

Air and Space Power Review

Volume 26 Number 1 Spring/Summer 2024

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Author: Wing Commander Mike Fonfé
Reviewed by Wing Commander David Caddick

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RAF Air and Space Power Review

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Book Review

The Falklands Guns – The Story of the Captured Argentine Artillery that Became Part of the RAF Regiment

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Reviewed by Wing Commander David Caddick

Introduction

by Group Captain Paul Sanger-Davies

Welcome to the latest edition of the *Air and Space Power Review (ASPR)*

This will be my last Introduction as Director before I move on to become the Senior Military Representative on the Defence Design Team in late Summer. As ever, this publication includes an eclectic selection of articles, which I trust you will find to be both interesting and thought provoking. The first section includes a variety of papers on air and space power challenges, and the second section provides a compilation of recent dissertations by CAS Fellows, which have all scored highly in their assessments. In future, dissertations will be published electronically, separately under a new Section named after the late Air Vice-Marshal Tony Mason, who was our first Director of Defence Studies (RAF) and was a prolific contributor to military academia. Dissertations from CAS Fellows will subsequently be made available under the 'Mason Papers'.

Additionally, considerable work has been done to digitally catalogue all past ASPR articles, with an open access search facility that should also be available through CORE and the Directory of Open Academic Journals. This will be going live later in the year on the CASPS Website, yet I wanted to take this opportunity to acknowledge the considerable work carried out by Flight Lieutenant Jack Duffield, which will vastly improve the accessibility of this publication to academics and the wider public.

For the first article in this edition, we publish the first of what would have been a series of papers by the late Air Marshal David Walker, with a study of the RAF and the approach taken by our leadership to ensure that the Service was combat ready for the outbreak of the Second World War.

The second article by Dr David Spruce, is a study of Robert Smith-Barry, who was considered by many as the architect for a flying training system introduced around the dawn of military flying.

Examining the evolution of flying training, the third article looks at the development of synthetic training equipment with an examination by Dr Trevor Nash, on how the RAF configured its training system to exploit the utility of synthetics in our early years and as the Second World War approached.

We conclude our articles with a study of the need to develop Space Control, by Squadron Leader 'Buzz' Payne. This is especially important and timely as space becomes increasingly contested and evolves into a warfighting domain.

This is followed by a viewpoint from Squadron Leader Andy Webb, looking at artificial intelligence and considers whether the RAF is ready to embrace this key emerging technology.

The second section provides a selection of dissertations completed within the last year or so.

Here we publish the papers in full so that the reader will gain a fuller understanding of the research topic and appreciate the level and depth of study that has been applied.

The first paper by Squadron Leader Robyn Mitchell, deals with a resurgent Russia and the implications of such geo-political tectonics on our air power doctrine.

The second paper by Squadron Leader James O'Doherty covers our renewed focus on Agile Combat Employment (ACE) and considers some of the challenges associated with implementing ACE.

Squadron Leader Jules McBean asks, in the third paper, whether uncrewed aerial systems can provide credible and capable solutions to meet medical support on the frontline – a capability which is being actively pursued within the current conflict in Ukraine.

In the fourth paper, Squadron Leader Zoë Tissington provides a timely study on energy resilience on deployed operations and asks how we can operate in an increasingly sustainable way in the future.

The final paper is a study on Nigeria and UK Foreign Policy, where Squadron Leader Joan Ochuodho presents an enlightening examination of how policy at a national level impacts on other associated nations.

Following the recent publication of the CAS Reading List for 2024, there is just a single book review for this edition with an interesting account from the Falklands Conflict by Wing Commander Mike Fonfé.

As this is my last ASPR as Director of Defence Studies (RAF), I would like to take this opportunity to thank all those who have contributed to the ASPR, which has now been in publication for over 25 years. This includes the authors, reviewers and of course the Editorial Staff for their diligence, industry and unfailing good humour. My appreciation also goes to my fellow Executive Editorial Board members and Editorial Board for their support during my tenure. What is certain is that we will win by the quality of our thinking.

Article

RAF High Command in the Second World War – A New Perspective

By Air Marshal (Retd) Dr David Walker

Biography: Air Marshal (Retd) Dr David Walker was a distinguished Harrier pilot, having seen action in Bosnia and Iraq. He went on to have an illustrious career in the RAF becoming Deputy Commander, Allied Joint Force Command from 2011 to 2013, having previously served as Deputy Commander, Allied Air Component Command at Ramstein in Germany. Prior to that he was Air Officer Commanding No.1 Group. He completed a Portal Fellowship for a PhD with the University of Birmingham. Air Marshal Walker sadly died in June 2023, and as a respected scholar this paper is published here in his memory and acknowledgement of his many contributions to military academia.

Abstract: This was intended to be the first in a series of three articles examining the development of the RAF High Command during the Second World War; unfortunately, due to illness only the first article was completed. Reproduced here the article covers the period from 1932 until the outbreak of war in 1939, shedding new light on the re-organisations of the Air Ministry in 1934, the RAF Command structure in 1936, and the tri-service debate in 1937 concerning the RAF proposal to establish a Supreme Air Commander. It challenges the established historiography casting a different perspective on RAF reforms, and as such offers a fresh starting point for analysing the RAF's High Command structure and organisation as the Second World War approached. The subsequent two articles were intended to assess the development of RAF High Command practice as the war unfolded and operational challenges were met. Nonetheless, as is characteristic of the author it presents a challenging contribution to the history of the RAF as wartime approached.

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Part I - Preparing for War – RAF Reforms in the 1930s

This article will address a new starting point for our understanding of the RAF in the Second World War and by implication the lessons that may be taken from that conflict for use and application today. It will look afresh at three significant reviews the RAF undertook in the mid-1930s and demonstrate that rather than being merely a managerial and organisational response to the rise of the German threat, they were in fact operationally driven adaptations to prepare for war.¹ A war as it was envisaged by the commanders of the time, not the one we now know unfolded with all the benefit that hindsight brings. In 1933 radar did not exist, the agile heavily armed fast fighter was a dream, and the bomber generally did get through because the air defence challenge of interception had no reliable solution. War in 1933 was an uncertain concept to all three services. The British Army had no official continental commitment, the Royal Navy could rightly be confident that it continued to rule the waves, and the Luftwaffe did not exist. Even by 1935 after Hitler and Goering revealed their embryonic air arm, few expected or planned for war earlier than 1942.² Hitler's plans for the domination of Central Europe and subsequent total war against the Soviet Union, were a long way from their final form.³ Against this contemporary uncertainty the RAF began to reform with a view to ensuring it could fight as its concepts demanded and that its peacetime organisation reflected its wartime ambition as closely as possible.

Between 1933 and 1938 the RAF transformed its operational posture in a way that few authors have adequately credited. The development and deployment of the Spitfire, Hurricane, radar, and the twin-engine bomber force were achieved, but without associated command and control developments these tactical advances would have amounted to little. Beginning in 1932 the RAF restructured the Air Ministry including basic and advanced training, war organisational planning, infrastructure building and support and gained grudging approval for the associated increases in manpower and resource. In 1935 to 1936 they restructured the frontline from the monolithic command entitled Air Defence of Great Britain (ADGB) which encompassed all frontline home-based forces into a mono-functional structure separating those forces required for the offensive, the bombers, from the defensive assets, the fighters, and creating a separate command to cover the naval co-operation squadrons. The mono-functional nature of the commands meant that multi-functional training and operations required higher co-ordination and direction. This led to a debate concerning the need for a Supreme Air Commander (SAC) which took place between 1937 and 1938. Altogether, by 1939, the RAF had evolved its command structure and method, and been instrumental in the development of tri-service co-ordination practices that would underpin the high command of British armed forces throughout the Second World War. However, apart from the 1936 frontline command review, this is an untold story and one which should lead to a new starting point for analysing RAF performance in the War, and the learning of lessons that may be relevant for today.

RAF Reforms in the 1930s

Operational Need – The Impetus for Change. All these reforms were initiated by the Chief of the Air Staff (CAS) issuing a series of memoranda to his staff tasking an investigation and review. In this there is nothing unusual for the CAS was responsible for the effectiveness and efficiency of the Service. However, given that the impetus came from the CAS it is clear that the changes under consideration were of significance and importance, they were not simply minor adjustments. All three memos included a clear statement of the issue and an equally clear statement of how the relevant CAS wished the matter to unfold. Today, both Marshals of the RAF (MRAF) Sir John Salmond and Sir Edward Ellington might be criticised for restricting the freedom of the staff to put forward the optimum solution, as such specific direction could be seen as pre-judged, but in the 1930s it was more the norm.

In the case of Salmond's Air Ministry review the RAF was still a very centralised organisation emerging from the tight control exerted by MRAF Sir Hugh Trenchard during the 1920s, and he was seeking to broaden its decision-making base, so perhaps we can understand his clear direction to achieve his desired goal.⁴ Ellington was equally unequivocal in his goal and desired outcome when tasking the 1935/6 frontline re-organisation and his subsequent strategic air commands review.⁵ Ellington's style was to set clear direction accompanied by an unequivocal view of how he wanted matters to develop. This contrasts significantly with some of the assessments of him as an ineffective and insignificant CAS.⁶ The Air Ministry files reveal a much more decisive and clear-thinking man who oversaw a transformation of the RAF.⁷

Salmond wanted an Air Ministry better configured for the challenges of a future European war.⁸ In 1935, Ellington wanted a frontline command structure optimised for the expected course of war with Germany that by then was the central planning assumption.⁹ And in 1937, Ellington sought to configure the higher command of the Service for the human and practical issues of command in wartime.¹⁰ The 1936 command restructuring is often said to have been undertaken to meet the needs of expansion as if it were solely a managerial challenge.¹¹ However, the primary evidence points squarely to the fact that central to all these key RAF reforms was the need to better prepare and configure the RAF for the war that was expected to come in around 1942. We now know of course that war came in 1939 and thus the preparations of the 1930s look late and rushed but those facing the challenge at the time were soundly of the view that war would not break out before 1942 at the earliest. This included the German High Command who were preparing for a war beginning in 1943 and lasting for 10 years.¹²

Despite the fact that war came three years earlier than expected the urgency of the time pervaded the reforms. If the view that Britain was reluctantly drawn into the Second World War were true then the focus, energy, and determination to reform the Service would be perverse. However, as David Edgerton has argued, Britain whilst seeking a peaceful outcome was far more prepared for war than popular history acknowledges, especially in terms of air preparedness.¹³ The Air Ministry specifications that led to the creation of the 4-engined heavy bombers that were central to RAF strategy during the second half of the War were issued in

1936 for delivery in 1940-42 and those for the development of the Hurricane and Spitfire in 1934.¹⁴ Thus the three organisational changes we are focussing on need to be seen in the context of the frontline capability developments and the personnel training initiatives that were also unfolding in the late 1930s. This was a time of significant change requiring a clear expression of what was required and why. For that reason the rather prescriptive nature of the memos issued by Salmond and Ellington must be seen in the context of the time, the urgency of the task, and the overriding stimulus of operational need, preparedness, and the ability to transition into war smoothly and efficiently.

