for each article published.

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Foreword

As you will undoubtedly have noticed by now — *Air Power Review* has a new cover. The decision to alter the format was not taken lightly, but it is hoped that the revised design will provide just as recognisable an identity as the previous version, but with the added benefit of fitting more neatly with the other professional journals on library shelves, and also enabling readers to see items of interest before opening it up. However, this does not mean any alteration to the standards expected for our articles, so you can still expect to see the same high quality of air power thinking in future editions, although you may see some further experimentation with regard to content during the rest of the year.

In terms of the content for this edition, we begin with a highly topical piece by Wing Commander Harv Smyth who, under the title of *From Coningham to Coningham-Keyes* addresses the often thorny issue of air-land operations. His contention is that when the British Army and RAF realised in 2003 that their ability to conduct properly integrated air-land operations in Iraq was inadequate, this did not in fact represent dealing with a new problem, but instead the re-learning of lessons which had been first discovered in North Africa during the Second World War. Although much has improved since then, and considerable activity is still underway to enable 'danger-close' CAS with a much higher degree of confidence on both sides, it is an important reminder of our frequent ability to forget lessons that have been learnt by our predecessors, often at considerable cost in terms of lives. This is not an easy circle to square, as much previous experience shows, but it is one where we have to do better — and the increasing emphasis on air power education may well be part of a longer-term solution.

Another contemporary issue is addressed in *A Frontier Too Far* by Wing Commander Johnny Stringer, who looks at the often vexed issues surrounding the weaponization of space from an American strategic perspective. The recent destruction by China of one of its old weather satellites in orbit via interception from a ground launched missile, together with Iran's claim to have launched a payload into space provide obvious examples of why America might well believe that this particular subject needs to be reconsidered, and this article provides a useful lead-in with regard to both the terminology and major areas of concern. Whilst concluding that current threats do not provide an immediate imperative for such action, it does act as a timely reminder of how dependent not just the USA, but also most Western countries are on continued American space superiority. It also cogently reinforces the "pressing need for a rational and considered debate regarding the weaponization of space", which is certainly a topic that RAF officers should have an interest in — and could quite rightly be expected to proffer an intelligent opinion on.

The first of this edition's historical papers is by Mr Paul Graham, and his article on the RAF's strategic nuclear deterrent — *The Unsteady Sword*— provides a useful and fascinating potted history of a part of our heritage which many today within the Service are sadly unaware of. The article is based upon an MA dissertation by the author, carried out under the auspices of the University of Salford's post-graduate course in International History and Intelligence, and provides an overview of the entire programme from initiation in 1947 through to the handover of responsibility for the strategic nuclear deterrent to the Royal Navy in 1969. What does come through is the tremendous scale of the undertaking, which comprised everything from the design, production and testing of the weapons themselves, as well as the delivery systems (the 'V' bomber force), and the complex infrastructure that was required to maintain the fleet at the highest degree of readiness which the RAF ever operated at in peacetime. A number of prescient observations make this a useful background article to accompany the current political debate on the replacement of our current strategic nuclear deterrent.

We return to current issues with Wing Commander Andy Myers, in his consideration of *The Legal and Moral Challenges Facing the 21st Century Air Commander.* This addresses an area which is likely to become of greater importance to us as a Service in the future, namely the use of unmanned systems within a relatively conventional air campaign. Based around a fictitious, but highly believable, scenario, carefully chosen to enable a number of key issues to be examined in a clear and straightforward manner, it looks at some of the problems that will have to be faced up to if the full potential of unmanned combat air vehicles (UCAVs) is to be made available to operational commanders in future years. As the author cogently points out, given the long timelines associated with the development of airborne platforms at the high-tech end of the market, the need for a mature debate on the legal and moral implications of operating UCAVs is very much in the present, as arguably that debate will shape how such systems will be able to operate.

The next piece returns to a historical theme, with an examination by Wing Commander Rob O'Dell of the part that *electronic warfare (EW)* played in the strategic bomber offensive of the Second World War. This is an area that is under-represented in historical study, and it not only presents a fascinating insight into the breadth and depth of the British EW programme during the war, but also makes strong case for the part that this programme played in defeating Germany's air defence (AD) systems. It is broad in nature, covering all aspects from navigation equipment and radar aids, through signals, communication and electronic intelligence gathering to radio counter measures, and also includes aspects such as post-war trials involving the use of the entire German AD system in Denmark against the suite of EW systems available to the RAF at that time. Furthermore it is also highly readable, which is not always the case when examining such technical subjects.

The last item in this edition is, fittingly enough, the first of a new series comprising extended book reviews for 'historic' air power publications. There are a number of books which hold a particular place in air power history — because of the ideas that they introduced, or the insights that they give us into our predecessors as airmen across the globe — but which are out of print and can therefore be difficult for anyone without access to a good library to obtain and read. These extended book reviews therefore aim to place both the writer and the book in context, as well as providing a flavour of the content and some analysis. The first of these is *Maurice Baring's RFC Headquarters 1914-1918*, which is one of the few books to shed light on Trenchard's character, written by an individual who knew him extremely well. Feedback is of course always welcome from readers, whether in relation to this particular initiative, the changes in layout, or any other matters pertaining to the journal.

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From Coningham to Project Coningham-Keyes

Did British Forces Relearn Historical Air-land Co-operation Lesssons During Operation TELIC?

By Wg Cdr Harv Smyth RAF

Introduction

Operation TELIC, the UK's contribution to Operation IRAQI FREEDOM, the conflict to liberate Iraq, lasted from 20 March to 22 April 2003.[1] Although Coalition forces emerged victorious, in approximately one month of warfighting the UK military exposed serious inadequacies in its ability to conduct, and understanding of, air-land co-operation. After TELIC, Air Vice Marshal Torpy, the UK's Air Component Commander (ACC) for the Operation, commented that, 'There is no doubt that we need to do more air-land integration. I believe there are lots of lessons that we have learned out of this particular campaign in terms of the core skill that air-land integration should form for all our fast jet aircraft'[2].

Although British aviators have been providing air-support to ground forces since World War 1 (WW1), there were still many mistakes made in this domain during TELIC. This paper asks the question, 'did we relearn historical air-land co-operation lessons?' To answer this, a comparative study will be completed between the North African Campaign of World War 2 (WW2), arguably the birthplace of true air-land co-operation, and TELIC. This comparison is relevant for 3 main reasons. Firstly, both campaigns were fought over similar desert terrain; therefore, lessons pertaining to operating environment can be discounted. Secondly, British forces entered each campaign ill prepared to conduct air-land operations. Finally, air-support doctrine utilised in TELIC was effectively identical to that developed in North Africa, since technology has had minimal impact upon contemporary British air-support methodologies.

A chronological examination of the North African Campaign will draw out the key British air-land lessons learnt, and demonstrate how these lessons were addressed. Briefly, the British successfully implemented 2 key enablers, which provided the springboard for successful air-land operations: gaining control of the air and centralised command of air-support assets. However, with specific regard to the implementation of air-land operations, 3 significant areas were lacking: command and control (C2) structures; training and doctrine; and tactical level situational awareness. During TELIC, British forces achieved identical successes and failures in the air-support arena to those of North Africa. Hence, it can be determined that British forces operating in Iraq in 2003, did relearn historical air-land lessons.

What Is It?

Current doctrine lists Anti-Surface Force Air Operations (ASFAO, or generically, air-support) as a core capability of airpower and defines it as either direct or indirect air operations that may be employed in the air-land environment. Indirect air operations are those intended to disrupt and destroy an opponent's military assets and infrastructure in the rear area whereas direct air operations are those intended to directly affect the outcome of a contact engagement between friendly and opposing forces. Direct air operations against an opposing force are normally conducted under the procedures for Close Air Support (CAS), which is defined as, 'air action against hostile targets that are in close proximity to friendly forces, and requires detailed integration of each mission with the fire and movement of those forces'[3]. During TELIC, the British implementation of CAS was most lacking.

Why Study It?

In 1943 General Montgomery stated, 'If you can knit up the power of the Army on the land and the power of the air in the sky then nothing will stand against you and you will never lose a battle'[4]. In contemporary warfare, the success of airpower in providing day, night, adverse-weather, precision air-support for ground forces has convinced Army leadership that it can make its forces more deployable and agile by reducing its own organic fire support, such as artillery, and relying more heavily on airpower.[5] This was reflected in Iraq in 2003: of 19,898 targets struck, over 15,000 were through CAS missions.[6] Moreover, as British forces suffer from defence cuts, it has become necessary for components to add weight of effort to the joint scheme of manoeuvre in order to maintain capability. All components operating in this joint arena must have a common understanding of each other's doctrine if agility (both in command and execution), tactical synergy and exponential capability are to be achieved. Integrated Air Operations, of which air-support is a part, is one of the 6 core air and space power roles; hence, it must be studied and understood.[7]

Since the end of the Cold War, there have been few real-world opportunities to test air-land co-operation within conventional operations.[8] Cold War joint air-land organisations, such as developed in 1 BR Corps in West Germany, were disbanded in the mid 1990s and not replaced. Hence, as stated by Air Vice Marshal Torpy after TELIC, '…we have forgotten some of the things we were quite good at during the Cold War…we have neglected the exercising of those [air-land operations] over the years'[9]. In 1940, the RAF similarly entered the North African Campaign poorly placed to conduct air-land operations. It is from this common baseline of ill preparedness that comparisons can be drawn.

The North African Campaign and Air-Land Development

Before North Africa

During WW1 relations between the RAF and the Army were relatively good. However, the period post WW1 brought with it intense inter-service rivalry as the British government began a process of large-scale defence cuts.[10] The RAF was desperate to maintain its independent status and hence, grasped the doctrine of strategic bombing as a proclaimed panacea for future warfare. Therefore, with overshadowing budget constraints, the RAF set about developing both doctrine and aircraft that could support the strategic bombing principles whilst air-land integration lessons learned during WW1 were largely sidelined.

Hence, since the RAF firmly rejected the concept of air-support during the interwar period, it was inadequately equipped and poorly trained to conduct air-land operations at the beginning of WW2. During the German invasion of the Low Countries and France, army requests for air-support had to pass through an unwieldy chain of command, involving assessment at both Army and RAF headquarters. The system proved completely inadequate to counter the rapid pace of German Blitzkrieg operations and broke down after German armour punched through the Allied Front and encircled the Anglo-French Armies.[11]

Conversely, German air-land warfare during the Blitzkrieg had been most impressive and inspired the British to concentrate its efforts in developing doctrine that would succeed in future air-land campaigns. What was noteworthy about the German campaign was its synergistic blend of firepower on the battlefield, termed Schwerpunkt, or 'joint fires' in contemporary parlance.[12] The Germans placed air-ground control teams in corps/divisional headquarters and with advancing infantry and Panzer units on the ground.[13] The overwhelming effect of German air-land integration is encapsulated in the following comment made by France's Pierre Cot: 'The Battle of France demonstrated the importance of air power in modern warfare; it proved that an army can do nothing without the support of an adequate air force'[14].

Army Co-operation Command

Defeat in 1940, and subsequent escape from the Dunkirk beaches, exposed the fundamental weaknesses of British air-land doctrine: insufficient contact between the Army and the RAF staffs, a situation exacerbated by dislocated positioning of their headquarters and the lack of a reliable communications and C2 network.[15] However, there is no doubt that the RAF made a definite contribution to the successful withdrawal to Dunkirk and eventual evacuation, despite Army claims to the contrary and subsequent renaming of the junior service as the 'Royal Absent Force'. Importantly though, the experiences of this campaign gave a powerful impetus to the development of an air-support organisation and resulted in the formation of Army Co-Operation Command in December 1940.[16]

The true function of the RAF, according to the pre-WW2 creed, was 'to generally create disorganisation and confusion behind the enemy front while the ground forces achieved their objectives'[17]. However, this philosophy had not worked in France and worse still, the contradictory German doctrine had been seen to work only too well. Hence, amidst continuing Army/RAF debate, Army Co-operation Command was formed, its purpose being to control policy, training and administration of all air-support matters. However, the AOC-in-C, Air Marshal Sir Arthur Barratt, had no operational responsibility and hence was excluded from discussions of policy in respect of such problems as the employment of bomber squadrons in close support.[18] Therefore, many saw Army Co-operation Command as a token effort to appease the Army during the post-Dunkirk depression and the situation in which Barratt found himself, did nothing for his quest to further air-land integration.

Nevertheless, during this same period, the Air Ministry sanctioned a number of air-support experiments and it was in Barratt's 'Cinderella' Command that some the most significant theoretical work on air-land co-operation was done. In September 1940, under the guidance of Colonel J.D. Woodhall and Group Captain A. Wann, the 'Wann-Woodhall Report' was produced.[19] Bomber Command's Army Liaison Officer described it as:

Moreover, the system called for the joint staff at the control centre (ASSU) to evaluate air-support requests as they came in, checking the proposed target locations in relation to the 'bombline'. A deconfliction measure to reduce fratricide, the bombline was based on a physical feature easily identifiable to both airmen and soldiers, projected forward of friendly troops, beyond which aircraft were permitted to engage targets. If the target was accepted by the ASSU, the squadron designated for the task was contacted via direct communications, and the Air Liaison Officers (ALOs) attached to the squadron were alerted to brief the pilots, who had then to identify their targets by means of photographic maps with grid references.[21]

Whilst this system was being developed in the UK, a parallel air-support system was being forged in North Africa. Unfortunately, due to poor communications with the UK, many of the theoretical lessons identified in the Wann-Woodhall Report were not promulgated to the desert forces; consequently, lessons were learnt the hard way in the tough test of desert battle.

North Africa 1940-41

After the fall of France, Britain felt powerless against the might of Germany. However, Italy's entry into the war in 1940, turned the Middle East into an active area of operations and provided a subsidiary theatre, where British forces could be employed to harass or even inflict some damage on the enemy. Churchill boldly reinforced the region

Photo: RAF AHB

Hurricane fighters of No 274 Sqn being serviced at Amriya, Egypt, November 1940

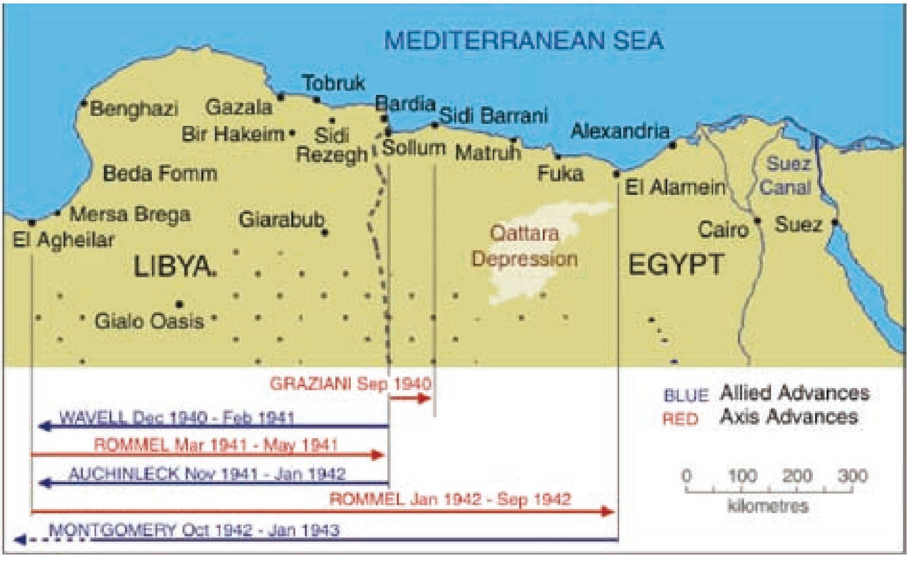
even though the German threat to mainland Britain was far from removed. He resolutely declared that the British would fight for Egypt, describing the desert flank as the 'peg in the sand on which all else hung'[22].

With Hitler's heart set on undertaking Operation BARBAROSSA on the Eastern Front, the British were once more able to indulge in their predilection of the indirect approach. They responded to Graziani's 10th Army's advance into Egypt in September 1940 and thus, the stage was set for a constant 'toing and froing' across the sands of North Africa for the next 2 ½ years. It would be upon this stage that the British 8th Army and the Desert Air Force (DAF) would hone the doctrine of air-support.[23]

At the start of the Italian offensive, the British were in no position to counter attack. However, air-support, in the form of reconnaissance and bombing, in conjunction with ground attacks, of Italian strong points, ensured a safe withdrawal of British forces from the frontier. The primary air effort, which contributed enormously to the land battle, was attacks on enemy motor transport, in an attempt to disrupt the Italian supply chain and stretch lines of communication. Consequently, the Italian forces culminated by mid

Figure 1: Overview of North African campaign 1940-43

(Taken from the Anzac Day Website)



September in the area of Sidi Barrani.[24] The prevailing RAF doctrine, which was doggedly anti air-land, defined air's primary role as action against the Italian Air Forces, their bases and supply lines; in effect, a strategic offensive.[25] Of the 5 stated objectives for RAF Middle East, 'full support for British Army operations' was listed fourth.[26] However, what the Italian advance had brought about was a recognition (which would become enduring) of what the RAF's main role in the Middle East should be: 'if the situation demanded [support to the Army] should be given first priority for as long as necessary'[27]. The Italian advance had denied the RAF forward operating bases, thereby reducing air's combat effectiveness. Thus, it emerged that 'modern war might take the form of a war for aerodromes' and since aerodromes are not in the sky, but on the land, what happened in the land battle bore direct effect upon the Air Force. Air-land co-operation had become a necessity.[28]

Operation COMPASS demonstrated the first satisfactory co-operative air-land enterprise of the War. A brilliantly orchestrated offensive by the British, COMPASS saw the Army advance 500 miles with only 2 divisions, routing an enemy army 5 times its size. The RAF established air superiority over the British forces, enabling the tanks and armour of Major-General O'Conner's tiny force to outflank the enemy without interruption by air attack.[29] The operation, said Wavell, 'could not have been executed without the magnificent support given by the Royal Air Force…it had been a triumph of inter-Service co-operation'[30].

Early 1941 saw Churchill strip resources from North Africa to support the campaign in Greece. This, coupled with the arrival of the German Afrika Korps, under the formidable command of Rommel, meant that the British were on the 'back foot' for the first German offensive in March. With the British in full retreat once more, Tedder concluded that the RAF must do something to stop the enemy, and urged the use of fighters to strafe Axis transport columns.[31] This reversal of fortune brought with it a number of command changes within the British desert force. The first was the appointment of Air Marshal Sir Arthur Tedder as AOC-in-C of RAF Middle East. 'Co-operation…and flexibility were the keynotes of Tedder's air strategy' and the first man he called for, to command 204 Group in the Western Desert, was Air Vice-Marshal 'Mary' Coningham. Coningham, a WW1 veteran, had a no-nonsense, common-sense approach to business.[32] Tedder's first instruction to him was to 'get together' with the Army.[33]

Undoubtedly, the proactive, 'non- stove piped' characters of both Tedder and Coningham contributed massively to the development of air-land co-operation over the next few years in North Africa. Both men understood the need for integration and appreciated the synergy that could be achieved when the effects of land and air forces were amalgamated. Coningham especially, had a reputation for talent in co-operation, and the achievement of a workable air-land support system is generally (and fairly) credited to him.[34] Moreover, Tedder had a good relationship with the army GOC-in-C, General Sir Claude Auchinleck: 'he made an immediate partnership …and from that moment Army/RAF misunderstandings in the theatre were for practical purposes at an end'[35]. Even when Lieutenant General Sir Bernard Montgomery later replaced Auchinleck, the cohesive trinity of air-land commanders remained intact. This is arguably the first air-land lesson gleaned from the North African Campaign: commanders must have a common understanding of each other, and what each component 'brings to the party'. Moreover, they must fully appreciate how to integrate the strengths of each component to offset the weaknesses of others. This understanding can only be achieved through joint training and establishment of robust joint doctrine.

During the summer of 1941, Operations BREVITY and BATTLEAXE would further test the air-land interface. Both offensives were designed to relieve the Allied-held Tobruk, but due to their shortness, they offered little scope for the practical development of integration techniques. However, there were lessons learned in retrospect:

The main difficulty in providing air-support was the almost complete lack of information from the Army. This was caused by the failure of the air-ground recognition system, brought about mainly by lack of response to aircraft signal by ground formations… failure of the wireless communications between forward troops and their headquarters had meant a serious lack of information at the headquarters regarding the dispositions of formations so that it was frequently impossible to give even a conservative bombline.[36]

Additionally, another cogent reason for the break down of air-land co-operation was that the Army and RAF headquarters had been sited some 80 miles apart.[37] The lack of information flow between the 2 components was a direct result of dislocated headquarters and poor quality communications.

BREVITY and BATTLEAXE exposed many of the difficulties encountered when attempting to conduct dynamic air-support operations: combat identification (CID) of friend from foe; unreliable communications between engaged forces; lack of situational awareness at the headquarters level, leading to stifled decision-making; and the emotive subject of bombline placement. These enduring problems are equally apparent in modern air-land warfare.

On arrival in North Africa in July 1941, Coningham noted that, 'my headquarters was a small hole in the ground 5 miles away from the Army Commander. There was no combined headquarters.' Therefore, with agreement from the Army, he initiated the establishment of a joint Army-Air headquarters when the 8th Army was formed 2 months later. This decision, wrote Coningham, 'was of fundamental importance and had a direct bearing on the combined fighting of the 2 Services until the end of the war'[38]. Coningham knew that in order to harness true air-land jointery, his headquarters must be joint.

Coningham's initial efforts also focussed on a joint air-land conference held in Cairo on 4 September to discuss the policy to be adopted in the Middle East for the provision of Air Support for the Army.[39] A memorandum issued by Churchill the next day regarding air-land integration backed up the efforts of this conference. Not only did his comments break the Army's belief that only aircraft visible overhead were really helping, but they expressed the principle command relationship required to enable successful air-land co-operation:

Nevermore must ground troops expect, as a matter of course, to be protected against the air by aircraft…the idea of keeping standing patrols of aircraft above moving columns should be abandoned…Upon announcing that a battle is in prospect, the AOC-in-C will give him [the army commander] all possible aid irrespective of other targets, however attractive. The Army…will specify…the targets and tasks which he requires to be performed [and] it will be for the AOC-in-C to use his maximum force on these objects in the manner most effective…the sole object being the success of the military operation.[40]

These rulings, which bore resemblance to the Schwerpunkt concept, were widely published and vigorously enforced by both Tedder and Coningham, giving the RAF assistance in 'sealing the deal' on its propositions from the September conference; the results of which were embodied in the Air Support Directive of 30 September 1941. This significant directive detailed the conceptual principles that informed co-operation between the Desert Air Force and the 8th Army for the forthcoming CRUSADER offensive in November 1941 and more importantly, for the remainder of the war.[41]

The Directive detailed the concepts of indirect and direct air support, conveying the message that not all support to the Army would be conducted by aircraft located immediately overhead.[42] These 2 concepts continue to form the bedrock of contemporary Anti Surface Force Air Operations (ASFAO) doctrine as detailed in the current RAF Operations Manual.[43] The additional principles of the Directive began with the merging of headquarters and associated development of intimate working relationships amongst component commanders. Coningham had by this stage already co-located his headquarters with that of the 8th Army and Tedder had merged his with that of General Auchinleck. Tedder, demonstrating a taster of today's joint approach, stated that, 'In my opinion… the Middle East theatre is now so closely inter-related that effective co-ordination will only be possible if the campaign is considered and controlled as a combined operation'[44].

The Directive also called for the establishment of Air Support Controls (ASCs) that could 'meet, modify or reject the requests for support' ensuring 'that the maximum effort is obtained from the available …aircraft'[45]. Finally, guidance was given regards bomber attack profiles, target selection, allocation of effort, bombline placement and air/ground communication and recognition signals.[46] Overall, the Directive provided a relevant doctrinal one-stop-shop for all air-land co-operation practitioners.

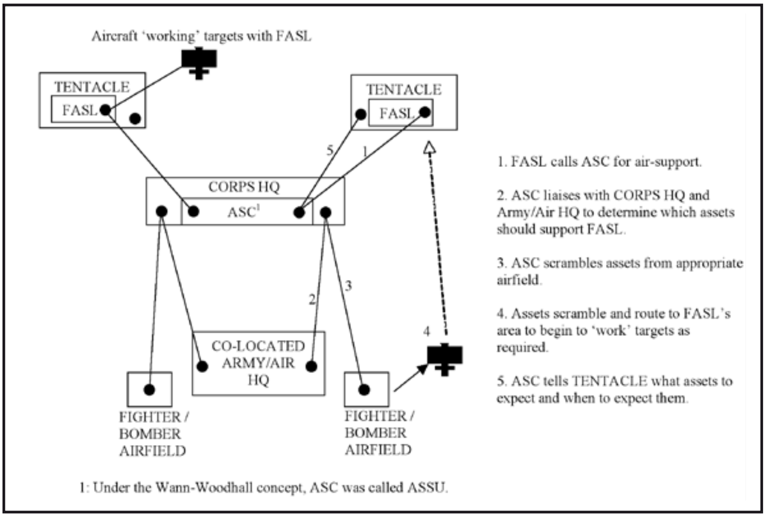
The formation of the ASCs arguably provided the solution to the majority of air-land problems in North Africa (similar in concept to the ASSUs proffered by the 'Wann-Woodhall Report'). A 'tentacle' concept was also adopted which established wireless communication between front line units and appropriate headquarters. In addition to the Tentacles, 'Forward Air Support Links' (FASLs) were developed for controlling air-support aircraft in the air, the equivalent of today's Forward Air Controllers (FACs). Tentacles and FASLs were assigned to infantry divisions to enable commanders in the field to call for air-support when needed. ASC headquarters would pass accepted requests to the appropriate airfields, effectively scrambling aircraft, and then inform the relevant Tentacle of the strength and intended arrival time of the support on its way. Pilots could be passed target details before take-off, shepherded to the target area by a reconnaissance aircraft or, most often, a FASL would give them a 'target talk-on' once established in the overhead.[47] This flow of information, from request, to tasking, to talk-on, is identical to that used in modern air-support operations. Through meticulous training and constant refinement by exposure to combat, Coningham was able to drill this system into the North African forces. Moreover, by December 1941, Air Liaison Officers (ALOs) began to arrive in the Desert, specially trained to explain to both aviators and soldiers the intricacies of air-support.[48] (Figure 2).

The summer of 1941 saw both sides prepare for decisive encounter and by November, Operation CRUSADER provided Coningham with the ideal test ground for the improved air-support system. The objectives of the Operation were to destroy Rommel's forces, relieve Tobruk and open Tripolitana to invasion. Whilst on the ground CRUSADER was a disappointment, resulting in the eventual withdrawal to the Gazala Line, in the air the air-support system generally functioned well. The British established air superiority early on and heavy rains caused the enemy armour to bog down, providing perfect targets for the DAF. The introduction of new technology, in the form of the Hurribomber, and implementation of newly developed dive bombing skills, allowed the DAF to harass German columns with 250lb bombs and cannon fire.[49] The introduction of the fighter-bomber (today known as swing-role) was, 'an important step in the development of what proved to be a formidable weapon for supporting the Army'[50]. Moreover, the shift in dogmatic thinking, from a reluctance to perform dive-bombing to a recognised need for this art, was a welcome development. The fighter-bomber soon demonstrated that it could rival the famed Stuka, with parallel success and survivbility.[51]

However, the air-support system had its share of difficulties during CRUSADER. For the greater part of the offensive, there was an average time lag of 2½ to 3 hours between initial call from the Tentacle to the employment of aircraft ordnance with the FASL. Clearly, this was hardly 'direct or close' support in the preferred meaning of the words.[52] The average distance from airfield to FASL was 200 miles, therefore increasing transit time, and on reaching the target area, many aircrew found it impossible

Figure 2: North African campaign Example of C2 Flow for Air Support

(Based on a diagram in Middle East (Army and RAF) Directive on Direct Air support)



to identify friendly forces from the enemy. Thus deprived of targets, pilots endured the further frustration of long waits for 'impromptu' support calls, as the Army itself battled with CID: a theme that was also apparent during Op TELIC in 2003.[53] There were unacceptable delays in the relay of messages from ASC to headquarters and unavoidable hold-ups caused by rendezvousing with fighter escorts on the way to the designated target area.[54] Target recognition, CID and fluidity of information flow stood out as the main areas that required attention post CRUSADER. For all its apparent 'paper symmetry', the air-support system still required much streamlining.[55] Nevertheless, 'none of this alters the fact that during CRUSADER the Army enjoyed the best air-support it had ever had'[56].

North Africa 1942-43

The Battle of Gazala followed in May 1942 and continued through to July with the 1st Battle of El Alamein. From an air perspective, common themes were developing. The Army again fell into great confusion, with commanders uncertain of the location of their own forces, and intercommunication between units fragmentary. Additionally, crews found it impossible to identify the bombline; conditions were extremely unfavourable for air-land support. However, at El Alamein, Rommel was forced into defence from which he was never able to escape; this signalled the turning point in the Desert campaign. 'The Air Force participated fully in the fierce battles of early July, in which Rommel's army was at last decisively checked'[57]. The refined air-support system worked extremely well throughout the battle and got better and better. 'The speed with which the Air Force answered calls for support steadily increased, until the average time of delay between request…and aircraft…was…35 minutes'[58]. As a result of a combination of doctrinal theory, experimentation, peacetime training in the UK, and operational experience in North Africa, an effective British air-support system had been developed by 1942, and essentially remained the same throughout the remainder of the war.[59] Moreover, its tenets still ring true in contemporary air-support doctrine.

By mid 1942, air-land co-operation had, as near as possible, been perfected, but it was the arrival of Montgomery that added the final, and arguably most crucial, element to the command relationship between the DAF and 8th Army. Montgomery had an innate understanding of the qualities air-land co-operation and he understood precisely the role of the DAF.[60] He handsomely acknowledged his reliance on the air arm by stating 'any officer who aspires to hold high command in war must understand…the use of air power'[61]. He amplified with, '…concentrated use of the air striking force is a battle winning factor…it follows that control of the available air power must be centralised, and command must be exercised through RAF channels…'[62]

He sited his headquarters with that of Coningham and encouraged continuous liaison between air and land. Tedder was later to comment that Montgomery put air co-operation as 'first in the order of priority'[63]. Although later in the war relations with Montgomery diminished, due mostly to his over-inflated ego, at this point in North Africa he complemented Tedder and Coningham perfectly, demonstrating once again the need for joint commanders who appreciate the 'business' of the other Services.

The Battle of Alam el Halfa in the late summer of 1942 saw Rommel's last attempt to break his defensive shackles however, this battle proved the climax of air-land co-operation and to all intents sealed the fate of Axis forces in North Africa.[64] It exemplified the use of air power on efficient and economical lines and was a proving ground for policies and theories for the handling of an air force.[65] Indirect air support began 9 days before the enemy attack and then, in a perfectly co-ordinated and integrated effort, the guns and armour of the 8th Army made a ring around the enemy and airpower gave the punch inside the ring. At the pinnacle of the operation, bombs were being dropped at an average of one every 40 seconds.[66] By 2 September, Rommel gave orders for retreat, largely because of British air superiority.[67] From the air perspective, the theory of indirect and direct support to the Army was proven. According to Montgomery, 'the tremendous power of the air arm in co-operation with the land battle was well demonstrated'[68]. In short, the battle of Alam el Halfa fully vindicated the new air-support organisation and stands out as a landmark in the development of air-land co-operation.[69]

With Rommel in full retreat, guaranteed air superiority and a slick, battle-proven air-support organisation, the 8th Army continued on the offensive, pushing Rommel further west. The 2nd Battle of El Alamein and subsequent advance to the West witnessed full integration of air power and by February 1943 the 8th Army entered Tunisia. At this point, Operation TORCH saw the determined entry of the USA into North Africa but unfortunately witnessed the heartbreaking relearning of lessons hard-won by the British in the previous 2 years. At Kasserine, a timid US ground commander committed to keeping his air assets close to his own troops, and not freeing them to prosecute indirect support. The Axis forces exploited this and thus set the stage for the greatest disaster ever to befall US ground forces in battle, proving the disastrous results that can emerge from poor air-land co-operation.[70] After this, and with vast input from the British, the Americans redeveloped their air-support doctrine in line with that of the DAF, in the form of FM 100-20.[71] With all Allied forces now operating 'off the same hymn sheet', Rommel's forces were once more defeated at the Mareth Line and eventually, by 13 May 1943, the last remnants of Axis resistance in Africa had ended. Tedder's Order of the Day summarised the indispensable contribution of the DAF and other air formations to victory in the campaign by stating, 'by magnificent teamwork between commands, units, officers and men…you have shown the world the unity and strength of air power'[72].

Air-Land Lessons Learnt from North Africa

Whilst the lessons drawn from the North African Campaign are numerous, 5 main air-land co-operation lessons are of relevance to contemporary military campaigns. The first 2 are concerned with enabling air-land operations whilst the remainder are specific to the actual conduct of air-support.

Firstly, and of overarching significance, control of the air must be achieved before successful air-support can be provided. The British enjoyed almost total air superiority throughout the North African Campaign, which afforded the manoeuvring room to develop, perfect and ultimately provide air-support to the 8th Army. Montgomery concluded that, 'if we lose the war in the air, we lose the war, and we lose it very quickly'[73].

Secondly, command of air assets must be centralised and maintained within the specialist realms of the Airman. Montgomery amplifies this point with his remark, 'the commander of an army in the field should have an

Air Headquarters…[but] air resources will be in support of his army, not under his command'[74]. He recognised that dedicating air assets solely to army support reduced their inherent flexibility hence, diminishing their overall combat effectiveness within the joint campaign. This recognition proved Montgomery's innate joint understanding of cross component capability. Even if the command of air remains within the domain of the Airman, this does not relinquish the Soldier from understanding airpower intimately.

Thirdly, and of prime importance to the effective conduct of air-support, is the need for robust C2. Commanders at the operational level need to understand the capabilities of each component, and recognize how to harness these into synergistic air-land effect. Moreover, joint planning and decision making, achieved in North Africa by co-location of headquarters, must be sought in order to exponentially increase integration and co-operation. Additionally, fluid communications and C2 between the operational and tactical levels are essential. For air-support to be successful, a system that connects operational decision-makers with tactical war-fighters must be in place to allow the right aircraft, to get to the right area, talk to the right person and prosecute the right target, all in as short a time as possible. No mean feat, and one that is continually grappled with in today's network-centric world of time-sensitive-targeting, and aspired to in the HQ Strike Command 2015 vision of 'precise campaign effects, at range, in time'[75].

The fourth lesson is that maintaining situational awareness (SA) at both the operational and tactical level is extremely difficult in the 'fog and friction' of war.[76] Systems must be in place to afford operational commanders the ability to maintain SA of friendly forces, especially concerning location. Only with this SA can sensible decisions, such as bombline placement, be made; hence, affording air the ability to conduct relevant indirect support operations. Furthermore, at the tactical level, robust recognition procedures are required to enable aviators to readily distinguish between friend and foe and therefore, bring air power to bear in a safe, timely and precise manner.

Lastly, but by no means least, the joint development, practice and proving of theoretical doctrine through relevant and frequent training is essential if air-land integration is to be successful. Moreover, doctrine must evolve and develop with time and capability in order to prevent it from becoming irrelevant dogma.

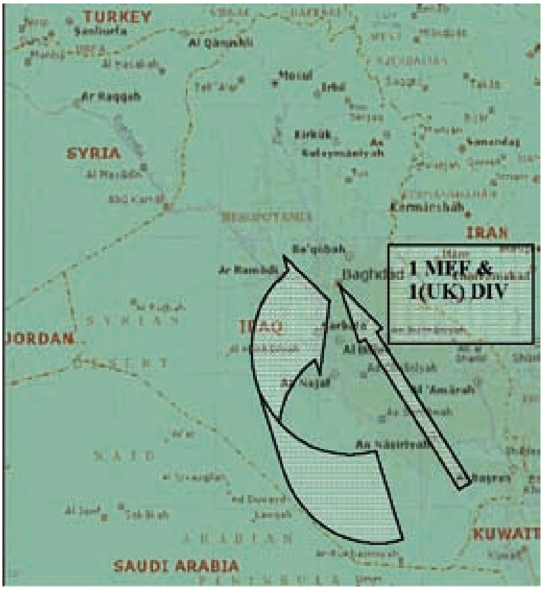
Operation TELIC Comparison

Operational Overview

There were 2 geographical objectives for this campaign: Baghdad and the Rumailia Oilfields. The Coalition Force Land Component Commander's (CFLCC's) plan was based on a two-pronged attack on Baghdad from Kuwait. V (US) Corps would attack on the left, approaching Baghdad from the South West. The 1st US Marine Expeditionary Force (1 MEF), a composite air-ground task force which included a dedicated Marine Air Wing (MAW) consisting of attack helicopters and fast-air, would approach Baghdad from the South and South East. The MEF included the 1st (UK) Armoured Division (1 Div): the UK's contribution to CFLCC's land scheme of manoeuvre. The synergistic integration of airpower into the land plan was fundamental for achievement of rapid, decisive success. Moreover, the speed and tempo associated with this campaign was of a different magnitude to that experienced during preceding contemporary operations. Using 'shock and awe'[77] as its bedrock, this plan was designed to overwhelm the Iraqi Regime. Therefore, joint decision-making and targeting had to be unrestrained.[78] Success depended upon deployment and integration of fast moving light forces, highly mobile armoured capabilities and Close Air Support (CAS).[79] Hence, a true understanding of air-support and air-land co-operation was essential if the planned momentum for the operation was to be maintained. Unfortunately, the UK military entered TELIC with a less than adequate grasp of air-support, especially concerning C2, and relearnt the key air-land integration lessons of their North African forebears identifid in the case study above.

Figure 3: Op TELIC Land Scheme of Manoeuvre

(Based on a map in British Army electronic Battle Box 8th edition, Disk 1, (2005))



A MiG-25RB Foxbat-B reconnaissance aircraft buried by the Iraqi Air Force

Control of the Air

As in the North African Campaign, coalition forces in Op TELIC enjoyed a very high degree of control of the air, thus enabling air-support operations. However, unlike North Africa, where the Allies had to conduct air-to-air engagements to gain air superiority, coalition forces in Iraq achieved air supremacy without having to fight a single enemy aircraft: this was due to 2 main factors. Firstly, the establishment of the Northern and Southern No-Fly Zones after the 1991 Gulf War banned the Iraqis from operating all aircraft in exclusion zones north of the 36th parallel and south of the 33rd parallel. To that end, the Coalition had control of the majority of Iraqi airspace even before TELIC began.[80] Secondly, the Iraqi Air Force was no match for that of the Coalition. Once combat operations began, no enemy aircraft got airborne. In fact, the Iraqis attempted to save as many of their air assets through ground dispersion, and even buried fighters at bases such as Al Taqqadum.[81]

However, with their airspace denied, the Iraqis invested heavily in establishing a robust Integrated Air Defence

System (IADS). This consisted of multi-linked fibre optics that afforded secure communications and hybrid surface to air missile systems (SAMS) that did not solely rely upon radars for guidance, thereby rendering them invisible to coalition Suppression of Enemy Air Defence (SEAD) aircraft. A 'Super-MEZ' (missile engagement zone) of overlapping, complementary SAMS protected the heart of Iraq and was deemed a serious threat to allied aircraft. However, precursor shaping operations destroyed key installations, communications and IADS nodes, therefore affording a favourable air situation above 20,000 feet from very early on in the Campaign. By 6 April 2003, coalition forces declared air supremacy over the whole of Iraq and considered the 'Super-MEZ' no longer a factor.[82]

Almost complete air dominance afforded commanders the luxury of concentrating air effort towards the support of the land component. In comparison with Gulf War 1, the proportion of air sorties flown in support of land forces increased from 55% to 78%.[83] Owning the air allowed for unhindered implementation of air-land operations from enemy air attack however, freedom of action was not absolute during TELIC, and the threat to coalition aircraft operating at lower levels was considerable due to an inability to completely suppress enemy shoulder-launched SAMS and anti-aircraft-artillery (AAA). The DAF were also exposed to AAA however, in the1940s, both politicians and the public anticipated friendly losses in combat therefore, pilots were expected to press home attacks at low level despite the threat. This is the opposite to contemporary warfare where the downing of even one coalition pilot would gain disproportionate media attention and have great strategic effect upon public opinion towards the campaign. Hence, British aircraft in TELIC were politically shackled to operate at medium altitudes above the threat however, at such heights, most targeting sensors did not perform optimally. Therefore, aircrew ability to achieve CID or find and positively identify targets was markedly reduced due to sensor technological limitations.[84] The vast proliferation of shoulder-launched SAMS throughout the world, coupled with Western governments' aspiration to fight zero casualty wars, means that future air-support will most probably be constrained to operate at medium altitudes. Thus, if British air-support is to be more credible, RAF CAS aircraft need to be fitted with more technologically advanced equipment.

Centralised Control of Air Assets

In Iraq, British land forces did not get priority for air-support because they were not on the CFLCC's main effort. However, many British Army officers claimed the shortfall in air-support for land forces had been because of a lack of organic, dedicated fast-air. The USMC MAW concept was hailed as the panacea to UK air-support post TELIC, mainly because the MAW had provided dedicated air for the MEF throughout the operation. Many British Army officers claimed that the future of UK air-support lay in the concept of dedicated Army fast-air.[85] However, the USMC operates in a fundamentally different way from the British Army. With no organic, indirect depth fire, such as UK forces have with artillery, the USMC relies solely on airpower to provide depth effects hence, it has its own dedicated fast-air.[86]

The argument for using UK fast-air to support only UK land forces, or more drastically, permanent allocation of 'CAS only' assets to the British Army, has endured since TELIC.[87] This argument is fundamentally flawed and would prove an inefficient use of British air assets and detract from one of the key tenets of airpower: agility.[88] Moreover, the UK's ACC for TELIC commented that, '…we would not have sufficient UK assets to provide cover to a UK land component 24 hrs a day. That is why airpower has always been used and planned on centralised methodology. It is trying to make the best use of the resources across the battle space'[89]. This was the approach to implementation of airpower during the North African Campaign, encapsulated by Montgomery when he said, 'the greatest asset of airpower is its flexibility and this enables it to be switched quickly from one objective to another. It follows that control of the available airpower must be centralised and command must be exercised through RAF channels'[90]. Undoubtedly, the argument regards organic air-support for the British Army will continue. However, TELIC proved Montgomery's guidance to be true, and centralising the RAF's air contribution for air-support during the Operation worked well.[91]

Command and Control (C2)

Lessons learnt from the North African campaign prove that successful air-land co-operation is reliant upon a robust C2 network that links together all necessary elements to ensure timely, effective and accurate support. During TELIC, air-land C2 was well catered for horizontally between components however, vertically, at the Divisional level and below, it was sadly lacking.[92] A major lesson identified during combat operations in Afghanistan in 2001, was that in high manoeuvre, high tempo warfare, such as that planned for TELIC, the relationship between air and land is extremely important; therefore, all senior commanders understood and appreciated the need for air-land co-operation.[93] Hence, at the operational level, C2 was well catered for. Within the Joint Force Air Component Command Headquarters (JFACHQ) the Army was represented by the Battlefield Co-ordination Detachment (Air) (BCD(A)). Conversely, an Air Operations Co-Ordination Centre (Land) (AOCC(L)) acted as the Air representative within the Joint Forces Land Component Headquarters (JFLCHQ).[94] Both the AOCC(L) and BCD(A) provided coherent cross-component C2, and using real-time communications and networking, effectively emulated the collocated nature of the Army and RAF headquarters, demonstrated as essential during the North African Campaign.

However, TELIC outlined the woeful state of the UK's capability to provide vertical air-land C2, between the operational and tactical levels. This was arguably the UK's biggest weakness concerning air-land co-operation during the Operation and was described by Chief AOCC(L) as 'not so much a capability gap as a gaping chasm'[95]. 1 Div deployed to TELIC expecting co-ordination of all air-land C2, from divisional level downwards, to be completed by a handful of Air Liaison Officers (ALOs). In peacetime, the ALOs provide the essential link between the Army and the RAF but during operations, their meagre manpower and resources are completely inadequate to fulfil a demanding, high tempo, C2 role.[96] The US chain of command recognised this shortfall and, since 1 Div was operating within the MEF, allocated a United States Marine Corps (USMC) ANGLICO (Air, Naval, Gunfire Liaison Company), to act as an Air Support Element (ASE) to fill the capability gap, hence masking the problem. The ASE consisted of over 60 Marines plus their associated communications suite and provided a substantial reinforcement to the inadequate UK air-land C2 structure.[97] It was widely acknowledged that had UK land forces received air-support in greater quantities during

TELIC than they did, they would have lacked the capability to control it without the assistance provided by the USMC ASE. [98]

Fortunately, plugging the C2 gap with the USMC ASE allowed UK forces to adopt a robust and flexible air-support network that was implemented with relative success throughout the Operation. The procedures for requesting air-support during TELIC effectively mirrored that utilised during the North African Campaign and the role of the USMC ASE in this procedure was pivotal, just as the role of its historical equivalent, the ASC, had been in North Africa. However, the lack of and end-to-end air-support C2 network was a fundamental oversight of UK forces during TELIC; this was undoubtedly the most apparent relearning of history during the Operation.

Situational Awareness (SA)

TELIC proved that contemporary conflict is more chaotic, complex and dangerous than previously thought.[99] Attaining and maintaining SA at both the operational and tactical levels is as challenging in the modern age as it was during the 1940s. Even though 60 years have elapsed since the DAF grappled with CID in North Africa, technology has only partially solved this conundrum.

At the operational level, one of the high points of TELIC was the successful fielding of the Blue Force Tracker (BFT) system. BFT is a transmitter carried by friendly forces that sends their position, via satellite, to their headquarters. It not only affords commanders near real-time SA of campaign progress but also allows them to know where their forces are at all times, hence making the 'fog and friction' of battle more transparent. [100] However, BFT is employed at unit level only; individual soldiers do not carry a transmitter, due to its weight and size.[101] Therefore, the fidelity of information provided is not accurate enough to allow for CID of individual troops on the ground. Moreover, there is currently no technological solution to allow UK air-support pilots to determine friend from foe on the battlefield. During TELIC, many CAS pilots found it extremely difficult to distinguish friendly troops from enemy forces, especially when engaged in dynamic and confusing close combat.[102] Inherently, it is in this situation when air-support and airpower effect is most urgently required hence, increasing the likelihood of fratricide. Whilst recognition markings and panels are painted or attached to friendly equipment, they are of limited use to aircrew when operating in the preferred environments of medium altitude or night.[103] Therefore, at the tactical level, and most especially in the air-ground environment, CID remains as difficult today as it was for the DAF. Until affordable technology can provide a solution to this problem, it will be vital to develop joint understanding through training and doctrine to militate against the possibilities of blue-on-blue. [104]

Training and Doctrine

Prior to TELIC, British air-support training and doctrine was anachronistic; it did not reflect advances in weapon and sensor technology and was steeped in Cold War methodology. Training was conducted on an ad hoc basis and air-support for Army exercises was viewed as a beneficial add-on vice an essential requirement. Apart from air-support provided for development of new FACs, no dedicated front line air-land training was conducted in the UK. Hence, joint understanding in 4 main areas of the air-land interface, especially from the land perspective, was lacking prior to operations in Iraq. [105]

Firstly, the Air Tasking Order (ATO) process of air allocation to the joint campaign was deemed inflexible. This was due mostly to a poor understanding of the process rather than the process itself however, it has been widely recognised that ATO flexibility could be improved. [106] Secondly, the notion of air-land integration was misunderstood. On many occasions during TELIC, the synergistic effect of joint fires was not achieved because air and land effort had been deconflicted rather than integrated. Whilst some UK doctrine describes the concept of choreographed joint fire effect in the form of the Joint Air Attack Team (JAAT), UK forces very seldom practice it.[107] Therefore, throughout TELIC, it appeared that some land commanders would exhaust all organic fire options, such as artillery, before attempting to utilise air-support.[108] Paradoxically, the JAAT concept is not detailed in current Joint Warfare Publications.[109] Thirdly, during TELIC, 2 new doctrinal concepts were introduced to British forces: Killbox Interdiction Close Air Support (KICAS) and Urban CAS. The UK had no detailed concepts for conducting either of these disciplines, whilst their US comrades appeared well practiced, thereby demonstrating the lack of emphasis UK forces had placed on air-land integration before the Operation.[110] Lastly, under current British doctrine, the Fire Support and Co-ordination Line (FSCL) has replaced the 'bombline' used during WW2 to prevent fratricide. Simply put, airspace beyond the FSCL is the domain of the air commander whilst that short of it belongs to the land commander. However, during TELIC, the FSCL appeared to be an outdated air control measure that could not be utilised with ease in the high-tempo of modern warfare. US forces almost overran the FSCL because it could not be adjusted quickly enough, whilst at other times the line was placed too far ahead of friendly forces, imposing unnecessary and counterproductive constraints on air attack.[111] The contentious use of the FSCL is a pan air-support issue; however, US doctrine is soon to modify this concept for the modern digitised battlefield, introducing a system of killboxes that can be opened and closed as required, to allow for seamless integration of joint fires.[112] Whilst the WW2 bombline concept has been an appropriate measure until recently, it will soon become obsolete due to the changing face of contemporary warfare, and British forces must acknowledge this fact.

Overall, the paying of 'lip service' to the development and understanding of relevant air-land doctrine and corresponding dearth of realistic joint training before TELIC, left UK forces poorly placed for air-land operations in Iraq. Whilst US forces discovered a new 'sweet spot'[113] in combat co-operation, the British completed TELIC stating, 'there is a lack of experience in requesting, co-ordinating and delivering CAS, the prevalence of which proves a need to conduct more CAS training.'[114]

Impact of Technology on Contemporary Air-Support

Exponential advances in technology since WW2 now allow air-land co-operation to be seamlessly rapid, precise and decisive.[115] Unfortunately however, British air-support assets are yet to benefit wholly from this fact. On the one hand, TELIC saw a significant change in the nature of the ordnance delivered by the RAF, with a shift towards precision-guided munitions (PGMs). Of all munitions employed, 85% were PGMs (compared to only 10% in Gulf War 1) and 90% of these hit their intended targets.[116] Conversely, sensors and targeting equipment fitted to RAF aircraft are outdated and incapable of achieving CID when employed at medium altitudes against small tactical targets. Hence, during TELIC, many RAF aircrew wasted valuable time attempting to find and then identify enemy targets from medium altitudes. This frustration, coupled with poor communications because of outdated and unreliable radio equipment, left British aircrew and FACs conducting air-support at the same technological level as DAF pilots and FASLs in North Africa. Whilst technology is not the panacea, it can go a long way to expedite air-support and alleviate the inherent danger involved with employing high explosives within hundreds of metres from friendly forces.

The RAF is slowly staggering into the world of data-linked CAS and enhanced resolution targeting pods, which has now become the norm for US forces. Until sensor and communication equipment is updated, the fundamentals of contemporary air-support in the British forces will remain practically identical to that of the DAF and 8th Army: a soldier on the battlefield, trying to talk a pilot's eyes onto enemy targets, using poor radios, amidst the 'fog and friction' of combat. With no affordable technological solution inbound, only rigorous training and the development and understanding of joint doctrine will prevent CID from becoming the hurdle that prevents British air-land co-operation from advancing apace. This was demonstrated extremely well during the discrete counter-SCUD operations conducted in Iraq's Western Desert during TELIC. Coalition Special Forces and air-support squadrons trained intensively together before the Operation, developing and refining a robust C2 network, a flexible airspace control system and specific 'scud-hunting' doctrine, that allowed for fluid joint fires effect.[117] Over 100 'danger-close' CAS missions were successfully conducted with no instances of blue-on-blue.[118]

History Relearnt?

The comparative study above demonstrates that British forces relearnt historical air-land co-operation lessons during TELIC. With specific regard to the conduct of air-support, the areas of C2, training and doctrine and tactical level SA were extremely lacking. Primarily, the lack of a robust air-support C2 network was a fundamental omission. Had the US not provided support in the form of the USMC ASE, the British air-support network would have been at best, rudimentary. Moreover, the lack of joint air-land training prior to combat, accompanied with outdated and misunderstood doctrine, left British forces poorly placed to conduct synergistic joint operations. Technology is often hailed as the fix-all solution to these issues, yet with current pressures on the British Defence Budget and a Government focus on health and education reform, it may be beyond the power of the MOD to supply cutting-edge technology in the near future. Hence, contemporary practitioners of air-support will have to focus on the basics, such as those learned in North Africa and subsequently relearnt in present-day Iraq, if air-land co-operation is to improve. Project Coningham-Keyes is attempting to bring these basics to the fore.

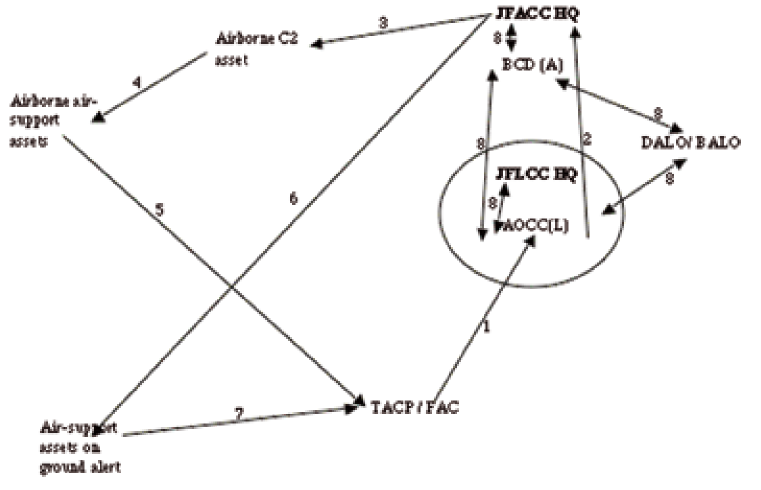
Project Coningham-Keyes and the Future

The initiation of Project Coningham-Keyes (PC-K) in 2003, a tri-Service, 2-Star led joint venture, was an attempt to address the air-land lessons identified from TELIC. It consists of 3 separate working groups; Concepts and C2, led by Land; Battlespace and ISTAR (Intelligence, Surveillance, Target Acquisition and Reconnaissance), led by Fleet; and Training and Simulation led by Air.[119] PC-K has resulted in many positive steps forward towards a more robust and capable British air-support system.

The creation of a Joint Air Land Organisation (JALO) now acts as a central body to develop tri-Service air-land integration. The JALO is also attempting to bring together hitherto stove piped equipment development programmes to produce interoperable technological solutions for future air-support.[120] Additionally, extra

Figure 4: TACS: proposed by Project Coningham-Keyes

(Based on a diagram in AOCC(L)/J5 plans/Doctrine)



1. FAC calls AOCC(L) for CAS.

2. AOCC(L) contacts JFACC HQ, requests air-support and relays FAC's details.

3. JFACC HQ calls airborne C2 asset and either delegates authority to it to allocate the most appropriate airborne asset for the air-support request or orders it to assign a particular airborne asset.

EITHER…

4. Airborne C2 asset either re-tasks an asset already airborne on an alternative mission to support the CAS request or tasks an air-support aircraft that is currently airborne-holding awaiting an air-support request.

5. Airborne air-support assets receive FAC details, route to FAC's location, attain contact with the FAC and begin to 'work' the target area.

OR…

6. JFACC HQ contacts appropriate airbase and scrambles assets that are holding on the ground awaiting an air-support request.

7. Airborne air-support assets receive FAC details, route to FAC's location, attain contact with the FAC and begin to 'work' the target area.

8. Constant communication from operational to tactical levels to maintain SA.

Tactical Air Control Parties (TACPs) and FACs are being trained for the front line commands. Moreover, properly integrated, air-land exercises are being conducted, both in the UK and on overseas deployments such as in BATUS, Canada.[121] Finally, and most importantly, the development of an overarching Tactical Air Control System (TACS) will plug the Air C2 gap. Unsurprisingly, the TACS closely resembles the Air C2 network developed and utilised during the North African Campaign (Figure 2). It includes the full range of C2 agencies involved in the air-support network, from soldier on the battlefield to joint headquarters. Moreover, the establishment of additional ALOs at Brigade and Divisional levels (BALOs and DALOs), to co-ordinate air-support requests into a bolstered BCD(A) and AOCC(L), allows for the development of a robust and efficient air-land C2 network.[122] (Figure 4).

Although PC-K has gone a long way to plug the majority of air-land co-operation gaps, there is still one major area that requires development: CID. The Battlespace and ISTAR Working Group within PC-K is attempting to provide solutions for future tactical level CID, but these are heavily reliant on technology and at present are costly. The need for upgraded targeting pods and data link CID solutions is acknowledged but this is subject to the priorities placed upon the Defence Equipment Programme.[123] However, optimistically, MOD's policy for equipment procurement remains focussed on this area and 'alongside precision strategic attack…air-land co-operation are [sic] the biggest focus for future equipment capability'[124].

Fortunately, the continuous tempo of current operations in both Iraq and Afghanistan maintains the focus on air-land co-operation. British forces have witnessed a quantum leap forward in jointery and a realisation of the importance of the air-land interface, especially for urban and counter-insurgency operations.[125] A British officer recently serving in Afghanistan had this advice to offer his comrades: 'anyone deploying [to Afghanistan]… down to the rank of Platoon Sergeant, must do…TACP practice. The one thing that can get to you in time in Afghanistan is air'[126].

If the British Army of the future is to fight successfully as lighter and faster forces, in a large, distributed battlespace, it must understand the basics of air-support. Conversely, tomorrow's RAF must become more adept at Integrated Air Operations.[127] Only then will the lessons identified from TELIC become lessons learnt. However, this will not be easy. As inter-component tensions endure, especially in the domain of defence spending, air-land interaction will remain difficult. Co-operation is 'a slow-growing and delicate plant, requiring time, much goodwill, regular human contact and careful training. It is a mood, not to be conjured into existence by decree at a moment's notice'[128]. Unfortunately, historical lessons were relearnt in Iraq in 2003. Only a joint approach towards air-land co-operation will prevent British forces from relearning the lessons identified during TELIC in the next major conflict.

Glossary

1 Div	1ST (UK) Armoured Division.
AAA	Anti-Aircraft-Artillery.
ACC	Air Component Commander.
Air-support	Generic term for Anti Surface Force Air Operations (ASFAO).
ALO	Air Liaison Officer. Normally an Air Force officer permanently assigned to a land unit (either at Division or Brigade level) to act as the link between air and land.
ANGLICO	Air Naval Gunfire Liaison Company. A USMC concept consisting of personnel specially trained in the art of bringing joint fires to bear.
AOC-in-C	Air Officer Commander in Chief.
AOCC (L)	Air Operation Co-ordination Centre (Land). An organisation consisting of approximately 20 personnel that represents the JFACC within the JFLCC Headquarters. Co-ordinates and directs air-support to Land forces in order to integrate air operations with the supported Land formation.
ASFAO	Anti Surface Force Air Operations. Defined as a core capability of airpower: either direct or indirect air operations that may be employed in the air-land environment.
ASC	Air Support Control. A concept developed in the North African Campaign and detailed in the Middle East (Army & RAF) Directive on Direct Air Support, to facilitate C2 of assets for air-support.
ASE	Air Support Element. A concept utilised by the USMC describing a team ascribed for integrating air-support with a land unit. Normally consists of an ANGLICO. This concept is shortly to be adopted by UK forces whereby members of the AOCC(L) will form an ASE and attach to a designated land unit as required.
ASSU	Air Support Signals Unit. The forerunner of the ASC concept developed in the 1940s during the Wann-Woodhall air-land co-operation experiments.
ATO	Air Tasking Order. A set of orders disseminated to airpower force elements detailing mission and assigned targets etc.
BALO	Brigade Air Liaison Officer.
BCD(A)	Battlefield Co-ordination Detachment (Air). An organisation that represents the JFLCC within the JFACC Headquarters. It fills 2 broad functions: passage of LCC's intent and concept of operations and passage of tactical detail to allow co-ordination of air-land operations.

BFT	Blue Force Tracker. A system that transmits location information.
Blue-on-blue	Fratricide. Friendly forces mistakenly attacking other friendly forces.
Bombline	An air-land deconfliction method used during WW2. A line, where possible based on a physical feature easily identifiable to both airmen and soldiers, projected forward of friendly troops, beyond which aircraft were permitted to engage targets, therefore providing for deconfliction between ordnance employed by air and friendly land forces. Similar in concept to the modern day FSCL.
C2	Command and Control.
CAS	Close Air Support. Defined as air action against hostile targets that are in close proximity to friendly forces, and requires detailed integration of each mission with the fire and movement of those forces.
CID	Combat Identification. The ability to determine the identity of friendly and enemy elements in the battlespace.
CFACC	Coalition Forces Air Component Commander.
CFLCC	Coalition Forces Land Component Commander.
DAF	Desert Air Force. The Air Force used in the North African Campaign of WW2.
DALO	Divisional Air Liaison Officer.
Danger close CAS	CAS which involves ordnance being employing within 1000 metres of friendly forces.
Direct Air Operations	Direct air operations are those intended to directly affect the outcome of a contact engagement between friendly and opposing forces.
FAC	Forward Air Controller. The FAC's principle function is the control and prosecution of CAS. The FAC can be either on the ground or airborne. During TELIC, only British ground FACs were used.
FASL	Forward Air Support Link. The FAC equivalent used during the North African campaign.
FM 100-20	An US field manual published in 1943 describing the command and employment of air power with particular reference to air-land integration.
Fratricide	Blue-on-blue. Friendly forces mistakenly attacking other f riendly forces.

FSCL	Fire Support and Co-ordination Line. A line established by the LCC to denote co-ordination requirements for fire by other force elements, which may affect his current operations. The FSCL applies to the fire of air, land or sea weapon systems. A modern equivalent to the bombline of WW2.
IADS	Integrated Air defence System.
Indirect Air Operations	Indirect air operations are those intended to disrupt and destroy an opponent's military assets and infrastructure in the rear area.
ISTAR	Intelligence, Surveillance, Target Acquisition and Reconnaissance.
JAAT	Joint Air Attack Team. UK doctrinal description of the concept of choreographed joint fires.
JALO	Joint Air Land Organisation. Acts as a central body to develop tri-Service air-land integration.
Joint Fires	The choreography of employing different fires effect, from air, land or sea systems, onto a target.
KICAS	Killbox Interdiction Close Air Support. A system of grids which can be opened or closed for CAS. If open, air can prosecute targets within a killbox safe in the knowledge that there are no friendly forces within the same killbox. If closed, air must co-ordinate with the local land commander to deconflict from friendly land forces before engaging enemy targets.
Killbox	A coded grid, normally 30 minutes of longitude by 30 minutes of latitude, used as an airspace control measure.
LCC	Land Component Commander.
MAW	Marine Air Wing.
MEF	Marine Expeditionary Force.
Montgomery	General Bernard Montgomery.
North African Campaign	The WW2 campaign fought in the deserts of North Africa between 1940 and 1943.
OIF	Operation IRAQI FREEDOM. The US name given to the 2003 campaign to liberate Iraq.
OODA Loop	Observe, Orientate, Decide, Action Loop. A decision-action cycle devised by Colonel John Boyd, describing methodology to employ to force the enemy to become reactive to the initiative of friendly forces.

PC-K	Project Coningham-Keyes. A project initiated after Op TELIC to investigate and implement methods of improving British air-land co-operation.
SA	Situational Awareness.
SAM	Surface to Air Missile.
Schwerpunkt	The German WW2 concept of synergistically blending firepower on the battlefield. Equivalent to Joint Fires in contemporary parlance.
SCUD	A long range, tactical, surface to surface ballistic missile system.
Super-MEZ	The Missile Engagement Zone that protected the heartland of Iraq during Op TELIC.
TACP	Tactical Air Control Party. A team of 4 personnel which generally includes 2 FACs and 2 signallers. The TACP is the 'point of the spear' in the prosecution of CAS.
TACS	Tactical Air Control System. The overall air C2 structure that supports UK operations at the tactical level.
TELIC	Operation TELIC. The British name for the campaign to liberate Iraq in 2003.
USMC	United States Marine Corps.
Wann-Woodhall Report	A report written describing the results and recommendations of air-land co-operation experiments conducted in 1940.

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A Frontier Too Far: Is There Credible Justification for the United States to Weaponize Space?

By Wg Cdr Johnny Stringer RAF

The United States has, since Eisenhower, honoured the notion of space as a sanctuary, militarized but not weaponized. However, technological advances, neo-conservative strategists, increasing military and commercial dependence on space systems and fear of 'near peer' rivals have challenged this position. This paper contends that current threats do not provide a strategic imperative for the US to weaponize space, but that the maintenance of space superiority and the need to cater for uncertainty requires activity across the 4 core space power roles. Moreover, the importance of continued space superiority for the US and her allies makes an informed, rational debate on weaponizing space all the more urgent.

Space science, like nuclear science and all technology, has no conscience of its own. Whether it will become a force for good or ill depends on man, and only if the United States occupies a position of pre-eminence can we help decide whether this new ocean will be a sea of peace or a new, terrifying theatre of war. [1]

It's politically sensitive, but it's going to happen. Some people don't want to hear this, and it sure isn't in vogue...but - absolutely - we're going to fight in space. We're going to fight from space and we're going to fight into space. [2]

Introduction

For almost 50 years, a mixture of formal treaties and informal consensus has guided spacefaring and space power nations in their approach to the military uses of space. Within the United States, a key principle established by President Eisenhower and honoured by all his successors has been that space should be militarized but not weaponized. Space based assets support conventional terrestrial conflict and underpin the security and assurance of nuclear deterrence, but weapons systems capable of delivering offensive effects from space have been neither manufactured nor deployed. However, this policy is under considerable pressure from both advocates of space weapons and those who reject outright any military use of space or space-based assets. Within policy and lobby groups, opinion is becoming increasingly polarised.

The last 20 years have witnessed a quickening of the pace in space weapons development and advocacy; indeed, the United States Air Force (USAF) leadership declared in 1996 that the Service was transitioning from an air force into an 'air and space force', and ultimately would become a 'space and air force'.[3] In November 2003, the 'USAF Transformation Flight Path' [4] set out an evolving space Operational Concept (CONOPS) in which space-based weapons and supporting systems architectures would enable the US to establish and maintain dominance of the 'Ultimate High Ground'. The US could become the first and probably only 'space hegemon'. The response in academia and the domestic and international political communities has been one of deep unease, although opposition has been largely and surprisingly uncoordinated. Fears of a new arms race in outer space have strengthened calls by Russia and China (amongst others) for an outright ban on weaponizing space; to date, the US has refused to sign any such treaties and is increasingly concerned by the perceived strategic challenge of her 'near peer' space power rivals. The traditional view of space as sanctuary shapes much of the current debate, and underpins the 4 broad schools of space power thinking identified by David Lupton: the 'sanctuary school'; the 'survivability school'; the space control school'; and the 'high ground school'.[5] Within all these schools, an admixture of moral justification, realpolitik, historical precedent, faith in technology and perceived strategic need inform to a greater or lesser extent the differing perspectives.

This paper will contend that there is no compelling strategic case either now or in the near future for the United States to weaponize space, but that prudent Research and Development (R&D) activity is required to provide flexibility against future uncertainty. To support this thesis and provide the necessary context for assessment, 'space weapons' will be defined before examining the 4 core space power missions: 'Space Support'; 'Space Control'; 'Force Enhancement'; and 'Force Application'. For the US, reliance on on-orbit assets will be shown to underpin terrestrial military supremacy whilst generating significant commercial income; the importance of the commercial sector to future US space strategy will be highlighted, and the extant treaties and legal guidance governing space activity outlined. It will be seen that moral justification has been claimed by diametrically opposed opinion. The paper will then assess the practical considerations shaping possible space weaponization, including the most viable technologies that would enable the deployment of offensive space weapons systems – be they space or terrestrially based.

US reliance on space assets will be shown to represent an operational – and possibly a future strategic – centre of gravity. Moreover, the threat to continued US military and commercial space dominance is real and encompasses a variety of potential actors. In particular, the challenge posed by China will require careful handling, but should not blind the US to other, less obvious opponents. However, these do not threaten to cause sudden and dramatic strategic shock, nor deny the US the continued ability to dominate the high ground of space. Instead, the most likely brake on weaponizing space will be financial; in the near term; this paper contends that the necessary exceptional expenditure is unwarranted, given current American military capabilities. Space weapons will have to justify their inclusion in a future force mix based on cost, unique capability and – ultimately – political acceptability. To date, there are clear and enduring strategic imperatives for the continued militarization of space, but 'technology push', rather than convincingly supported 'strategic pull', has informed the pro-weaponizing viewpoint. More worryingly, the current debate over weaponizing space will be shown to be both ill-defined, debilitatingly polarised and poorly articulated; there is a pressing requirement for more informed and rigorous global public dialogue. To contribute to this process, this paper will advance a strategically coherent approach to the high frontier, centred on mutually supporting activity in the 4 core space power roles.