Vision and Urgency. Looking back it is notable how quickly and efficiently these reforms were carried out. The Air Ministry review ran from initiation in December 1932 to enactment in April 1934; the Command re-organisation from June 1935 until July 1936; and the SAC consideration from December 1936 until March 1938. However, the actual debate and deliberation before the ultimate solution was broadly agreed was remarkably short. One interpretation of this could be that the open consultation was merely the 'socialising' of a decision already reached and there is evidence which seems to support this view.

Air Chief Marshal (ACM) Sir Robert Brooke-Popham, who led the Air Ministry review completed his consultation, deliberation, and report writing in just less than a month, from 24 January 1933 until the 22 February 1933. He made four broad recommendations.¹⁵ He argued that training should be expanded to encompass war training and that the Staff Duties element of the Air Ministry should expand to address War Organisation. He also suggested that the Air Ministry works and buildings section should go to the Air Member for Personnel (AMP). These were seemingly small changes but they significantly altered the manner in which the Air Ministry operated and in which headroom could be found to create the extra staff work required to prepare the organisation and plans for war.

On 1 April 1933 Salmond stood down as CAS to be succeeded by his older brother ACM Sir Geoffrey. However, by 5 April it was announced that Sir John would resume his role as CAS whilst his brother battled advanced cancer; sadly, Sir Geoffrey died on 27 April 1933. Sir John continued as CAS on a temporary basis before Ellington, previously AMP, became CAS on 22 May 1933 and assumed responsibility for the review process. Internal RAF discussion continued until the CAS gave his views to the Deputy Chief of Air Staff [DCAS] via a Minute on 29 June 1933 just over a month into his appointment.¹⁶ He wanted the works and building element to remain with CAS as he argued that the airfield expansion planned required the closest integration of the plans and operational staffs. Likewise, collective training should also fall under the CAS as training had to reflect plans and plans had to reflect operational capability and reality. This effectively ended the discussion which, despite a period of debate with the financial staff in the autumn in which the need for personnel increases was conceded by the Treasury, enabled enactment of the changes in April 1934. The result was that the Air Ministry was far better configured to address the urgently developing needs of preparing for massive frontline expansion and the increasing risk of war.

On 5 June 1935 Ellington tasked the DCAS, ACM Sir Christopher Courtney, with a study into the frontline structure of the Service.¹⁷ Immediately, the senior staff began to reply offering their views and on 12 July 1935 the Air Member for Supply and Organisation (AMSO), then Air Vice-Marshal Cyril Newall presented a lengthy paper drafted by Welsh, his Director of Organisation entitled 'The Organization of the Home Commands – 1935 Expansion Scheme C'.¹⁸ Newall recommended Welsh's paper as the basis for further discussion and highlighted where it differed from CAS' stated views.¹⁹ He supported Welsh's contention that the present Air Staff were over-worked and thus incapable of addressing all the issues necessary for the preparation of the RAF for war stating: 'There is no doubt in my mind that the Service as a whole, particularly at Home, is under-staffed. There is no pool to meet war requirements and, practically speaking, there is no time available to mobilize a Home Defence Force for war. It is, therefore, essential that our staffs and organization in peace-time should be as near as possible to our requirements for war.'²⁰

The final form of the 1936 command re-organisation was very close to the proposals set out by Welsh on 19 June 1935, some 14 days after CAS's tasking memo. The primary sources do not suggest that these events are directly linked, but it is hard not to conclude that the CAS and his AMSO would not have at some time discussed how the RAF frontline should be better organised for war. So, although the time between initiation and enactment was over a year, the time between initiation and effectively coming to a conclusion was a matter of days.

A similar theme emerges with the debate over the establishment of a SAC begun on 11 December 1936 when Ellington set out his views stating: 'The method of exercising higher command or control of the Fighter and Bomber Commands in War will have to be settled before long. During the present stage of the expansion, and while I was CAS and Sir Robert Brooke-Popham, Inspector General, I had intended to exercise the control by making him DCAS on the outbreak of war, and the existing DCAS, D O I [Director of Intelligence] only.'²¹ The outcome of this debate was to have significant implications for the higher direction of the war not just in the RAF, but in the other Services and the War Cabinet. On this occasion the intent was clearly stated by Ellington who was not to be deflected in his view by the opinions of his senior colleagues. Little staffing of this concept took place, it was more a process of enacting the CAS' wishes. The concept of appointing his Inspector General to the role of co-ordinating the activities of Bomber and Fighter Commands was sensible given the Air Ministry's role in the higher direction of the Service. However, this was less obvious or welcome in the Headquarters of the two respective Commands where their Commanders-in-Chief (Cs-in-C), ACM Sir John Steel at Bomber Command and ACM Dowding at Fighter Command, to whom Ellington had first raised the matter in November, were strongly against the idea.²² The responses from members of the Air Council arrived in late December 1936 and early 1937. Ellington eventually faced a situation in which the senior staff were broadly in agreement with the idea, although the junior staff were less convinced, and the operational commanders were strongly opposed. The debate to resolve this impasse never really occurred, Ellington's mind

was made up and he simply continued in line with his November and December memoranda. In all three reforms little time, by modern standards, was spent reviewing options and debating the possible advantages and disadvantages. All three followed a sequence of clear statement of intent, short confirmatory review, short period of consultation, followed by the enactment of a plan that bore a very close resemblance to the original intent. In many ways one could see this as efficient and clear sighted and in the case of the Air Ministry Review and the Frontline Re-organisation the outcome endured. However, although it is easy to see this as old-fashioned autocracy, the debate that did occur was broader and more firmly stated than is often portrayed as the style of the time.

Dissent and Debate. The popular image of the military of the 1930s is one which is more aligned to the style of the Edwardian period and the First World War in which strict hierarchical deference was the norm. Unsurprisingly, the higher commanders and staff of the 1930s were all born in the late Victorian period and came of age during the reign of Edward VII, they were reflections of their time. The difficulty we have today in understanding them is that we see them with the hindsight of history and the historical theories that have subsequently been advanced to explain the period. A period portrayed as a period of appeasement, lack of preparation, and failure in the early war years.²³ The reality revealed in the primary sources paints a somewhat different picture, one that it is important to understand to be able to see the actions and decisions of the Second World War in a truer context.

Although each of the reforms we are considering unfolded broadly in tune with the schemes set out in the initiating memos from the relevant CAS, the process of internal discussion was still broad and comprehensive. All members of the Air Council were expected to offer their views both from their own area perspective and in terms of the needs of the Service as a whole. The relevant field commanders were also asked for comment despite not being members of the Air Council; C-in-C ADGB in relation to the Air Ministry and Frontline reforms and the commanders of Bomber, Fighter, and Coastal Commands concerning the SAC debate. The views ranged from broad agreement with differences of a minor nature to outright opposition. Trenchard, who was asked by Ellington for his views on the need for a SAC was typical of the latter: 'I am dictating this letter on the platform at Euston Station, so I shall not see it before it is sent to you, nor shall I be able to sign it!' Thank you for your letter and also the enclosures with reference to a C-in-C'. ...'I am afraid I have never read anything that so fills me with alarm as the two letters you have sent me, as not, in my opinion, showing a grasp of the problem. As far as I can see both advocate the Air Ministry being Commander in Chief. This, of course, means eventually the Secretary of State – Quite impossible. I hope you will change it. Remember, I will not have read this after dictation.'²⁴ One wonders how helpful this response was for Ellington, but at least it was clear. Equally, outspoken was Dowding: 'The Commanders-in-Chief of the Bomber and Fighter Commands will be conducting two separate campaigns abroad and at home respectively, and I think that there is no necessity for the creation of any additional Command outside the Air Ministry. In fact, I think that the creation of any such Command would be definitely harmful as introducing an additional wheel of the chariot.'²⁵

On the other hand, some offered perspectives that were to prove remarkably prescient. ACM Sir Fredrick Bowhill, as AMP, considering the proposed frontline re-organisation stated: 'I am of the opinion that to have a C-in-C Offensive and a C-in-C Defensive is the ideal solution except for one most important point, namely that it will really mean that the CAS will become Commander in Chief in wartime as far as home defence goes.'²⁶

This led him to conclude that it was inevitable that the Air Staff would have to be 'the co-ordinating body to give the main directions of the campaign.' If his views were accepted, he suggested the Air Ministry would need an operational room and that the Chief of Staff (COS) for the CAS would be the Deputy CAS (DCAS) who would require enhanced staff support. This, he felt, would be best offered by an enhanced Air Staff in which DCAS acted as CAS' operational executive.²⁷ Over time this would be exactly what unfolded.

Also supportive was Brooke-Popham who was unequivocal in calling for co-ordinated command and control in relation to the need for a Supreme Air Commander: 'There must be someone in supreme control to co-ordinate the Bomber and Fighter activities. For instance, if the Fighter Command are having great difficulty in dealing with one particular type of enemy aircraft, the Supreme Commander might have to order the Bomber Command to attack the depots that feed this particular type of enemy aircraft, or the aerodromes whence they operate, possible after consultation with the War cabinet through the CAS.'²⁸

Perhaps in relief at gaining wider support, Ellington side-lined this passage in pencil commenting 'Certainly'.²⁹ Ellington, was also willing to listen to more junior officer opinions from his direct staff or officers recently returned from operational duty. Air Commodore Arthur Barratt would, in 1940, command RAF forces in France during the German offensive and in 1935 had recently returned from the post of Senior Air Staff Officer (SASO), HQ RAF India and prior to that appointment commanding No 1 (Indian) Group, and Chief Instructor at the RAF Staff College. He was both an accomplished staff officer and seasoned commander. On 4 October 1935 he wrote directly CAS to outline his views on the proposed re-organization.³⁰ That he should feel able to do this says much for Ellington's openness and approachability, traits which he is often not credited with having in abundance.³¹

Barratt began by recognising that CAS had already offered his clear view on the future organization of the Home Command but he thought that 'control under CAS of the Bomber and Fighter Commands is likely to be dangerous' from the point of view of staff work and operational reality.³² Therefore, he felt that on the outbreak of war the demands on CAS would be enormous, so much so that he would rarely be able to dedicate sufficient time to pure operational matters. This would necessitate the DCAS assuming the operational role, 'in other words the DCAS becomes a virtual C-in-C'.³³ In this sense, Barratt could be seen as the originator of the idea of a SAC for at this time Ellington was not advocating one.