Defining 'Space Weapons'

There is no agreed definition of 'Space Weapons';[6] for some, the term 'mean[s] things intended to cause harm that are based in space or that have an essential element based in space'.[7] Although useful, this would exclude nuclear-tipped ballistic missiles used in the Anti-SATellite (ASAT) role, any Airborne Laser (ABL) concept, or other land or sea based systems capable of engaging targets in space. USAF Space Command (AFSPC) defines space weapons as 'weapons systems operating from or through space which hold terrestrial targets at risk', whilst including their capabilities – if not specifically naming them – as also being employed for the offensive counter space mission.[8] A precise definition of 'space weapons' and their intended purpose(s) is more than mere semantics; it defines and assists the context of the weaponizing debate. For the purpose of this paper, space weapons are defined as 'Space, land, sea or air-based weapons systems capable of offensively engaging targets in space, and/or space-based systems capable of engaging terrestrial targets'.

The 4 Core Space Power Roles

USAF Space Command – operating under United States Strategic Command

– defines its mission as the defence of the US '..through the control and exploitation of space'.[9] Unsurprisingly, AFSPC's 4 'primary mission areas' map directly to the 4 core space power roles of 'Space Support', 'Force Enhancement', 'Space Control', and 'Force Application'. These 4 roles will be considered in turn; it will be seen that the space weaponization debate - for all bar the pure 'space as sanctuary' school - revolves largely around the last 2 of these roles:

Space Support. 'Space support involves capabilities to provide critical launch and satellite control infrastructure, and capabilities and technologies that enable the other mission areas to effectively perform their missions'.[10] There are now a number of nations or commercial organisations providing 'space lift', ranging from the traditional spacefarers of the US and Russia, through the European Space Agency to newer entrants such as China and the US Orbital Corporation. Of note is the age of current US national launch systems: the Shuttle, and the Titan and Delta family of rockets do not provide the US with a truly modern, reliable and more affordable means of accessing space. In short, the US risks being overtaken in launch capability, with attendant military and commercial risks.

Force Enhancement. 'Space force enhancement provides capabilities that contribute to maximizing the effectiveness of military air, land, sea and space operations'. The provision of capabilities derived from space-based assets that increase the effectiveness of military air, land, sea and space operations.[11] These capabilities include: positioning, navigation and timing assistance from the Global Positioning System (GPS); satellite communications; environmental monitoring; Intelligence, Surveillance,(Target Acquisition and) Reconnaissance (ISR); and Command and Control (C2).[12] As with space launch capability, much of the US national satellite infrastructure is ageing. Improvements are planned to the GPS system – in part driven by the rival European 'Galileo' programme – but US national satellites are few in number and expensive to build; they must repay their investment in long operating lives but in so doing risk technological obsolescence. To address this shortfall, and in tandem with overhauling national launch capability, USAF officials are pushing the notion of 'responsive space' to address the problem identified by outgoing USAF Chief of Staff General John Jumper in Autumn 2005: 'It costs so much to launch a satellite that, when you launch it, you have to pile everything you can on it...why don't we make space launch easier… [so that] we don't mind if [the satellites] only stay operational for months?' [13]

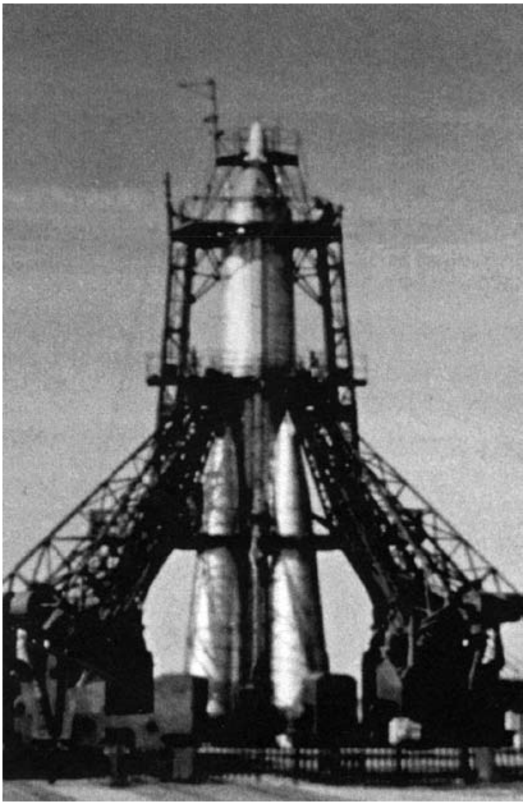
Space Control. '[The ability] to attain and maintain a desired degree of space superiority by allowing friendly forces to exploit space capabilities while negating an adversary's ability to do the same';[14] it is sometimes referred to as 'Counterspace', and prefixed with either 'Defensive' or 'Offensive'. Space control encompasses a number of potential approaches to maintaining space superiority. Although 'offensive counterspace' includes the 'hard kill' aspects of deliberate satellite degradation and destruction, there are a variety of 'soft' options open to the US: satellite up- and downlinks can be jammed; ground stations can be attacked; and most prosaically, potentially damaging commercial imagery can be bought, as occurred during operations over Afghanistan in 2001-02.[15]

Force Application. '[The capability] to execute missions with weapons systems operating from or through space which hold terrestrial targets at risk'.[16] 'Force Application' is the most contentious of the 4 core space power roles. To opponents of space weaponization, the ability to hold terrestrial targets at risk illustrates the true purpose of space-based weapons. They are not about space superiority, but earth superiority: 'Space domination is a hegemonic concept. Its essence is monopolization of space and denial of others' access to it. It aims at using outer space for strategic objectives on the ground'.[17] The technologies and concepts that would underpin force application will be discussed later, but it is interesting to note how definitions of this particular role have become blurred. By including weapon systems that merely pass through space, the AFSPC definition confuses militarized space and weaponized space, further stating that 'Space force application includes nuclear deterrence, missile defence, conventional strike and counterair.'[18] The inclusion of 'nuclear deterrence' does not feature in other definitions of the role, and is usually grouped within other 'militarized space' missions or roles; whether this is wilful obfuscation or not, it does not aid objective debate. Additionally, ABM systems that are terrestrially based do not fit obviously into the force application role; rather, any latent ASAT capability could more properly place them in the 'space control' category, albeit not for their primary purpose. Once again, this distinction is important and explains why the US has felt able to deploy Ground Based Interceptors (GBI) at two sites in the US; such systems do not lay the Administration open to charges of weaponizing space and are thus politically acceptable.

The Commercial and Military Importance of Space

Space is a key environment for both civilian and military users; indeed, much of the commercial, personal and military infrastructure of 21st century existence is increasingly dependent on and enabled by space based systems. In 1998, revenue from the global satellite industry totalled $12.4Bn; by 2003, commercial space revenue had increased to $90Bn. In the US alone, the commercial space industry was worth over $95Bn in 2002.[19] In the military sector, modern Western 'network-centric' warfighting is predicated on unfettered access to space. Space based surveillance assets, some of which were originally used to provide security and early warning that underpinned the nuclear deterrents of the US[20] (and USSR), now support conventional warfighting at the tactical level. The GPS constellation provide exceptional '4-D' navigational accuracy (x, y, z axes and time) to support and synchronise battlespace movement, whilst being integral to the targeting process and accurate delivery of satellite-guided munitions, such as the Joint Direct Attack Munition (JDAM); in Afghanistan during 2001-02, over 5000 JDAMs were delivered.[21] As Lambeth has noted, the GPS constellation is '..a particularly glaring US space vulnerability...thanks to our extraordinary dependence on that system'.[22] Imaging satellites provide the commander with an array of intelligence 'product', whilst satellite communications (SATCOM) support increasingly voracious voice, data and imagery transmission needs whilst enabling C2; in Operation Iraqi Freedom, coalition military SATCOM usage peaked at 2.4 gigabits per second[23] and the coalition remained reliant on buying spare civilian satellite capacity to cope with demand.

This use of civilian systems for military purposes illustrates a key aspect of satellites; practically all civilian satellites can be seen as 'dual use' systems, whether they be remote sensing (eg earth imaging) or dedicated to communications. This poses difficult questions for 'offensive counter-space' proponents of space control; when is a satellite providing a military service for a potential or actual opponent, and when is it employed on purely civilian tasks? To further complicate the picture, the cost of access to space and of the satellites that are put there have driven extensive international collaboration and cooperation; space is not an environment where systems are exclusively either 'theirs' or 'ours'. A recent example of this was the launch onboard a Russian Cosmos 3M rocket of UK, Chinese, Russian and Iranian 'small satellites' in March October 2005. In 2006, 50 nations possessed active space programmes. Moreover, nominally 'Western' satellites can provide sub-1 metre resolution images to any commercial organisation or private individual. The recent product launch of 'Google Earth' brings access via the internet to an impressive array of imagery product; US military commanders have already voiced their concerns that this and similar access provides their opponents with a damaging warfighting enabler. [24]



The launch of Sputnik in 1957 established the notion of freedom of territorial overflight by spacecraft of all nations

Space – the Legal Framework

Further difficulties arise when space is assessed from a legal perspective. The launch of Sputnik in 1957 established the notion of freedom of territorial overflight by spacecraft of all nations, aping the existing freedom of passage embodied in maritime law and refuting the notion of usque ad coelum ('as far as the sky') within air law that extended a state's territorial rights into the 3rd dimension – the airspace above its borders. In short, spacecraft have freedom of innocent passage outside of the earth's atmosphere. Additionally, precedent from the Treaty of the Antarctic (1956) has informed legal understanding of space, culminating in the most significant formal codification of 'space law', the 1967 Outer Space Treaty (OST).

The OST outlines the key broad principles pertaining to man's use of space, amongst which the following impact most obviously on any weaponizing of space: outer space shall only be used for peaceful purposes; outer space cannot be claimed as national sovereign territory; and 'no nuclear or any other kinds of weapons of mass destruction' may be placed in earth orbit or on the Moon. An impressive feat of logic enables 'peaceful purposes' to include space-based surveillance systems and the right to self-defence under Article 51 of the UN Charter. Three further legally ratified treaties (and one that is unratified – The Moon Treaty of 1979) guide the behaviour of states in space and their responsibilities: the 'Agreement of States on the Moon and Other Celestial Bodies (1968); the Convention on International Liability for Damage Caused by Space Objects (1973); and the Convention on Registration of Objects Launched into Outer Space (1976). Additionally, the Limited Test Ban Treaty (1963) prohibits all nuclear detonations in space, whilst the Anti-Ballistic Missile (ABM) Treaty (1972) banned the development, testing or deployment of sea, land, air or space-based ABM systems, other than at 2 fixed sites in the then USSR and the US.

The US response to this legal framework has been contentious yet has provided freedom of manoeuvre. The ABM Treaty limited options and had been problematic for President Reagan's Strategic Defence Initiative; President Bush's first Administration unilaterally abrogated the treaty in 2002, judging correctly that Russian objections would be sufficiently muted. The OST is arguably less problematic; if US space weapon systems remain clear of the nuclear sphere, nothing in the OST prevents the weaponizing of space.

The future commercial uses of space are yet to be fully determined, but commercial exploitation beyond current data and imaging purposes is a certainty. In 2008, Virgin Galactic will take the first fare-paying passengers into 'near space'; the age of mainstream 'space tourism', heralded by Dennis Tito's fee-paying journey into space in 2001, will have arrived. Asteroids and other bodies could be mined for their mineral content, whilst production in space and eventually colonisation will be a reality, if not for some decades yet. The legal framework that will guide and direct such activity remains nascent, but basic tenets of what could loosely be termed 'space law' have already been the subject of debate. The 'Commons' of the sea, land and air had been subject in Roman times to the distinct Latin principles of *res communis* (a thing for everyone) and *res nullius* (a thing for no one); however, these had been blurred by John Locke's view that the 'admixture of labour' to the latter conferred ownership rights to the labourer. As Dolman has noted, 'The vast and untold resources of space would belong to those first finders who admixed their labour to the extraction therof.'[25]

However, this view of the ownership and exploitation of the 'Commons of Space' brought protests from non-spacefaring nations, who demanded a return from others efforts despite little or no financial contribution or actual participation on their own part.[26] In truth, it is difficult to envisage any spacefaring nation willingly accepting such a proposition. It is more likely that increasingly significant private sector investment in space – and the leverage that such commercial financial commitment brings – will put pressure on national governments to support and protect space assets with the 'hard' power of weaponry, rather than the 'soft' power of legislation and lawyers.[27] The realist school – noting the previous exploitation of the other 3 environments and the creation of environmentally-specific military forces within them – thus sees the development of a military Service(s) and supporting infrastructure within space as inevitable. The paper will return to this theme in its later consideration of strategic imperatives guiding US space strategy.

Space Dominance and Morality

> If [the US is] forced to flight-test or deploy space weapons by the actions of others, that is deeply regrettable. If we take the lead in doing so, that is reprehensible.[28]

Debate over the potential weaponization of space has generated more heat than light; apocalyptic scenarios are invoked by both pro- and anti-weaponizers, with hyper-realists and liberals, hawks and doves exchanging insults from behind irreconcilable intellectual positions. For the author of 'Arming the Heavens', space weapons can be directly linked to the Nazis;[29] for Baker Spring, 'Arms control advocates…have [pointed to] an idealized outcome by defining the starting point in fictional terms.'[30] Moral justification is claimed by both sides: viz, '..the United States is the morally superior choice to control and seize space, and.. it should endeavour to do so as soon as possible'.[31] In truth, and unsurprisingly, there are considerable shades of intellectual grey between those at the monochromatic extremes of the debate - Upton's 'space as sanctuary' and 'space as high ground' schools.

It has been impossible to attain any international consensus on preventing the weaponization of space; as has been noted previously, the OST and related treaties proscribe certain types of weapons systems from being placed in orbit, and may infer by association prohibitions on other systems. They do not, however, specifically ban them. The United Nation's Conference on Disarmament 'Prevention of an Arms Race in Outer Space' committee has been stalemated on the issue since 1998; Russia and China have been in the vanguard of attempts to gain agreement on an outline framework outlawing all space weapons, despite the USSR deploying a co-orbital ASAT system during the Cold War and consistent rumours of Chinese ASAT programmes.

Disagreement over the morality or otherwise of space weapons have further hindered debate. Speaking in 2001, the Canadian Foreign Affairs Minister stated 'The big red line we all have is the weaponization of outer space, which would be immoral, illegal, and a bad mistake'.[32] A utilitarian philosopher could posit the opposite; if certain weapons provided for the greatest good for the greatest number, then surely they would indeed be moral? The asymmetric edge that current space systems offer the US and her allies allow the prosecution of increasingly precise warfare, limiting casualties on both sides and amongst non-combatants. The Global Network Against Weapons and Nuclear Power in Space may contend that '..satellite systems that identify and direct war on the earth, which essentially allow for 'full spectrum dominance' are not acceptable in our view',[33] but theirs is an extreme and currently ineffectual voice. It would be inconceivable for nations to voluntarily withdraw space-based systems that enable and enhance terrestrial warfighting capability; the dual-use aspects of nominally commercial/ civilian satellites would make it impossible. A more measured assessment within the sanctuary school favours a comprehensive approach to preventing the weaponization of space, including confidence-building measures, the use of existing legal recourse, and treaty negotiations: 'There needs to be the clear, overarching goal of creating a legally binding space security regime and embedding an unequivocal taboo on the deployment or use of weapons in and from space.'[34] Thus, the concept of weaponizing space has - across the spectrum of opinion - seen morality and ethics used to support divergent strategic options.

Space Weapons – Advantages and Limitations

From a scientific and physical viewpoint, space-based weapons have much to commend them. Any system outside earth's atmosphere is at a position of relevant advantage regarding earth's gravity well,[35] whilst earth-based missiles must consume considerable amounts of fuel to overcome their disadvantageous position at the bottom of the well.[36] (This limitation does not apply to directed energy weapons). Space-based systems should have more time to react to sensed launch events, decide as to whether they constitute threats, and engage that threat early in its flight profile. This is of particular use during a ballistic missile's boost phase, prior to deployment of multiple independent warheads. For strike systems, the effect of gravity imparts significant velocity to a descending munition or vehicle for minimal initial energy expenditure, allowing smaller delivery systems to be employed, and with effect a product of kinetic energy rather than or in addition to an explosive warhead. The vantage point offered by space-basing allows a significant geographical area to be held 'at risk', although this is offset in part by the need to place space weapons in Low Earth Orbit (LEO); the attendant 'absentee ratio' mandates the requirement for multiple systems to offset the transient coverage offered by a single system, due to LEO orbital mechanics.[37]

However, space weapons – and particularly those based in space – have several significant disadvantages, quite beyond the technical maturity of some current concepts and the sheer effort involved in placing systems in orbit. The supporting ISR infrastructure must be reliable and all-sensing, particularly when supporting ABM intercepts or ensuring accuracy and status of terrestrial targets prior to engagement. Of course, if a purposefully hegemonic US was to weaponize space regardless of international opinion, such considerations would be largely irrelevant. Satellites are also inherently predictable due to their orbital path; 'satellite savvy' opponents already predict the overflight of reconnaissance satellites and conceal activity accordingly. The corollary is the ease with which one's own satellites could be targeted by a suitably equipped adversary; of note, the USSR maintained 2 ground-based laser sites at Sary Shagan and Dushanbe during the Cold War that would have been capable of engaging US satellites – weather permitting. [38]

If an opponent could not physically attack or degrade any future US space weapons system(s), there are other methods that could be employed to ensure the likelihood of at least some penetration or survivability of one's own weapons or satellites. The USSR has already tested or is developing ballistic missiles – such as the Topol-M – with enhanced thrust motors that limit the burn time during the boost phase, complicating the detection and tracking process for ABM defences. Manoeuvrable Independent Re-entry Vehicle (MARV) warheads greatly increase the possible impact area, and/or force the continual adjustment of flight profiles for high altitude and terminal phase interceptions. The use of decoys is a known tactic to enhance warhead survivability. Laser attack systems could be countered by wavelength reflective coatings and/or spinning the missile or component body to limit the concentration of laser energy on any fixed spot; however, the effectiveness of these counter-measures against very high powered lasers is uncertain. Satellites can be moved away from potential co-orbital ASAT threats, although at the cost of using precious and irreplaceable on-board fuel. If all else fails, simply saturating any ABM system could do the trick.

The physical destruction of an opponent's space-based systems, missiles or warheads in space creates one final and potentially self-defeating problem: space debris.[39] To date, only one satellite has been known to have been destroyed by extremely high velocity space debris, the French craft 'Cerise', through collision in 1996 – for connoisseurs of irony – with the second stage from an Ariane rocket launched in 1986. However, between 1981 and 1996, 55 windscreen panes were replaced on the Shuttle fleet following impact with space debris; the 'big space' school of collision avoidance is offset in part by the relatively high density of satellites on a few orbital paths. As the biggest single user of space, and with no current scientifically plausible means of removing extant space debris, the US undoubtedly has the most to lose from fielding destructive ASAT systems; an opponent's satellite may be destroyed, but at an increased risk to one's own constellations. This logic applies equally to other nations that own or are reliant on space-based assets, and may serve to limit development of destructive ASAT systems or techniques.

Space Weapons - Candidate Technologies

Directed Energy Weapons (DEW) – Lasers. The most attractive DEW is the laser, offering speed of response and engagement, and the variety of potential effects that can be created – from disruption of onboard sensors and control processes, to outright destruction. However, both suffer from fundamental limitations that limit their utility. Chemical lasers require fuelling, and thus have a finite capacity or number of firings. The effectiveness of the laser reduces at the square of the range to target, requiring space-based systems to be placed in LEO and thus rendering them more vulnerable to attack from earth-based systems.[40] Finally, laser energy suffers from distortion whilst passing through the atmosphere; this must be anticipated during targeting, tracking and laser firing. Lasers do however offer flexibility in basing, as demonstrated by the USAF's ABL programme and Space Based Laser (SBL) concept, and the US Army's land-based Mid-Infrared Advanced Chemical Laser (MIRACL).

Kinetic Energy Weapons. Kinetic Energy (KE) weapons rely solely on the energy released by their own mass during a high velocity impact, whether that be with a space or terrestrial based target. The 'Brilliant Pebbles' concept for engaging ballistic missiles, and the proposed Mach 10+ tungsten penetrators (colloquially known as 'Rods from God') for use against targets on earth illustrate the span of potential utility. Both are relatively lightweight, although the latter would have to contend with extreme heating caused by atmospheric entry. KE weapons also include GBI and other 'direct ascent' weapons such as the USAF's ASAT air-launched missile of the 1980's.

Nuclear Weapons. The potential use of nuclear weapons in space has been possible since the fielding of the first nuclear-tipped ballistic missile. The 3 damage mechanisms would be: direct destruction from detonation; 'electronic destruction' from the attendant and intense electro-magnetic pulse (EMP); or degradation or destruction from charged particles. In 1962, the US 'Starfish' test of a one megaton nuclear warhead 250 miles above Johnson Island in the Pacific (inadvertently) destroyed 7 friendly satellites over a 7 month period, and left the Van Allen radiation belts charged until the early 1970's.[41]

DEW - High-Powered Microwave (HPM) Weapons. HPM weapons produce short-lived but very high bursts of energy, able to disable or permanently destroy sensitive satellite electronics. The 'warhead' required to produce the HPM waveform could be fitted in a small satellite and be effective out to hundreds of metres.[42] HPM weapons offer the attractions of minimal size, technological simplicity, potential for multiple-engagements and 'tuneable' effect. They also offer 'plausible deniability' in their employment.

Space Mines and other Conventional Explosives. The potential to use space mines to cripple or destroy satellites is a further 'hard kill' option; similarly, otherwise innocuous 'small sats' or their larger brothers could be used as explosive 'mules', to be detonated when adjacent to a target space system. The obvious drawback with such weapons is the creation of space debris, and the ability to trace ownership and thus responsibility for the attack. They undoubtedly represent the least advanced end of the space weapons spectrum, but their potential employment cannot be ignored.

Current and Future USAF Space Weapons Development

The USAF Transformation Flight Plan proposed a future development path for the Service, with a heavily revised Space CONOPS as a key element. Three epochs are envisaged: a near-term out to 2010; a mid-term from 2010 to 2015; and a long-term, from 2015 onwards.[43] The systems envisaged across all 3 epochs are both comprehensive and ambitious, designed to ensure continued US dominance of space across all 4 core space power roles. ASAT capabilities would be enhanced with the development of an air-launched missile for use against targets in LEO. Laser development efforts would focus on the ABL and ground-based lasers, but using space-based systems where appropriate, all with their reach significantly enhanced via airship relay mirrors.

The Counter Satellite Communications System (CCS), designed to deny or disrupt an opponent's access and control over their own communications has already been declared operational.[44] Passive system developments would include the Rapid Attack Identification Detection and Reporting System (RAIDRS), designed to identify any attack against a space system.

The Transformation Flight Plan supports continued development of high speed air and space craft; in the near term, the most significant US effort focuses on FALCON – Force AppLication from the CONtinental United states. This Mach 10 vehicle would take-off and land from earth, but be able to deliver kinetic and non-kinetic effect anywhere on the globe within 1 hour. Recent press speculation contends that the US has possessed a similar capability for some years – the so-called 'Black Star' two stage to orbit mother ship and orbiter.[45] Whether the reality is more mundane is a moot point; conceptually, such a system would offer the US unrivalled global strike.

The Financial Quandary

The one certainty over weaponizing space is that it would not be cheap. Realistic forecasts are almost impossible to achieve, although the de-scoping of President Reagan's 'Strategic Defense Initiative' and its mutation over the last 20+ years into a more limited Ballistic Missile Defense programme indicates both the technological challenges and the sheer cost of development and acquisition. Dolman believes (albeit with no supporting justification), that 'Three to five trillion dollars..might just turn the trick'. [46] Unfortunately, by 2025 it is estimated that federal budget expenditure on social security and Medicare/ Medicaid provision will represent 13% of GDP;[47] current fiscal pressure, exacerbated by the costs of the war in Iraq, have caused President Bush to raise the US budget deficit ceiling to in excess of $5 Trillion.[48]

The Strategic Imperatives for Weaponizing Space

'At this moment in history, the United States is in position to take the mantle of hegemony and provide [economic prosperity and liberal democracy] for all humankind. As part of the strategy for such a collective good provision, the United States must seize physical control of low-Earth orbit and station weapons there with the capacity to engage and destroy targets in space, in the atmosphere, and on the surface of Earth'.[49]

The reliance placed by the US on space-based assets, and the future commercial opportunities offered in space have been outlined previously. For the US, space represents an operational centre of gravity: '[a] capability..from which a nation, an alliance, a military force or other grouping derives its freedom of action, physical strength or will to fight'.[50] The protection of this CoG is therefore vital to success in the military sphere; it is sensible to presume that increasing commercialisation of space will make it a strategic CoG for the US in due course. As Lambakis has noted, 'The United States' expanding, boundless trust in space-based assets to perform a full spectrum of military, civil, scientific, and commercial activities parallels its growing inability to act on Earth without them'.[51] Secure access to space and secure assets in space are thus vital to US national security.

The launch of a Russian satellite. During the Cold War, the chief rival to American dominance in space was the Soviet Union. However, by 1999 the Russian space programme was chronically underfunded

It is, therefore, surprising that the importance of space is not more fully codified within US strategic thinking. Current US National Space Policy dates back to 1996 and the Clinton administration;[52] although work is ongoing to update that document under Secretary of State Rice, it is not expected to be released in the near future. In the meantime, the intellectual vacuum that has resulted has been filled by a variety of papers, plans and visions. Arguably, the report of the 'Commission to Assess United States National Security Space Management and Organization' (the 'Space Commission'), released in January 2001, has provided the most significant direction for policy in the interim. Chaired by Donald Rumsfeld prior to his appointment as Secretary of Defense, the commission undertook a comprehensive analysis of US space activity and the threats posed to US space dominance. Some of its language was emotionally charged, with warnings of an impending 'space Pearl Harbour' designed to heighten awareness of US vulnerabilities and provoke wider debate; 'We are on notice, but we have not noticed'.[53] However, the recommendation that the Air Force should 'organize, train, and equip for prompt and sustained offensive and defensive space operations'[54] has justified subsequent USAF thinking and is clearly embodied within the Transformation Flight Plan.

Understanding the Threat

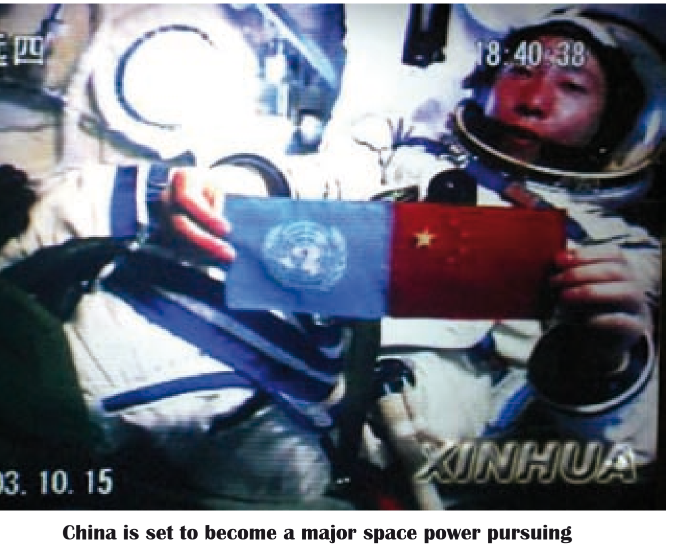
The potential threats to US space systems encompass the talented computer hacker at one extreme and the near peer competitor at the other, and across the groupings of state and non-state actors. Both pose the necessary capability and intent to threaten US space systems. Additionally, US commercial dominance is challenged by the growing number and capability of other space faring nations.

Russia. During the Cold War, the chief rival to American dominance in space was the Soviet Union. However, by 1999 the Russian space programme was chronically underfunded; 70% of her 130 active satellites were operating beyond their planned service lives, and during the Kosovo campaign Russia was unable to monitor NATO's operations over Serbia.[55] Russian expansion into the commercial sector may offset hardship elsewhere, but there is currently no national funding to seriously rival American space dominance; in 2001, the Russian Federation's space budget was $193M, half of the minimum needed by the space agency Rosaviakosmos. In an attempt to ensure an asymmetric response, the Russians have sought to increase the survivability of their Strategic Nuclear Forces through MARV warheads and enhanced boost rockets. It is also conceivable that previous R&D of co-orbital ASATs and ASAT lasers could be re-started, although there is no open source evidence to confirm any current active programmes. Instead, Russia has sought to ban space weapons through international law, whilst observing a unilateral moratorium on deploying ASATs since 1983. It is unlikely however that she would stand by idly if America sought to deploy such weapons.[56]

India. The Indians represent an interesting example of a relatively recent entrant into the community of spacefaring nations. Indian satellite capabilities include imaging and communications, and she possesses the means to launch both her own spacecraft and those of other nations; in time, this may well become a flourishing commercial offshoot. India has no plans to develop offensive space weapons, although the 'Avatar' reusable space plane concept is indicative of a forward-looking space power that sees the clear potential to use space for the more overt support of national security.

The European Space Agency (ESA). The Space Commission identified the need for the US to 'Promote government and commercial investment in leading edge technologies to assure that the U.S. has the means to master operations in space and compete in international markets'.[57] With the exception of mastering operations in space, this statement could equally describe the approach taken by the European Space Agency (ESA). France is the prime mover behind and within ESA, but despite the emphasis in the French '2001-05 Strategic Plan' on the military utility of satellites, it is the commercial market that most energises French thinking.[58] For the United Kingdom, the recently published 'Future Air and Space Operational Concept' notes the ISR contribution provided by satellites; moreover, 'adaptable, affordable small satellite technology providing wide area coverage is a realisable UK aspiration.'[59] It is highly unlikely that the French, British or their European colleagues within ESA would envisage the development of their own space weapons; put simply, there is no strategic benefit or requirement that would drive such a programme.

China. For US policy makers, China represents a number of difficulties. Her economic potential remains largely untapped, but once harnessed will undoubtedly enable the Chinese to challenge US global trading pre-eminence; Chinese GDP is forecast to treble over the next 20 years.[60] Her nuclear weapons, although low in number and at a reduced state of readiness, have the strategic range to reach the US. Additionally, concerns over human rights and the environment, the enduring impact of Tiananmen Square, and the disputed status of Taiwan all serve to complicate relations between the two nations; for some, China is more 'strategic competitor' than 'strategic partner'.[61] Against this backdrop, US concerns over Chinese space capability can be understood.



China is set to become a major space power pursuing regional and intercontinental objectives. It could be the world number two in space by 2020

China's space programme ('Project 921) is undoubtedly ambitious; the French Centre National d'Etudes Spatiales has forecast that 'China is set to become a major space power pursuing regional and intercontinental objectives. It could be the world number two in space by 2020'.[62] In the last 2 years, the Chinese have conducted two manned Shenzou flights; the second mission included orbital manoeuvring, real time voice and video streaming, and re-entry to within 1 km of planned landing spot, all achievements with clear military utility. The commercial and military benefits of space are clear to the Chinese. The Chairman of China's National People's Congress, Wu Bangguo, stated upon the return of Shenzhuo-6 that 'It [Project 921] is of great significance in elevating China's prestige in the world and promoting China's economic, scientific and national defence capabilities, and its national cohesiveness'.[63] The Chinese military aspire to a national space infrastructure to support terrestrial warfighting, effectively mirroring the US model. China is a partner in the European 'Galileo' programme, and is enhancing its indigenous launch capabilities to support both commercial and military space activity.

Publicly, China remains in the vanguard of those seeking to ban weapons in space and prohibiting attacks against space-based assets. Privately, the position is far less certain. Alexander Neill has suggested that the traditional Chinese tactic of biantan bianda ('attacking whilst negotiating') could be in play, and that little is known of the military Chinese space programme.[64] Certainly, numerous American strategists have identified the need for China to neutralise the United States's space superiority as a prelude to success in any future conflict in the Taiwan Straits.[65] Although much of their analysis has been conducted without reference to the rest of the strategic environment, or rests on the notion of inevitability,[66] O'Hanlon is right to argue that 'It is doubtful that the United States could operate its space assets with impunity, or count on completely dominating military space operations in such a scenario.'[67]

Non-State and Irrational Actors. Current official US thinking on the threat posed to its space systems appears focused on the national capabilities of rational state actors. An area that is under-researched is the threat posed by non-state actors – a seeming oversight, given the focus of 'the Long War' against international terrorism. Although it is stretching credibility to imagine Al-Qaeda possessing the capability to physically interfere with US assets in space, the US could be vulnerable to computer network attack that blighted part of its satellite constellations. Krepon contends that most terrorist organisations would rather attack terrestrial targets – thus achieving both impact and mass casualties – than attempt to interfere with space-based assets.[68] However, this argument ignores the immense damage that can be caused to a nation's financial well-being by targeted terrorist action, something well understood by the IRA in their attacks against the City of London in the early-mid 1990s. Computer hackers have already attempted to get into US satellite control systems, and the ability to interfere with satellite up- and down-links is well proven. Concerted terrorist action that interfered with satellite command and control could have significant implications for military capability and commercial life; it should not be easily discounted.

Proponents of space weapons point to one final potential threat – the irrational actor. In this scenario, US space assets are deliberately targeted to provide an asymmetric advantage against the superior American opponent, or as a last chance 'roll of the dice' by a regime with nothing left to lose. The irrational actor is unconcerned by likely international reaction nor the damage done to the space environment by his actions. Although such a scenario cannot be discounted, it is highly improbable, and would be reliant on the capability to put a rudimentary (probably nuclear) ASAT into space. The response from the US would be immediate and massive. US Space Policy 'considers the space systems of any nation to be national property..purposeful interference with space systems shall be viewed as an infringement on sovereign rights'.[69] It is also likely that any attack against space capabilities that would reduce US combat effectiveness would concomitantly increase the risk to American servicemen's lives, inviting proportionally greater response and increasing losses on one's own side. It would be a 'lose-lose' option.

Is a Threat Required?

Even if there were no threat to assured US space access and capabilities, neo-conservative strategists such as Dolman and Spring believe the US should place weapons in space regardless. For Dolman, it would guarantee and uphold the imposition of US-style liberal democracy, ensuring benefits for the citizens of a grateful globe from the largesse of a benign hegemon.[70] Clearly, this manifestation of US strategic munificence would not be shared by all; an irrevocably subverted international system is unlikely to be accepted by friend and foe alike. Those, like Spring, from the 'weaponization is inevitable' school may in time be proved right; Gray for one believes that 'Spacepower and space warfare is coming. The only issues are how and when.'[71]

However, the previous assessment of possible threats to US space capabilities does not justify a 'Manhattan Project'-type effort on the part of the current or near future Administration. Indeed, the negative consequences of such a programme would be threefold. Firstly, it is almost inconceivable that other nations would allow the US to weaponize space unchallenged; it is likely they would develop similar weapons systems or counter-measures to negate the asymmetric American advantage. Attempts at preventing further nuclear proliferation could

Maintaining US Spacepower

'Given the dependence of US military forces on space-based assets…it is critical that the Pentagon find ways to protect those assets. I believe that weapons will go into space. It's a question of time. And we need to be at the forefront of that'.[77]

The following options for enhancing US capability across the core space power roles are consistent with all extant treaties and obligations. Importantly, they seek to maintain the maximum freedom of manoeuvre across the relevant lines of development without unnecessary limitations. Specifically, by being consistent with all extant space law, they reject the need for additional treaty negotiation or abrogation. Krepon, O'Hanlon[78] and others see merit in the US engaging in treaty obligations that would prohibit the deployment of space weapons. However, the damage caused internationally by the US abrogation of the ABM Treaty acts as a cautionary note against over-hasty and policy-limiting arms control legislation. The US can maintain freedom of action and the moral high ground by continued informal and unilateral restraint that in time could evolve into more formalised 'rules of the road' in space. Wherever possible, commercial and military space capabilities have been given equal prominence – an essential element where systems are capable of 'dual use'. It will be contended that the US can achieve much and risk little without yet weaponizing space. This section constitutes a realpolitik approach to Dolman's envisaged astropolitik domain.[79]

Space Support. The United States has consistently under-invested in space launch systems; consequently, its fleet of current systems is expensive, elderly and insufficiently reliable to provide the regular access envisaged by USAF's 'responsive space' concept. The enforced recently announced 2 month delay to July 2006 for the next launch of Shuttle[80] mission STS-121 launch merely reinforcesd the extent of the problem that has afflicted both Titan and Delta launches periodically during the 1980s and 1990s.[81] Overhauling launch capability should be viewed as an urgent requirement, with heavy launch systems such as the Enhanced Expendable Launch Vehicle augmented by more novel solutions. A key driver must be reduced acquisition and launch costs, matched to greater reliability; the obvious commercial benefit would be to make US launch capacity attractive to civilian operators and rival the (currently) cheaper launch costs elsewhere.

Space Control. The space control role and the maintenance of assured friendly access to space-based capabilities dictate a holistic approach. Additionally, it is an area where the US must demonstrate a deft political touch to ensure that '..innovative strategic theory with clear policy relevance [is not] impeded by harassment from essentially irrelevant, but potent, controversies.'[82] The military uses of space are understood and supported by many who equally and vehemently oppose the need for force application from space. Put bluntly, the US has the opportunity to build a consensus view that is currently lacking.

The deployment of offensive systems to provide space control represents an unnecessary raising of the ante, although the US can use to its advantage in debate the earlier development by the Soviet Union of just such systems, and the latent utility of nuclear ballistic missiles. Given the self-defeating nature of creating space debris through kinetic hard kill of satellites, the US should concentrate on passive defensive measures of its own systems. Currently, only high value satellites such as the DSP and MILSATCOM series are hardened against enemy ASAT attack; consideration should be given to hardening all critical military or dual use satellites. Reductions in launch cost and the potential for large yet affordable constellations of 'small sats' offer protection through redundancy; the US would not be reliant on a few, high value satellites but could call on the capabilities available within many. Clearly, any denial options that are open to the US may equally be available to her opponents. Satellite up- and down-links must be protected, even as the US should seek to jam or interrupt those that may be used against her. Satellite C2 systems must be protected against CNA, whilst multiplicity in ground stations offers redundancy against physical attack. If all else fails, the US could buy satellite imagery product to reduce the coverage available to others. The variety of options open to the US in ensuring her own access to space and the denial of that to others indicates the inflexibility of solely offensive action against enemy satellites; offensive denial through space weapons represents a poor and selective interpretation of available options, and would be politically damaging.

Force Enhancement. The essential 'Force Enhancement' role is well understood across all levels of warfare, and the US must maintain and develop the current technological edge that it provides to own and friendly forces. Unfortunately, many current systems are approaching the end of their useful lives; replacing them will cost c $60Bn during the next decade,[83] money that will have to be found from a USAF budget struggling to procure and support conventional air breathing systems. Space assets must 'buy themselves' into the force mix; namely, they must offer similar capabilities available through other means at significantly cheaper cost, or offer a step change in capability. Given this, any move of air breathing C4ISR capability into space (such as the replacement of the Boeing E3 AWACS fleet by Space Based Radar) should be programmed against current system obsolescence. Even then, prudence dictates a residual air breathing capability may still be required to offer redundancy.

The use of civilian systems in support of the military should continue; indeed, the military must seek to actively leverage off the commercial sector and its spare capacity where practicable to reduce costs and promote redundancy. This should be incorporated within the notion of 'responsive space'; advances in 'small sat' technology should help turn vision into reality.

Force Application. Any proposed future development path of space weapons for the force application role could be situated purely on the relatively straightforward aspects of feasibility, cost and actual requirement. Using the methodology of 'buying themselves in' to a future force mix outlined above, space weapons could be assessed alongside conventional alternatives. However, assessment must be reconciled with the political ramifications of weaponizing space; as Lambeth has noted, '..the United States retains the power of the initiative in this respect.'[84] The most effective means of maintaining this position would be to continue R&D into the most practical technologies examined earlier; in the near term, lasers and other DEW offer the most promise. Such a strategy ensures continual understanding of 'the art of the possible' and represents a prudent insurance policy. Failure to maintain the technical wherewithal to deploy space weapons would represent a deliberate choice not to plan for unknown future outcomes; it would thus invite strategic shock through well-intentioned but utterly unsupported good faith in other nations. A benign and optimistic view of international relations is no foundation for national security policy.

One promising concept for continued development and potential deployment is that of the hypersonic 'space plane'. The conventional take-off and landing characteristics of FALCON-type concepts, and their use of both air and space as mediums for flight, blur the line between militarized and weaponized space. As such, the delivery of kinetic or non-kinetic effect from such a vehicle could be seen more in the context of 'earth wars', rather than 'star wars'. There would undoubtedly be significant domestic and international debate over deployment of such a system, but one could equally argue that the Shuttle is conceptually almost identical.
If nothing else, the debate should be had.

Conclusion

Twenty years on from the Strategic Defence Initiative, the United States possesses the technological capability to implement the development, production and deployment of space weapons. The epochs envisaged by the Transformation Flight Plan are not a generation away; they are the near term. It is a sobering thought. The neo-conservative think-tanks' views of a benign American global hegemony – underwritten by space-based weapons – cannot be dismissed as mere 'arrogance'. The US is uniquely placed to dominate space and earth if she so chooses; it is incumbent on those who do not share that view to provide a rational, evidential and convincing rebuttal.

This paper has argued that there is no clear strategic imperative for the United States to weaponize space, and that the threats posed by a raft of nations and other actors do not – in the near term – require Eisenhower's principle of 'militarized, not weaponized' space to be superseded. Conventional US military capabilities – further maximized by 'space force enhancement' – are unmatched; America is not approaching a 'tipping point' where her current space-derived asymmetric edge requires the added contribution of space weapons. Instead, extant capability in 3 of the 4 core space power roles should be either enhanced or upgraded; in the case of 'force application', the need to provide a 'hedge'[85] against future uncertainty is more than sufficient justification for continued R&D activity.

Space-based systems represent a military and, increasingly, a commercial centre of gravity for the United States; failure to provide for their continued security would be to ignore a vital national interest and to compromise both national security and de facto that of her increasingly space-reliant allies.

What is equally apparent is the pressing need for a rational and considered debate regarding the weaponization of space; current discussion and analysis relies on ill-informed yet entrenched dogmatism and the simplistic, selective and subjective treatment of a complex and multi-faceted issue. For Mueller:

'The polarization of the space weaponization debate…discourages real dialogue among those who favor different military space policies. Many of the debate participants appear to be interested only in preaching to their fellow believers, treating their adversaries' arguments so dismissively that they cannot possibly change the minds of those who view the issues differently from themselves. The marketplace of ideas breaks down when contending camps turn inward from healthy competition to mercantilist isolationism'.[86]

It is difficult to disagree with this depressing but accurate assessment. That discourse has sunk to this low is due to more than the usual animosity felt between those holding mutually exclusive positions on space policy and strategic necessity. There is a clear need for better definition and articulation of that policy and strategy within the current Administration.

'..what one can say about the current US space strategy is that it most certainly is not decisive, guiding, or illuminating. In a word, it is not strategic'.[87]

As US National Space Policy approaches its tenth anniversary without overhaul this year, the strategic environment has altered so radically in the intervening period that its continued value must be questioned. The vacuum created by outdated policy has been filled by a diverse assortment of – amongst others - would be-strategists, technophiles, arms control campaigners and single-issue zealots. The 'Space Commission' report could have acted as a catalyst for informed debate to support a process of continual evaluation and development of space policy and American space strategy. That it has not represents more than a missed opportunity; it marks a failure to adequately engage nationally and internationally on a key policy area. Space weapons are more than just another way of waging warfare; their deployment - by unilateral choice or clear strategic necessity - would be emblematic of American hegemonic political power within the international system. For the United States, it is a vitally important strategic issue.

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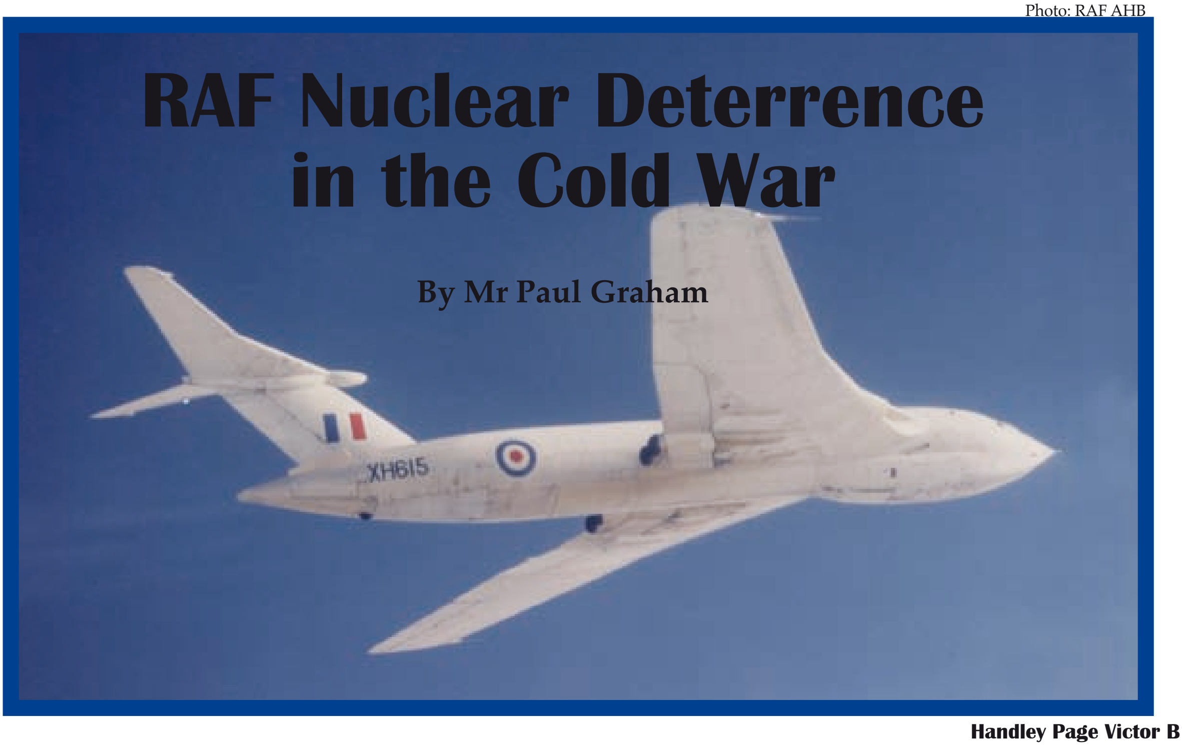
Photo: RAF AHB

RAF Nuclear Deterrence in the Cold War

By Mr Paul Graham



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The history of the RAF's strategic nuclear deterrent, the V-bomber force, can be said to be that of an organisation attempting to discover, justify and maintain a role within the rapidly changing environment of the Cold War. This study will provide a selective investigation and a critical look at the establishment, evolution and eventual obsolescence of the RAF's deterrent. It will attempt to assess whether the V-force was capable of fulfilling the role assigned to it, both that of providing a credible deterrent and in the event of conflict an effective retaliatory capability.

It shall cover three main areas, firstly an exploration of the rationale, requirements and history behind the creation of the British airborne deterrent, secondly an assessment of the independent nature of the deterrent, and lastly an examination of the evolving nature of the V-force during its period of active service.

The New National Deterrent

In the immediate post-war era only three nations, the United States, the Soviet Union and, less obviously, the United Kingdom were in a position to exploit the recent advances in military technology. The potential of the airborne delivery of nuclear weapons had been demonstrated in dramatic fashion by the raids on Hiroshima and Nagasaki, where a single aircraft and bomb had inflicted devastation equivalent to the massed aerial attacks previously required. Allied to the first-generation of jet engines it was apparent that the nuclear-armed strategic bomber would represent the apex of military power for the foreseeable future.[1]

Although nominally still a world power of significant standing, Britain had been economically devastated and had quickly taken the post-war opportunity to massively cut back its military forces.

The result for the Royal Air Force was a reduction in front-line aircraft from a peak of 55,000 at war's end to little more than 1000 by 1947.[2]

Despite grudging recognition of its new status as a second-tier power in the shadow of the new American and Russian 'superpowers' and economic constraints the United Kingdom was soon committed to a massive military rearmament, largely centred on the acquisition of atomic weapons and the means to deliver them. The perception of a future Russian threat with its own nuclear-armed bombers and due to the magnitude of the devastation that could be caused by even a limited assault, the belief resulted that the 'defence of the Realm' would rest on the capacity to deter such an attack from ever being attempted. This policy of deterrence could only be effective if the United Kingdom possessed, and was seen to possess, its own potent retaliatory capability.

Official estimates of the period, including the 1947, White Paper on the Supply of Military Aircraft, (Cmnd. 9388), which examined procurement philosophy for a decade hence assumed that no war was likely in the immediate future. Therefore no urgent re-equipment of the RAF would be needed before 1957, the year that the Soviet Union was expected to possess a significant stockpile of weapons and the means to deliver them.[3]

The decision to proceed with the creation of a British atomic weapons capability was taken by a small ad hoc committee of ministers, GEN 163, on 8th January 1947. Before this, on 17th December 1946, the Operational Requirements Committee had drawn up specifications for a future long-range bomber. Designated O.R. 229 it set the ambitious requirements of a cruising speed of over 500 knots and a service ceiling of 45'000 ft. It was to have no self-defence armament, the assumption being that speed and height would be protection enough, and a five-man crew to be accommodated in a pressurised cabin. The bombers commissioned to fulfil this B.35/46 specification were to become known as the Vulcan and Victor, produced by Avro and Handley Page respectively.[4] They, along with the other commissioned variant the Vickers Valiant were given their titles and the collective designation as the 'V-Force' from a remark made by Marshal of the Royal Air Force Sir John Slessor during a meeting of the Air Council to decide their names in 1952. He stated that his own inclination was '…to establish, so to speak, a 'V' class of medium jet bombers'.[5]

The parallel British nuclear weapons and 'Medium Bomber Force' (another name for the V-force) development programmes were carried out successfully over the next decade. In some respects the V-bomber program was the more complex, the theory behind the creation of nuclear weapons being well established, with much of the difficulty coming from the creation of the substantial infrastructure required to develop and produce them, in comparison the V-bomber program represented not an evolutionary but a revolutionary leap forward in capabilities from the piston-engined, propeller driven bombers of the Second World War.

Logically the next generation of bomber aircraft should have been reliant on the turbo-prop variant of propulsion. The British Air Ministry however took the risky strategy of commissioning three separate variants of medium-range bombers to be powered by the relatively immature technology of the jet engine. A fourth variant, the Shorts Sperrin, was initially ordered as a fallback in the prospect of the more advanced variants failing to materialise. Nicknamed the 'Insurance bomber' its more achievable specification, B.14/46, was cancelled by the Air Staff after the testing of two flying prototypes.[6]

The background to the development of the V-force is worth describing in some detail, as it remains a matter of controversy and speculation even today. On 9th January 1947, in an apparent coincidence, one day after production of the atomic bomb had been approved (although according to Paul Jackson the date was 7th January) the Ministry of Supply sent letters to four British aircraft companies for the advanced B.35/46 specification; these were Armstrong Whitworth, Avro, English Electric and Handley Page. Vickers and Short Brothers made unsolicited tenders and Bristol also expressed an interest. A Tender Design Conference held on 28th July 1948 decided in favour of the Avro delta-winged proposal with Armstrong Whitworth and Handley Page as runners up. On 19th November the Handley Page crescent wing HP.80 was declared joint winner and also sent an ITP (Instruction to Proceed but not a contract).[7]

Increasing international tension in the late 1940s and the unexpectedly rapid detonation of a Soviet atomic bomb on 29th August 1949, resulted in an accelerated re-armament programme and the Air Staff asked for another medium bomber proposal designed to the lower specification, B.9/48, with the expectation of earlier service entry. This was the Vickers Type 660, later named the Valiant, and issued with an ITP on 16th April 1948.[8]

This Byzantine procurement process raises the question as to why the United Kingdom was willing to make such a large expenditure on three, four if the abortive Shorts model is included, medium bombers from different companies. A possible explanation is that the British government wished to retain its world-leading aerospace industry, in danger of stagnating in the post-war economic malaise, or that they simply did not comprehend the economic expenditure required in the development of complex modern aircraft. A further consideration is that both Handley Page and Avro assumed that the RAF would order only one B.35/46 contender into large-scale service and so were spurred to ever greater efforts to beat the competing design on performance and delivery.[9] This assumes, however, a Machiavellian scheme on the part of the Ministry and it is more likely to have been simply an unexpectedly advantageous by-product. As it transpired both designs were ordered and operated in parallel.

The most likely explanation, however, is simple government indecision. Due to the uncharted aeronautical realms that were now being explored there was a fear of committing the RAF to a single design, which might later prove to have fatal flaws. This was partially justified by the eventual premature retirement of the Vickers Valiant due to airframe fatigue. This, however, was no reflection on the original design; the airframe was subjected to an operational environment of extended low-level flight for which it was never intended, for reasons explored later.

The procurement process could be succinctly, if cynically, summed up by stating that the Air Ministry and Ministry of Supply could not decide between the different aircraft and simply opted to 'have them all'. The Ministries seemed to favour the prospect of world-beating designs in limited numbers at a later date rather than the, perhaps more suitable, option of a considerable number of slightly inferior bombers at an earlier date. In justifying their decision, Duncan Sandys of the Ministry of Supply asserted that, '…in equipping an air force, as in racing, it is risky to put all your money on one horse, or to try to guess the winner too long before the race'.[10]

In the event all three V-bomber variants compared favourably with their contemporaries of other nations, and in some respects were markedly superior, the Vulcan for example was famed for its 'fighter-like' handling, especially at high altitude.[11] Comparison is often made with the American B-47 Stratojet. However, although they represent each nations first-generation jet-bomber project and the V-bombers were qualitatively superior, with service entry dates years apart, '…the thousandth B-47 was delivered before either of the British bombers was cleared for service'.[12] A more accurate American comparison, in terms of timing, would be with the B-52 Stratofortress and B-58 Hustler of which the former boasted massive range and the latter extremely high speed. While the V-bombers still compare favourably the difference is much less marked.

different operational niches. However it does illustrate that in all major areas the V-bombers compared favourably with their contemporaries and marked a quantum leap in performance over their Second World War predecessors.

Despite British expectations, instead of concentrating on manned aircraft as delivery platforms, by the mid 1950's the USSR had begun to focus on long-range surface-to-surface ballistic missiles as the primary means of nuclear deterrence.[14] This was to prove a shrewd move on the Soviet's part and would present substantial problems to the United Kingdom and its airborne deterrent in later years.

The British bomber and atomic weapons programmes ran in parallel and the close relationship can be established by the fact that the physical nature of the British atom bomb was based on an Air Staff Operational Requirement, O.R.1001, issued on the 9th of August 1946 which outlined the prerequisites for an air-delivered weapon.[15]

Aircraft	Nation	Service Entry	Number Built	Thrust (lb)	Range (km)	Max speed (knts/mach)	Service Ceiling (ft)
B-29 Superfortress	USA	1943	c.3000	n.k	5260	575	31850
Avro Lincoln	UK	1946	804	n.k.	3600	404	22000
Boeing B-47	USA	1950	2041	6x7200	5800	964	40500
Tupolev Tu-16 Badger	USSR	1951	c.2000	2x20550	4800	945	49215
Myasishchev M-4 Bison	USSR	1955	n.k.	4x19190	11000	900	42650
Vickers Valiant	UK	1955	104	4x10000	8340	912	54000
B-52 Stratofortress	USA	1956	744	8x9000	12900	883/0.84	45000
Tupolev Tu-20/95 Bear	USSR	1956	c.300	4x14795	14800	970/0.79	41000
Avro Vulcan B Mk1	UK	1957	45	4x13000	6450	0.84	48000
Victor B Mk1	UK	1958	80 mk 1&2	4x11090	9856	0.98	55000
Victor B Mk2	UK	1960	80 mk 1&2	4x17250	9765	0.96	60000
Avro Vulcan B Mk2	UK	1960	89	4x20600	5550/7400 (high)	0.96	65000
Convair B-58 Hustler	USA	1960	116	4x15600	3219	2215/2.1	63400
Mirage IVA	FRANCE	1962	33	2x14990	1426	2.2	c.50000

Table 1.1. Statistics of Contemporary Bombers[13]

The above table is intended only to give the most cursory comparison of strategic bombers of the period. Bare statistics cannot be used to conclusively determine relative merit as each aircraft may be intended for substantially

The two programs were however not inextricably entwined, even without nuclear weapons research the RAF still required a new heavy bomber, although it is likely that in this case the procurement programme would have been much more modest in ambition and scale.[16]

The atomic weapons program was first to bear fruit with the initial test at Monte Bello on 2nd October 1952. Codenamed 'Operation Hurricane' it was the 33rd nuclear weapon to be detonated since the war and the first by a third nation. From the start of the programme to its successful conclusion took just over five years, a significant achievement. It was to be more than a year after this test, November 1953, before the RAF began to receive its first atomic weapons, designated Blue Danube. However it was over another year before Bomber Command took delivery of the first of the airplanes that were to carry them.[17] In the mean-time technology had progressed from the atomic-bomb to the massively more powerful Hydrogen – bomb, and so, with governmental approval, the British development programme continued. This resulted in the first British thermonuclear detonation, during the 'Grapple' series of nuclear tests, an air-burst delivered from a Valiant bomber over Malden Island in the Pacific on 28th April 1958.[18] The British nuclear weapons program had 'proceeded through a series of exotically named weapons'. With the original Blue Danube representing a moderate 20 Kt (kiloton) yield. This was followed by Violet Club, intended to give the RAF a 'megaton' capability at the earliest date. It was a complicated and sensitive device which required construction by specialists on-site before being loaded on to the aircraft. Only five were produced and the more viable Yellow Sun Mk 1 entered service in 1960 with the definitive British weapon Yellow Sun Mk 2 becoming operational in 1962.[19]

Although none of the V-bombers suffered from insurmountable technical problems their design and production was a lengthy process, as Humphrey Wynn describes, '…the biggest problem, as far as the Air Staff was concerned, in a period when the Bomber Command front-line was being sustained by borrowed [American] B-29's (designated 'Washingtons' in RAF service) and Lincolns with inadequate range, was the length of time to get the new bombers into service'.[20] Until 1955 the British deterrent was mostly based on the English Electric Canberra, a light bomber which, although nuclear capable, was not suitable for use in the strategic role, at least if the pilot wished to fly a two-way mission.

The interim Valiant was not received by the RAF until February 1955, the Vulcan in August 1956 and the Victor until November 1957, from the award of contract until service entry was therefore seven years for the Valiant, 8.5 for the Vulcan and ten years for the Victor.[21] This has led to suggestions that the British aviation industry was somehow remiss in delivering the bombers so long after the original commission.

This, however, is to ignore the fact that when the initial proposals were drawn up and disseminated there was a general belief that no large-scale conflict could be expected before 1957 and so procurement was centred around that target date. Despite all three V-bombers being afforded 'super-priority' status, (whereby named projects had foremost access to scarce resources) by Prime Minister Churchill in March 1952, planning had been projected for a much later date of delivery and development and production could only be brought forward to a limited extent.[22]

With the touch-down of the first Vickers Valiant at RAF Gaydon on 8th February 1955 the development period could be said to have ended, although the V-bomber force would not reach full operational capacity until 1957. From that date until 1963 Bomber Command was to receive a steady influx of V-bombers and build up squadrons with them, creating the United Kingdoms airborne strategic deterrent. Developing and producing the V-bombers up to the end of the first era, that is with the three Mk 1 types in service and the first Mk 2 variants, cost £119 million at contemporary values.[23]

Despite the substantial costs involved, most of the nations leadership considered the outlay entirely justified, with the Minister of Defence stating, 'In terms of military and political value for money, the V-Bomber Force is the cheapest element in the defence program'.[24] Furthermore, it was also the base on which the nation's Cold War defence policy would be built, and therefore, 'If we do not provide an adequate deterrent, then the rest of the defence programme is an utter waste of money and manpower'.[25]

The Air Staff had originally predicted that there would be 200 medium bombers by the end of 1957 with an ultimate strength of 240. As we shall see, for various reasons, the final figure was significantly below this early estimate.[26] The post-1957 period also saw the move from isolation and independence to collaboration and interdependence, most particularly with the United States, as the newly functioning V-force sought to discover its place within the wider defence of the West. This is the subject of the next section.

In summary, for Britain the philosophy behind the acquisition of the V-force can be aptly described by the famous dictum of Flavius Vegatus Peratus, 'Qui desiderit pacem, praeparet bellum'.

The Independent Deterrent?

The British deterrent did not exist in a vacuum. Alongside France and West Germany the United Kingdom ranked as a secondary power in western defence, however unlike those two nations Britain was in possession of a nuclear capability. It would not be until 1966 that France would have an operational deterrent and until then the United Kingdom remained the sole European nuclear state. France also lacked the 'special relationship' established between the UK and the United States, a central component of which was built on each nations nuclear capability. During the period under study a recurrent debate centred on the issue of British nuclear independency, or the lack of it. Regarding the importance of martial prowess in determining world standing, Williams has stated that, '…military power is regarded as an index of world status'. And that the former requires, 'a largely self-sufficient weapons base and a sophisticated technological capability'.[27] In nuclear matters the United Kingdom's technical competency has rarely been seriously questioned, however its self-sufficiency has often been a matter of heated debate.
The earliest debates questioned whether the United Kingdom required an independent nuclear capability at all. It was suggested that instead of pursuing an expensive and time-consuming atomic weapons program Britain could instead rely on the extended 'nuclear umbrella' of America. This possibility was dismissed by the Chiefs of Staff, who declared that:

> Britain, as a great world power could not leave her security in the hands of the Americans who, however friendly, could veer so unpredictably from generous international collaboration to self-centred isolationism.[28]

This summary also illustrates the prevalent belief that, despite economic reality, Britain remained a 'great power' and as such it was only fitting that she gain access to the unparalleled might of atomic weapons.

Despite this it was believed that the close wartime relationship between Britain and America in nuclear research and development would continue. This expectation was shattered by the unilateral termination of existing and potential arrangements by the American Atomic Energy Act, more commonly known as the McMahon Act in 1946.[29] This was imposed, at least partially, due to American fears of laxity in British security, a fear later justified somewhat by the unveiling of several British spies, including the infamous 'Cambridge Five', in the early 1950's. The UK was therefore forced into the pursuit of a deterrent capacity by its own efforts. Attempts to restore links with America were continuous however and it was believed that if Britain could show substantial progress in nuclear development this would reassure the USA that a mutually beneficial relationship could be re-established. This policy was seen to bear fruit after the initial British nuclear test in 1952, when restrictions were eased, and more importantly after the 'Grapple' tests in 1957, by the signing of the Agreement for Cooperation on the uses of Atomic Energy for Mutual Defence Purposes on 3rd July 1958.[30] Ironically this rehabilitated Anglo-American collaboration was to directly lead to the eventual end of the RAF's role as primary provider of the British deterrent.

Bomber Command had been lobbying persistently for the proposed Douglas AGM-87A 'Skybolt', an American ALBM (Air Launched Ballistic Missile – to be tipped with a British warhead), which, with its thousand-mile reach could be launched from outside the range of Soviet air defences.[31] Its acquisition was expected to extend the lifespan of the British bombers, which were being faced with ever-greater difficulties in fulfilling their operational mission, a subject covered in the next chapter.

As Peter Malone has stated in his study of the British deterrent, 'Skybolt was an airman's dream, combining the high-technology of the missile age with a continuing role for bombers and pilots', it was also however, 'a systems analyst's nightmare, as it combined the bombers' disadvantages of vulnerability and slow response with the mobile missiles' drawbacks of low payload and unimpressive accuracy'.[32]

The British military and political establishment had based all future plans for the United Kingdom's deterrent on the successful development and delivery of the missiles, cancelling plans to build and deploy a British MRBM (Medium Range Ballistic Missile) Blue Streak in 1960 and proposed indigenous weapons upgrade programs for the V-bombers themselves.[33]

This was considered possible because the British believed that there was a tacit understanding that if Skybolt should not materialise the new sea-borne 'Polaris' ballistic missile carrying submarine system would be provided as an alternative.[34] On 11th December 1962 however, US Secretary of Defence, Robert McNamara, informed the British Minister of Defence, Peter Thorneycroft of his decision to cancel Skybolt. As a result, '…both Anglo-American relations and British nuclear policy were thrown into crisis'.[35]

Photo: RAF AHB

An Avro Vulcan B2 carrying Skybolt trials rounds, 1962

The junior position of Britain can be established by the fact that the decision was taken unilaterally by the American leadership, albeit with prior heavy hints that the program was not progressing to plan.

At the pre-scheduled meeting at Nassau in the Bahamas held a week later proceedings were dominated by the Skybolt debate. Prime Minister Macmillan rejected the offer of the lesser 'Hound Dog' system, concentrating on securing Polaris instead.[36] This was eventually granted by President Kennedy despite the vocal reservations of some sections of the US defence industry. With the subsequent signing of the Nassau Statement on Nuclear Defence Systems and the later, and more detailed, Polaris Sales Agreement Macmillan had, in the words of Colin McInnes, '…secured for Britain the most advanced strategic weapons system available at that time', and furthermore that, 'it had been done at an extremely low cost, and with a negligible loss of political control'.[37] While the latter assertion is contestable what was certain was that the supply of Polaris signalled the end of Bomber Commands pre-eminence.

The Nassau Agreement raised the spectre for some that Britain had lost political control over its deterrent, with the Polaris force to be assigned to NATO and pressure to fully commit the V-force as well. In the event a proportion of the Valiant fleet was assigned to SACEUR's command, with however the provision that it may be withdrawn in a case of 'supreme national interest'. There was also the proposal of a new multilateral force (MLF), pushed mainly by the Americans, who were understandably uneasy at the existence of national deterrents outside of their direct control.[38] The ambiguous reference to the proposed MLF in the agreement made it unclear whether it was to be multilateral or multinational in make up. In the event the question would gradually fade from prominence and by the mid-1960s the entire concept of a joint NATO nuclear force had been permanently sidelined.[39]

It had sparked debate over the question of the independence of the national deterrent among the countries military, political and intellectual centres. Sir John Slessor remained one of the most outspoken critics of the concept of an independent deterrent, believing that it could only prove effective within the network of an alliance such as NATO and with close links to the much larger American national deterrent. In other words he was a proponent of interdependence as opposed to independence. On the matter of the assignment of the V-force to NATO after Nassau he was unreservedly positive. Comparing NATO strategy to lessons learned in the Second World War he enthused, 'The tendency of history to repeat itself is a reason to welcome one of the decisions agreed at Nassau… namely the agreement to assign Bomber Command of the RAF to NATO'.[40] He remained a proponent of the MLF concept stating that:

> We British and French should assign our Bomber Commands unreservedly to NATO, to form the hard core of an allied nuclear strike force under the command of SACEUR, with the primary role of defence against invasion.[41]

The history of the French deterrent shows the unlikelihood of this occurring. The French had been forced by circumstance to create a national deterrent capability entirely in isolation. Becoming fully operational in 1966 it was reliant on the Mirage IVA bomber as a delivery platform and a low-yield sixty – kiloton bomb.[42] The French leadership, unlike the British, had few reservations about a smaller state owning a national deterrent. Their attitude was succinctly summed up by the, possibly apocryphal story, of General de Gaulle's response when challenged on the point by the Soviet ambassador, he is said to have replied, 'It is true that we cannot beat you but we could, perhaps, tear off one of your arms'.