Accurately anticipating the needs of 1940, Barratt suggested that there would be occasions when the bomber force might need to be directed against enemy aerodromes, and he asserted that he believed that 'this action is better controlled by a C-in-C who is freed from all other distractions.' Ellington read Barrett's memo and although not altering his immediate plans he did concede to Newall, AMSO, that: 'DSD's proposal really means introducing a super C-in-C between the Air Ministry and the organization proposed last July. Should it be considered necessary to do this, it can be done later. In any case during the expansion I am satisfied that we should adopt the organization by which Fighter and Bomber C-in-Cs come direct under the Air Ministry.'³⁴

Barratt became the Commandant of the RAF Staff College with promotion to Air Vice-Marshal (AVM) on 1 January 1936 and so speaking his mind in a reasoned, logical, and loyal way to a CAS willing to listen and be challenged was no hindrance to Barratt's future prospects. It reveals that the RAF and Air Ministry of the 1930s was an organization which tolerated debate and the expression of well-considered but contrary views in a way which is at odds with the popular image of strict hierarchical deference. Nonetheless, there is little evidence that plans were much altered as a result of the consultation process. Again, everything points to the conclusion that the outcome was largely predetermined, and that consultation had an element of going through the motions. However, the RAF of the 1930s was not an autocracy, so the CAS still had to gain acceptance at the highest level for his proposals to be enacted regardless of how pre-determined they may have been. Ellington was CAS for the final stages of the Air Ministry review and the Frontline reform. Newall led the way as the SAC debate reached its conclusion. The approach taken by them highlights both a difference of style and a difference of circumstance.

Top Level Support – Guarantor of Success. Ellington worked hard to gain support from his political master, the Secretary of State for Air (SofS), initially Lord Londonderry (5 November 1931 – 7 June 1935) and subsequently Viscount Swinton (7 June 1935 – 16 May 1938). As the Air Ministry review proceeded a dispute arose between the Secretary to the Air Ministry and the CAS over the detail of the proposed changes. Much of this has the hallmark of the Secretary establishing his position with the new CAS who had, perhaps unwisely, not included him in the early discussions. Eventually, Ellington wrote to the SofS to gain his approval for the plan before the SofS departed for a tour of Egypt.³⁵ He stated simply that war training would move to his department, war organization would be bolstered and come under the CAS and that the Works and Building Directorate would remain with CAS for a further two to three years despite the Secretary's objection. The next day Lord Londonderry replied that he approved.³⁶ This drew a line under the debate and the Air Ministry re-organisation went ahead in April 1934 as per Ellington's plan.

Ellington acted in a similar way in December 1935 concerning the on-going discussions about frontline reform. Even before all Air Council members had been consulted the year concluded with the CAS asking Lord Swinton to write to Lord Wigram, His Majesty's Private Secretary,

on 12 December 1935 seeking HM's approval to a series of senior appointments he wished to make and informing the King that: 'I am proposing to divide the Command into two, one Command of bomber squadrons and one of fighter. The squadrons will be organized in groups under these two Commands, and responsibility for co-ordination will rest with the Chief of the Air Staff.'³⁷

It would have been very difficult for the SofS to walk away from such an unequivocal statement to the Sovereign, whose constitutional position was the Chief of the Royal Air Force.³⁸ It should also be remembered that at that time King George V was mourning his beloved sister Princess Victoria who had died on 3 December 1935 and he was increasingly ill at Sandringham where he would die on 20 January 1936. It is thus doubtful HM gave much consideration to Lord Swinton's letter but the fact it was sent ensured that the plans Ellington sought would not be changed as the Air Council deliberated the matter.

On 15 January 1936, AMSO asked his colleagues to 'consider this organization and to agree to it in principle.'³⁹ Their responses showed that they were far from convinced. Bowhill, AMP, contended that he was unclear as to what useful function the Training Command would perform in peacetime and thus the case for a C-in-C was dubious.⁴⁰ The Air Member for Research and Development (AMRD), Dowding, replied on 1 February 1936 in his own hand and as far as AMSO would have been concerned, in a less than fully supportive way.⁴¹ He stated: 'I am sorry to say that I should find the greatest difficulty in agreeing to this organization **in principle**. It is often the case that a system, not theoretically sound, can be made to work by energy and good will, and it may be that this is such a system, but I have my doubts.' [Emphasis in the original]⁴² One wonders what AMSO must have thought on reading such a submission. However, with typical efficiency and speed, CAS had already written to AMSO on 20 January 1936 stating: 'I agree in principle with this organization.'⁴³

This swiftness of response, and the close working and personal relationship Newall enjoyed with the SofS, Lord Swinton, were to be pivotal in securing the decision he and the CAS sought.⁴⁴ However, if Ellington's style and circumstances allowed him to gain overt senior support as the established CAS and carry through his reforms in the way he wished, the same fortunate combination did not carry Newall to success with the SAC debate.

The Limits of Power – External Scrutiny. When Newall assumed the post of CAS on 1 September 1937 the final SAC decision was far from resolved. The internal RAF discussion had settled in favour of the post, despite the opposition of the Cs-in-C of Bomber and Fighter Command, and Ellington had gained Lord Swinton's approval for the SAC role provided no publicity was planned.⁴⁵ The Air Ministry Secretary informed the Home Commands on 19 April 1937 of the procedures to be introduced in wartime, but the wider debate with the Royal Navy, Army and Committee of Imperial Defence (CID) secretariat had a way to run.⁴⁶

In March 1936 Sir Thomas Inskip had been appointed by the Prime Minister Sir Stanley Baldwin to the new post of Minister for the Co-ordination of Defence. In early 1937 he addressed the Royal Navy's continual demand for the transfer of naval aviation back to their oversight. Unsurprisingly, the RAF's view was that this was not an efficient or effective use of the very limited air resources available to the country. Thus, in the autumn of 1937 the RAF was faced with a significant challenge to its operational structure and needed to win support for the SAC role amongst its sister services and the members of the CID, especially its Secretary Colonel Sir Maurice Hankey RM, who had been in that post since 1912. On 15 October 1937 the 22nd Meeting of the Deputy Chief of Staff (DCOS) Committee considered the SAC proposal with AVM Peirse representing the RAF as DCAS.⁴⁷ The meeting did not go well and the RAF proposal was swiftly rejected as not suitable for co-ordination with the established RN procedures and of limited relevance to Army command methods. At this point, Newall faced a significant challenge. The methods of Ellington of gaining the highest support and then driving the matter through could not work in the wider setting of external review. Likewise, the new CAS' influence with the other Services was limited, the RN were on the charge over the Fleet Air Arm and the Army were beginning to consider the implications of a much larger expeditionary force with its attendant air arm.

Newall's response was to avoid confrontation and adapt. In this he was greatly assisted by the Deputy Chief of the Naval Staff (DCNS), Vice-Admiral Sir William James RN. James had stated at the DCOS meeting, in response to a question from Peirse as to with whom the air commander should co-ordinate, that the air commander: 'should go to the Admiralty. The Admiralty, that is to say the Chief of the Naval Staff, was in effect the Supreme Naval Commander.'⁴⁸ Then on reflection he added: 'In actual practice the officer with whom the Supreme Air Commander would get into touch would be the Deputy Chief of the Naval Staff.'⁴⁹

Afterwards James wrote to Hankey on 18 October 1937 stating that he had been 'reflecting on our recent discussion about the proposal emanating from the Air Ministry'⁵⁰ Reiterating the Admiralty experience of the First World War, James suggested that by establishing a 'central war room' properly manned and continually updated, the COS, or their Deputies, could meet and quickly give direction and decision to any short notice issue that might arise. He copied his proposal to Peirse and Haining, Director of Military Operations and Intelligence at the War Office, and he wrote separately to DCAS on 21 October 1937.⁵¹

James suggested to Peirse that he might wish to consider 'the possibilities of establishing your officer who is to control the British aircraft at your Ministry in the same way as the DCNS is located here.' He asked whether it might be that a DCAS would be 'a better practical solution in view of the inevitable centralization of all information at your own Ministry?' Once more reverting to Admiralty experience in the First World War, he explained that DNCS was responsible for the main operations while the Assistant Chief of the Naval Staff (ACNS) concentrated on the specifics of the anti-submarine war. He suggested to Peirse that he felt DCAS embraced the duties of both DCNS and ACNS and wondered if the time had not come

for the Air Ministry to expand its organization and introduce an additional senior officer onto the Air Staff to allow DCAS to operate in a manner analogous to DCNS? Pierse acknowledged James' letter on 23 October 1937 thanking him for his helpful and positive suggestion which he found 'very heartening' and convinced him that a practical solution could be found.⁵²

Thus, in the space of eight days from the 15 October 1937 DCOS Meeting to the 23 October 1937 when Pierse replied to DCNS, the RAF's position on the establishment of a SAC fundamentally shifted towards the methods and procedures of the Admiralty. While James' counterproposal had much to recommend it, it stopped short of addressing many of the underlying challenges identified in the original SAC paper. It also failed to meet published Air Council policy, namely the creation of a SAC.⁵³ That such change could take place so quickly suggests a number of possibilities: the idea was fundamentally flawed and a great error of organization was prevented by the helpful intervention of the DCNS; the RAF singularly failed to prepare its case and gain support for a sound concept; or the RN were determined to resist change, protect their ownership of allocated aircraft, exploit a favourable period of institutional advantage following their success in the Fleet Air Arm debate, exploit the dominance and prestige of the First Sea Lord/Chief of the Naval Staff Admiral Sir Ernle Chatfield, and the sympathetic ear often given by Hankey to RN viewpoints. Or perhaps the Air Staff, and especially the DCAS' heart, were not truly committed to the idea.

Pierse had opposed the concept at the start of the year and could see that a SAC would seriously complicate his appointment's war role and significance in the eyes of the CAS. Newall was a supporter of the overall concept but one wonders what his view was, having assumed the post of CAS, of his predecessor occupying such a critical role in war since Ellington was now the Inspector General and therefore putative SAC. Could that have been partly behind Newall's suggestion that the SAC should not be located in the Air Ministry? Either way, the argument was shifting significantly towards the Admiralty solution and a memorandum published by the DCNS on 11 November 1937 added further weight to the RN argument.⁵⁴

Entitled 'Operational Control in War' James set out over three closely typed pages the rationale behind the Admiralty's position. It was an expertly argued paper and an important document in the development of Britain's command structure for the Second World War. Its basic premise was encapsulated in the opening sentence of the third paragraph: 'Furthermore, the Admiralty were not convinced that it would be necessary or desirable for the Chiefs of Staffs to remove their hands from the pulse of operations to the extent suggested in the Air Ministry proposal.'⁵⁵

This was an important point of disagreement and one which the Admiralty had every right and responsibility to argue. The First Sea Lord, Chief of the (Imperial) General Staff, and CAS, stood, constitutionally, ahead of their Service Board colleagues responsible to the Sovereign and Government for the fighting and operational effectiveness and efficiency of their respective Services.⁵⁶ While other commanders would of necessity be charged with the detailed execution

of the allotted operational plans, it would remain the COS's responsibility for their ultimate success. It is difficult to see, given this constitutional position, how the RAF proposal would not have resulted in the CAS being weakened in the eyes of his War Cabinet and COS colleagues.