Illustrating his belief that there was no foreseeable scenario in which the United Kingdom would wish to commit its deterrent unilaterally into action, Sir John Slessor gave the following intentionally implausible example, ironic in the light of later events:

> …some day in some part of the world (and some politicians have even mentioned Kuwait in this connection) a situation may arise in which the United States would say it is no concern of their's, but we should regard the issue as being so nearly supreme a national interest that we should go it alone.[43]

In summary he states that for an independent deterrent to be worthwhile it must be, 'truly independent', and a 'credible deterrent'.[44] Criteria which, in his opinion, both the British and the newly emergent French deterrent failed to satisfy as they were unable to inflict 'equivalent' damage on the USSR in a retaliatory strike and that it was impossible to determine what level of damage would be considered unacceptable by the Soviet leadership in any case.[45]

In response to this issue of 'equivalence' it was the opinion of MRAF Sir Dermot Boyle, among others, that the British deterrent would not have to inflict equal damage on the USSR in retaliation but merely enough to make the Politburo reconsider the wisdom of launching an offensive against the UK that could only result in limited gain for unacceptable damage, in other words '…a much smaller retaliatory force can give us as much, or greater security than the U.S.A. with their vast nuclear capability'.[46] This assumption does of course still rest on the virtually impossible task of determining what level of damage Russia would consider unacceptable. For their part, in January 1960, the Joint Intelligence Service Group for the Study of All-out Warfare (JIGSAW) outlined its views on the three essential requirements for an effective deterrent:

> (a) Western Forces must be capable of inflicting on the Soviet homeland a level of damage unacceptable to Soviet leaders;
>
> (b) The Soviet leaders must believe that the West is technically capable of inflicting this level of damage in spite of any Soviet countermeasures;
>
> (c) The Soviet leaders must believe that the Western powers would, in the event, order their forces to make this attack.[47]

As regards to the question of what level of damage the Soviet Union's leadership would consider unacceptable, this was defined elsewhere as, '[The] degree of damage from the United Kingdom as would severely reduce the Soviet Union's economic and military strength in its struggle to overtake the United States and dominate the world'.[48]

In stark contrast to the strains apparent in the wider defence relationship between the United Kingdom and America, the 'post-Grapple' thaw had enabled a close working association to be quickly re-established between the RAF and the USAF. In his forward to Wynn's *The RAF Strategic Nuclear Deterrent Forces*, Air Chief Marshal Sir Kenneth Cross, the Air Officer Commanding-in-Chief RAF Bomber Command between 1959 to 1963, notes enthusiastically:

> [SAC and Bomber Command] alone provided the Western deterrent in the

> nineteen fifties and sixties; theirs was a great working partnership based on a common aim, a mutual respect for each others professional capabilities and, as time went on professional friendship at all levels.[49]

Even during the earlier isolation on nuclear matters, 'SAC had encouraged the RAF to build the V-bomber force, had provided substantial assistance in interdepartmental and inter-service disputes, and took part in many interesting and useful discussions on operating procedures and future developments'.[50]

> On the initiative of Bomber Command a series of exploratory talks and meetings were held to establish areas of mutual interest and benefit. After one such meeting the opinions of both organisations were summed up as follows:

S.A.C. impressed by:
(a) Nuclear capability
(b) Aircraft and crew standards
(c) Reaction potential of 'V' Force
(d) Dispersal concept
(e) U.K. geographic position
(f) R.C.M. Equipment
[Radio Counter-Measures]
(g) Similar target philosophy

Bomber Command impressed by:
(a) Co-operation
(b) Freedom in discussion
(c) Target and intelligence resources
(d) Effective control
(e) Alert force concept[51]

As a consequence a Memorandum of Understanding was drawn up outlining future co-ordination of strike plans and the supply of American nuclear weapons to the RAF in the event of general war.[52] In addition the V-force was incorporated into the USAF strike plan from 1st July 1958.[53] As highlighted by Peter Malone, it was in the realm of 'Collaborative strategic targeting…where the two most important and 'special' Anglo-American relationships – nuclear and intelligence collaboration – commingled'.[54]

It had quickly been established that many potential targets had been 'doubled-up', and so taking this and other factors into consideration a new joint targeting plan was established. The allocation of particular targets between SAC (Strategic Air Command) and Bomber Command would be determined by considerations of timing, tactics, aircraft performance, weapon availability, national doctrine and particular interests.[55]

A primary aspect was that due to Britain's geographical position the V-force would reach the Soviet borders several hours before the SAC bombers, even if both air forces took off at the same time. Because of this the Chiefs of Staff noted that, 'A fully integrated plan has now been produced taking into account Bomber Command's ability to be on target in the first wave several hours in advance of the main S.A.C. force from the United States'.[56]

The smaller scale of the V-force meant that it had to be targeted more carefully on areas of direct interest to the defence of the United Kingdom, namely Soviet nuclear infrastructure such as LRAF airfields and bases. The Strategic Target Policy approved by the Chiefs of Staff designated targets as follows:

> (i) Centres of Government and military control
> (ii) L.R.A.F. [Long Range Air Force] Headquarters and bases
> (iii) The Soviet Air Defence Systems.[57]

It was hoped that with this integration of planning and targeting procedures the V-force would act as a partial 'force-multiplier' for the main SAC thrust, destroying Soviet defences and time-sensitive targets in advance of the SAC bomber fleet. It could be argued therefore that Bomber Command would have been faced with the more difficult task, 'clearing the way' for the follow-on forces. The implacable reality of simple geography dictated that this would have to be the case however because of the United Kingdoms relative proximity to the Soviet Union. This is often cited as a positive characteristic, as Sir John Slessor explained, 'Owing to its location close to its potential targets, Bomber Commands military value is out of all proportion to its minimal strength'.[58] Although this would have provided a more direct route, and therefore a shorter flight time, a less discussed consideration, certainly in official Air Ministry documentation, is that to reach the Soviet border the V-force would have been forced to over-fly the heavily defended airspace of the Warsaw Pact nations first. That the potential difficulties were recognised by the bomber-crews of the era is made clear by the words of former Vulcan crew-member, Bobby Robson, as he recalls, 'The satellite countries had left alleyways between the SAM sites exactly where we would go. I thought they would be killing fields'.[59] Although the polar route taken by the SAC fleet would have been longer it may have been significantly less hazardous.

It was also recognised that British estimates could not be entirely reliant on integration with American war-plans, as was made clear, 'target selection [should] cover two eventualities' that of, 'Co-ordinated action with the U.S.A.F'., and, 'Action on an emergency basis in a situation in which the United Kingdom was forced into unilateral action'.[60] This second national targeting plan became operational in November 1957 and was updated in 1958.[61] The V-force became an integral part of the American SIOP (Single Integrated Operations Plan) from December 1960.[62]

A further aspect of collaboration was the holding of regular joint exercises, including the large-scale, Exercise Skyshield, a test of the SAC/NORAD air defence system with a number of Vulcan's attempting to penetrate American airspace.[63] The mutual training benefits of such episodes however are obvious.

A US Mk 43 2,100lb nuclear weapon

Photo: RAF AHB

One of the most significant consequences of renewed cooperation was the provision of nuclear information and weapons to the UK by the United States. In a program known as 'Project E' a number of US Mk 5 thermonuclear weapons were supplied to meet RAF requirements until sufficient British 'megaton weapons' were available. Mk 28 and Mk 43 weapons were also supplied for the tactical Canberras and Valiants.[64] These weapons reached the RAF in October 1958 and remained operational until 1962.[65] Although they were stored on British bases, by US law, they had to be protected and maintained by USAF personnel and could only be transferred to British use on a direct order of the US president. This obviously raised many difficulties in regards to the survivability and reaction times of the V-force, especially when the issue of force dispersal was taken into consideration, something 'the inflexible US custodial and release procedures were not designed to cope with'.[66] Furthermore they could not be released for training purposes with consequences that can be imagined.[67]

As mentioned previously, one of the areas of closest collaboration was in the realm of intelligence. In regards to the British and American nuclear deterrents this alliance took the form of intelligence gathering operations about, within and over the USSR. These were intended to discover, designate and prioritise potential targets, necessary if the bombers were to be capable of reaching and striking their targets effectively. In 1951, during the 'freeze' in Anglo-American nuclear relations, the Commander of SAC, General Curtis Le May, persuaded the American Chiefs of Staff to invite the RAF to participate in a joint reconnaissance project with the intelligence product being shared between both parties.[68] From the American perspective this collaboration was necessary because although President Truman had prohibited US over-flights of Soviet territory the original Cold Warrior, Prime Minister Churchill, had no such qualms.
Designated Operation Ju Jitsu the six flights were flown at night in RB-45 reconnaissance aircraft with RAF markings and crew. As well as radar-derived imagery the British electronic intelligence gathering 'Y force' network and USAF ELINT (Electronic Intelligence) aircraft monitored the response of the Soviet air defence system. The first mission took place late in 1952 but the unexpectedly rapid evolution of the Soviet air defences is made evident by the fact that a flight commanded by Flight Lieutenant Crampton on 28th April 1954 was forced to abort after encountering heavy Russian resistance. On a flight conducted two years previously, and following a similar route, virtually no opposition had been detected at all.[69] These dangerous, but productive, missions furnished both Bomber Command and SAC with a wealth of information on the Soviet target and enhanced ties between the two organisations. The surprisingly swift development of the Soviet air defences however provided the unwelcome message that the projected window of effectiveness of manned bomber aircraft may have been overly optimistic. The new bombers were in a race against time before the advent of missiles en masse made them obsolete. This, and the tactics employed to ensure a useful operational life span for the V-force is the subject of the final section.

Threat and Response, The Evolving Deterrent

As mentioned previously, three technologies which emerged during the Second World War were to have profound implications for the subsequent development of national defence. The first of these were the jet engine and nuclear weapons, but the conflict also saw the earliest use of militarily viable surface-to-surface ballistic missiles, in the form of the German V-2 rockets used to bombard England and Europe. Why the British military and political leadership of the post-war era chose to ignore this obvious precedent remains an unanswered question.

It is likely that the true significance of missile technology was simply not recognised and, in any matter, it was believed that it would not be a mature area of military technology until after the V-bombers had been in service for some time. The result of this myopia meant that by the time the Medium Bomber Force was deployed in strength it had, to an extent, already been superseded.

In the late 1940's, and into the early part of the next decade, Soviet air defences were believed to be totally inadequate, with radars susceptible to jamming, surface-to-air weapons ineffective over 30'000 feet and with no all-weather interceptors.[70] This being the case it is perhaps not surprising that British planners believed that the advanced V-bomber fleet would not be unduly troubled for the foreseeable future. Stalin however, quickly set out to remedy this unacceptable situation, ordering that the Soviet Air Defence network be given high priority. Known as the National Air Defence Command, or PVO Strany, it became an independent branch of service in 1954, which is in itself indicative of the importance placed upon it.[71] Although all three aspects of an effective air defence system, comprising interceptors, AAA (Anti-Aircraft Artillery) and communication and detection systems were substantially overhauled it was in the emerging realm of missile technology that the Soviet Union was to become the premier exponent.[72] The increasingly lethal nature of Soviet airspace was made evident by the shoot-down of the previously invulnerable American U-2 reconnaissance aircraft piloted by Francis Gary Powers on 1st May 1960, while deep inside Russian territory. It was believed to have been brought down by the new two-stage SA-2 'Guideline' SAM which could reach 80'000 ft at a range of roughly 27 miles.[73] As the V-bomber fleet had an average service ceiling of approximately 50'000 ft the problems posed become apparent.

Events were also unfolding at home which would have major consequences for the V-force. The pivotal episode that would determine the later evolution of the V-bomber force came in the form of the Defence Ministers, Mr Duncan Sandys, 1957 White Paper, Outline of Future Policy on Defence, presented to the House of Commons on 13th February of that year.
Based on the assumption that the advent of the hydrogen bomb, which with its vastly superior power had rendered early defence planning, centred as it was around the atomic bomb, irrelevant, it outlined the future shape of Britain's defence policy.[74] While reiterating that the primary means of homeland defence would be the retention of a potent national deterrent the method of delivery would change dramatically. Due to the new hazard posed by Soviet thermonuclear tipped ballistic missiles and the unexpectedly rapid obsolescence of manned bombers, future development in the field was to be built upon ballistic missile technology.[75] Although the White Paper marked a Rubicon in the history of Bomber Command, confirming that the era of the manned bomber, at least in a strategic role, was now in sight, for the immediate future British defence policy would remain based on the nuclear deterrent power of the V-force.[76]

Nevertheless, the RAF's anticipated next generation aircraft, the Avro 730 supersonic bomber, was cancelled in favour of the abortive Blue Streak ballistic missile, itself subsequently cancelled on grounds of cost and vulnerability.[77] In an effort to maintain operational viability the V-bomber fleet was to be equipped with the Blue Steel stand-off missile which could be launched from outside of the range of Soviet defences, and was intended to, '…ensure penetrative capabilities into the mid-60s'[78] In the event it was to serve until the end of that decade.

The reaction to the report with the RAF was mixed, although it would retain its major responsibilities it was expected that the role of national deterrence would eventually pass from manned bombers to a ground based missile system. This was to prove only partially correct; the RAF would indeed lose the role of national deterrence but that duty would pass, not to ballistic missiles under its own command, but to the Polaris submarines of the Royal Navy.
In one sense the Sandys' White Paper of 1957 only confirmed what was already known, in order to maintain a viable

airborne deterrent the means of delivery would have to undergo substantial upgrades and changes of doctrine. That such changes were necessary is made apparent by Air Chief Marshal Sir Edmund Huddleston who lamented in 1962 that:

There is now no area within range of Bomber Command aircraft which is not defended by numbers of efficient supersonic fighters and no worthwhile target which is not defended by Surface-to-Air missiles…the last two years have seen considerable advances in the air defences of the USSR.[79]

The first method of upgrading the V-force was by the introduction of more advanced Mk 2 variants of the Vulcan and Victor. These had more powerful engines, an upgraded airframe, sophisticated electronics and counter-measures and increased payload. Ironically, in the light of subsequent developments, detailed below, in setting out the rationale behind the development of the Mk 2 variants the Ministry of Supply stated that:

> The Air Staff say that, on current assessments of enemy defence capabilities, as many as possible of the medium bombers must be able to fly at over 50'000 feet towards and over their targets; and, since fighter performance falls off sharply at such altitudes, the higher the better.[80]

Some observers questioned the necessity of these improved versions of the basic bomber, believing that the expenditure would be more profitably directed towards improved armaments for the aircraft itself. Unfortunately these developments, including engine upgrades which practically doubled available thrust over earlier models, arrived in concert with a dramatic change in V-force operations, from the highest attainable altitude to the lowest.[81] As Soviet defences were much more effective at high altitude due to operational constraints of Soviet missiles and radar this created the possibility of enabling penetration by operating the V-force at extreme low level on approach to and over enemy territory.

While this would significantly reduce the V-bombers range they would still be able to, 'cover all the 40 targets arbitrarily selected by the British Nuclear Deterrent Study Group'.[82] The move to low-level operations in March 1963 also created significant problems with delivering high-yield freefall nuclear weapons, such as the Yellow Sun Mk 2. This required a 'pop-up' to at least 12'000 feet for release, leaving the aircraft exposed during the most dangerous part of its mission. This problem was not solved until the final clearance of the specially designed WE177B 'lay-down' bomb for operations in September 1966.[83] Furthermore, the range of the Blue Steel powered bomb, which had only entered service one month before, was reduced from the standard 115 miles (185 km) by almost three-quarters, which restricted its use to peripheral targets.

The new mission profile also created substantial strain on the bombers airframes, due to the thicker and more turbulent atmosphere at low level. The discovery of cracks in the fuselage resulted in the early retirement of the Valiant fleet, a decision taken in December 1964. As a consequence the Valiant refuelling and strategic reconnaissance aircraft were also lost.[84] The subsequent gaps were not filled until the hasty conversion of several Victors in late 1965. That this was not simply a concern of the British, or any flaw in the planes original design, is made clear by the fact that the American B-52 fleet had to undergo a $300 million upgrade programme for similar reasons.[85]

A further area of controversy concerned the size of the V-bomber fleet. From initial expectations of a total force of 240 aircraft this upper estimate was inexorably whittled down until questions began to be raised about at what minimum level the force would become entirely ineffective. As a result the Cabinet Defence Committee decided

Avro Vulcan B1s Photo: RAF AHB

in August 1957 that the V-force should consist of 144 aircraft, 104 of them Mk 2 Vulcans and Victors.[86] The RAF and the British aircraft industry must have envied Boeing and SAC whose B-47's were ordered in batches of 100.[87]

While in most respects the V-force was a quantum leap in capability over their Second World War predecessors the actual method of delivering weapons had remained unchanged, that of free-fall delivery over the target, until the advent of the indigenous Blue Steel powered bomb. While revolutionary in capability, the V-Force was merely an evolution of existing technology and doctrine. The Blue Steel concept however contained a, carefully concealed, fundamental weakness. Although unarmed and un-refuelled missiles were fitted to QRA aircraft (Quick Reaction Alert, see below) from August 1963, due to safety considerations at least thirty minutes work was required to make them operational. In the event of a deteriorating political situation they would, of course, have been armed but they were entirely impotent in the face of surprise attack, for which the expensive alert procedures had been instituted in the first place. It must have come as a great relief when new safety procedures introduced a year later enabled them to be armed within ten seconds.[88]

It was not only in defensive capability that the Russian lead in missile technology was to prove problematic. The increased accuracy and power of Soviet IRBMs (Intermediate Range Ballistic Missile) targeted on known British V-bomber bases raised the spectre of the entire fleet being destroyed on the ground in the opening stages of any conflict. As stated by T.C.G. James, 'A deterrent strike force would be no deterrent at all if it could be destroyed on its bases before it could be launched'.[89]

To counter this an Air Staff Requirement for a ballistic missile early warning system (BMEWS) was issued in 1958 whose sole purpose was to provide adequate warning of attack to enable the deterrent to be launched. As it transpired the United States was seeking a European location for the third site in its extended BMEWS network. In a further example of Anglo-American collaboration it was finally emplaced at Fylingdales in North Yorkshire. The US government provided the radars and associated equipment and the UK was responsible for the building and staffing. When it became operational in

1964 the UK had been able to acquire a BMD (Ballistic Missile Defence) asset at modest cost.[90] However as N.J. McCamley noted in his study of the British passive defence network, '…[BMEWS] would give a whole four minutes warning of annihilation by Russian nuclear missiles'.[91]

The possibility of a surprise attack with such short notice led to two main measures, that of dispersal and the imposition of a Quick Reaction Alert (QRA). The MBF had in fact a measure of dispersal from its inception in 1955, with the three initial squadrons being formed at three different bases, (Wittering, Wyton and Marham) but over the subsequent years a much more comprehensive system of UK wide dispersal airfields was created.[92]

The dispersal concept contained its own inherent dangers, the Kremlin could interpret its initiation as heralding an imminent British offensive and so precipitate the very attack that it was designed to protect against. As such it was not a measure to be taken lightly in times of international tension.[93]

The high-intensity QRA was introduced early in 1962 and involved one aircraft in each squadron being at fifteen minutes notice twenty-four hours per day, 365 days per year. Thirty percent of available aircraft should also be able ready to deploy within four hours and 100 per cent within twenty hours.[94]

In situations where war appeared imminent at least one aircraft from each squadron would be at Cockpit Readiness, with the crew strapped in.[95]

The innovations of bombers parked on operational readiness platforms (ORPs) by the runways edge and the 'Simstart' engine-start system, introduced in 1963, enabled the four aircraft on QRA to be, '…well away within the 'four-minute warning' of a pre-emptive missile attack'.[96] Humphrey Wynn has described the QRA procedures as, '…the ultimate expression of strategic nuclear deterrence by bombers and the operational embodiment of an alert and readiness posture'.[97]

As a result of the Nassau meeting it had become inevitable that the role of primary provider of the British nuclear deterrent would pass from the RAF to the Royal Navy. It was always expected that Polaris, or an equivalent system, would eventually be necessary if the UK was to retain a deterrence capacity when, '…the V-bombers [could] no longer penetrate Russian defences without prohibitive loss'.[98] It was simply how early this transition would now take place that was unforeseen.

During these earlier debates the BNDSG (British Nuclear Deterrent Study Group) Technical Study Group assessed the relative merits of ballistic missile armed submarines and aircraft, having initially dismissed all alternatives such as mobile land based missiles. While no clear recommendation was made in favour of submarines the implication was that Polaris was preferred to the V-force / Skybolt combination.[99] Their arguments hinged on the question of vulnerability, with the V-force, even if an airborne alert was instituted, being considered too vulnerable to a pre-emptive nuclear attack partially because early warning was reliant on successful detection by Fylingdales BMEWS station.[100] A further consideration was that as BMEWS was directed eastwards it could not provide warning of a Soviet SLBM attack launched close off the western shores of Britain. This potentiality was however assessed as unlikely, as the Russians would wish to preserve their scarce submarine assets for use against American targets due to the short flight time of their missiles.
In addition Admiral Sir Caspar John noted that he considered a surprise attack unlikely, stating '…personally I find it

difficult to envisage a genuine bolt from the blue, completely disassociated from any political crisis'.[101]

Perhaps this assumption that a sudden Russian pre-emptive attack was unlikely to occur led directly to the extraordinary laxity in British command-and-control procedures for nuclear retaliation, certainly in comparison to the American system. Until a comprehensive review of release procedures under GEN 743 in 1962 the Commander-in-Chief of Bomber Command (in the late 1950's Air Marshal Sir Kenneth Cross) had the power to launch the V-force on his own initiative, under 'positive control', that is in the expectation that by the time the bombers reached their 'start-line' on the borders of Eastern Europe (approximately ninety minutes later) a 'go/no go' confirmation signal would have been received from the nations political leadership.[102] It is not difficult to imagine how easily this system could break down under the extraordinary strains of an actual Russian surprise attack.

It was recognised that the Polaris system possessed all the qualities that were considered essential in a British nuclear deterrent, i.e.:

> …the system should be invulnerable to pre-emptive attack without strategic warning, [retaliation] should be seen to be inevitable, [it] should give time for operational and political decisions and should be capable of posing a threat against any country in the world.[103]

However Sir John Slessor's belief that the acquisition of the deterrent role by the Royal Navy was unfortunate and unwanted because, '[they] would rather be spending scarce resources on other things', did indeed reflect a majority of the opinion in the Royal Navy who feared that the outlay on a ballistic missile armed submarine fleet would result in a cutback on conventional expenditure, such as new aircraft carriers, and that it was the RAF and not the Royal Navy that had the relevant prior experience.[104]
Nevertheless the first British Polaris submarine, HMS Resolution, was commissioned in 1967 with two other boats following in 1968 and one in 1969. The entire program had cost £330 million, unusually, slightly less than predicted.[105] At midnight on 30th June 1969 QRA was discontinued and the Royal Navy's Polaris fleet assumed the obligation of deterrence. The Chief of the Air Staff, Air Chief Marshal Sir John Grandy, sent a message to AOC in C Strike Command (which had formed with the amalgamation of Bomber and Fighterr Commands in 1968), Air Chief Marshal Sir Denis Spotswood acknowledging the transfer of responsibility and stating:

> I think it appropriate to remember that this task has meant maintaining at all times throughout the seven years the highest state of readiness which the Royal Air Force has known in peacetime. The way in which this has been performed…has been an unsurpassed demonstration of professional skill, dedication and tenacity…I send my congratulations to you.[106]

Conclusion

In retrospect the V-force could be said to have had experienced three major eras; a decade long development period (1947 – 1957), a six year period of increasingly intricate collaboration with America, which also marked its apex of power and capability (1957-1963) and finally a further six years of slow decline and final obsolescence (1963-1969) concluding with the advent of the British Polaris programme.

It has been suggested, correctly in this writer's opinion, that the British airborne deterrent was created as much for political as military reasons and as such it did indeed help to, '[provide] the British state with a tinge of great power standing, in times when it…had few other such tinges'.[107]

Despite this it did not entirely fulfil expectations, at least politically, as James Spigelman asserts:

> The program never produced the strategic and diplomatic dividends the British leaders felt the new weapon could secure. They had sought the weapon to enhance national prestige, but they found the Empire nevertheless continued to disintegrate along with Britain's position as a world power.[108]

Nevertheless, in many respects the programme was almost a complete success with the United Kingdom becoming the world's third nuclear power with only the two superpowers as contemporaries. The V-bombers themselves were comparable, and in some respects superior, to any of those fielded by other nations. They began entering service within the ten-year 'period of grace' initially predicted, a remarkable achievement considering their ambitious specifications and the nations post-war economic state.

Despite this, the Medium Bomber Force was overtaken by events somewhat out of the early planners control or reasonable prediction. Only in 1961, with the peak force of 180 bombers armed with thermonuclear weapons, did the deterrent become fully operational. Unfortunately by this time they were already extremely vulnerable to Soviet air defences, with some estimates putting penetrative capability as low as 3%.[109] Against the rapid advances of technology, such as the advent of viable ballistic missiles and nuclear submarines, the manned bomber began to appear increasingly outmoded. This of course raises the question as to why this eventuality was not foreseen, as the V-2 rocket had already set an unmistakable precedent. It must be considered likely that the sheer pace of technological advance, which was to a large extent spurred by international Cold War tensions, simply took British planners by surprise. By the time the situation was fully comprehended the V-bomber development programme had already been set to a relatively inflexible time-table, all that could be hoped for was that the V-force would have a useful operational lifespan before its inevitable obsolescence. In his study of the relationship between British planners and ballistic missile technology, Jeremy Stocker is much less forgiving, stating that, 'Threat assessments that were both late and over-optimistic seem to have been a consistent feature of British defence planning in respect of missiles throughout the 1950s'.[110] In fact, a 1949 joint Anglo-American intelligence report concluded that despite the USSR's access to captured German missile technology an operational Soviet ballistic missile was unlikely before 1955.[111] As it transpired the first Russian SS-1 and SS-2 (Surface-to-Surface) missiles were in service as early as 1951 and Sputnik was launched on a converted IRBM only six years later. While the unexpectedly rapid advance of Soviet technology can perhaps be understood, even taking the reports initial estimate of 1955 would mean that Russia was expected to have functioning ballistic missiles before the earliest predicted V-bomber delivery. This systemic myopia was to have a major impact on the British airborne deterrent, resulting in massively increased expenditure in an effort to maintain its effectiveness. This was a Sisyphean struggle at best and one which ended with the unexpectedly early transfer of the primary deterrent role to an unappreciative Royal Navy. Ironically in spite of Mr Sandy's earlier concerns during the V-force's procurement about not, 'putting all your money on one horse', with the Skybolt debacle the RAF and Air Ministry proceeded to do exactly that. As Paul Jackson states, 'There might have been no Polaris had not the RAF backed a loser when looking for a second air-launched strategic missile', with its cancellation, '…the whole future of the RAF's airborne deterrent was swept away'.[112]

As regards the independent nature of the British deterrent this could best be described as 'paradoxical'. Over time the United Kingdom became increasingly dependent on hardware supplied by the United States while still proclaiming flexibility of use, as is evidenced by the insertion of the 'supreme national interests' clause in the 1962 Nassau Agreement. Though it is difficult to envisage under what other circumstances the deterrent could be used. In the 1966 report, Command and Control of Nuclear Weapons by the Ministerial Committee on Nuclear Policy, it was stated that:

> …we have assigned the V-bomber force and shall assign our Polaris force to NATO for targeting in accordance with NATO plans… except where Her Majesty's Government may decide that supreme national interests are at stake'. As a result, '…in emergency Her Majesty's Government are free to use British nuclear weapons anywhere in the world.[113]

However, a trace of envy is perhaps detectable in their final point that, 'French nuclear weapons are under the independent custody and control of the French Government, and their use is untrammelled by any international agreement or understanding'.[114] Nevertheless, even including limited aberrations such as the Suez misadventure, it is difficult to imagine a situation where the United Kingdom would have embarked upon such a course of action without at least the blessing of the United States itself. Furthermore, the relationship between the United Kingdom and United States was not simply one of dependence but an interdependent relationship. The United States desired to prevent the United Kingdom being forced into unilateral retaliation as much as Britain itself. Even during periods of seemingly complete dependence on American hardware, such as during the four year 'Project E' period, such technologies were only required to be maximally effective. In extremis the V-force could have been committed to the attack using indigenous atomic weapons and the limited stock of British thermonuclear warheads. Therefore by giving up limited concessions, mostly revolving around flexibility of use, Britain received in return a deterrent capability more potent than that achievable by its own means, a measure of political influence, both of world standing and in influencing the United States and the reassurance that America remained committed to the defence of Europe. As summarised by Peter Malone, '…neither 'integration' with American forces in 1958 nor 'dedication' to NATO in 1962 imposed conflicting missions upon Britain's strategic forces. In both their NATO and national missions these forces were to be employed only at the final hour and only with the deadliest effect'.[115]

Photo: RAF AHB

Valiant crew scramble

The wisdom of the deterrence strategy itself can perhaps be established by the fact that during the Cold War there was no open conflict between the competing ideological opponents, fulfilling Winston Churchill's hopes when, in 1955, contemplating the coming age of mutual deterrence, he stated '…we shall, by a process of sublime irony, have reached a stage…where safety shall be the sturdy child of terror, and survival the twin brother of annihilation'.[116]

During its operational lifetime the V-force was beset by many difficulties, of varying severity, such as the initial problems with the Blue Steel stand-off missile, which potentially rendered a substantial proportion of the force entirely impotent. During such periods of vulnerability we are fortunate that the V-force was not called upon to fulfil its duty.

However in the realm of deterrence perception is at least as important as reality, the mere existence of the British airborne deterrent must have given the Soviet leadership pause and undoubtedly complicated Soviet planning with the 'second-centre of nuclear decision-making' (to use the contemporary phrase) that the United Kingdom represented having to be taken into consideration.

In the final analysis what counted was what the Politburo and any other potential enemies believed. The view from Moscow would have been of an extremely potent and efficient British retaliatory capability and in most respects this was unquestionably what the V-force represented during the twelve years when it carried the burden of providing the British national deterrent. In respect of the V-force Cold War Bomber Command could more than justifiably display its proud motto, 'Strike Hard Strike Sure'.

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An artist's concept of an operational US Air force Boeing UCAV

The Legal and Moral Challenges Facing the 21st Century Air Commander

By Wg Cdr Andy Myers RAF

Who will believe that your cause is just when your behaviours are so unjust?

(16th Century French Peasant)[1]

The year is 2020; a Royal Air Force Unmanned Combat Air Vehicle (UCAV) has just destroyed an armoured personnel carrier believed to contain the leader of a rebel opposition group during the latest conflict in Uzbekistan. Some 20 minutes later the UK's controller of offensive air operations is sat at his desk in Southern England when he receives a call from the head of Reuters' Central Asian Bureau. A commercial news satellite has imaged the area around the burning vehicle and early analysis suggests that up to 15 civilians may also have been killed. During the next few days the political fallout from the incident prompts the Uzbek President to demand an International Criminal Court investigation into the 'sinister use of Western air power to oppress the citizens of his country'. Under its Rome Statute obligations the UK government agrees to carry out a full criminal investigation into the incident and the UK's Ministry of Defence (MoD) is obliged to arrest those personnel deemed responsible. But who should be charged? The operations controller in England did not task the mission; the engineers who loaded the aircraft with its weapons did not know its patrol area; and the UCAV software engineer was not even aware it was deployed on operations. Equally, what would be their defence?

At first glance this scenario appears to have more in common with a thriller novel than a critical examination of the legal and moral implications of modern airpower. Yet it encapsulates many of the issues crucial to the development and effective employment of such systems. Moreover, UK personnel already operate an armed Unmanned-Air-Vehicle (UAV) in the skies of Iraq as part of a Joint UK and United States Air Force (USAF) unit.[2] These crews operate an American military UAV; they operate the UAV remotely via satellite from the United States; the UAV is serviced by American personnel; and they receive their operational tasking from a Combined Air Operations Centre (CAOC) based in the Middle East. Clearly these issues are not futuristic or indeed fictitious.

In order to better understand the issues at play in this scenario, this essay will examine the moral and legal implications of high technology weaponry and in particular explore the issues associated with the employment of unmanned systems within a conventional air campaign. Reference will be made to the fictitious scenario, not simply as a means of answering the questions posed, but rather to expose the areas which need critical examination within the essay. Furthermore, to avoid unnecessary legal jargon and detailed examination of international law, the legal and moral perspectives will be examined using the classical just war concept of jus in bello – 'justice once war has started'.[3] It will be assumed that the fictitious campaign has the higher level authority of the United Nations Security Council. While such an endorsement does not necessarily lead to a justly fought campaign, such an assumption permits more absolute moral and legal judgements to be made on weaponry and systems used as opposed to the conduct of the campaign. The essay will also concentrate on the issues associated with their employment on operations as opposed to the airworthiness issues regarding operation within civilian airspace or potential limitations imposed by treaties such as the Intermediate-range Nuclear Forces agreement

At its most basic level this essay will support 2 simple contentions. Firstly, that the development of systems like UCAVs, increasingly discriminate weapons, smaller yield weapons and perhaps even non-lethal weapons all have the potential to improve the jus in bello legality of a future offensive air campaign. This is primarily achieved through a simple reduction in the degree of double effect associated with the use of air delivered weaponry and hence an improved degree of proportionality within the offensive phase of an air campaign. Additionally, a more sophisticated intelligence and surveillance system should enable an increase in the resolution of the battlefield available to air commanders of the future thereby increasing the degree of discrimination available within any targeting process. However, the second and perhaps conflicting contention is that the moral issues associated with the deployment of unmanned systems have the potential to present counter arguments to this improved legality, even to the point whereby they could begin to undermine the legal basis of future air campaigns. A range of issues will be used to support this second assertion including: the principle of double intent allied with the notion of radical force protection[4]; the extensive use of automated targeting combined with unmanned prosecution of offensive operations; and the removal of the airman from the battle-space.

By way of structure this essay will briefly examine some of the more likely developments in air power doctrine and technology during the next 2 decades. The legal ramifications of such changes will then be examined to see whether any legal obstacles are likely to impede the deployment of unmanned combat systems. The moral implications of these innovations will then be examined to see if they present a different perspective on the legal position previously established. Throughout, historical analysis will be used to determine whether similar debates have occurred during the development of warfare in order to see how they were resolved and hence understand the implications for UCAV employment. Furthermore, the implications and themes brought out by this analysis will be applied to current air doctrine in order to understand whether there are any concerns for today's operations. The summary will bring together these strands to highlight the legal and moral challenges facing 21st century air commanders.

> Weapons classed as 'unfair' often make their appearance during periods of rapid technological progress.[5]

There is little doubt that we are in a period of rapid technological development but in order to understand how air campaigns of the future could be fought one must first assess the likely impacts of structural and doctrinal changes. There is also no shortage of material to examine when trying to gain an understanding of future air operations; indeed as the majority of air forces contract in size it seems the number of transformation initiatives somehow increases. Accordingly, this section will concentrate on publicised air force transformation programmes and associated research and development.