The failure of the RAF to carry the day with its SAC initiative should not alter the recognition of its role as a key player in the development of the processes and procedures for high command in war that came from the debate. On 29 November 1937 the RAF Director of Operations and Intelligence (DOI) issued a memorandum ambitiously entitled 'Co-ordination of Higher Control of Operations by the Three Services in time of War and the Organization of the Higher Command of the Royal Air Force'.⁵⁷ The paper sought to consider: 'The war organization of the Air Staff in the Air Ministry, with whom – whether a Supreme Air Commander is appointed or not – must remain the higher direction of the RAF in war.'⁵⁸

This document was an important steppingstone in the development of the RAF's wartime command structure and it showed that the Air Staff, regardless of the CAS and Air Council's decisions, were unconvinced about the concept of a SAC. However, Newall was not prepared quite yet for the staff to administer the coup de grace to the SAC concept. When Pierse attended the 23rd DCOS Meeting on 14 December 1937 he outlined the RAF's position as it had developed over the previous weeks.⁵⁹ But he stated that: 'in the opinion of the present CAS there might be some political outcry if there was no individual designated as responsible for the co-ordination of the air offensive and defensive. ... If a Supreme Air Commander were appointed, his functions would now be limited to co-ordinating the air offensive and defensive. He would have no functions in regard to the Coastal Command'.⁶⁰

Following the DCOS meeting and their agreement, Pierse circulated his Draft Report on the Co-ordination and Control of Defence Operations.⁶¹ Over the next few days it was commented on by his colleagues, re-drafted and issued as DCOS 57 'The Co-ordination and Control of Defence Operations in a War against Germany'.⁶² On 22 April 1938, the DCOS 57 Paper was re-worked into CID Paper 1425-B and circulated summarising the winter's discussions and setting out the agreed process for the higher co-ordination and control of defence operations.⁶³ Its contents were the bedrock upon which higher command would be conducted in the coming war and a knowledge of its broad principles is essential for assessing the performance of the RAF and other Services as the war unfolded.

High Command in War - CID 1425-B

Responsibility for the supreme direction of the war at the highest level rested with the Cabinet.⁶⁴ The PM would discharge that duty through the War Cabinet or War Committee as determined by the size and scope of the crisis. It was expected that the Defence Plans (Policy) Committee would form the basis of the war time structure.

The machinery for submitting advice to the War Cabinet would be the same as had been developed in peacetime. The 'mainspring of this machinery was the COS Sub-Committee'.

The COS Sub-Committee would support the War Cabinet in all matters relating to the planning, execution, and assessment of the war situation. They would propose changes and enact the decisions reached by the War Cabinet and be present or represented at the War Cabinet whenever discussions of military matters were envisaged. Collectively they would act as a military advisor "in commission" to the Cabinet.'

The Joint Planning Committee (JPC) would provide the COS Sub-Committee with the necessary appreciations and reports for submission to the War Cabinet; the Joint Intelligence Committee (JIC) would provide the joint intelligence appreciations for the Joint Planning Staff (JPS) and the COS Sub-Committee; and the DCOS Sub-Committee would 'produce agreed reports containing advice and recommendations on matters usually of current as opposed to long range importance.'

The COS would receive the Minutes of the War Cabinet meetings but their actual instructions would be transmitted to them by the PM, Minister for Co-ordination of Defence, Service Ministers and/or the Secretary of the War Cabinet depending on the degree of urgency of the matter. Once received the instructions would be translated into 'terms of action' for each Service by the Chief of Staff concerned. This placed the CAS and the Air Staff in the operational command position envisaged for the SAC.

This process would prove satisfactory for the handling of strategy and long-range planning but the co-ordination of day-to-day operations in war required new processes and procedures. The paper reprised the path to the final decision, conceding Newall's requirement for the SAC role to be retained for possible use but only for the 'co-ordination between the action of the bombers and fighters.' It highlighted that the Air Staff had already been re-organized and an Assistant CAS (ACAS) introduced into the structure so that: 'the air war will be exercised from the Air Ministry on lines similar to those in force in the Royal Navy.'

Against this background the proposed system for operational co-ordination assumed that 'direct control of the operations of the forces of any one Service must be vested in that Service; and only when the necessity is proved beyond doubt should any Service assume control over any of the forces of another Service.' Thus, it was argued, the problem boiled down to 'the provision of an organization whereby, while each Ministry controls the operations of its own Service, those operations shall be co-ordinated with those of the other two Services, and of the civil air defence organization.'

To accomplish this goal each Service Ministry's War Room would act in concert and harmony with the Central War Room that would be situated 'in some convenient building in proximity to all the Ministries concerned.' The Central War Room would act as the meeting place for the COS or their Deputies 'for discussion on the current situation or plans for the immediate future.' Decisions taken would 'be implemented by each COS through his own individual Ministry.' Thus, the process for short notice and day-to-day events was, in effect, a compressed version

of the higher-level process but one that relied heavily on the establishment of the War Rooms and a spirit of co-operative working among the Joint and Single-Service staff. It lacked the singular authority that Ellington had sought but it embraced a far stronger element for it was the agreed position of a complex institutional structure that had grown from discussion, compromise, co-operation, and agreement. Indeed, it was a quintessentially British compromise, but one that preserved the teamwork necessary to face the uncertainty of the unfolding international scene.⁶⁵

Sixty-Six Men on the Eve of War

The course of the War is well known, but from the perspective of September 1939 the unfolding crisis was one of unknown risk and uncertainty. The preparations of the 1930s had created a far better air force, but its readiness to meet the demands of war had yet to fully evolve. In retrospect it is easy to criticise those responsible but a more mature and nuanced approach is required to fully understand the pressures of the time.

As war broke out the War Cabinet and COS were content with the arrangements set out in CID 1425-B for the control and co-ordination of the nation's defence forces.⁶⁶ The COS delivered the strategy agreed by the War Cabinet after discussion informed by the input from the COS. It was expected that the frequency of War Cabinet meetings would make it possible to balance policy with practical military reality through an iterative process of directive, action, assessment, and re-assessment that would enable the necessary adjustments to be made. It was inevitable that pressure would build to carry out actions for which preparations were scant or absent but that was the reality of war, where the enemy could always dictate the tempo or direction of events. But this was not a phenomenon new to Britain in 1939, or resulting from the years of equivocation and appeasement in the 1930s. It was how all crises and wars developed and the British War Cabinet process, borne from hard won experience in the First World War, was as developed as any to cope with the pressure, indeed paragraph 1(a) of the first War Cabinet meeting stated that its work would be conducted 'in accordance with the practice of the War Cabinet in the last War'.⁶⁷ For the RAF, CAS was at the heart of its policy making and operational performance. It was his duty to ensure, through accurate briefing and advocacy, that War Cabinet policy was fully aware of operational capability so that strategy was achievable.

The historian, Sir Hew Strachan neatly summarised the essence of strategy as 'a profoundly pragmatic business' in which it 'has to deal in the first instance not with policy, but with the nature of war'.⁶⁸ Newall held a vital role in ensuring the War Cabinet was aware of the actual capability of the RAF. It was also Newall's responsibility to ensure that the RAF's contribution to the agreed strategy was as efficient and effective as it could be. This was the key operational role of the CAS and the Air Ministry, and the reforms of the 1930s all emphasised that CAS and the Air Staff would act in high command, with the CAS as SAC 'in effect', to ensure the direction and co-ordination of the home and overseas frontline commands. It is a key point which many histories of the RAF in the Second World War underplay in favour of focussing on the Cs-in-C and their frontline Commands.

Newall accepted that the debate over the SAC post was closed but he had left the matter with a clause that the post could be considered if events were to develop that made it advisable. Between 1938 and 1939 events did not suggest that the SAC debate needed to be resurrected.⁶⁹ However, Newall, had strongly supported the need for a SAC to act as the point of effective co-ordination and as the 'generalissimo' to whom the public could look for reassurance in command of the air.⁷⁰ Against this background it is reasonable to conclude that Newall still felt that a form of the SAC role might have a part to play and might be required as the complexity of the war unfolded.

At 9 am on 2 September 1939, Newall convened his first Morning Conference with his senior staff and advisors.⁷¹ The Air Ministry Handbook listed the responsibilities of the Air Staff.⁷² Newall was charged with 'all questions of Air Force policy', 'advice on the conduct of air operations and the issue of orders in regard thereto', the 'fighting efficiency and collective training of the Royal Air Force, and, *inter alia*, the 'collection of intelligence'. This placed Newall squarely in the role of a commander. Pierse, DCAS, was responsible for the 'plans and orders for air operations and home defence', the work of the CID and League of Nations, the collection and distribution of air intelligence and liaison with attaches. To undertake the detailed work AVM Peck's duties as ACAS Ops and Int were summarized as being 'operational policy' and liaison with the War Office Admiralty, Home Office and other agencies as required. This cascade of increasingly detailed responsibility emphasised the central role envisaged for the Air Staff in the conduct and oversight of operations. The detailed liaison with the Commands would be undertaken at the lower Directorate level who were linked to the Commands through the respective SASOs, whose role was to support the Commanders in the conduct of operations. Direct liaison between the CAS, DCAS, or ACAS and the C-in-C was normal, but invariably it was supplemented by written correspondence, in the form of an Air Council Directive or directed letter, to record the decisions taken or opinions expressed. As war began ACM Sir Edgar Ludlow-Hewitt led Bomber Command; Dowding led Fighter Command; and Coastal Command was led by Bowhill.⁷³

These men were all well known to each other. Some were friends, some rivals, some worked harmoniously while others were best kept apart. The RAF of 1939, while expanding very rapidly, was still commanded and staffed by a close-knit group of men who knew a great deal about each other's strengths and weaknesses. They were also subject to many of the dangers that over familiarity and homogeneity can bring to any organization. The numbers were small, in January 1939, there were 3 serving Air Chief Marshals, 6 Air Marshals, 22 Air Vice-Marshals, and 35 Air Commodores in the RAF giving a total of 66 officers above the rank of group captain on whose shoulders the enormous responsibility of wartime command would fall.⁷⁴

A New Starting Point

This article set out to examine the RAF's organisational changes of the 1930s in order to establish a new starting point for assessing the performance of the RAF in the Second World War especially the command role undertaken by the CAS and Air Staff.

A common theme runs through the Air Ministry Review of 1934, the Command re-structuring of 1936, and the SAC Debate of 1937, namely, the need to move the focus of the RAF away from the institutional survival and development identified by Brooke-Popham onto concentrating on its real function, the preparation for war.⁷⁵ Likewise, Ellington's memorandum that initiated the re-organisation of the commands was motivated clearly by the need to organise in peacetime as it was expected the RAF would fight in war.⁷⁶ And the RAF's proposal to establish a SAC to oversee operations was also to meet perceived operational need, with Ellington stating unequivocally that he intended in time of war to introduce Brooke-Popham into the command chain to oversee the activities of Bomber Command and Fighter Command.⁷⁷

The Air Ministry review addressed the needs of growing a coherent force, establishing a secure operating base within the UK and ensuring the co-ordinated training and development of the frontline. It also addressed the chronic shortfall in manpower, not by the creation of larger staff, but by the establishing of the need for greater staff that would inevitably develop over time. By winning this argument in 1934 the RAF was able to expand its staff capability over the coming years with the grudging but positive agreement of the Treasury and other government bodies. This achievement alone went a considerable way to delivering the air staff envisaged by Smuts in 1917 as being capable of developing air strategy and conducting air operations on a par with its counterparts in the Admiralty and War Office.⁷⁸ Ellington's insistence on retaining the works department and unit training direction within the Air Ministry ensured the close control of two vital aspects of any air force's capability, namely effective and secure operational bases and common training standards that would allow co-ordinated and effective operations to be centrally directed by the Air Ministry. The re-structured arrangement in the areas of operations, intelligence and staff duties and organisation all contributed to the creation of a system not aimed at the command of the RAF of 1934 but of a future RAF of much greater size and equipped with much more capable aircraft facing the challenge of a major European war against Germany.