Assuming modern defence procurement processes first establish a requirement and in order to develop equipment; one must understand the emerging conceptual thinking within these air forces in order to determine their likely capabilities in the 2020 timeframe. By, 2020 the doctrine of expeditionary air operations is likely to be deeply ingrained in the psyche of most Western air forces. Therefore, the significant doctrinal changes are likely to be focused elsewhere; this certainly appears to be true of US and UK thinking. The UK's Joint Doctrine and Concepts Centre (JDCC)[6] attempted to capture the implications of the future strategic environment across 7 'dimensions' within its Strategic Trends Paper.[7] Recognising the technological innovation already underway it outlined the likely timescales for unmanned systems:

> after 2015, an important driver of change in military operations is likely to be the increasing dominance of unmanned capabilities … by 2020 the aspiration of a number of Western air forces is to be able to deploy unmanned semi-autonomous systems capable of undertaking the full gamut of air operations.[8]

Mindful of the fact that an analytical concept will never deliver actual equipment one must examine published documents that are more applied in nature to understand the progress of UCAVs towards their operational employment date. Both the USAF's

Transformation Flight Plan 2003,[9] and the UK's Future Air and Space Operational Concept (FASOC)[10] make repeated reference to the possibility of UCAV deployment within the next 10 to 15 years. Indeed, the USAF has articulated a near-term goal to deploy UCAVs which are capable of, 'lethal and non-lethal suppression of enemy air defences as well as strike missions… and to consider the longer term potential to integrate directed energy and precision all weather capabilities'.[11]

Having established the likely utility of UCAVs across a number of air forces we should aim to understand the likely capabilities of this platform. However, an exhaustive list of probable development programmes would add little to the moral or legal arguments which we seek to outline. Therefore, we shall assume our UCAV is broadly similar to the Boeing X45A which was developed as part of the now defunct US Joint Unmanned Combat Air System programme. In simple terms the X45A, along with its Northrop Grumman counterpart the X47A, demonstrated the potential of a 21st century UCAV, with the Boeing aircraft completing 2 aircraft semi-autonomous operations and successful releases of inert precision guided munitions. [12]

The air vehicle merely represents the means of delivering weapons onto targets. In order to fully capitalize the benefits of unmanned platforms a global C2 architecture that provides a secure, 2-way high capacity data-link is essential, indeed without such a system there is little operational benefit over conventional manned fast jets. A glimpse of the type of architecture required can be gained from current US methods of controlling in-service UAVs such as Predator which has proven the concept of global reach-back operations. Current US doctrine in this area typically has the UAV located at a forward operating base with a line-of-sight control cabin used to carry out take-off and recovery operations. After take-off, control of the platform, its sensors and weapons is handed to another agency who exercises control of the vehicle via a satellite capable data-link housed within the forward fuselage. This capability allows control of the UAV from virtually any position on the earth's surface although it is routinely carried out by crews based within the Continental US; on recovery a similar hand over is affected to the original ground station. The imagery provided by these aircraft is normally down-linked to an agency within the operational theatre but again it could be sent worldwide the only requirement being a suitable satellite data-link.[13] Clearly this C2 architecture provides an insight into potential future UCAV operations but does not provide the whole picture.

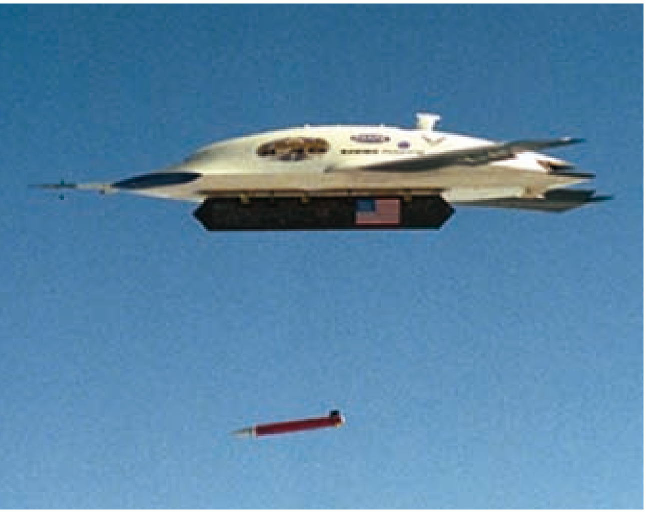
If UCAVs are to deliver real operational and financial advantages over conventional manned fast jets then they must possess a high degree of autonomy in order to reduce the manpower burden. These personnel savings need to be measured both in terms of the reduced numbers required to support them and those not put at risk operating them. Many routine functions which current generations of UAVs use manual input to perform will be automated in the future. The X45A carried out routine flying functions automatically whilst its in-flight routing followed a pre-programmed profile. This profile was amended via a 'drag and drop' computer screen thereby removing the skill set and cost of highly trained aircrew. Furthermore, functions such as threat reaction, formation keeping, collision avoidance and weapon delivery were demonstrated either autonomously or as directed by a ground control agency.[14] The on-board sensors and computational capacity bring about the potential for automatic be neutered, with the Nuclear Non-proliferation and Limited Nuclear Test Ban Treaties under severe pressure. It would probably be accompanied by other, less predictable and asymmetric terrestrial actions. Secondly, global political and public opinion would harden against the United States; even traditional friends such as the United Kingdom would almost certainly find their relationship with the US permanently altered. Both outcomes pose vital questions for US grand strategy, but would be acceptable to 'pro-hegemon' strategists; recent American anger at 'Old Europe' over Iraq can only harden their position.

The third effect would be to undermine and unbalance those US conventional warfighting capabilities required now to meet current and future commitments as resources were sucked into an exceptionally expensive space weapons programme. As General Ron Keys recently noted with regard to current financial pressures within USAF: 'People always ask me, 'Well, what do you have too much of, and what do you need more of? Let me give you a newsflash. I've got too much of not enough'.[72] The extant fiscal challenges facing the current Bush Administration are severe; the need for considerably increased spending on social security and health care in coming decades, worsening the budget deficit, has already been discussed. Moreover, it is difficult to foresee circumstances in the near future where US global military dominance will be threatened; in effect, a 'tipping point' where the US must embrace space weapons to reinforce extant terrestrial conventional systems. The nuanced responses available across the spectrum of conflict for General Keys and his fellow Component Commanders would be reduced through enormous investment in a technologically impressive but strategically, operationally and tactically inflexible 'white elephant'. Ozymandias would have approved.

The Need for Debate

'Space weapons (like conventional weapons more generally) are a far more complicated and diverse subject [than nuclear weapons], and require at least as much effort and attention to debate satisfactorily, yet surprisingly little work has yet been done to describe and analyze them in satisfying detail.'[73]

It is difficult to make a credible strategic case, given current realities, for weaponizing space. Indeed, proponents of that case fail to heed the words of Hedley Bull: 'Marginal increases in security may be pursued at exorbitant economic or moral cost'.[74] 'Technology push' cannot be allowed to trump 'strategic pull' and Lambeth is right to offer the following cautionary note: 'Functions should not be migrated to space just because it is technologically possible'.[75] Unfortunately, the debate over space weapons has been consistently conducted against an ill-informed background. James Oberg has criticised both 'Gung-ho space-superiority mantras…from U.S. Air Force leaders [and] the near-hysterical ranting from American newspapers, from lobby groups posing as 'information centers' but having long-familiar agendas, and from foreign nations eager to score cheap propaganda points'.[76] Against this polarized background, and in the absence of clear policy direction to guide conceptual thinking and research effort, it has been almost impossible to engage in rational discussion over the future direction of US space strategy. The importance of continued space superiority for the US and her allies makes the debate all the more urgent. A viable national strategy, providing the United States with continued commercial and military benefits and guarantors against future uncertainty, is long overdue.



Boeing X-45 UCAV

target recognition within the platform or UCAV formation which further increases the degree of autonomy available for delegation to the platform.

The ultimate aim of all this technological innovation is of course in pursuit of one goal, namely to deliver lethal, or perhaps non-lethal, weaponry against enemy targets. The most obvious trend within the field of air guided weapons is the reduction is size of the warhead, with a gradual move away from the more traditional weapons such as the Mk80 series bombs towards lighter weapons such as the US Small Diameter Bomb (SDB). This programme is able to reduce the size of warhead by increasing the accuracy of the weapon, 2 natural spin offs from this trend are a potentially increased kill per-sortie capability and a decreased collateral damage footprint. It is this latter point which is of interest to this essay as the reduction of collateral damage is a prime consideration when targeting air-to-ground weapons.

Whilst the development of UCAVs tend to grab the headlines, perhaps the most important developments in this area of warfare are the US drive towards Network Centric Warfare and the UK move towards Network Enabled Capability. Both programmes are just as vital to the legal and moral efficacy of modern air power. Concepts such as Machine-to-Machine (M2M) interface and Network Centric Collaborative Targeting (NCCT) seek to change the way ISR assets, command networks and delivery platforms are integrated. Essentially, the cross cueing of ISR sensors is facilitated via common networks and protocols and aims to improve the resolution and discrimination on any given target. Whilst they were initially developed to decrease the sensor to shooter timescale they have much broader applications and implications.[15] The ability to cross cue an electronic intelligence asset to correlate a potential target identified by a satellite and then further refine using an air breathing platform's radar would be an impressive capability. This improved discrimination could be used to present the commander with a greater level of clarity and hopefully improve the ability of the commander to make timely and accurate decisions – assuming of course that the human remains in the loop.

Aside from the potential operational benefits of the UCAV outlined within the previous analysis, the predicted financial benefits are unlikely to be a restraining influence on the pace of development and may actually increase the pressure on air forces to field such systems. Clearly any cost predictions regarding operating costs of UCAVs are speculative at this stage. However, variable operating costs such as crew training will be much reduced through extensive use of simulation; this could reduce the operating and support costs to as little as 25% of the cost of a conventional F16 squadron.[16] Hence the very real interest being expressed by many air forces.

Bringing together the preceding analysis it is clear that by 2020 a stealthy, unmanned, and armed air vehicle may be in service with US air forces and perhaps even their European counterparts. This platform is likely to be similar in nature to the X-45A and supported by an improved C2ISR architecture which could feature elements of automation within the on-board and off-board targeting process. The difficult questions raised by the preceding analysis are not whether we can develop this technology, but whether we should and can we legally employ it? The real dilemmas in the area of unmanned combat systems stem from the legal and moral questions raised as opposed to the technological feasibility of such systems.

> The greatest kindness in war is to bring it to a speedy conclusion…it should be allowable with that view to employ all means save those that are absolutely objectionable.

The above quote paraphrases General von Moltke as he contemplated the St Petersburg Treaty of 1868 which sought to define the legalities of war and limit the military use of certain types of equipment.[17] Clearly he did not pass judgement on whether he considered the X-45A as 'objectionable' but we may infer from his tone that he would probably have approved of its use. However, despite the implicit approval of a deceased Prussian Staff Officer, we cannot assume that simply replacing a pilot with a system of electronics and data-links automatically confers some inherited right of legality upon UCAVs. Rather, the totality of the system, its weaponry, modes of operation and means of control must be examined in order to arrive at a more considered legal position.

Throughout the history of just war theory the notion of jus in bello has been governed by 2 simple principles, those of discrimination and proportionality.[18] Despite the passage of time and the movement from 'Divine Law' based on religion, through 'Natural Law' based on ethics and finally 'Common Law' based upon treaties, they still remain valid.[19] These principles were formally enshrined within the Hague Conventions of 1899 and 1907 and superseded by the Geneva Conventions of 1949 and the 1977 Additional Protocols.[20] Whilst these modern documents go into great detail as to how and when the rules therein should be applied the 2 guiding principles are still self evident. The following quote is taken from the 1977 Geneva Additional Protocols and clearly shows the continued obligation for discrimination placed upon forces engaged in an attack:

> In order to ensure respect and protection for the civilian population and civilian property obliges the Parties to the conflict to distinguish at all times between the civilian population and combatants, as well as between civilian property and military objectives and to direct their operations only against military objectives. (Additional Protocol 4 Article 57 Paragraph 2 ii).

Or put more simply there are good targets and bad targets, warring parties are permitted to strike one and forbidden from striking the other. The principle of proportionality is similarly detailed within the same document and expressed as follows:

> Parties should refrain from deciding to launch any attack which may be expected to cause incidental loss of civilian life, injury to civilians, damage to civilian objects, or a combination thereof, which would be excessive in relation to the concrete and direct military advantage anticipated. (Additional Protocol 4

Article 57 Paragraph 2 iii).
Again this can be expressed in layman's terms as the military benefits of striking a target must outweigh the consequences – it must be noted that such calculations must also take account of expected collateral damage and potential unintended consequences such as malfunctions. However, despite the seemingly intractable constraints of first part of this quote, air operations which could result in harm to civilians or prohibited structures may still be carried out, courtesy of the 'principle of double effect' as witnessed by the latter portion of the quotation. The principle of double effect requires that attacking forces must reduce to an absolute minimum the number of civilian casualties and where possible choose the military option which limits collateral damage to the greatest degree.[21] However, it must be pointed out that despite the endorsed Geneva Conventions and Protocols there is no specific law pertaining to the conduct of aerial warfare, rather the details regarding air combat and aerial bombardment must be interpreted from the broader protocols which deal with protection of those involved in International and non-International conflicts. A situation which led to Pierre Boissier, a former head of the International Committee of the Red Cross (ICRC), to suggest that military commanders seeking to commit an atrocity would be well advised to do so from the air given the paucity of legal recourse upon aircrew and commanders.[22] Despite this situation international custom would dictate that there is still a requirement for our UCAV operators to ensure that attacks are fully justified and carried out with the aim of minimising collateral damage.

Previously we examined the potential capabilities of the UCAV in the 2020 timeframe and considered in detail the C2ISR network which supported our UCAV on its mission over Uzbekistan. At first glance this improved system appeared to solve many issues facing today's airman. The platform is likely to possess a superb sensor suite which encompasses multi-mode radar, electro-optic targeting systems, blue-force tracking means, automatic target recognition algorithms, data-linked connectivity, and is an integral part of the GIG.[23] Therefore, it is difficult to suggest that this particular platform does not meet the highest possible standards when considering the principle of discrimination. Moreover, due to the fact that weapons systems such as SDB are likely to be the weapon of choice, the principle of proportionality appears to be well covered courtesy of the reduced collateral damage implications of its armament. So in simple terms it appears that our proposed UCAV solution presents many of the answers to questions of legal application of air power in the 21st century – so why is the ICC so interested in the incident? Is there something sinister about the use of unmanned systems which promotes such interest, does the asymmetric application of air power automatically provoke such an outcry, or are they merely interested in the process used to authorise the strike?

Debates surrounding the legality of individual weapons systems have occurred throughout history and yet to the modern observer some now appear ridiculous. Perhaps the best example is the long argument which centred on the numerous variants of the bow. Within Greek mythology the bow was used as a weapon by the 'lower' Gods, whereas 'the bravest of Gods were those who used hand-to-hand weapons'.[24] Within Homer's 'Iliad' Paris is referred to as 'a woman, weakling and coward' for using the bow, and in 1139 the Second Lateran Council sought to impose a ban on the crossbow and longbow for being 'too cruel and too effective'.[25] The stated motives for the prejudice against the bow are often cited as its effectiveness and low cost, an argument which the modern airman seldom faces. However, the true reasons are more social in nature, the fact that a body of men armed with simple and cheap weapons could annihilate a more traditional cavalry based army had the potential to threaten the established military and civil order. Clearly this historical example proves that there is little new in the concept of an 'unfair' or morally unacceptable weapon. The notion of a much cheaper weapon undermining the established military order is of particular interest when considering the potential for the UCAV to challenge manned fast jets for supremacy in offensive air power delivery.

Whilst the example of the bow has some relevance to UCAV development, the argument which perhaps has most resonance with this debate is that which surrounded the introduction of the aeroplane and more particularly the manned bomber. The deliberations at the Hague Conferences of 1899 and 1907 naturally had little inclination of the potential power of the aeroplane yet they did attempt to legislate for its future development. In 1899 the signatories agreed to, 'prohibit, for a term of five years, the launching of projectiles and explosives from balloons, or by other new methods of similar nature'.[26] This was again proposed at the 1907 conference but few continental powers supported the treaty and it was not endorsed.[27] Not surprisingly after the Great War attempts were again made to define the use of air power and limit its use, firstly at The Hague in 1922-23 and secondly at the Geneva Disarmament Conference of 1932-34. The Rules of Air Warfare drafted in The Hague sought to codify the practice of air power but were never adopted.[28] More significantly the Geneva Conference discussed a number of alternatives such as: the establishment of an international air force at the disposal of the League of Nations; the total abolition of military aircraft; and the restriction of aerial bombardment.[29] With the adoption of the Benes Resolution at Geneva in July 1932 contracting countries agreed, 'that all bombardment from the air shall be abolished…there shall be affected a limitation by number and a restriction on the characteristics of military aircraft'.[30] Difficulties in determining the definition of civil aircraft and the withdrawal of the newly established Nazi Germany brought this process to an end. Although it must be noted that the RAF bitterly opposed the banning of bomber as this was 'intimately linked to the survival of the RAF'.[31] In line with similar debates, the military establishment often wish to preserve the status quo.

As discussed previously, the air vehicle is but one aspect of the UCAV as a system, with the C2ISR architecture and associated weaponry integral parts of the whole and hence subject to the same degree of legal scrutiny. By means of our scenario it is possible to gain a simplistic understanding of these issues. Let us consider how we targeted our now deceased rebel leader. A SIGINT UAV detected an initial voice broadcast from an area known as a rebel stronghold. The voice is assessed to be that of our rebel leader and has an 80% certainty factor applied to it by a computer algorithm; the geo-location of this broadcast is used to automatically cue another sensor. Space based radar detects a convoy consisting of 2 armoured personnel carriers in the vicinity of the original plot, based on vehicle recognition techniques the lead vehicle is assessed as the likely source of the first transmission. An ELINT platform then detects transmissions from a mobile communications device known to have been used by the rebel leader within the last 2 hours, the probability our target is using it is again assessed as 80%. If this process is automated and the results presented to a commander as a potential target what level of detail should he be presented with? In simple mathematical terms the chances that our rebel commander is in the lead vehicle is only 32%[32], yet human intuition suggests that there is a very strong possibility that our target is in the lead vehicle. This simple vignette underplays the role that network analysis plays and the wide range of other information potentially available to the commander. But it also highlights the tremendous importance of ensuring that the cross cueing and correlation envisaged by concepts such as NCCT is underpinned by thorough and legally defensible processes. After all the very brief process outlined above is being used to determine whether lethal means of force should be applied to a target – in this case a human being. The UCAV and its weaponry outlined above potentially provides an answer to many air forces equipment needs: it prevents loss of politically valuable personnel; provides access to the vast majority of the battle-space; delivers measured lethality and persistence to a degree not yet seen within the air domain; and does so at a much reduced financial cost. Yet at the same it presents very definite legal challenges, the level of autonomy permitted allied to the degree of automation within the targeting process being key areas for further legal clarification. In sum, there is nothing per se that is illegal about UCAVs, but we must understand that legal opinion and argument is often based on moral reasoning.

> The moral reality of war is not fixed by the actual atrocities of soldiers but by the opinions of mankind.[33]

Having concluded that the deployment of UCAVs may overcome some of the legal issues currently facing the air commander, we must now examine the other side of the legal and moral debate in order to understand if the moral calculus supports or counters this legal position. In broad terms the moral considerations associated with the notion of jus in bello naturally follow the same principles of discrimination and proportionality; however, they intuitively explore subtly different areas and arguments. For example when dealing with the legal side of proportionality we examined the notion of 'double effect' or in modern jargon 'collateral damage'. When examining the same principle from the moral standpoint we must consider the notion of 'double intent' a subtly different argument centring on the degree to which the combatant accepts increased risk in order to minimise risk to non-combatants.[34] Equally when considering the principle of discrimination we must understand that discriminating between friend and foe, combatant and non-combatant is not permitted as they all possess the same inalienable rights – distinction between them or in favour of one is not permitted.[35] This is self evidently a moral position yet one that is enshrined in the laws of armed conflict. So how does an unmanned platform, capable of penetrating all areas of the battle-space and attacking at will, sit within the spectrum of moral proportionality and discrimination?

The first requirement of the moral debate is to truly understand the concept of double intent and the requirements it places upon air commanders when deciding between potential courses of action. In any given military situation there are probably several methods available to achieve a given military end-state, each with different modes of attack and levels of risk to both those prosecuting the attack and innocent bystanders. Given the requirement to protect non-combatants, the commander is therefore morally bound to choose the option which results in the lowest degree of risk to non-combatants yet still meets the military objective. In all probability this choice will result in an increased risk to those aircraft and crews assigned to the task – ergo the air commander is balancing the degree of risk to his own crews with the risk to the safety of non-combatants. Two seemingly disparate historical incidents highlight the notion of double intent in its most basic form.

Our first example concerns the Mosquitoes of Number 140 Wing and their attack on Amiens prison on 18 February 1944 – aptly named Operation JERICHO. The aim of the raid was to affect the release of over 700 French Resistance prisoners, a large number of whom had been convicted and were facing imminent execution. The degree of risk inherent within this raid was far in excess of that usually displayed within 2 Group; this extra risk can be attributed to the fact that the prisoners were essentially friendly combatants and hence worthy of such bravado. Moreover, the Air Officer Commanding 2 Group, sought permission to personally lead the raid; it is worth noting he had previously been a prisoner of war and was assisted in his escape by the French Resistance.[36] The raid required extremely accurate bombing and involved releases of weapons at staggeringly low heights, in some cases no higher than 10 feet.[37] The question that could of course be asked is should the same degree of precision have been applied to other targets across Western Europe? In contrast the bombing of a refugee convoy on 14 April 1999 in the village of Djakovica was a direct result of NATO commanders imposing a minimum height on air operations over the Balkans in order to reduce the risks to friendly air forces. In this particular incident an F-16 pilot misidentified a Kosovar Albanian refugee convoy as a Serbian military convoy and instigated a series of attacks which resulted in the deaths of approximately 70 civilians with a further 100 injured. The misidentification was as a direct result of the height the pilot was flying at, had he been lower it is likely that the original mistake would not have been made.[38] Initially it appears that the 2 incidents display either end of the spectrum of double intent, however, on closer examination things become much simpler.

In accepting a higher or lower degree of risk to friendly aircrews, the air commanders involved implicitly placed a relative value on the human lives at stake within a particular operation. In the World War 2 case the lives of the French prisoners were sufficiently 'valuable' in order to warrant increased risk to Allied aircrews. Conversely in the Kosovo incident, the lives of NATO aircrews were valued above all others. In both cases value judgements had been made which violated a fundamental principle of human rights which places all involved on an equal footing. In the 2 cases outlined above, the principle of double intent was satisfied, or could have been so, by an increase in the level of risk and sacrifice to those executing the raids – can this principle be satisfied during UCAV operations? It appears that in order to satisfy the principle of double intent one must bear an increased risk to ones own military, yet decreasing the risk to one's own forces is one of the main motives for development of technology across all 3 military environments.

Having examined the notion of double intent we must understand the drive towards the use of unmanned systems and associated technology within the air domain and examine whether any moral considerations have been included. Part of the reasoning behind development of UCAVs is to overcome the physiological limitations of the human body, and in that sense their deployment should ultimately make economic and military sense. However, is this a prime driver for such developments, or are their more complicated reasons for such a move? The notion of 'radical force protection' is now common within Western military operations as the expectation of the Western media moves towards almost total rejection of friendly casualties during Western military interventions.[39] Allied to this is the seemingly perverse expectation that enemy casualties can also be avoided, a situation brought about in part by the 1991 Gulf War in which clinical air strikes were shown to the World's media.[40] These 2 factors combine to present the modern day air commander with a set of expectations which he must deliver, a large number of which may have little to do with the military objectives in question. On the one hand he must reduce the risk to his own crews in order to protect his government's likely centre of gravity – public will. Whilst on the other hand he must be seen to prosecute a clinical campaign which does not undermine the legal basis of the campaign. Both of these objectives no doubt contribute to the requirement to field increasingly capable weapons and platforms, perhaps the ultimate expression of which is the UCAV. Hence the legal and political imperatives can be seen to drive elements of their design and development, but the moral arguments have not yet been considered.

In many respects the lack of international law regarding aerial warfare has not stifled the legal debate surrounding the present day execution of air strikes. One only needs to visit a typical CAOC to see the pivotal role of the lawyer in the targeting process as he sits close by the Chief of Combat Operations. However, this lack of international law has in many respects allowed morality to fill the void.[41] But in the absence of law how is the moral debate guided? Usually societal norms or accepted principles are codified into formal laws over a period of time. This can clearly be seen within the Geneva Conventions with many articles directly reflecting historical military practice. However, the pace of technological development throughout the military domain is in danger of leaving the moral debate behind. The following quote from the JDCC's Strategic Trends Paper highlights the need for a moral debate but does not place a timeframe upon it:

> The development and employment of unmanned and then fully autonomous weapons systems is likely to cause significant debate about the morality of combat where only one side's personnel are at risk, and more significantly, the acceptability of machines potentially choosing to take human lives.[42]

We have briefly examined the notion of autonomous targeting and M2M cross-cueing to improve the resolution of the target area but only highlighted that the processes and algorithms behind them must be legally defensible. No discussion of whether it is morally correct for a machine to be able to take a life was considered, yet this very question may ultimately limit the development of UCAVs and similar unmanned combat systems in other military environments.

The concept of a computer based system deciding on whether a target should be struck seems somehow to go beyond what would be morally acceptable, no matter how long the debate raged or under what circumstances the battle was being fought. Yet an evolutionary approach to this same debate could very easily see that situation come to fruition. If one considers the case of a B2 Spirit bomber as it cruises across the battlefield, it is essentially invulnerable to conventional radar based surface-to-

Northrop-Grumman X-47B UCAV

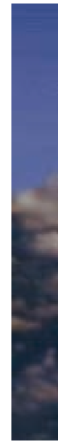
air systems and can therefore be used to attack targets at will. Those personnel directly targeted by the bomber have little or no idea of its presence or their impending demise. Is this situation immoral and if not why not? Does the fact that 2 men reside in the cockpit actually make any difference to the situation on the ground – clearly not. Equally if a Predator UAV had been used to target our rebel leader, would the innocent bystanders know of the UAV's presence or capabilities – much less whether it was unmanned? So the fact that a UCAV could combine the elements of invulnerability and a degree of automation is merely a convergence of 2 well established technologies. This very simplified argument does not adequately capture the moral arguments surrounding the automation of killing but does highlight the fact it is not beyond the grasp of certain air forces. Precision represents a capability already widely fielded in many air forces. Precision weapons as we understand them today have been around since the latter stages of the Second World War. However, the real advances in precision were spurred by the Vietnam War and fully proven during the clinical execution of the Desert Storm air campaign. It is this legacy which provides many of the moral issues associated with the prosecution of tomorrow's air campaigns. As outlined previously, lack of law can allow morality to dominate the debate; this is potentially true of PGMs. Indeed, it has been suggested that 'the moral advantage of PGMs can be morally seductive… and it is easy to be seduced into believing that because they are discriminate weapons any use of them is acceptable'.[43] The fact that a weapon can be targeted in a discriminate manner, has low collateral damage implications and is used only against targets with a clear military need does not confer morality upon the campaign as a whole. Therefore there are clear precedents that the degree of proportionality and discrimination available to our UCAV operators does not automatically infer just use of these weapons systems. This should come as no surprise to those involved in the delivery of airpower but highlights the political tensions associated with clinical warfare as Dunlap points out, 'the real issue facing statesman and soldiers is ensuring that the casualty-minimising features of high-tech weaponry do not induce decision makers to inappropriately lower the threshold for the use of force'.[44]

When looking into the development of future advanced weaponry much is made of so called non-lethal weaponry such as systems designed to 'burn-out' integrated circuits within computer systems, more commonly known as directed energy weapons. Clever direction of radio-frequency energy at an electronic system can disrupt such integrated circuits. However, should one require a very high power device to increase the effective range there is the potential for directed energy systems to not only have effects on the ground but also on the host platform or crew. The logical deduction from this is that unmanned systems provide an ideal means with which to deploy directed energy weapons. Surely the notion of an unmanned system delivering non-lethal effects onto enemy targets is approaching the nirvana of modern warfare? However, before such systems are developed we must understand whether any limitations would be placed upon their use. It seems morally counter-intuitive to limit the development of non-lethal weapons yet there are recent examples of such cases. In September 1995 the use of laser weapons specifically designed to cause permanent blindness was adopted worldwide.[45] Whilst permanent blindness is not a trivial disability one has to ask how the restriction has increased the jus in bello legality of various military operations. Presumably the desired effect sought by the inventors of such weapons was immobilisation on the battlefield, an effect which is still required and still achieved – by lethal means. So whilst non-lethal weaponry obviously has a place in future warfare we must be aware of the potential for legal restrictions to be placed upon certain means of inflicting harm. Equally, we must be certain that such weapons are correctly labelled – the intention maybe to apply force in a non-lethal manner, yet directed energy weapons designed to burn-out electronic circuits at long range could be very damaging to persons operating the target system. It appears therefore that the morality of a weapon is not necessarily linked to its lethality but rather the means employed to deliver its effect.

Much of the debate surrounding immoral weaponry has centred upon the duration of the effects caused by its employment. Notwithstanding the debate surrounding the legality of the bombing of Dresden and Tokyo, it is a widely held view that the bombing of Hiroshima and Nagasaki was somehow more sinister and truly amoral. This is despite the fact that more innocent civilians were killed in the first 2 cities than the latter 2.[46] The fact that only 2 weapons were used in the atomic attacks underlines the sinister power of the atomic weapon, but it is perhaps the long lasting nature of radiation and its effects that marks out the atomic weapon for particular moral censure. Similarly the employment of poison gas as a weapon is subject to moral outrage yet in pure military terms it is, 'relatively humane with a much lower proportion of those who became casualties actually dying'.[47] The outrage surrounding gas is again linked to the long lasting nature of effects; effects which last beyond the timescale in which a combatant should expect to be classed as such. So in common with laser blinding weapons it seems that the period of residual effects has a significant bearing upon the moral character of a weapon. Thus a morally acceptable weapon is one that affects 'only combatants and only while they are combatants'.[48] In this sense our proposed UCAV with its highly discriminate sensors and proportional weaponry could fit the bill as a morally acceptable weapon system. However, as van Creveld observed, 'the distinction between good and bad weapons exists solely in man's mind' hence by definition the morality of a weapon will always be subjective.[49] This subjectivity is perhaps dependant upon whether one possesses this weapon or is in turn threatened by it, and underlines the reason why so few weapons are outlawed when legislating through consensus.

Notwithstanding the perceived morality of UCAVs, the remaining issue to resolve for those air forces that deploy such systems is the degree of autonomy granted to the on-board and off-board computers in deciding the fate of targets they sense and observe. As outlined above, the degree of suspicion surrounding a weapon is likely to be at its greatest as it enters service, once it becomes the established norm this debate is likely to subside. Logically therefore it would be sensible to restrict the degree of autonomy during the early service of UCAVs. Indeed, until such systems have been thoroughly tried and tested it is difficult to see how such weapons could legally be left to roam freely with authority to engage targets at will. During the early stages of their development it is highly likely that the human will remain firmly in the loop. So assuming that our UCAV over Uzbekistan was controlled by a human, we have our first contender for censure or arrest. But to paraphrase President Truman, ‘the buck does not stop there’. It is entirely possible that our luckless UCAV operator followed the procedures laid down and yet still had the misfortune to permit release of a weapon which ultimately claimed the lives of 15 innocent civilians. Any of the personnel involved in ordering the mission, drafting rules of engagement and providing the information upon which the operator acted are just as liable to censure. But let us consider the case if the UCAV had been operating in fully-autonomous mode, clearly no human operator would be directly involved in the missile strike. In simple terms this merely removes one person from the chain of responsibility. The same process of planning and authorisation would take place therefore these personnel would be similarly liable. Whilst an operator was not present in the cockpit, the designer of the computer software was there in all but name. So despite the absence of a pilot the chain of responsibility remains remarkably similar with the only exception being the movement of the brain behind the execution moving further back into the defence industrial base.

When examining the concept of UCAVs the concept of invulnerability appears to bring with it significant moral baggage, yet throughout history numerous weapons have at first seemed invulnerable. The tank’s first foray on the battlefield seemed at once to offer an exit from the horrors of trench warfare and the ability to roam freely. Equally the oft repeated maxim that ‘the bomber would always get through’ underlined the perceived invulnerability of the aircraft. Eventually the weaknesses behind such weapons were exposed and ultimately countered; hence there should be a natural time limit on the perceived immorality of any new form of weaponry. The moral outrage behind Hiroshima and Nagasaki did not stop another 7 countries from developing similar weapons or others trying to do so. Therefore, if UCAVs flourish and become part of the established norms of warfare then only those disadvantaged by their presence will be left proclaiming their sinister nature.



We have also discussed that the lack of reciprocal human threat could undermine the moral basis for a campaign, but these characteristics are to a large degree already present in many of today’s asymmetric conflicts. During the first 43 days of Operation Iraqi Freedom (OIF) the 735 fighters deployed into theatre flew a total of 20228 sorties for the loss of a single A10 aircraft to enemy fire.[50] Faced with such an overwhelming air threat most adversaries have historically sought to nullify this advantage through asymmetric means, this was certainly true during OIF and equally so during Operation Allied Force. The alternative approach is of course to reduce the West’s air power domination to a level whereby a more equal contest is achieved. However, air power is seldom used in isolation from other components and hence Western military domination is not solely limited to air power. The fact that UCAVs have the potential to

Boeing X45A UCAV

exacerbate this imbalance must be borne in mind when framing future air power doctrine.

As an aside to this debate, the airman has enjoyed a unique perspective of the battlefield for over 100 years. Often the airman views the land and sea in the same glimpse; the differences between their operating environments do not bother him nor affect him as he operates in another. But the prospect of conducting aerial combat through exclusively unmanned methods is by no means impossible. Indeed the UK's own Defence Industrial Strategy sees the Typhoon and Joint Strike Fighter as the last manned combat aircraft types and, 'does not envisage the UK needing to design and build a future generation of manned fast jet aircraft'.51 Whilst the loss of the 'airman's perspective' may be inevitable, it could have significant long term implications for the relationship between air forces and their land force colleagues.