Likewise, in the 1936, Ellington was clear that the purpose of reform was the establishment of greater operational capability and the potential for better operational development. This was reinforced by his attempts to establish the post of SAC in his last days as CAS. This was the thinking of an operationally aware commander, something very few have given Ellington credit for being. He was content for the frontline to focus on developing its capability under the headings of offence for Bomber Command, defence for Fighter Command and maritime co-operation for Coastal Command, but when war came, he expected that the demands would not fall so simplistically into these narrowly defined mono-functional stovepipes, hence his perceived need for a 'Super Air C-in-C' to oversee the whole and create multi-functional effect.

The process encapsulated in CID 1425-B required the RAF to be centrally co-ordinated by the CAS and Air Staff to achieve the desires of the War Cabinet. It was an entirely logical approach and one that had the benefit of having gained credibility in the First World War. It suited the RN

and the British Army whose frontline assets, once allocated to a particular mission or task, were effectively fixed in that endeavour until completion. Neither the RN nor the British Army were faced with the possibility that political or inter-service operational demands could be exercised on their frontline forces in such a moment-to-moment way as was faced by the multitude of demands placed on the RAF even with the very limited aircraft of 1939. Flexibility may have been the key to air power but it was also a curse.

So, what does all this mean for today? Three clear lessons stand out. First, change needs clear vision, strong leadership and coherent purpose. In all three reforms of the 1930s the purpose was operational preparedness and readiness for a war. Secondly, communication, debate, dialogue, openness to dissenting views and opinions, coupled with a firm determination to deliver, were essential ingredients in achieving the aim within very pressing timescales and under severe resource constraints. Finally, the need for intelligent compromise and adaptation epitomised the final change, the call for a SAC, and through that compromise a far more resilient plan was born, one which laid the foundations for RAF higher command in the War. But perhaps the most telling reflection is that the history of the RAF, especially in the Second World War, has for over 80 years begun from a false starting point. The CAS and the Air Staff held a far more central role in the command and direction of the war, especially those operations conducted from the UK mainland. The Cs-in-C and their AOCs were central to the day-to-day tactical execution, but their guidance and direction emanated from the War Cabinet, through the CAS. The mono-functional structure of Bomber, Fighter, and Coastal commands was never designed to fight a war without co-ordinated direction from a higher authority. That was the essence of the SAC debate and the logical outcome of the structural re-organisations of the Air Ministry and frontline. These 3 reforms set the conditions for the higher command of the RAF in the War, and the 66 men mentioned above were the ones who would, for better or worse, carry out that command and leadership role.

Notes

¹ D Walker, "Supreme Air Command – The Development of Royal Air Force Command Practice in the Second World War" (PhD Thesis, University of Birmingham, January 2017) University of Birmingham *etheses* website: <http://etheses.bham.ac.uk/id/eprint/8209>.

² John Terraine, *The Right of the Line: The Royal Air Force in the European War 1939-1945* (London: Hodder and Stoughton, 1985), 32-33.

³ Richard Overy, *Goering Hitler's Iron Knight* (New York: I B Tauris and Co Ltd, 2012), 82-86.

⁴ TNA AIR 2/673 S32201 Encl 1A, dated 22 December 1932.

⁵ TNA AIR 2/8875, S35818 Part I, E6b, Minute 1, dated 5 June 1935, Minute by CAS to DCAS outlining his intention to re-organise the Home Commands and TNA AIR 2/1950 S39818 Control of Bomber and Fighter Commands in Time of War, Minute 11, dated 11 December 1936.

⁶ Anthony Furse, Wilfrid Freeman, (Staplehurst, UK: Spellmount Ltd, 2001) 95, footnote*.

⁷ Terraine, *The Right of the Line*, 44-45.

⁸ TNA AIR 2/673 S32201 Encl 1A, dated 22 December 1932.

⁹ TNA AIR 2/8875, S35818 Part I, E6b, Minute 1, dated 5 June 1935.

¹⁰ TNA AIR 2/1950 S39818, Minute 11 dated 11 December 1936.

¹¹ Harford Montgomery-Hyde, *British Air Policy between the Wars 1918-1939* (London: Heinemann, 1976), Malcolm Smith, *British Air Strategy between the Wars* (Oxford: Clarendon Press, 1984), Tami Davis Biddle, *Rhetoric and Reality in Air Warfare, The Evolution of British and American Ideas about Strategic Bombing, 1914-1945* (Princeton: Princeton University Press, 2002); Terraine, *The Right of the Line*; Dennis Richards, 'Royal Air Force 1939-45, Vol 1, The Fight at Odds' (London: HMSO, 1974).

¹² Asher Lee, *Goering Air Leader* (London: Duckworth, 1972), 60-61 and Overy, *Goering Hitler's Iron Knight*, 93, 106-107.

¹³ David Edgerton, *England and the Aeroplane: Militarism, Modernity and Machines* (London: Penguin Books, 2013) 66-69, 171.

¹⁴ Terraine, *Right of the Line*, 16-17.

¹⁵ TNA AIR 2/673 S32201 – War Organization of the Air Ministry – Sir R Brooke-Popham's Report Minute Sheet attached to E2.

¹⁶ *Ibid.*, M10, dated 29 June 1933, Minute from CAS to DCAS.

¹⁷ TNA AIR 2/8875, S35818 Part I, E6b, Minute 1, dated 5 June 1935.

¹⁸ *Ibid.*, Minute 3, dated 12 July 1935.

¹⁹ *Ibid.*, Welsh's Paper entitled Memorandum by D of O on the Organization of the home Commands – 1935 Expansion Scheme C, is filed as E1A, dated 19 June 1935.

²⁰ *Ibid.*, Minute 3, dated 12 July 1935.

²¹ TNA AIR 2/1950 S39818 Control of Bomber and Fighter Commands in Time of War, Minute 11, dated 11 December 1936. The DCAS was also Director of Intelligence at this point.

²² *Ibid.*, E 1A, 2A dated 16 November 1936.

²³ Winston S Churchill, *The Second World War Vols I-VI* (London: Cassell and Co Ltd, 1948), David Reynolds, *In Command of History – Churchill Fighting and Writing the Second World War* (London: Penguin, 2004) and Frederick Woods, *Artillery of Words – The Writings of Sir Winston Churchill* (London: Leo Cooper, 1992) all show the impact Churchill's narrative has had on shaping the development of the historiography of the SWW and the preparations made in the 1930s.

²⁴ TNA AIR 2/1950 S39818 E 8A dated 25 November 1936.

²⁵ *Ibid.*, E 5A dated 20 November 1936.

²⁶ TNA AIR 2/8875, S35818, E 6c, dated 18 July 1935.

²⁷ *Ibid.*

²⁸ TNA AIR 2/1950 S39818, E 9A dated 1 December 1936.

²⁹ *Ibid.*, E 9A dated 1 December 1936.

³⁰ TNA AIR 2/8875, S35818, Min 19, dated 4 October 1935.

³¹ Montgomery-Hyde, *British Air Policy*, 494.

³² TNA AIR 2/8875, S35818, Min 19, dated 4 October 1935.

³³ *Ibid.*, Min 19, dated 4 October 1935.

³⁴ *Ibid.*, Min 20, dated 8 October 1935.

³⁵ TNA AIR 2/673 S32201 M22, dated 11 December 1933 - Minute from CAS to Sof S

Lord Londonderry.

³⁶ Ibid., M25, dated 12 December 1933 - Minute from SofS to CAS.

³⁷ TNA AIR 2/8875, S35818, Loose leaf copy of letter to Lord Wigram from S of S, dated 12 December 1935.

³⁸ *Air Force List*, January 1935.

³⁹ AIR 2/8875, S35818, E 30a, dated 15 January 1936.

⁴⁰ Ibid., E 30c, dated 29 January 1936.

⁴¹ Ibid., E 30d, dated 1 February 1936.

⁴² Ibid.

⁴³ Ibid., E 30b, dated 20 January 1936.

⁴⁴ John Arthur Cross, 'Lord Swinton' (Oxford: Clarendon Press, 1982) p. 150. Cross records that Swinton's relationship with Ellington was 'never close' and that he found Dowding 'prickly'. On the other hand, Cross records that 'he had high regards' for Newall, whom he first met in January 1934 when on his East African tour as Colonial Secretary.

⁴⁵ TNA AIR 2/1950 S39818, M 27 dated 15 April 1937.

⁴⁶ Ibid., E28D dated 19 April 1937.

⁴⁷ TNA CAB 54/3/1, 22nd Meeting of the DCOS Committee of the COS Committee dated 15 October 1937, and TNA AIR 9/81 E7 dated 15 October 1937.

⁴⁸ Ibid., E7 dated 15 October 1937.

⁴⁹ Ibid., E7 dated 15 October 1937.

⁵⁰ TNA ADM 1/4, Letter to Sir Maurice Hankey from DCNS Sir William James RN dated 18 October 1937.

⁵¹ Ibid., DCNS to DCAS, dated 21 October 1937.

⁵² TNA AIR 9/81, E11 dated 23 October 1937.

⁵³ TNA AIR 2/1950 S39818, E28D dated 19 April 1937.

⁵⁴ TNA ADM 1 and TNA AIR 9/81, E13 dated 13 November 1937, DCNS Paper to DCOS colleagues, Operational Control in War, dated 11 November 1937.

⁵⁵ Ibid., dated 11 November 1937.

⁵⁶ HC Deb 21 February 1918, vol.103,c.959; and TNA AIR 8/1354 - Chiefs of Staff Relationship with HMG dated 24 February 1936.

⁵⁷ TNA AIR 9/81, E14, Co-ordination of Higher Control of Operations by the Three Services in time of War and the Organization of the Higher Command of the Royal Air Force, dated 29 November 1937.

⁵⁸ Ibid., dated 29 November 1937.

⁵⁹ TNA CAB 54/1/7, DCOS 21st-23rd Meeting, dated 14 December 1937.

⁶⁰ Ibid., dated 14 December 1937.

⁶¹ Ibid., E25 and 26 dated 3 March 1938.

⁶² TNA CAB 54/4/4 DCOS 57 The Co-ordination and Control of Defence Operations in a War against Germany, dated 1 March 1938.

⁶³ TNA CAB 53/38/3 CID, Memorandum by the Chiefs of Staff Sub-Committee, CID 1425-B, The Co-Ordination and Control of Defence Operations, dated 29 April 1938.

⁶⁴ TNA CAB 54/4/6 CID, Report by the Deputy Chiefs of Staff Sub-Committee of the Chiefs of

Staff Committee, DCOS 68, The Co-Ordination and Control of Defence Operations, dated 22 April 1939.

⁶⁵ Ibid.

⁶⁶ TNA CAB 65/1/1 War Cabinet 1 (39) - Meeting held at 5pm Sunday 3rd September 1939, dated 3 September 1939.

⁶⁷ Ibid., para 1(a) dated 3 September 1939.

⁶⁸ Sir Hew Strachan, *The Direction of War Contemporary Strategy in Historical Perspective* (Cambridge: Cambridge University Press, 2013), 12.

⁶⁹ TNA AIR 9/81 E32 and 33 dated 14 October 1938.

⁷⁰ TNA AIR 2/1950 S39818, M14 dated 3 March 1937.

⁷¹ TNA AIR 2/3155 CAS War Conference Minutes of Meetings, Final Minutes of the 1st Meeting held on 2nd September 1939, dated 2 September 1939.

⁷² Air Ministry Handbook, *Department of the Chief of the Air Staff - List of Staff and Distribution of Duties*.

⁷³ *Air Force List*, September 1939.

⁷⁴ *Air Force List*, January 1939.

⁷⁵ TNA AIR 2/673 S32201 – War Organization of the Air Ministry – Sir R Brooke-Popham's Report Minute Sheet attached to E2.

⁷⁶ TNA AIR 2/8875, S35818 Part I, E6b, Minute 1 dated 5 June 1935.

⁷⁷ Ibid., E 7a dated 22 July 1935.

⁷⁸ TNA CAB 24/22/58, Second Smuts Report, dated 17 August 1917.

Article

The Man and the Myth – Robert Smith-Barry as ‘The Man Who Taught the World to Fly’

By Dr David Spruce

Biography: After twenty-five years in senior roles in industry and commerce, David gained a Master's degree with Distinction in *Britain and the First World War* in 2020. His MA thesis focussed on the development of the Royal Flying Corps (RFC) in 1914 and 1915. He continued his research into the RFC and was awarded a PhD for his thesis on the recruitment and training of the Corps this year. Both his MA and PhD research have been awarded academic prizes by the RAF Museum.

Abstract: Today, the Smith-Barry Academy is a training facility within the Central Flying School of the Royal Air Force (RAF). Based in the Trenchard Building at RAF Cranwell, the academy is responsible for researching new training methodologies. That Marshal of the RAF Sir Hugh Trenchard (later Lord Trenchard) and Robert Smith-Barry's names are enshrined together within the same institution today has a certain irony. Though both men are intrinsic to the history of pilot training, their relationship, as will be shown, eventually reaches a breaking point. This article will investigate how Smith-Barry's reputation in the RAF was created, examine his First World War experience and opine on the extent to which his prestige is deserved.

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Introduction

In 2014, a blue plaque was unveiled at Gosport, celebrating the contribution of Robert Smith-Barry to flying training development. The British Broadcasting Corporation's (BBC) account of the event included several assertions that chime in today's historiography of the Royal Flying Corps (RFC) during the First World War. Amongst them was the claim that more than half of pilots died in training until Smith-Barry created a system that 'increased the chances of survival'.¹ Smith-Barry 'invented the Gosport Tube'. He 'revolutionised the system and wrote the first flying training manual', and finally, 'He was described by Lord Trenchard as the 'man who taught the air forces of the world to fly''. My new research proves these assertions to be false. This article will focus on how Smith-Barry gained his reputation, and by exploring his service during both world wars, place his contribution in context and opine on whether his reputation is justified.

The Creation of a Reputation

Smith-Barry's moniker as 'the man who taught the world to fly' has become generally accepted by aviation historiography. As the BBC suggested, purportedly, it was Sir Hugh Trenchard himself who gave Smith-Barry this title. However, this research has been able to find no direct evidence that this was the case, and believes it more likely that the comment was attributed to Trenchard by C.G. Grey, the influential but controversial editor of *Aeroplane Magazine*.² Grey made similar assertions on many occasions, such as at a 1938 Gosport Reunion Dinner when he also claimed 'the fact that the Gosport System was worldwide was the greatest monument to Smith-Barry'.³ Grey remained a staunch advocate and would later claim in his magazine after the Second World War that Smith-Barry 'landed a Blenheim on an impossible field when his engine quit on him'.⁴ This interesting interpretation of Smith-Barry's accident will be investigated later.

The first use of the 'man who taught the world to fly' description appeared in the press in May 1940. On the 1st and 2nd of that month, a few newspapers ran a piece entitled, 'Father of Flying Training'.⁵ In it, Smith-Barry was described as 'genial, bearded, powerfully built [...] and now 54 years old'.⁶ The timing of this article was no coincidence. Smith-Barry was at this stage determined to be involved in training during the Second World War, and the timing of the article coincides with the height of his efforts. Aside from this, other references are hard to come by. When Trenchard wrote a foreword about training in a 40th Anniversary celebratory book for the Central Flying School (CFS) in 1952, he did not mention Smith-Barry at all in his introductory words.⁷ Even amongst family members, there was some confusion about where the term emanated. In 1950, for example, Smith-Barry's cousin claimed, 'Sir John Salmond told me recently he 'did more than anyone else to teach the world how to fly''.⁸ In the Press, the only other significant mention of Smith-Barry before his death in 1949 was concerning his tax affairs, disputes over which landed him in the High Court.

Former pilots also make little or no mention of him. Gwilym Lewis, in his diary, detailed significant improvements that were made in ground-based and in-flight training but did

not mention Smith-Barry.⁹ Sholto Douglas, who is passionate and articulate regarding his view of training, is the same. Ditto Cecil Lewis and countless others. An interesting illustration that Smith-Barry was not widely renowned can be found in the two autobiographies of Norman Macmillan. Macmillan attended the Gosport school as a pupil, so one would imagine he was well-placed to comment on Smith-Barry. However, it is notable that he does not seem to have known for sure who was responsible for the school. In his 1929 memoir, he wrote that 'I flew to Gosport to the Special School of Flying, commanded, and I believe originated, by Lieutenant Colonel (Lt Col) Smith-Barry.'¹⁰ Macmillan reissued his memoir forty years later, a very different acerbic version to fit in with the style of First World War memoirs at this time. In this 1969 re-write, any doubts about Smith-Barry's contribution had gone. Macmillan now declared, 'The man who created this – Lt Col Smith-Barry was a genius. He believed in short hours and concentrated work.'¹¹ There is a good reason why Macmillan's memory had improved by 1969. By then, efforts had been underway for as many as a dozen years by Smith-Barry supporters to create a new version of his achievements. Macmillan himself had been approached as a potential author. The seeds for this work, first planted in 1957, would eventually blossom into Frank Tredrey's book, *Pioneer Pilot: The Great Smith Barry who Taught the World How to Fly*, nearly twenty years later. This book has become the source of information on flying training and is widely quoted by historians - good and bad - today.

Smith-Barry may have fallen from the limelight after the Second World War, but his reputation was partially cemented not long after the Great War ended in 1918. The official history of the war in the air spawned six volumes between 1928 and 1937, and sections on training commend Smith-Barry's methods and achievements. This research has traced the source of these sections predominantly to a 1919 memorandum from Ewan Gilchrist entitled, '*Report by Captain Gilchrist on the Special School of Flying, Gosport*'.¹² Cape Town-born Gilchrist was not an impartial observer. He had served under Smith-Barry in No.60 Squadron between July and December 1916 before being seriously injured in a crash that left him unable to fly until August of the following year. During this period, Smith-Barry stayed in regular contact and promised Gilchrist a role as an instructor at the newly formed School of Special Flying, a promise he duly delivered on. The two later became close friends. Gilchrist wrote of Smith-Barry: 'Perhaps the feature that was the most striking about Gosport - very carefully fostered by Smith-Barry, who was in this respect a great leader - was the high flying 'moral' that formed the atmosphere of all the school's activities. We not only were charmed by Smith-Barry's very strong personality; we admired his audacity in the air, and I think I should be upheld unanimously in my statement by all the instructors - and quite unquestionably by the first half dozen to be appointed when I say that the driving force of our efforts - was the desire to please Smith-Barry.'¹³ Other Gilchrist comments were not included in the history, such as: 'For the rest, one's memory consists of living in great luxury at a private house we took about 3 miles from the aerodrome and of quite furious and infinitely dangerous 'stink-bike' races down to the aerodrome or back that we used to have every day.'¹⁴

The affection and loyalty to Smith-Barry, whilst genuine, are essential in understanding the creation of his legacy. His unorthodox methods drew men in. Smith-Barry had an aura of a maverick that some subordinates found attractive. It is important to note that some senior figures close to training also give Smith-Barry credit. Guy Livingston, Sir John Salmond's Chief of Staff, for example, stated in his memoir that Smith-Barry: 'Evolved a system of training so superior to that which existed before that the standard of pilots of the RFC was so immeasurably superior to that produced under the old system that the RFC rapidly regained its superiority over the Germans.' Sir William Sefton Brancker,¹⁵ Deputy Director-General of Military Aeronautics, writing before he died in 1930, recalled: 'I do remember the extraordinary work done by Major Smith-Barry at Gosport [...]. We established a school for the training of instructors under Smith-Barry [...], from which was evolved the famous Gosport system of training; it completely revolutionised our old hide-bound and slow methods; it made training far safer and more thorough.'¹⁶

Even Andrew Boyle, Trenchard's biographer, writing six years after his subject's death, described 'the great Smith-Barry, who contributed more to the art of airmanship as a result than any other pilot on earth.' That said, perhaps Boyle's description of Smith-Barry as an 'opinionated individualist' is equally deserved, as will be shown.¹⁷

The Writing of Frank Tredrey's Book

Smith-Barry's current reputation is built not on the comments of those above, but rather on the work of former RAF Group Captain Frank Tredrey. It is his book, after all, that contains the famous quote attributed to Trenchard on the title page. It is an important work because it has become the de facto story of Smith-Barry's career and used by just about every air historian since.¹⁸ Tredrey claimed that he leaned heavily on a short memoir by Sidney Parker. Parker, a former No.60 Squadron pilot and friend of Smith-Barry, later succeeded him at the School of Special Flying. Writing in 1964, he stated: 'There has been a lot of nonsense written about Smith-Barry and a lot of sense that has not been written [...], and it is with the object of doing some small measure of justice to this great man that this screed is being written.'¹⁹

The construction of Tredrey's book is, however, more interesting than this. Tredrey's work can be reconstructed from private letters, which to his credit, he left with the RAF Museum. The book was built by a small group of Smith-Barry's friends and fellow No.60 Squadron officers, led by Canadian Duncan Bell-Irving. Bell-Irving's support for a project is demonstrated by a presentation he made to the Royal Canadian Air Club Association in the 1950s, during which he said that Smith-Barry: 'Produced practically all the great pilots in the last years of the war [and] if it had not been for him, the Allies would have very probably been beaten in the air, which would have meant losing command of communications, and eventually the war.'²⁰ This hyperbole is rendered even more astonishing when Smith-Barry's surprisingly short tenure is considered, as we shall see.