Let us never forget our enemies are men'.[52]
(Emanuel Vattel)

The development of the UCAV in many ways represents the next logical step in an evolutionary process which progressed from the biplane to the B2. However, the employment of UCAVs has the potential to institute a revolutionary approach to combat in the air. This revolution is perhaps most acute within the legal and moral arenas. Whilst this essay has dealt exclusively with unmanned systems within the air domain the moral and legal principles highlighted are equally applicable to the other military environments. The potential to deploy systems capable of taking human life without a corresponding risk to the attacker represents a key area of moral debate, a debate which will need to be resolved prior to their introduction into service. Moreover, a simple declaration of their morality is unlikely to satisfy bodies such as the ICRC or belligerents without access to their capabilities.

The physical employment of UCAVs should bring an extra dimension to the air commander's ability to prosecute a conventional air campaign. Moreover, the economic benefits of unmanned systems will become very attractive to many air forces as defence budgets come under increasing pressure. This economic pressure allied to a desire within most governments to avoid military casualties combine to make the future deployment of UCAVs highly likely within the next 15 years. Given that high technology weapons, and particularly airborne platforms, have a long design and development process the need to mature the legal and moral debate is already upon us. Should legal issues be identified which preclude the deployment of UCAVs or limit the degree of autonomy granted to them, then significant research and development costs may be avoided in the short term. It is highly likely that the first such systems will not be employed in fully autonomous modes for 2 reasons. Firstly, the maturity level of autonomous control algorithms will be such that they may not be able to achieve the level of cognitive understanding or situational awareness available to similar platforms controlled by humans. Secondly, the degree to which such autonomous systems will be trusted, or more importantly legally, proven will probably not be met during their initial deployments; hence their early service will be in a human controlled mode. This should assuage the concerns of many regarding the automation of killing, which is perhaps the largest moral and legal hurdle facing unmanned combat systems. Whether the development beyond human only control is ultimately pursued will be driven not by technology but by legal opinion backed up by moral debate.

The degree to which reciprocal human threat is overcome by the employment of UCAVs is of sufficient importance to accelerate their development. Yet at the same time this lack of reciprocal danger poses a threat to the ultimate employment of UCAVs, primarily because the moral right of the attacker could be undermined. The utility of UCAVs within high intensity and high threat scenarios has been established, and their long endurance and relative cost of operation will make them attractive for the more mundane but reactive tasks associated with post conflict scenarios. But it is precisely these latter tasks which are the most complex decision making arenas as the discrimination of target from non-combatant becomes increasingly difficult.

We must also be aware that the current technological superiority of certain air forces has the potential to set the conditions of an adversary's response to coercion. Faced with an even greater capability which is unmanned, what will be the response of most belligerents? The majority will probably seek an asymmetric response which seeks to underplay the strengths of the West's air power, this is already true today and the deployment of UCAVs has the potential to further exacerbate this problem. Indeed, the West's current air power dominance already presents us with many of the legal and moral issues surrounding the deployment of unmanned combat systems, and today's air commanders must understand the relevance of the arguments outlined within this essay as they consider contemporary campaigns. Although current predictions see the UCAV able to access the majority of the battle-space unhindered, in reality their vulnerabilities will eventually be established and ultimately countered in line with the previous cycle of warfare. By the time this occurs it is likely that the debate surrounding the legality and morality of unmanned killing machines will seem as outdated as the arguments surrounding the crossbow. Nevertheless, the debate has the potential to be every bit as controversial until their utility is proven and such systems are seen as the norm within warfare.

As a final thought, van Creveld sought to understand the nature of future conflict. His basic thesis was that computers, no matter how advanced, 'could only respond to those circumstances explicitly foreseen by their programmers' and thus future conflict would remain a fundamentally human issue.[53] He went on to suggest that, 'war would not be waged by neatly uniformed men in air conditioned rooms sitting behind screens manipulating symbols and pushing buttons'.[54] Yet this is precisely the type of activity which is envisaged for the command and control of UCAVs in the early part of the 21st century.

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Photo: RAF AHB

A Boeing Fortress B Mk III electronic warfare aircraft of RAF Bomber Command

To What Extent Did Royal Air Force Employment of Electronic Warfare Contribute to the Outcome of the Strategic Night Bomber Offensive of World War II?

By Sqn Ldr Rob O'Dell RAF

The war in the air is a technological war which cannot be won by a technologically inferior fighting force, however high its moral or dauntless its resolution'
(Luftwaffe 158 victory ace, Colonel Johannes Steinhoff.[2])

Introduction

During World War II offensive strategic air power evolved from principles little changed from the German Gotha raids of World War I to highly complex and technical operations. In particular, the night bomber offensive of World War II saw the first intensive employment of Electronic Warfare (EW), precipitating a race for technical supremacy arguably unprecedented in the history of warfare.

Many contemporary studies of the Royal Air Force (RAF) bomber offensive have suggested that the campaign was of little relevance to the final collapse of Germany. Indeed, RAF 'area bombing' of German cities has sometimes been accused of undermining the moral superiority of the Allies. Moreover, fuel shortages and the loss of the Luftwaffe's early warning network of radars and Command and Control (C2) facilities to advancing Allied land forces is generally cited as the primary factor in the final collapse of Germany's night defences.

This essay offers an alternative perspective that RAF employment of EW was the most significant factor in the campaign. Bomber Command EW allowed the RAF to limit the effects of increasingly advanced Luftwaffe C2 and fighter technologies, ultimately reducing German Air Defences (AD) to virtual impotence. It is also suggested that RAF navigational systems enabled quantum leaps to be made in bombing accuracy, given the conditions and technology available.

In reaching its conclusions, this essay examines the impact of the principle RAF and Luftwaffe EW technologies upon the strategic night bomber offensive against Europe during 1939-45. The EW capabilities examined include navigation, radar, passive detection, Signals Intelligence (SIGINT) including Electronic Intelligence (ELINT) and Communications Intelligence (COMINT), and Radio Counter Measures (RCM) jamming. The significance of such systems is compared with other factors in the campaign such as leadership, C2, and the wider strategic context of the conflict. RAF studies suggested that loss rates of 5% over a period of 3 months reduced the effectiveness of a bomber force to unacceptable levels, whilst losses of 7% made a force ineffective.[3] Therefore, for the analytical purposes of this essay, RAF losses exceeding 5% are considered unacceptable whilst those exceeding 7% are classed as unsustainable.

The campaign is examined in 4 stages. Firstly, the period from September 1939 to December 1941 saw extremely poor results from RAF night bombing due to unsuitable aircraft and navigation methods, while German military expansion had emphasised offensive rather than defensive operations. Consequently, Luftwaffe night defences were ill-equipped to challenge early RAF bomber sorties; however, the appointment of the inspirational Colonel Josef Kammhuber saw a rapid expansion of the night-fighter force, enhanced by improved C2 and Germany's technological lead in early warning and gun-laying radars. Nevertheless, Britain retained a lead in Airborne Interception (AI) technology which enabled RAF night-fighters to challenge early Luftwaffe intruder operations over Britain. Moreover, British AI radar contributed significantly to Britain's development of long range navigation capabilities. Overall, the period was characterised by stalemate between the RAF and the Luftwaffe as they each struggled to overcome early technical and organisational limitations.

The second phase, between January 1942 and July 1943, saw rapid developments by both sides. The Luftwaffe took an increasing toll on RAF bombers as the so called 'Kammhuber Line' was refined and Germany's own AI radar equipped night-fighters entered service. However, the RAF introduced a variety of navigation and RCM systems which improved bombing accuracy and enabled more effective penetrations of Luftwaffe defences. Despite innovative German technology, further RAF tactical refinements, under the leadership of the aggressive 'Bomber' Harris, led to RAF ascendancy during this period which included the 'Thousand Bomber Raids'. Nevertheless, RAF losses were barely sustainable and at times threatened to curtail the entire campaign.

The third phase commenced in July 1943 with the Battle of Hamburg. This was a pivotal operation in which RAF employment of 'Window' EW jamming paralyzed existing methods of Luftwaffe C2. After a brief period where RAF losses plummeted, Window precipitated an overhaul of German defences and the introduction of a wide range of innovative measures which allowed a rapid recovery by the Luftwaffe. RAF losses reached unprecedented levels in early 1944 and forced the withdrawal of a third of Harris' bombers from operations. Ironically, much of the Luftwaffe's success was due to passive tracking of the navigation and EW systems upon which the British crews were increasingly reliant. Only continued RAF RCM, diversionary tactics and expanding Allied aircrew training and aircraft manufacturing programmes prevented RAF failure.

From April 1944 the RAF regained the initiative from the Luftwaffe. The invasion of Europe and decreasing German fuel supplies were significant factors in this reversal. However, it is suggested that omnipotent RAF EW and, in particular, the formation of a dedicated Bomber Command RCM and intruder force ultimately proved decisive. Despite continued German technological developments during the last year of the War, Luftwaffe defences and C2 were systematically disrupted by this RAF EW supremacy.

The primacy of EW was illustrated in June 1945 when RAF and Luftwaffe personnel evaluated Bomber Command tactics during trials against the largely intact German C2 system in Denmark. It is suggested that these experiments, against an AD system unhindered by Allied land forces, proved that EW was the most significant single factor in RAF victory during the night bomber campaign.

September 1939 – December 1941: Stalemate

…only 5% of aircraft getting within 15 miles of their targets…I don't think it would have surprised anyone who was bombing in 1941.
Bomber Command Pilot[4)]

Faced with the threat of German aggression, Britain had emphasised defensive measures during its pre-war expansion. Therefore, in 1939 Bomber Command could muster a combined daily average of just over 200 of its principle aircraft types, the Whitley, Wellington and Hampden.[5] All 3 were characterised by inadequate performance, payload and defensive armament. Significantly, they also lacked any form of accurate long-range navigational system beyond dead reckoning navigation supported by radio fixes and astro-navigation. In contrast, Luftwaffe doctrine emphasised the offensive tactical employment of air power in support of land forces.[6] Indeed, Germany considered the possibility of nocturnal attacks by bombers so remote it possessed only small numbers of obsolete biplanes for night-fighting tasks in 1939.[7] The emerging EW capabilities of each nation reflected these priorities.

Part of the Chain home radar system

Britain had developed the Chain Home AD radar and its associated C2 system, and led the world in airborne radar technology. In contrast, Germany had focused upon the offensive potential of EW. The Knickebein (Crooked Leg) navigation system allowed accurate 'blind' bombing through cloud cover. However, in September 1939 Germany also possessed small numbers of Freya early warning and prototype Wurzburg gun-laying radars, each developed in complete secrecy.[8] Freya had a range of 75 miles but could not measure an aircrafts altitude whilst Wurzburg was a small radar with a range of 25 miles and an ability to plot an aircraft's position and altitude to extremely fine limits.[9] Yet despite German success in navigation and ground based radar, the Luftwaffe lagged behind Britain in night-fighter AI technology and C2. German disregard of such defensive EW capabilities would later prove significant. In contrast, the RAF's 80 Wing increasingly disrupted Knickebein and other German navigation systems from November 1940 in what became known as the 'Battle of the Beams'. The emerging significance of such EW techniques was not lost upon the RAF and wider British scientific community.

Early Bomber Command daylight sorties against German naval targets resulted in loss rates of up to 50% and forced Bomber Command to adopt a night strategic bombing policy in April 1940.[10] Unknown to Britain, the Luftwaffe daylight successes had been partly due to Freya radars detecting approaching RAF bombers at ranges of over 70 miles[11]. EW had already fundamentally influenced the campaign. In contrast, nocturnal RAF leaflet dropping over German cities had forced the allocation of single-seat Bf109D fighters to night defence duties. To aid vision and limit the glare from searchlights these fighters operated with their canopies removed but, lacking AI, the Bf109D proved severely limited in the role.[12]

Following the German bombing of Rotterdam on 14 May 1940, Churchill authorised attacks against point targets in mainland Germany. By 4 June 1940, RAF bombers had flown some 1700 night sorties over Germany for the loss of only 39 aircraft.[13] However, without navigation aids crews struggled to find their targets. One pilot describing a bombing raid against a railway station in Dusseldorf stated that upon reaching their target area German blackout procedures prevented them from locating the station. They then conducted a fruitless 'square search' of the city before dropping their weapons into the darkness.[14] This illustrates the problem of locating targets at night without appropriate navigation systems and the impotence of German night defences at the time. Furthermore, Germany also lacked the EW capabilities required to locate the bombers at night, beyond primitive sound detection systems.

Faced with increasing RAF raids, the significance of Luftwaffe night-fighter defences increased. On 19 July 1940 Goring appointed Colonel Josef Kammhuber to formally establish a force of twin-engined night-fighters, the Nachtjagd. Initially, Kammhuber advocated aggressive 'long range night-fighting' intruder operations against RAF bomber airfields, commenting, '…vigorous and correctly launched long range night-fighter operations are, in my view, the most effective tactics of any kind of night-fighting.'[15]

EW again contributed to these intruder operations. In the hours preceding a bombing raid, RAF aircraft would test radios and other systems. By eavesdropping on such communications, the Luftwaffe Radio Monitoring Service, known as the 'Y-Service', was able to determine the approximate numbers of bombers planned to fly that night, and their departure airfields. Such COMINT allowed night-fighters to catch RAF bombers as they departed airfields in Britain and produced immediate results.[16] Prior to 1 August 1940, only 10 aircraft had been destroyed by Luftwaffe night-fighters.[17] In contrast, long range night-fighter operations over Britain accounted for almost 100 RAF aircraft within 12 months of commencing in October 1940.[18] Success for the Luftwaffe aircraft would undoubtedly have been greater had they been furnished with effective AI radar. In contrast, RAF Beaufighter night-fighters equipped with AI and controlled by the formidable RAF C2 system were able to account for 26 Luftwaffe intruders throughout the same period.[19] Despite the success of Kammhuber's tactics, Hitler wanted the German population to be able to see RAF bombers being destroyed over their own territory and intruder operations ceased in October 1941.

With Kammhuber's Nachtjagd still lacking AI radar, 'illuminated' night-fighter operations employing searchlights were conceived as the only realistic method to locate and attack bombers in the dark over Germany. This involved the establishment of a Helle-gurtel (searchlight belt) but this was limited by cloud and the time taken by searchlight crews to acquire bombers in the darkness. In October 1940 a solution arrived with delivery of production Wurzburg radars. The accuracy of Wurzburg allowed radar guided 'master-searchlights' to be introduced, as well as an increasing number of radar controlled Flak. Upon acquiring a target, the bluish beam of the master-searchlight's 200 cm lens would slew directly onto a bomber and attract smaller 150 cm unguided searchlights to 'cone' the target for engagement by Flak and night-fighters.

RAF losses rose immediately. Between June 1940 and February 1941 the average Bomber Command loss rate was under 2%.[20] However, attrition increased to 3.5% between July and November 1941 with losses of up to 21% recorded over Germany itself.[21] Including non-operational losses in England, the entire front line strength of Bomber Command had statistically been wiped out in the final 4 months of 1941.[22]

Following the first Ground Controlled Intercept (GCI) kill employing Freya information passed to a night-fighter, Kammhuber initiated 'dark night-fighting' GCI zones ahead of his Helle-gurtel. Whereas searchlight activity had previously indicated the likely presence of night-fighters, bomber crews now faced attack without warning. However, although the Wurzburg was extremely accurate, its range of 20 miles limited the time available to track targets. As a result the Wurzburg-Riese (Giant Wurzburg) was developed, with range doubled to 40 miles.[23] Despite these promising developments, by October 1941 around only 50 RAF aircraft had been destroyed in GCI engagements compared with 325 in cooperation with searchlights. In an attempt to refine the integration of EW data into Luftwaffe C2, Wurzburg-Riese information was displayed on a newly developed plotting system, the Seeburg-Tisch (Seeburg-Table), at each radar station. Using information from the radars, the position of a bomber and night-fighter were projected onto a horizontal map of the area. This allowed Fighter Controllers, known as Jagerleitoffiziers (JLO), to better direct engagements.

Meanwhile, RAF bombing accuracy remained compromised by poor navigational accuracy. Between June and July 1941, less than 7% of crews came within 5 miles of their targets on moonless nights.[24] Such poor bombing accuracy was aggravated by the increasing use of decoy 'fire sites' throughout Germany. These replicated cities under air attack with fires, explosions and even sparks from simulated tram cables, and diverted up to 69% of RAF bombs on specific raids.[25]

The first attempt to improve navigation was Gee, a radio aid employing ground transmissions from Britain to produce a complex grid of pulses. By interpreting the pulses on a display in the aircraft, navigators could determine their position to within 2 miles when up to 400 miles from the transmitters.[26] However, it would be March 1942 before sufficient Gee sets were available to commence full operational use. Therefore, by the end of 1941 it had been recognised that a city was the smallest feature which most crews could be guaranteed to hit given current navigational technology and precision targeting was abandoned in favour of an 'area bombing' policy.[27]

Meanwhile, it was clear that the Luftwaffe was employing radar by the increasing reports of night-fighter attacks independent from searchlights. It was essential that the nature of such radars be ascertained to enable countermeasures to be developed and EW would once again prove instrumental in the hunt that followed. By Spring 1941, SIGINT Wellingtons had located several radar sites and intercepted signals associated with both Freya and Wurzburg. Moreover, intercepts of German Morse code appeared to provide range and bearings on British aircraft from locations which coincided with the suspected radar stations. Such COMINT identified several other radar sites.

In this first phase of the night bomber offensive, the RAF and the Luftwaffe were severely hampered by technical limitations. Bombers proved unable to locate their targets whilst German defences struggled to find RAF attackers in the darkness. Yet, even at this early stage, EW had played a decisive role in shaping the RAF's campaign. Luftwaffe employment of radar had contributed to the decision by the RAF to switch from daylight to night operations. Similarly, SIGINT was assisting the RAF in mapping GCI sites and Gee promised to considerably improve RAF bombing effectiveness.

January 1942-July 1943: The EW battle Intensifies

I don't like high-frequency gadgets. I once went on a flight in southern Germany and ended up in northern Germany by mistake, all because of your high-frequency gadgets. (Adolf Hitler, 1943[28])

Increasing Wurzburg production now allowed the development of the Himmelbett (four-poster bed) system, often referred to as the 'Kammhuber Line'. Himmelbett coordinated Freya and Wurzburg capabilities within a series of boxes approximately 20 miles wide. Following long range Freya detection, a 'Red' Wurzburg would obtain a target's altitude whilst a 'Blue' radar controlled fighters to within visual range of their quarry. In boxes close to the coast, early warning was augmented by 2 new radar types, Mammut (Mammoth) and Wassermann (Aquarius), each capable of detecting a target's position and altitude to ranges of 150 miles.[29] Himmelbett C2 methods combined with these new radars showed much promise but its efficiency was still hampered by the lack of effective night-fighter radar.

This shortcoming was remedied in February 1942 when the first Lichtenstein AI radars were delivered. Although less advanced than its British equivalent, RAF losses immediately increased from 2.5% to 3.7% between

February and May 1942. From June, the average was approximately 5% although specific raids resulted in losses of up to 15%.[30] Whilst some casualties were due to the clear summer nights, Germany's night defences were being transformed by EW.

Under the newly appointed Air Chief Marshal Sir Arthur Harris, Bomber Command employment of Gee commenced on 8/9 March 1942 in a raid upon Essen. The industrial haze precluded visual refinement of Gee fixes and Essen records recorded only a 'few houses and a church destroyed'.[31] Gee's accuracy was, however, sufficient to enable bombers to be concentrated in a 'stream'. By routing this stream through a single Himmelbett box defences could be saturated, with similar effects against the Flak and searchlights over the target itself. This tactic was initiated over Germany in the 'Thousand Bomber Raid' against Cologne on 30 May 1942 when 3 waves of bombers were concentrated within 150 minutes compared to previous raids exceeding 7 hours.[32] Despite clear visibility favouring the night-fighters, losses in successive waves were 4.8%, 4.1% and 1.9% suggesting that Gee bomber streaming had enabled the defenders to be progressively overwhelmed.[33]

The Germans were quick to realise the significance of Gee, and a Y-Service unit formed in July 1942 to jam Gee's signal via a system codenamed 'Heinrich'. By August, Gee had been impaired over occupied Europe, although it remained sufficient for bomber stream tactics to be maintained.[34] With Gee jammed, and increasing numbers of Luftwaffe Lichtenstein and ground based radars, RAF losses again increased from an average of 3.7% between February-May 1942 to 4.5% during August-December 1942.[35] The latter figure is particularly significant when compared to the previous winter's losses of only 2.5%.[36] Indications of a German AI first came from ELINT, detecting unidentified signals on a frequency of 490 Megahertz (MHz), and COMINT. However, direct association with night-fighter activity was only obtained when an ELINT Wellington accompanied a raid to Frankfurt on 3 September 1942. Near Mainz, faint 490 MHz signals increased in strength until the aircraft was attacked by a JU88 night-fighter. Despite being forced to ditch the Wellington off Dover, the final link in Himmelbett's reliance upon EW systems had been confirmed and countermeasures were initiated.

Active jamming of German night defences commenced on 6/7 December 1942 during a raid against Mannheim. Defiants equipped with a 'Mandrel' jamming system circled over the North Sea to blind coastal Freya, Mammut and Wassermann radars. Meanwhile, Mandrel equipped bombers provided RCM along the route. This forced the Germans to embark on a lengthy programme to modify radars for alternative frequencies. Simultaneously, German control frequencies were targeted via 'Tinsel' communications jamming. Tinsel allowed a bomber's radio operator to activate a microphone in one of the bomber's engine compartments and transmit engine noise directly onto the Luftwaffe frequency.[37] This was an unpleasant surprise for the Luftwaffe and a night-fighter diarist noted of Mandrel and Tinsel's first use, 'Heavy jamming of Freya. It was nearly impossible to control the night-fighters'.[38] The result was an RAF loss rate reduced that night to 3.7%.[39]

Aside from the introduction of RCM, 1942 saw several other enhancements within Bomber Command. In August a dedicated Pathfinder Force (PFF) had been created, from experienced crews, to accurately mark routes and targets for the main bomber force using a variety of marker flares. Despite the jamming of Gee, the percentage of bombs plotted as being released within 3 miles of the aiming point rose from 35% to 50% following the instigation of PFF operations.[40] Of more significance to bomber offensive, however, was the introduction of 2 new navigation systems by Bomber Command, Oboe and H2S, which Harris described as introducing 'a new era in the technique of night bombing'.[41]

Like Knickebein Oboe relied upon 2 intersecting beams from transmitters in Britain allowing extremely accurate flight along a radius until a second beam provided countdown and bomb release signals for the navigator. Introduced on PFF Mosquitoes in December 1942, the high operating altitude of this superlative aircraft allowed Oboe signals to be received up to 270 miles from the transmitter, sufficient to cover the majority of the Ruhr.[42] The accuracy of Oboe Mosquito bombing was such that it aroused German suspicions that homing beacons had been placed in factories by agents.[43] The second system was H2S, a navigation radar first used operationally on 30 January 1943 which owed its origins to AI technology. Mounted beneath the bombers' fuselage H2S produced an image for the navigator of coastlines, rivers and even built up areas within a 6 mile radius. As it was carried by the bombers themselves, H2S offered more accurate navigation without reliance upon vulnerable external signals.

By April 1943, approximately 60% of sorties dispatched bombed within 3 miles of the aiming point compared to less than 30% prior to the introduction of H2S and Oboe.[44] However, the secret of H2S was compromised by the loss of a Stirling near Rotterdam. The discovery of this equipment, codenamed 'Rotterdam' by the Germans, shocked the Nazi technical community whose own research into such radars was in its infancy. Even Goring, whose interest in EW was limited, was concerned by the discovery:

> I expected the British…to be advanced, but frankly I never thought that they would get so far ahead. I did hope that even if we were behind we could be in the same race![45]

Besides navigational improvements, the RAF also introduced 2 threat warning devices in early 1943. The first, 'Monica', was a tail-warning radar which provided a series of beeps increasing in frequency as an aircraft approached from behind the bomber. In practice, Monica was unpopular due to the high rates of false alarms resulting from other bombers. 'Boozer' however was a passive system designed to warn of Wurzburg gun-laying and Lichtenstein night-fighter radars. Unfortunately, the increasing amounts of radars now being fielded meant that Boozer also provided almost constant warnings. Neither system reduced losses and Monica would soon be exploited by the Luftwaffe.

Photo: RAF AHB

Ju 88 R-1

On 9 May 1943 a Luftwaffe crew defected to Scotland with their Lichtenstein equipped JU88R. Examination of the aircraft confirmed that Lichtenstein was vulnerable to a simple jamming technique, known as

'Window'. This employed the dropping of metal strips cut to half the wavelength of the target radar to create false plots on an operators radar screen. Plans to jam the 53.5cm wavelength Wurzburg radars via Window were already well advanced and the Lichtenstein's wavelength of 61cm meant that metal strips approximately 27cm long would degrade both.[46] The British had known of this jamming principle for several years but feared that use of Window would compromise its secrets and allow the technique to be employed against their own radars. Ironically, Germany had already recognised the value of such metal strips and had avoided its use for similar reasons to the British. However, the differing approaches taken regarding the use of Window by each side illustrates the influence of leadership upon EW during the campaign.

Churchill himself had been closely involved in decisions regarding Window's deployment.[47] Harris too retained a sound understanding of the increasing technology employed by his Command.[48] In contrast, Goring's interest in EW was limited and he once remarked, 'radio aids contain boxes with coils, and I don't like boxes with coils.'[49] When presented with the results of experiments with Germany's own version of Window in 1942, Goring was so horrified that he forbade further experiments, even those aimed at developing countermeasures, lest the secret leak out to Britain.[50] Following the development by the British of modifications to limit the effect of Window on their own radars, Churchill himself authorised the operational introduction of Window from July 1943.[51] Goring's decision to ignore the question of Window was about to have enormous repercussions for Germany's defences.

To add to the challenges faced by the Luftwaffe RAF Beaufighters now started to accompany the bomber stream. Beaufighters were fitted with the British AI Mk IV radar and a system named 'Serrate' which passively homed onto Lichtenstein signals.[52] Within weeks the small number of Serrate Beaufighters had accounted for 23 night-fighters over Europe.[53]

The period between January 1942 and July 1943 saw a transformation in the night bomber campaign. In January 1942 Bomber Command had only 88 4-engined types out of a total of 802 bombers available for operations. By July 1943, this total had increased to 978 4-engined bombers and 51 mosquitoes out of a total of 1153 aircraft.[54] The Luftwaffe night-fighter force had also increased in size, from 132 serviceable aircraft in December 1941 to 371 in June 1943.[55] However, the Himmelbett Line's effectiveness had been reduced via the introduction of the bomber stream and RCM, whilst bombing accuracy increased by 43%, largely due to H2S, Oboe and PFF marking.[56] Losses resulting from Lichtenstein resulted in the RAF introducing EW threat warning systems. Despite the significance of EW in the bomber campaign, the German leadership failed to appreciate the importance of such technology. In contrast, Harris and Churchill took a personal interest in EW throughout the conflict and were about to inflict a crushing blow upon Germany.

July 1943-March 1944: Germany recovers from disaster

The enemy are reproducing themselves…it is impossible…too many hostiles…I cannot control you!
(Luftwaffe JLO encountering Window for the first time[57])

During the first minutes of 25 July 1943, some 746 RAF bombers en route to Hamburg started releasing 92 million strips of Window, creating radar echoes similar to a force of 11 000 bombers.[58]

Almost immediately Wurzburg radars, critical to the direction of night-fighters, Flak and searchlights were being swamped by responses. One radar operator described, 'an indecipherable jumble of echo points.'[59] Night-fighters suffered equally, 'My radar operator suddenly had more targets than could have been possible…I was picking up targets that didn't exist everywhere.'[60] To assess the impact of Window, Tinsel jamming had been suspended for the night and satisfied British COMINT operators listened to the results:

> We gained an impression of panic and confusion from the German controllers. They were highly agitated. Stress, fear, anger and bewilderment were evident in their voices.[61]

Bomber crews also recalled Window's effect:

> It was a magic effect…I felt reasonably safe over a target for the first time…The Master Searchlights and all the others were waving aimlessly about in the sky like a man trying to swat an ant in a swarm.[62]

Window reduced losses to a mere 1.5% on this first raid of what became known as the Battle of Hamburg.[63] In comparison, a raid to Hamburg in July 1942 in similar meteorological conditions had cost 7.2% of the bombers.[64]

To take maximum advantage of Window, 3 further raids were mounted against Hamburg within 10 days. Although Window remained effective, the Luftwaffe recovered more quickly than expected and loss rates grew to 2.2%, 3.6% and 4.1%. Nevertheless, in the words of one experienced Luftwaffe JLO, 'Window was the death sentence for [Himmelbett].'[65] With some already questioning Kammhuber's emphasis upon rigid C2, the Battle of Hamburg weakened his credibility still further. In November 1942 Kammhuber was sacked and replaced by General 'Beppo' Schmid. Schmid overhauled Luftwaffe C2, with Divisional Command Posts assuming responsibility for night-fighting from individual radar sites. These new bunkers employed huge vertical plotting boards to display the evolving battle and were christened 'Battle Opera Houses' by General Adolf Galland due to their internal resemblance to theatres.[66] Simultaneously the rigid Himmelbett C2 was replaced with a more flexible Reportage (running commentary) exploiting the fact that Window highlighted the route of the bomber stream as a whole. By monitoring the GCI broadcast, night-fighters infiltrated the stream and attempted to close visually with RAF aircraft. Additionally single-engine fighters were reintroduced to night-fighting duties over the target area in a form of illuminated night-fighting named Wilde Sau (Wild Boar). However, despite early successes during clear summer months, Wilde Sau proved prohibitively costly in landing accidents by single-engined fighters operating at night without blind-flying equipment.[67] One Wilde Sau pilot remarked on the desperation of the tactic, 'If you were above clouds and wanted to land, you just had to look for the 'duty hole in the clouds'. If you couldn't find it, you baled out. It was a matter of profit and loss'.[68]

However, Wilde Sau spawned the Zahme Sau (Tame Boar) method whereby large numbers of twin-engined night-fighters used Reportage to attack the bomber stream along its entire route. Zahme Sau was first used in strength during the RAF attack on the V-weapons test site at Peenemunde on 17/18 August 1943 and inflicted 7% losses.[69] A secondary advantage of Zahme Sau was that it reduced the amount of night-fighters operating within range of Serrate Beaufighters. In this respect at least, the introduction

of Window had proved detrimental to RAF operations.
Due to Zahme Sau's reliance upon the Reportage broadcast, RAF EW next targeted Luftwaffe communications. Monitoring stations in England determined the in-use frequency and informed bombers so that Tinsel jammers could be combined to overwhelm the commentary. This 'Special Tinsel' was first used in late August over Monchengladbach and reduced losses to 3.8%.[70] A more sophisticated communications jamming system named 'Airborne Cigar' (ABC) followed in October on specially equipped Lancasters. ABC aircraft carried a German linguist crewmember to monitor Luftwaffe communications and jam up to 3 separate frequencies. Additionally, ground based jamming named 'Corona' employed other German linguists in England to transmit false orders to night-fighters. The nicknames ascribed to such jamming by Luftwaffe crews give some indications of their effect. The warbling tone of ABC was known as Dudelsack (bagpipes), whilst the transmission of engine noise via Tinsel was named Seelenbohrer (Soul-borer).[71]

In the face of such jamming, the German forces Anne-Marie radio station was used as a crude means of fighter direction. For instance, Waltzes meant that fighters should go to Munich whilst jazz meant Berlin, and a further ground based jammer, 'Dartboard', was introduced to obliterate Anne-Marie transmissions.[72] Similarly, 'Drumstick' jamming from England obliterated Luftwaffe Morse commands. The introduction of such jamming often caught the Luftwaffe by surprise and degraded communications considerably until countermeasures could be introduced. Indeed, the introduction of ABC on a raid against Stuttgart reduced losses to 1.2% when combined with an effective diversionary raid.[73] The previous comparable raid to Stuttgart in April 1944 had resulted in losses of 5%.[74] Although Nachtjagd rapidly recovered from the shock of Window via Zahme Sau, Reportage and improved C2, Mosquitoes continued dropping bombs or flares with high degrees of accuracy via Oboe. Attempts to jam Oboe had met with limited success until an Oboe Mosquito was finally downed and its secrets compromised in January 1944. Within a week, Oboe signals were being jammed by a network of ground EW transmitters and associated bombing accuracy fell from a 90% hit rate to less than 25%.[75] However, the British had long anticipated that Oboe would be jammed and immediately introduced Oboe Mark II and III employing different centimetric wavelengths. To disguise the introduction of these new frequencies, the original signal was maintained as a decoy, a ruse which proved effective for over 6 months.[76]

By October, H2S was being fitted to main force bombers and further improved via 'Fishpond'. This modification provided warnings of aircraft approaching from below via a second radar display installed at the Wireless Operator's position. Such attacks were a favoured tactic of night-fighters and avoided a bomber tail gunner's field of fire. By November, 553 of 1030 H2S sorties were equipped with Fishpond, with the remainder of radars so modified by early 1944.[77]

The value of H2S and Fishpond, however, encouraged the majority of crews to operate radar throughout a sortie. Having rebuilt an H2S set from downed bombers, Germany developed several passive H2S detection systems. Naxos, was fitted to night-fighters from November 1943 and enabled the detection of H2S signals at up to 60 miles.[78] Korfu was a ground based equivalent augmented by Naxburg, a Wurzburg radar modified by the addition of a passive H2S detector. In addition a further passive system, Flensburg was fitted to night-fighters to detect RAF Monica tail-warning radars.[79] Moreover, the Germans now used RAF Identification Friend or Foe (IFF) transmissions to highlight bombers within the Window cloud. Unknown to the RAF, the Luftwaffe was now exploiting British EW systems to track the bomber stream literally from take-off to landing.

Despite the value of such passive EW systems, Lichtenstein remained severely degraded by Window. A solution was provided by Lichtenstein SN-2 using frequencies unaffected by Window and by early 1944, the majority of night-fighters were so equipped.[80] Moreover, many aircraft had been fitted with upward firing Schrage Musik (Jazz Music) cannon. This enabled night-fighters to formate beneath a bomber prior to attack, appearing no different on Fishpond than another bomber, before dispatching their prey at point blank range. Schrage Musik became the weapon of choice for Nachtjagd and accounted for 50% of night-fighter kills by 1945.[81]

During November 1943 - March 1944, the RAF mounted 32 major raids on Germany, 16 of which were against the German capital, in a period which became known as the Battle of Berlin. Not only was this to prove Bomber Command's biggest test, it was also to see the full weight of each sides EW capabilities thrown against the other. Bomber Command's navigational systems would be severely tested by the winter conditions, whilst its defensive and RCM technology would be facing the reorganised and re-equipped Luftwaffe night-defences.

Within a week Harris was forced to permanently withdraw Stirling squadrons from operations over Germany due to 15.2% attrition of the type within 3 raids.[82] The Stirling, the first of the RAF 4-engined heavy bombers, had a lower operational ceiling than the Halifax and Lancasters, and therefore, was more vulnerable to Flak and night-fighters. Additionally, Window was sometimes less concentrated at these lower levels due to wind dispersal.

Oblivious to SN-2, Flensburg and Naxos, RAF losses mounted correspondingly. During November 1943, average losses over Germany were 4.1%, in December 4.4% and in January 6.3%.[83] More alarming for Bomber Command were the statistics from specific raids. The highest loss experienced in November was 6.2% against Berlin, whilst 8.7% failed to return on 2/3 December. Finally, 8.8% of bombers were lost during a raid on Magdeburg on 21/22 January 1944, almost exclusively to night-fighters; of this figure, 15.6% of the Halifax force was destroyed.[84] It is also significant to note that severe weather had grounded many night-fighters on 4 of the 9 raids where losses fell below 5%.[85] As the night-fighters were growing in lethality, so too was the effectiveness of the Luftwaffe Reportage, which was proving increasingly skilled at exploiting unrestrained use of H2S and Monica by the RAF. On at least one occasion, Luftwaffe ground stations were able to accurately track the progress of the bomber stream when only 40 miles from the British coast.[86] Indeed, General Schmid himself subsequently described H2S as 'the most reliable basis for plotting the enemy's courses.'[87] Such losses were unsustainable and Bomber Command suspended operations for a 2 week period from 1 February 1944.

While the EW initiative now lay with the Luftwaffe, the RAF was increasingly capable of absorbing such attrition. Between January 1943 and March 1944, the number of crews available to Bomber Command had almost doubled from 515 to 974.[88] In contrast, Luftwaffe night-fighter crew strength had only increased by 67 to 376 in the 12 months from March 1943.[89]

Despite continuing British losses, an H2S Mark III variant was introduced from November offering improved resolution and largely negating German attempts at seducing H2S bombing with radar reflecting decoy sites in open country. Indeed, to be effective against these new H2S wavelengths, 500 reflectors were required for every square mile; each reflector calibrated to within one-third of a degree to the others.[90] Throughout this period, an additional RAF navigation system, named G-H, was entering service. This was essentially an inverse Oboe, incorporating a transmitter-receiver unit to measure distance from ground stations in England. Offering accuracies similar to Oboe it could, however, be used by up to 100 aircraft simultaneously. However, G-H required considerable skill by aircrew as opposed to Oboe where the workload lay primarily with the ground stations to provide positional information. Nevertheless, from November G-H was introduced on both Mosquitoes and Lancasters.[91] More ominously for the Luftwaffe was the formation of Bomber Command's 100 Group, comprising Serrate and AI equipped Mosquito intruders, on 23 November 1943.

When operations over Germany recommenced losses remained high. On 19/20 February 1944, Leipzig was raided by 823 bombers for the loss of 78 aircraft, 9.5% of the force; of this amount, the Halifax crews suffered 14.9% of those losses. Like the Stirlings in November, Harris was forced to permanently withdraw Halifax Mark II and V squadrons from operations over Germany.[92] Only the Lancaster and Halifax III squadrons now remained to bear the burden of the night offensive.[93] Nevertheless, use of diversionary raids and 100 Group intruder operations had an increasing effect on the Luftwaffe. Raids to Stuttgart on 20/21 February and Essen on 26/27 March 1944 were particularly successful examples of diversionary tactics where losses fell to 1.5% and 1.3% respectively;[94] however, such diversionary tactics also diluted Bomber Command strength by a considerable measure.

The reduced losses associated with diversionary tactics also illustrate the lethality of night-fighters in comparison to Flak, and the continued significance of EW. On most nights, Window continued to degrade the Flak and searchlight Wurzburg radars, resulting in kill ratios favouring the SN-2 equipped night-fighters. Despite a doubling of heavy Flak batteries and an increase in the amount of RAF night sorties, the number of kills attributed to Flak barely increased during late 1943.[95] During a similar period, the fighter-Flak kill ratio was 2.7 to one.[96] In contrast, on 24/25 March 1944 extremely strong winds dispersed both Window and the bomber stream itself. Without their usual EW protection, 50 of the 72 bombers lost that night were attributed to radar guided Flak.[97] Moreover, when diversions failed the consequences were catastrophic, as was proved over Nuremburg on 30/31 March 1944. Ignoring diversionary mine-laying operations in the Heligoland area, the Luftwaffe took advantage of a clear night and enemy contrails to destroy 95 out of 795 bombers.[98] This 11.9% attrition was the single highest loss for Bomber Command during the entire war.

The period between July 1943 and April 1944 saw the significance of EW raised to unprecedented levels. Window crippled the existing Himmelbett system but precipitated tactical and technological changes enabling the Luftwaffe to

A BF-110 equipped with SN-2 radar

passively track radar emissions from the bomber stream. Meanwhile, despite RAF communications jamming, Zahme Sau tactics allowed a greater number of night-fighters to infiltrate the bomber stream. With improved EW systems, most notably SN-2, the night-fighters brought Bomber Command to its knees. Between November 1943 and March 1944 Bomber Command lost no less than 1047 aircraft, with a further 1682 damaged.[99] As a result, the RAF was forced to introduce elaborate deception tactics which depleted the number of bombers available over the intended target. The enforced withdrawal of Harris' Stirling and Halifax squadrons from operations over Germany, some 33% of his heavy bomber force, suggested that Luftwaffe EW was now dictating RAF tactics.[100] Yet the Nachtjagd had reached its zenith. The RAF was capable of absorbing such losses and the introduction of 100 Group was soon to prove decisive.

April 1944 – May 1945: RAF EW turns the tables

It has been reported that the attacks which take place so often at night now, are considerably more effective than daylight attacks…an extraordinary accuracy in attacking the target is reported.[101]
(Albert Speer, 19 January 1945)

From April 1944, Bomber Command was redirected against France and Belgium in preparation for D-Day, Operation Overlord. Further targets in France were associated with Operation Crossbow, the destruction of V1 sites. Bomber Command's experience of coordinating diversionary raids to frustrate Zahme Sau in recent months now proved beneficial to this entirely different scenario. Although diversions diluted RAF assets over targets, navigation and bombing accuracy had been refined to compensate and would now prove decisive in the most crucial period of the War.

In an echo of Bomber Command policy of 1939-41, targeting directives again specified railway marshalling yards, ammunition depots and airfields, rather than area objectives. However, the accuracy required for such a policy was now provided by the EW and tactical advances made by Bomber Command. By 1944 there were 11 approved bombing techniques, 9 of which employed Oboe, H2S or G-H.[102] The switch to multiple, precision attacks in France was a welcome change for bomber crews recently subjected to long flights deep into Germany. The new task would limit their exposure to night-fighters, and both Oboe and G-H would be available for all targets.

Recent experience of coordinating separate diversionary forces was now applied to accurately attack multiple small targets. Oboe bombing accuracy now averaged 680 yards, reducing to 380 yards when reinforced by visual means.[103] Such accuracy was vital when attacking targets within French towns and results greatly exceeded Harris' own estimates.[104] Between April and July 1944, Bomber Command dispatched 1249 sorties in over 100 operations against targets associated with Operations Overlord and Crossbow. Simultaneously, the proportion of bombs dropped on Germany declined from 40% to 8%.[105]

Significantly, Bomber Command's EW now proved relevant to the invasion itself. It was clear that coastal radars would pose a significant threat to Operation Overlord if they detected the approaching air and naval armadas. Accordingly, a new type of longer 'concertina' Window was deployed against coastal radars to simulate 2 large naval forces approaching the French coast further north. This Window was to be dropped by Bomber Command Stirlings and Lancasters, supported by Mandrel RCM jamming. However, to be effective the Window needed to be dropped accurately by formations of bombers gradually advancing in a complex rectangular pattern towards the French coast. This accuracy was provided by Gee and G-H.[106] Simultaneously, 29 bombers enticed night-fighters away from Normandy via Window spoofing and ABC jamming over the River Somme.[107] As Operation Overlord commenced, Bomber Command's EW had the desired effects. Luftwaffe night-fighters intercepted the Window 'bomber stream', and German naval artillery and E-boats attempted to engage the 'ghost' armada laid by the Lancasters and Stirlings.[108]

As Bomber Command busied itself over occupied Europe, 100 Group intruders were joined by a variety of larger aircraft. After initial operations with Mandrel and ABC equipped Stirlings and Halifax, modified B-17s and B-24s, whose higher operating altitudes enhanced the jamming ranges available, were delivered. Known in RAF service as the Fortress III and Liberator VI respectively, these aircraft carried large amounts of Window and 'Jostle'. Jostle was a powerful jammer capable of radiating 2000 watts over German VHF night-fighter control frequencies.[109] So effective were the combined impact of Jostle, ABC, Tinsel, Corona, Dartboard and Drumstick, that the latest night-fighter variants now carried an additional crewmember to assist with the bewildering range of systems required to overcome RAF RCM. However, even with numerous options for radio communication the Luftwaffe was still sometimes forced to revert to visual signals initially designed to support single-engine Wilde Sau fighters whose limited communications equipment demanded such measures. It is a measure of the impact of 100 Group RCM that the twin-engined Nachtjagd had also now been reduced to a complex series of star-shells fired by the Flak, searchlights and visual beacons to assist their navigation and direction.[110]

On 13 July 1944 an inexperienced JU88G night-fighter crew landed in Suffolk following a navigational error. Examination of the aircraft showed that it was equipped with both SN-2 and Flensburg, each unknown to British intelligence. The new operating frequency of SN-2 was quickly determined and it was apparent that Operation Overlord 'concertina' Window would also be effective against this new AI radar. Within days, such Window was being employed by Bomber Command.[111] Adolf Galland lamented the impact of these improved RAF EW methods, 'They had obstinately improved their tactics and instruments. Our night-fighters were blinded again… by new methods of interference.'[112]

Next, the JU88G Flensburg was evaluated against Lancasters operating Monica. The danger of the tail warning radar was now revealed as Monica emissions were detected by Flensburg at up to 130 miles.[113] Harris immediately ordered the removal of Monica from all Bomber Command aircraft and restrictions placed upon the use of IFF and H2S.[114]

Despite the deteriorating strategic situation of Germany in the summer of 1944, the Luftwaffe's technical capabilities remained, and they continued to introduce innovative systems in an attempt to counter RAF EW. A new radar designed to operate in the face of RCM, the Jagdschloss (Hunting-lodge) was capable of showing the entire 360 degree panoramic air situation. Jagdschloss operated in the centimetric frequency range which was more resistant to EW and produced extremely accurate positional data ideal for control of aircraft.[115] Although insufficient numbers of Jagdschloss were yet available, one experienced JLO recalled:

> It was technically the most advanced control device…we had a perfect picture of [the raid] approaching. Kill followed kill. There was no jamming on the equipment.[116]

With the secrets of SN-2 and Flensburg compromised, further measures were introduced by 100 Group. 'Modified Serrate' capable of detecting SN-2 emissions was fitted to 100 Group Mosquitoes. Additionally, a further system known as 'Perfectos' was added, which enabled RAF intruders to 'challenge' all Luftwaffe IFF in the area. The IFF sets would then reply, compromising the night-fighters position and confirming that they were hostile; a valuable advantage in airspace containing large numbers of friendly bombers. Although the Germans simply countered Perfectos by turning their IFF off, Luftwaffe C2 was now denied the ability to positively identify night-fighters within the bomber stream. The 100 Group intruders now initiated what became known as the 'Moskito panic' by Luftwaffe crews. One night-fighter pilot recalled the impact of 100 Group intruder ops, '…it was a strain on our nerves. [We used] extreme caution when we took off.'[117] Others resorted to extremely dangerous night flying to altitudes as low as 100 feet in an attempt to avoid the attentions of Mosquitoes.[118]

In October 1944 100 Group Fortresses were equipped with the 'Piperack' system designed to jam Luftwaffe SN-2 radars and compliment the concertina Window already in use. Increasingly, Fortresses and Liberators accompanied the bomber stream or conducted their own diversionary raids whilst Halifax aircraft maintained Mandrel screens. An indication of the impact of 100 Group can be gauged by an incident when a Fortress failed to receive a recall signal cancelling a raid. The aircraft continued alone to the Ruhr, dropping Window whilst conducting ABC and Jostle RCM. COMINT indicated the Luftwaffe believed a force of 50 aircraft had been involved rather than a lone Fortress.[119] In another raid on 22/23 March 1945 against Berlin, 100 Group Window dropping successfully diverted 6 squadrons of night-fighters from the intended target.[120]

Luftwaffe night defences were now facing an irreversible decline. Between August 1944 and January 1945 Bomber Command losses during the principle night raids amounted to only 1.3%.[121] Where higher losses were encountered it is significant that meteorological conditions were often such that night-fighters had not needed their degraded EW systems.

However, it would be naive to suggest that other factors were not relevant to the decline of the Luftwaffe's night defences. The loss of Germany's forward radar and Y-Service sites in France and Belgium significantly reduced the warning of approaching raids. An additional advantage was the forward deployment of mobile Oboe and G-H equipment which extended the range of these navigational aids into Germany, eventually covering

Berlin itself. Moreover, the quality of Luftwaffe aircrew declined rapidly from 1944 due to the curtailment of training in the face of reduced fuel production, itself a product of the strategic bomber campaign. This qualitative reduction initiated a vicious circle in the face of overwhelming Allied air superiority. Between January 1941 and June 1944 the Luftwaffe lost 31 000 aircrew. Yet between June and October 1944 a further 13 000 casualties were inflicted.[122] These losses were predominantly inflicted in daylight combat and had little direct effect upon the experten night-fighter crews still operating exclusively in darkness. Nevertheless, in the final months of the war, the Luftwaffe remained capable of meeting the EW challenges being faced. Small numbers of Me262 jet-fighters equipped with a new AI radar, Neptun (Neptune) finally challenged the invulnerability of high flying Mosquitoes and accounted for a disproportionate number during 1945.

The Nachtjagd also remained capable of launching large numbers of aircraft and inflicting unacceptable losses upon Bomber Command. In Operation Gisella on 3/4 March 1945, 200 night-fighters followed bombers returning from raids in Germany and destroyed 20 RAF aircraft over England.[123] On 16/17 March 1945, night-fighters accounted for 8.7% of a force of 277 Lancasters attacking Nuremburg.[124] Such figures contradict assertions that it was shortage of fuel and loss of territory which crippled the night-defences. Rather, such losses illustrate what happened when RAF EW protection was removed. In the case of Operation Gisella, the Luftwaffe intruders over England were unhindered by RCM. Similarly, RCM support over Nuremburg was negated by excellent visibility allowing night-fighters to visually acquire targets. One pilot who destroyed 7 Lancasters that night reported:

> Visibility could not have been better. There might have been between 20 and 30 of them, flying in loose formation. The Tommies must have taken [my JU88] for one of their own machines because not a single one of them took evasive action.[125]

In June 1945, following the German surrender, the RAF was presented with the opportunity to examine the Luftwaffe's AD infrastructure in Schleswig-Holstein and Denmark, which had been bypassed by advancing Allied land forces and remained virtually intact. Following a series of interviews with the Luftwaffe personnel and the examination of aircraft and equipment, 11 trials were flown. These 'Post Mortem' exercises involved the entire German AD network in Denmark, some 10 GCI sites and 40 individual radars linked to a Divisional Command Post.[126] These facilities were manned by experienced Luftwaffe operators with RAF observers able to note at first hand the results of their EW. The German 'defenders' faced a fully representative raid of RAF bombers. Although peacetime safety required trials be flown during daylight without the involvement of night-fighters, Post Mortem provided a graphic illustration of the significance of EW upon the outcome of the night bomber offensive.

Luftwaffe operators proved able to overcome Mandrel but failed to maintain situational awareness on the bomber streams advance. On the most elaborate Post Mortem trial, RAF bombers were totally lost by the German AD system and were able to simulate an attack and re-cross the Danish coast undetected. Whilst the real raid progressed, false contacts derived from Window had been plotted. In other cases, Window was assessed to have been dropped when none was present. Luftwaffe estimates of the size of the bomber formations were also inaccurate. On one occasion Window was misidentified as a force of 150 bombers. Significantly, on no occasion during Post Mortem did the Germans succeed in identifying decoy from genuine raids. Perhaps more tellingly, one Luftwaffe radar operator involved in Post Mortem confided that he needed to be a 'clairvoyant' to discharge his duties in the face of RAF EW.[127]

The final months of the war had seen EW's significance rise to its zenith. The navigational accuracy provided by Oboe, G-H and H2S was the foundation for Bomber Command's primary tactical innovations of PFF marking, diversionary raids and the bomber stream. Such capabilities proved pivotal in preparations for Operation Overlord within occupied countries. Meanwhile RAF RCM, and 100 Group in particular, denied the Luftwaffe the capability to defend their airspace. Such advances were of direct significance to what was arguably the War's campaign fulcrum, Operaion Overlord. The advance of Allied armies, the shortage of fuel and the decline in Luftwaffe aircrew standards undoubtedly played significant parts in the campaign's final year. However, the rarely acknowledged Post Mortem results suggest that EW was the most significant factor in the final demise of the Nachtjagd.

Conclusion

Few campaigns remain as controversial as the RAF strategic bomber offensive against Germany, and contemporary studies often cite the lack of fuel and Eisenhower's armies as the principle factors in the Nachtjagd's demise. Throughout the many debates on the subject, however, the impact of EW is often neglected.

In 1939, RAF concepts of the self-defending daylight strategic bomber force were quickly shown to be flawed. Early Freya radars played a key role in this realisation, and the subsequent decision by Bomber Command to adopt night tactics. However, the RAF lacked the navigational capability to mount a strategic night offensive. The rudimentary dead reckoning navigation then employed by bomber crews resulted in targeting errors measured in tens of miles as entire cities were missed in the blackout below. This weakness was further exploited by the German employment of sophisticated decoy and fire sites. It is therefore suggested that lack of an effective navigational capability was the most significant weakness of Bomber Command's early operations. The solution was provided by navigational systems such as Gee, H2S, Oboe and G-H.

As the efficiency of RAF navigation improved, so too did the defences it was required to penetrate and EW was also at the forefront of Germany's efforts. Radar was central to the mounting toll of RAF bombers inflicted by Kammhuber's Himmelbett system. The introduction of Lichtenstein on Luftwaffe night-fighters was the final element required to complete the German defences. In response, the RAF introduced the bomber stream to overwhelm German defences and a variety of EW devices. The unrestrained employment of EW systems such as tail warning and navigation radars allowed the Germans to plot RAF bombers with considerable accuracy. Meanwhile, the RAF expanded their EW efforts by jamming Luftwaffe early warning radars and communications via such systems as Mandrel and Tinsel. However, it was the introduction of Window which changed the entire nature of the night campaign. At a stroke Himmelbett was made virtually obsolete, and the Battle of Hamburg precipitated an unparalleled shock wave through the Nazi leadership, Milch himself commenting after Hamburg that 'I am beginning to think that we are sitting out on a limb. And the British are sawing that limb off'.[128]

This galvanised the Luftwaffe into measures which saw the lethality of their night defences rebuilt. Wilde Sau, Zahme Sau and Reportage facilitated a rapid recovery throughout the winter of 1943-44. Moreover, the blinding of Wurzburg and Lichtenstein by Window expedited deployment of the SN-2 AI radar and further EW passive detection measures. Within months the Luftwaffe had not only recovered from Hamburg, but was inflicting unprecedented losses upon Bomber Command. But Zahme Sau relied upon Reportage which was heavily targeted by RAF communications jamming and this forced Luftwaffe night-fighters to carry increasing amounts of radio equipment which both degraded aircraft performance and complicated C2.

Respite for Bomber Command was initially provided by subordination to Operation Overlord and Operation Crossbow tasks which reduced exposure to German defences. However, it is suggested that RCM and communications jamming by the RAF was ultimately responsible for the terminal degradation of Luftwaffe night defences. Once the secrets of SN-2 and Flensburg were laid bare the final Luftwaffe advantages were removed. RAF intruders equipped with a phalanx of EW devices precipitated the Nachtjagd Moskito Panic, whilst expanded RCM and Window spoofs saw bomber losses plummet to less than 1% over Germany itself.

Nevertheless, other factors also influenced the campaign. German and British leadership displayed very different attitudes towards EW. Goring in particular never appreciated the significance of such technology and lost all credibility in the eyes of his aircrew. In comparison, Churchill and Harris each took a personal interest in the fielding of key EW capabilities. More significant to the Luftwaffe, however, were the loss of early warning stations to the Allied advance and increasingly tenuous fuel supplies. These undoubtedly had a major bearing upon operations and are often cited as the primary causes of the Luftwaffe's decline, yet even in the final months of the war, sufficient fuel remained for night-fighters to operate in large numbers and inflict heavy losses upon Bomber Command. However, such occasions were invariably when circumstances negated the value of EW.

The pre-eminence of EW in Bomber Command's night offensive is strongly reinforced by the Post Mortem exercises against a German AD system unfettered by Allied armies. The results from Post Mortem definitively demonstrate the impotence of Luftwaffe night defences when exposed to RAF EW, which reflected experiences over Germany in the final year of the war. The ability of a large and anticipated RAF bomber force to penetrate Luftwaffe defences, accurately navigate to and 'attack' a simulated target, and egress without being plotted by the Germans is mute testimony to the significance of EW.

The influence of EW was evident from the very first weeks of the bomber campaign. Such technology raised navigational accuracy to unprecedented levels, facilitated effective weapons delivery in all weather conditions, and reduced the world's most sophisticated AD system to impotence. When RAF EW could not be effectively applied, losses were immediately incurred. Whilst the advancing Allied armies and the Luftwaffe's own critical fuel supplies were significant, they did not prevent the Nachtjagd from flying in large numbers even in the final weeks of the conflict. It is therefore suggested that RAF EW technology was the primary factor in the maintenance of Bomber Command's effectiveness throughout the strategic offensive, and was instrumental in the final collapse of Germany's night defences. This study concludes with the words of the most respected commander of Germany's wartime fighter defences:

Today the night-fighter achieves nothing. The reason for this lies in the enemy's jamming operations, which completely blot out ground and airborne search equipment. All other reasons are secondary.
(General Adolf Galland, 5 January 1945.[129])

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Notes

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7 Hinchliffe (1996), p.23.
8 Freya was a mythical Nordic goddess whose guardian, Heimdal, could see 100 miles.
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12 Hinchliffe (1996), p.31.
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45 Price (1978), p.131.
46 Hinchliffe (1996), p.144.
47 Price (1978), p.114.
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89 ibid, p.502.
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93 Despite its designation, the Halifax Mark III entered service after the Mark V and was capable of flying at higher altitudes than the Mark II and V.
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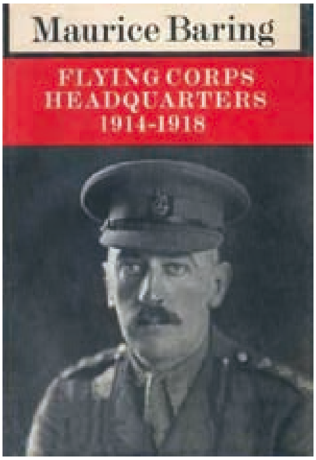
128 ibid, p.163.
129 ibid, p.226.

Historic Book Review



RFC Headquarters 1914-1918

By Maurice Baring

Publisher: G Bell & Sons

Reviewed by Gp Capt Neville Parton

This edition of *APR* sees a new element in the form of a series of historic book reviews. A roughly chronological approach is being taken, beginning in the immediate post First-World War period , but it is intended to cover more modern 'classics' such as Warden's The Air Campaign in due course. The next few editions of *Air Power Review* will see reviews of Basic Principles of Air Warfare, Slessor's Air Power and Armies and Douhet's The Command of the Air. If readers have any particular books that they would like to see reviewed in this series, they are invited to write to D Def S (RAF) with suggestions – or indeed if they would like to contribute a review along these lines that would also be welcomed.
Maurice Baring, the author of *RFC Headquarters 1914-1918*, had what could be described as at best an indifferent military career, joining the British Army in 1914 as a lieutenant in the Intelligence Corps, and retiring some 8 years later as a wing commander in the newly formed Royal Air Force. These are facts of a sort, and based solely on them any reader would be forgiven for asking why such an individuals' reminiscences, which is fundamentally what RFC Headquarters 1914-1918 consists of, justify a place on an air power library shelf. But this bald statement of achievement does not really describe the man of whom General Foch said, 'there was never a staff officer in any country, in any nation, in any century, like Major Maurice Baring.' And it certainly does not reflect Trenchard's own thoughts, who wrote, in a private letter to Sir Maurice Hankey that '…Maurice Baring was, and still is, the greatest personal friend I have ever had". However the comparison between the unvarnished facts of the opening statement and the following assertions begin to hint that in this case possibly details should not be taken at face value – and that would certainly be an appropriate approach in general when considering this tome. Perhaps the most cogent reason for its importance, and subsequent place in the pantheon of air power history, is the light that it sheds on Hugh Trenchard during his time with the RFC and Independent Force in France. But although there is much more within its cover, nonetheless, before considering the contents in any detail, it is worth getting to know the author a little better.

So who was Maurice Baring? Largely unknown today outside of a small band of air power and RAF cognoscenti, Baring was a well-known figure in establishment circles from the end of the 19th century until half-way through the 20th. An educated man (Eton and Trinity College, Cambridge) with a particular gift for languages (Latin, Greek, French, German, Italian, Russian and Danish) and widely read in all of them, it was perhaps no surprise that he began a career in the Diplomatic Service in 1898. However, more unexpectedly, this career was not to last long, and in 1904 he left the diplomatic lifestyle behind and became a journalist, initially working as a war correspondent covering the Japanese-Russian conflict in Manchuria. A move to St Petersburg, Russia, and a change of role to regional correspondent followed before continuing in this position firstly in Constantinople and then the Balkans, where he successfully represented The Times. Baring was also a distinguished writer, with 20 or more published works including novels, collections of poetry and short stories, and, unusually for an English author, enjoyed even more critical success in France than he did in England, with 10 of his books being translated. He converted to Roman Catholicism in 1910, and his faith permeated much of his work – indeed he is considered, along with G K Chesterton and Hilaire Belloc – one of the foremost Catholic novelists of the 20th century. However his career as an author was not particularly long: his first novel was published in 1921, but the onset of Parkinson's disease some 15 years later brought his writing to an abrupt end, as well as resulting in his eventual death in 1945. But it would be unfair to leave this pen-picture at that, as Baring was anything other than simply a man of letters. He enjoyed living life to the full, and was possessed of a wicked sense of humour – this was after all the man who in 1914 sent a telegram from Vienna to a friend in the War Office saying 'Feel all could be settled if we really got together. Signed, Franz Joseph.' He also had an open and generous heart, as was amply demonstrated by the depth of his loyalty and commitment to both Sir David Henderson and Trenchard. Baring was, as they say, a very complicated character indeed.

But what of the book itself? The contents are, at first sight, an almost haphazard mix of prose, poetry, early air power thinking, notes on key individuals, and copies of lists produced whilst on inspections with 'Boom'. However understanding the sub-plot that lies behind the production of the book does much to explain why it is as it is, as well as telling us something about both Baring and Trenchard. In 1923 Trenchard had run into trouble with the history of the RFC and RAF in the First World War that he was determined to have written. The problem was that the original author, Sir Walter Raleigh, had rather inconveniently died after producing only the first out of a planned 6 volumes. Trenchard wanted Baring to complete the job, but Baring was not keen; partly because he knew that what was wanted was a detailed history and he did not want to commit himself to such a mammoth task, and partly because he had already put a significant amount of work into a personal memoir aimed at capturing his experiences with the 2 generals who had directed most of the war in the air – Henderson and Trenchard. However when Baring submitted his manuscript, Trenchard appears to have requested that most of the elements relating to him be withdrawn. This left rather a hotchpotch of elements, arguably without the main theme that held them together, but one can imagine Baring, who had put the manuscript together over a 2-year period, being keen to get something out – and the story certainly provides an explanation for the contents as they are. Fundamentally RFC Headquarters is based upon Baring's diary entries from the war years, beginning with his somewhat desperate efforts to get into the war in 1914. This resulted in his joining Sir David Henderson, the first head of the RFC, as a member of his staff on an Intelligence Corps commission – although not, it should be noted, on the basis of any particular military skills[1] but purely on his proficiency with languages. The most vivid descriptions pepper the book – from the then-Colonel Brooke-Popham[2], and his 'portmanteau of gold' which was used to pay the RFC's bills wherever they went, to a dining-in night in 1917 where he reported that '…after the dinner everything in the room was broken; all the plates, all the glass, all the tables, the chandeliers, the windows, the doors, the people.' Indeed it is in these titbits of observation that much of the charm of this book lies; also apparent throughout is that the peculiar sense of irreverence which exists within the RAF to this day was very much in evidence in the RFC from its earliest existence. It is also possible to track the development of the RFC in technical terms, as various trials are reported, beginning with cameras and bombs, interruptor gear and wireless, to finish with bombsights and navigation equipment, and it is certainly noteworthy that bomb dropping trials frequently took place on front-line RFC aerodromes in the early part of the war!


Maurice Baring

But the heart of this book is undoubtedly contained in what it reveals about the relationship between Trenchard and Baring, which was without doubt an odd pairing. Baring – articulate, multi-lingual, a deeply devout convert, writer and sensitive soul, and Trenchard – almost the complete antithesis – unscholarly, frequently inarticulate, a firm agnostic, and very much a man given to action rather than introspection. The start was certainly rocky: when Baring collected Trenchard from the docks on his arrival in France he almost succeeded in delivering him straight to the German lines, thanks to a map-reading error. And when Trenchard took command of the RFC in France he told Baring that "he was willing to keep me for a month. He would see by that time whether I should be of any use to him, and if I was of no use I should have to go." But this unlikely partnership was unquestionably at the root of much of the success of the RFC in the later part of the First World War, and the early success of the RAF up until the early 1920s. For whilst Trenchard was an intuitive problem solver, and possessed of tremendous insight, he did not find it easy to explain his ideas, either orally or on paper. Baring was the first in a line of interpreters, or 'English merchants' as Trenchard would later refer to them, whose task it was to elucidate his ideas to a wider audience.

Trenchard is still something of an enigma, and the only biography that currently exists really does not do justice to this complex character, but this book does provide glimpses into his character from the man who probably knew him better than any other. An incident early on in their relationship occurred when Trenchard happened to mention that he was rather fond of a particular type of marmalade – and the next day Baring saw to it that a pot was at the general's place at table. Trenchard was quite obviously pleased, and commented that he could see that Baring had a memory – and that he (Trenchard) intended to make good use of it – which he certainly did. The fact that 'Make a note of that, Baring' became a saying in the RFC is testament to the fundamental role that Baring played in enabling Trenchard's management style, as Trenchard was very definitely a commander who believed in a hands-on approach. The systematic way that he approached running the RFC in France – making notes whenever he visited a location, and then following them through with his staff officers immediately he returned – and most importantly of all, making sure that the problem was resolved, clearly made a difference. As Baring pointedly remarked, 'This did not conduce to our repose, but it did further the efficiency of the R.F.C.'

The clarity of Trenchard's thought on operational matters also comes through clearly – for instance in his ability to see the need for a clear line of logistics support, which led him to provide each Army RFC Brigade with its own dedicated Air Park. And although willing to accept considerable losses to achieve his objectives, he did not lose sight of the human cost contained therein. An example towards the latter end of the war, when he insisted on seeing a severely injured pilot in hospital in order to personally present him with an immediate gallantry award, reveals a side of Trenchard that is perhaps not so well known. But Baring himself also had a tremendous ability with people, as Trenchard's fulsome tribute to him in The Times after his death makes clear:
"He knew more about what mattered in war and how to deal with human nature, how to stir up those who wanted stirring up, how to damp down those who were too exciteable, how to encourage those who were new to it, and in telling me when I was unfair than any other man I know. He was a man I could always trust … He never once failed me and only once lost his temper with me, though I must have tried him highly. All the juniors had confidence in him … I can pay no higher tribute: words fail me in describing this man."

It is certainly interesting to contrast the role of Baring with that of a latter-day staff officer – whose function is much more to do with managing their principal's diary and duties than to stirring up and damping down – or even telling the principal when he is being unfair! Of course the difference comes down to the fact that Baring was a successful and well-connected individual in his own right, not dependant on the Service for his future career, and of a similar age (and with similar values to) his General.

What then is the real legacy of Flying Corps Headquarters? It is a most difficult book to review , but despite all its obvious shortcomings; the lack of a consistent style or theme, the enormous variations between various components, and the frequently archaic allusions and metaphors, it does paint in an odd way a most vivid picture of what the early RFC was like. It also reinforces the part that luck has to play in war – if Baring had not ended up in the RFC, and if Trenchard had followed his first instincts to get rid of him when he took over – would anyone else have been able to articulate Trenchard's thoughts to the rest of the world so well? Without that articulation, and the constant attention to detail, would Trenchard have ever reached beyond command in the field at brigadier level? And without Trenchard, how would the Royal Air Force have fared in those critical post-war years? These are questions that have no satisfactory answer, but Baring's writings, especially when compared with those of Trenchard's 'in the raw', clearly show where the finesse and articulation occurred. The picture that we gain of Trenchard also presents a more 3-dimensional and human view of this most pivotal character in the early Air Force. This then is Baring's greatest legacy: a combination of artless narrative and deep insight which provides us with a unique window into both the RFC and Trenchard, and thereby allows us to understand much more about the spirit of each of them. Anyone wishing to gain a more in-depth understanding of either would be well advised to read it at least once.

Notes

1 When they arrived at Maubege to set up their first airfield, Baring was asked to make a map, and noted that 'He [Brooke-Popham] told me to draw a map of the Aerodrome, but I didn't know what to mark on it. The result was picturesque rather than useful.'

2 Later Air Chief Marshal, and the first commandant of the RAF Staff College at Bracknell.

ROYAL
AIR FORCE