Work for a potential book began in May 1958, nine years after Smith-Barry's death, when Bell-Irving reached out to his widow Anne. Bell-Irving had been a pilot in No.60 Squadron in 1916

and was brought to Gosport as a Flight Commander when Smith-Barry took over No.1 Reserve Squadron in 1917. In a letter to Anne, Bell-Irving articulates the idea of a book for the first time: 'At this late date, some of 'Smith-B's' old friends have come around to the idea that something should be done to recall to posterity the very great contribution to aviation and to the first war victory of the Allies made by Bob Smith-Barry.'²¹

Bell-Irving continued why he believed the project was necessary in what became the essential *raison d'être* for Tredrey's later book. It is worth quoting in full: 'The broad basis of our thinking is that Bob was purposely and designedly side-tracked and submerged by various of his Service seniors by reason of his personal brilliance: that in comparison with sundry regular officers whom we have been invited to recognise as Air Force pioneers and also many 'star-turn' air heroes, the great name of Smith Barry is in grave danger of being forgotten!... 'We think of him as the man who revolutionised flying training and flying technique, and in doing so, in the face of the strongest opposition of many lesser men, made the difference which enabled us to win the war: possibly both wars!...' 'We think, too, of how near Smith-B came to the top-most Air Force command and of the machinations which lost him the appointment.'²²

Smith-Barry's story then, according to Bell-Irving, was not simply a tale of improving flying technique but a rather more intriguing one of a man against the system. Soon after his contact with Anne Smith-Barry, in June 1958, Bell-Irving approached author Quentin Russell about writing the book for them. In colourful language, Bell-Irving suggested: 'The man who won the first war in the air, and had a remarkable influence on winning it in the second, was the Irish nonconformist R.R. 'Bob' Smith-Barry. He was [...] designedly 'shot down' and pushed into Air Force oblivion by lesser men of the Regular Soldier variety. Even Boom Trenchard did less for the RAF than Smith-Barry: yet who hears of Smith-Barry now?'²³

Anne had been consulted on the choice of author and opined that: 'I feel it should be somebody with discretion as to the use of the papers. They may be libellous, particularly Bob's paraphrase - not sent - answer to Portal.'²⁴

The letter that Smith-Barry wrote but never sent occurred after Sir Charles 'Peter' Portal rejected his training proposal in 1939 – a rejection that will be discussed later. Portal was one of those approached by Parker and Bell-Irving to take part in their Smith-Barry venture but replied on 23 July 1958 that: 'I am sorry to have to tell you, however, that I don't think I ever wrote to him or had a letter from him in my life: my time in (No.) 60 Squadron was very short, and I left Gosport with the Squadron in early May '16 and never returned there.'²⁵

This is demonstrably untrue, and perhaps due to discretion or disdain, Portal wanted no part in the work. When informed of Portal's comments, Anne Smith-Barry told Bell-Irving: 'Lord Portal certainly did write to Bob as he showed me his letters at the beginning of the war - they were always most tactful and conciliatory but **not** helpful. Presently you will see a copy of what Bob

wrote to him, also what he **would like** to have written but didn't send.²⁶ Whatever Smith-Barry would have liked to say remains hidden. Anne must have thought twice about sending it, as it is not in Bell-Irving or Tredrey's file.

Other No.60 Squadron men were approached, as well as selected others whom Bell-Irving hoped would be sympathetic to the story. Parker, Bell-Irving and a third former No.60 Squadron pilot, Stanley Vincent, were careful in selecting whom they approached, choosing not to make contact if they perceived forthcoming comments might be negative. Vincent committed to contacting Sir John Salmond, who, as head of the Training Division, one would have thought would have been an essential witness. However, there is no record of him doing so, and nothing from Salmond ever made its way to Tredrey. This approach led to a narrow, one-sided tale of Smith-Barry's role.

By 1959, Bell-Irving had received several rejections from authors, including Russell and MacMillan as well as another former RFC man turned author Arch Whitehouse. Vincent also approached John Taylor, who had just released his book, *C.F.S. Birthplace of Air Power*. Vincent had provided material for Taylor and told Bell-Irving that Taylor's work 'does, in fact, give considerable credit to Smith B (a good deal of it owing to me!)'²⁷ At this stage, having tried and failed to find an author, Bell-Irving was forced to conclude that his project was dead. That was until Air Chief Marshal Sir James Robb saw an advertisement in *Aeroplane Magazine* in 1961. Robb had dealt with Smith-Barry in the Second World War.

The advertisement placed by Frank Tredrey was seeking information on the career of Smith-Barry. It would take Tredrey until the summer of 1962 to discover, having also contacted Anne Smith-Barry, that Bell-Irving had made initial approaches. Before handing over his material, Bell-Irving sought assurances from Tredrey that the materials would be used 'responsibly.' In discussing his progress, Bell-Irving told Tredrey: 'Some were quite interested [...] Some are disinterested: the late 'Boom' Trenchard and Smith-Barry did not see eye to eye, and Lord Rothermere resigned rather than take sides with Smith-Barry against Trenchard and the established scheme of things.'²⁸

Tredrey continued his research but found fewer records than he would have liked or expected. Firstly, he found that nothing remained from Smith-Barry's tenure at the School of Special Flying. In February 1965, a frustrated Tredrey wrote to Bell-Irving: 'Part of my struggle in collecting material about him has been because he seemed to burn everything, lose it or otherwise dispose of it whenever he left a station. The vital records of Gosport, HQ Training Brigade York, No.60 Squadron in 1916 - all are missing from the official archives. And finally, his private papers were 'lost in a flood' at Durban.'²⁹

In the meantime, Robb provided Tredrey with a copy of Scott's No. 60 Squadron history and some of his personal correspondence.³⁰ Tredrey notes the conflicting nature of accounts. Was he a good pilot or a poor one? Hands-on or absent? Misunderstood or a schemer?

These contradictions, plus a dearth of official material, led to Tredrey writing to Robb in November 1962 to say that he was to make another effort to find the truth in the archives before starting work on the book in 1963. In the event, Duncan Bell-Irving would die in 1965, James Robb in 1968 and Anne Smith-Barry in 1969. None would see Tredrey's book, which would not be released until 1976.

Robert Smith-Barry's First World War

Robert Raymond Smith-Barry was born in London on 4 April 1886. He was the only child of James Hugh Smith-Barry and Lady Charlotte Cole, the daughter of the Earl of Enniskillen, with both families descended from the Irish gentry. The young Robert had all the opportunities his class brought him but he failed to seize them fully. As with many other early officers of the RFC, family connections allowed an easy passage for him into Eton. Showing problems with authority that would dog his career, he was expelled, 'your son we can do nothing for, he is idle and appears to take no interest in the subjects before him', his tutor allegedly told his father.³¹

James Smith-Barry hired a private tutor for his son and sought a place for him at Cambridge University. Some historians claim that Smith-Barry attended but failed to complete his degree, while others state he failed his entrance exams.³² Either way, Smith-Barry had failed to show sufficient prowess to complete his studies. He returned to his family home in London and was allowed to pursue a passion for the piano, which he was said to have mastered. His father found him a position in the diplomatic service in Istanbul, but again his son showed no gumption and soon returned home. It was then that his parents paid for him to take flying lessons. Finally, Smith-Barry had found his vocation, securing Royal Aero Club certificate number 161 on 28 November 1911 at the Bristol Flying School. Pre-war Smith-Barry spent some time as a civilian instructor before joining the new Royal Flying Corps as a Second Lieutenant (2/Lt) in the Special Reserve in October 1912. A week later he started the first RFC course at the new Central Flying School.

It is intriguing to wonder whether the conflicts that Smith-Barry would create later in his career originated in this early period. He came from a wealthy family but had squandered many of the advantages his class had given him. Now he found himself in the RFC, very much a minority. He was good enough to be selected among the first 101 officers sent to France in August 1914, but he was one of just ten from the Special Reserve, that is recruited from a civilian background. The other men were all former army officers and lacking a military background, the transition to army life, albeit in a new and in many ways different service like the RFC, must have been challenging for Smith-Barry.³³

Smith-Barry's initial war in France lasted just a few days. On 18 August, near Peronne in the Somme region of France, Smith-Barry's BE8 was wrecked in an accident which killed his observer Corporal Fred Geard.³⁴ The crash resulted in a lengthy hospital stay for Smith-Barry, and it was March 1915 before he could fly again at Brooklands. He then spent over a year in

various training squadrons, eventually being promoted to Flight Commander. It was not until 10 May 1916 that Smith-Barry joined No.60 Squadron as one of three flight commanders under Major 'Ferdie' Waldon. The Squadron left for France on 25 May 1916, and following the death of Waldon in early July, Smith-Barry was promoted to command the squadron. After 192 days in France with No.60 Squadron, he returned to England to head No.1 Reserve Squadron on 29 December 1916.³⁵ By comparison, having spent 460 days in training positions, it is perhaps strange that he later declared training was 'left to those who were resting, those who were preparing to go overseas, and those who had shown themselves useless for anything else.'³⁶

We know from Smith-Barry's service record that he became commander of the new School of Special Flying for instructors at the beginning of August 1917, by which time he had experimented with his methods on only approximately sixty students. Tredrey claims that on the first course at the new school, only two of the men 'had flown as observers.' The rest, he said, were regimental officers from the School of Aeronautics at Reading and had not yet been in the air.³⁷ Tredrey may have been spun a yarn by Smith-Barry's acolytes, as from archival files, in Smith-Barry's own words, 'twelve of the thirteen are Observers so that there was somewhat better material to work with than the average.'³⁸ Divisional Command asked for details of the outcome of this course and thus, the men whose training hours and progress were sent were the pick of trainees, quite unlike the men Tredrey mentions in his book.

In his reminiscences of his experiences at the school, Gilchrist claimed: 'One of the ways in which we used to flatter ourselves was by training pilots who had been turned down as useless and incapable of flying from the training schools, and with these, we had few failures.'³⁹ The assertion that poor flyers were sent to the school runs contrary to all other evidence. Throughout the war and at all stages of flying training, instructors were encouraged to weed out those incapable – there were few second chances. In planning, the RFC and RAF both assumed 25 to 30 percent attrition. In fact, Smith-Barry himself wrote of his course, 'In 16 weeks work it has been found necessary to remove 45 per cent of the pupils from Maurice Farman Squadrons, and 5 per cent of those from Higher Training Squadrons. This has not been enough. I should certainly have got rid of more, i.e. have set a better standard.'⁴⁰ Finally, Gilchrist's claim that the cream of the flying training schools would take in 'useless and incapable' flyers is simply unimaginable.⁴¹

In May 1917, Smith-Barry articulated his early thoughts based on his experience at No.1 Reserve Squadron.⁴² He acknowledged that 'some may think them heterodox, but most, it is thought, will consider them quite normal, and indeed rather old fashioned.'⁴³ In the document, Smith-Barry stressed the importance of dual control and an important change to current practice: at least half of the dual control instruction should occur after 'the pupil has gone off alone.' In other words, this was the sensible recognition that a pupil should return to his instructor after attempting manoeuvres himself to remove any bad habits that might have been picked up in practice. While Smith-Barry believed his school would train men to fly, it was only a month after the school's approval that Brigadier General Charlton, the Director

of Air Organisation, announced a new purpose for the school. In what Charlton called 'super training', the School would now focus solely on a new important activity, the instruction of instructors.⁴⁴

Interestingly if, as Tredrey claims, Smith-Barry's methods were 'immediately accepted' as the new basis for teaching, it was not until October 1917 that some five hundred copies of his notes were distributed to other training squadrons.⁴⁵ As well as ordering this distribution of the Gosport methods, Salmond also ordered that all new instructors should be trained in them going forward. Additionally, existing instructors would be required to do refresher courses at Gosport, and veteran Gosport instructors should visit other pilot-training units to check on methods and standards.⁴⁶ Instructors were told to let advanced pupils: 'fly exactly as they chose, their experiments being limited only by the state of their own nerve.' Instruction entailed teaching: 'Pupils by means of dual control how to get out of all the various difficulties which one may get into in flying. The object has not been to prevent flyers from getting into difficulties or dangers but to show them how to get out of them satisfactorily and, having done so, to make them go and repeat the process alone.'⁴⁷ In his distinctive style, Smith-Barry noted, 'If the pupil considers this dangerous let him find some alternative employment, as whatever risks he has been asked to run here, he will have to run 100 times as many when he gets to France.'⁴⁸

Thus, some of Smith-Barry's ideas had had an impact.⁴⁹ At this stage, Smith-Barry's star seemed to be in the ascendant. His methods were accepted for instructors, and plans were afoot to make the school a specialist instructor's academy. However, this was not to Smith-Barry's liking, and within just a few short months, he had been marginalised. The bald facts from his service record are that on 23 January 1918, he was promoted to head the Northern Training Brigade. At some point, he returned to Gosport and from there, on 21 May 1918, he was sent to America.⁵⁰ At face value, this seems like a reasonable progression and certain No.60 Squadron acolytes of Smith-Barry claim that he was indeed promoted. Parker states, 'Changes were now taking place in Smith-Barry's career, and he was shortly afterwards promoted to Brigadier General and moved to NE Group.'⁵¹ Given this, why would historian Dennis Winter claim in *First of the Few* that 'the RAF [sought] to get rid of him and ignore his achievements as soon as it decently could'?⁵²

The truth can be pieced together from several different sources and is quite different to both Parker's and Winter's versions. Things started to turn for Smith-Barry in October 1917 when his commanding officer Salmond moved from the Training Division to London to become Director General of Air Organisation.⁵³ While there is no evidence of a close relationship between Smith-Barry and Salmond, Salmond had trusted the maverick in Smith-Barry to put his ideas into practice. Salmond was to be joined in London by Livingston, and their successors in the Training Division were Edgar Ludlow-Hewitt and Charles Longcroft. Smith-Barry likely saw Ludlow-Hewitt as a peer rather than a commanding officer. Both had been pilots in the fledgling RFC when it was sent to France in August 1914. Longcroft too, was not someone with

whom Smith-Barry would have a natural affinity. Sandhurst graduated and an Army officer since 1903, he had joined the Air Battalion at the first opportunity in 1911 before moving to the RFC when it formed. He had risen through the ranks commanding squadrons, wings and then brigades. He, therefore, had significant experience in managing large organisations and was well suited to head the training organisation.

On 9 November 1917, Smith-Barry issued a report on French flying schools and potential personnel savings that could be affected.⁵⁴ Why he was instructed to head to France is not definitively known, but given Salmond's desire to drive efficiencies in the organisation, this was likely a fact-finding mission to aid comparisons. On his return, Smith-Barry submitted a lengthy but rather confused document. Initially, he extolled the virtues of the larger French schools. 'At Pau', he said, 'no new machines are received and [...]none are struck off charge however badly they may be damaged'. All machines, he claimed, were repaired by mechanics on-site.⁵⁵ However, then he turned to French techniques. 'The flying', he said, 'is of a very second-rate character, and the moral of both instructors and pupils could not possibly be worse. Pupils are on this account, reluctant to go there'. Having also ridiculed French efforts at aerobatics, he stated that 'the aeroplanes appeared to be being smashed at an astounding rate. Every landing was a matter of the gravest anxiety'. With no underlying data, he then claimed that the French suffered 12.5 per cent of their machines smashed per diem, the Training Brigade in Britain almost 10 per cent, and his Gosport school just 3 per cent. Thus he said, 'the French at Pau have to cope with four times as many smashes per machine as I do here, despite the risky experiments that are being made'.⁵⁶ Smith-Barry neglected to mention that his French and British statistics, even if true, would have been based on 1,000s of machines, his Gosport comparable was based on just twelve.

Even though Smith-Barry was presumably also to investigate French teaching methods, he saw no need. He arrogantly proclaimed, 'Owing to this marked inferiority in the French flying, I did not enquire too closely into the methods of teaching or the output of pilots'. Smith-Barry then made a rather large leap to his conclusion. 'Therefore, if we could abolish wings and squadrons and create large schools by uniting several aerodromes under one head and running them as one unit with a single main workshop', significant efficiencies in manpower and machines could be achieved. His calculations of a possible 50 per cent saving were based more on creative mathematics than any weight of evidence.⁵⁷

Smith-Barry did not wait for a reply and, on 14 December 1917, issued a second paper, this time nakedly entitled *Report on Proposed Large Flying Schools from Gosport*. Now, he set his sights on commanding the larger flying school and taking over all ground instruction from the long-established Schools of Military Aeronautics, which would be abolished. He claimed that despite his instructors working no more than a maximum of one and a half hours per day, his pilots could be ready for France in half the time of other training establishments. Based on only three months of data and having taken in the ablest recruits, such claims were contentious, to say the least.

In remarks unlikely to endear him to fellow members of the Training Division or its Commanders, he stated: 'The present arrangements [in Britain] are so chaotic, even if I were to enter upon a long description of them, it would be very difficult to say precisely what the proposed scheme or any other partial scheme would replace. [...] It would need too much space to criticise [the Training Divisions' aircraft requirements and length of training courses]. I leave it, therefore, to be its own criticism.'⁵⁸

No official response to Smith-Barry's proposals can be found in archival files. Wiser, more experienced training figures were likely unmoved by his proposal. Indeed, Brigadier General Ludlow-Hewitt chaired a second conference of 'Officers Concerned with the Training of Pilots in the RFC' at the Air Board Office of the Ministry not long after Smith-Barry's proposal. It is telling that Smith-Barry was not invited to the sessions during which his proposals were not discussed.⁵⁹

The report ignored, Smith-Barry's indignation would have been amplified on 6 January 1918, when his school was 'demoted' back into the Training Organisation alongside other schools. Henceforth it would be administered by the Southern Training Brigade and not by the Training Brigade HQ directly.⁶⁰ On 27 January, Smith-Barry was told he would leave Gosport to take command of the Northern Training Brigade at York. Soon afterwards, in early February, George Philippi, one of Smith-Barry's closest friends and another No.60 Squadron pilot, moved to the Air Ministry. Philippi had spent much of 1917 unfit for flying, having been wounded and was now made the Personal Secretary to the first Air Minister, Lord Rothermere.⁶¹

Smith-Barry used his time in York not to take forward Northern Training Brigade but to scheme for a more prominent role for himself in London. What is clear from archival files and many other accounts is that Smith-Barry reached out directly to Rothermere at the Ministry. The communication was uncovered, and on 6 February, Smith-Barry was formally reprimanded. Tredrey quotes Longcroft's letter stating: 'It is noticed that you are in the habit of communicating directly with the Air Ministry. Your attention is directed to the King's Regulations, para. 445, which clearly lays down that this procedure is illegal. Under no circumstances, therefore, will you communicate directly with the Air Board either by letter or by telephone, nor will you visit the Air Board without first obtaining permission from this Headquarters.'⁶²

Parker claims that Smith-Barry had gone beyond writing letters and had visited Rothermere and, rather less convincingly, Prime Minister Lloyd George.⁶³ While the latter visit is almost certainly Smith-Barry bravado, Boyle writes that 'Longcroft began to receive a "daily barrage of petulant minutes' from no less a person than Rothermere.'⁶⁴ Longcroft confronted the minister to find him astonishingly well briefed on training losses at Gosport. Further, Rothermere made insinuations that Longcroft was not rolling out Gosport methods quickly enough. On learning what had happened, Longcroft was furious at being undermined in this manner and requested

a return to France. It would appear that at this point, Smith-Barry had convinced Rothermere that he should take over RFC training.

From his inside position at the Air Ministry, Philippi wrote on 8 March to Smith-Barry, 'I think we've got 'em by the short hairs at last. Don't make any moves at all until you see me again.'⁶⁵ Parker claims that Smith-Barry was recalled to London by Rothermere and that the two of them began planning a training overhaul. Lacking any self-awareness whatsoever, Parker wrote that Smith-Barry had decided: 'Trenchard was to go [...] Removing Trenchard from his command was the most difficult task SB had to cope with.'⁶⁶ While, with the benefit of hindsight, such a scheme sounds crazy, it is apparent that Smith-Barry genuinely believed it was happening.

At this stage, Ludlow-Hewitt discovered Smith-Barry back in London, apparently installed as Longcroft's replacement. Trenchard simultaneously heard from both Ludlow-Hewitt and Longcroft about what boiled down to a coup. While Trenchard could not appease Longcroft sufficiently for the latter to stay, he ordered Smith-Barry back to Gosport and confronted Rothermere. The Minister admitted that 'Smith-Barry had proposed several radical suggestions for the reorganisation of the Training Division in a series of private letters.'⁶⁷ Smith-Barry's temerity 'staggered Trenchard less than Rothermere's bland acknowledgement that he had encouraged the correspondence.'⁶⁸ As Parker put it naively: 'In establishing Gosport, it was necessary to win over the heads of the Flying Corps but to establish a fighting force, it was necessary to go much further, right over the heads of the Air Force Command to the Government itself.'⁶⁹

Clearly, these events soured the relationship between Trenchard and Rothermere, although, in truth, their relationship had already been seriously damaged due to differing opinions regarding the creation of an independent RAF. Trenchard used this issue as the proverbial straw that broke the camel's back and resigned, causing a military and political stir. When the dust settled, Trenchard would return to head the new Independent Force, a strategic bombing function, but the uproar cost Rothermere his job. With his political sponsor gone and trust amongst senior officers no doubt devastated, Smith-Barry was finished as a force in the new RAF.

While Smith-Barry's subsequent move to America was portrayed sympathetically as an opportunity for him to extol Gosport's methods there, even Parker referred to the move as 'Smith-Barry's exile to the USA.'⁷⁰ He recalled that 'Smith-Barry had to be removed. First, it was suggested that he be posted to far away Egypt, but then as America was showing great interest in the Gosport system, it was decided to 'exile' Smith-Barry and a small staff (including Philippi) to the USA and let them expound his theories to the Red Indians.'⁷¹ He was officially told of his move on 29 May 1918.⁷² There he would report to Brigadier General Charles Lee at the British Aviation Mission in Washington. Lee was a former Lt Col in the West Somerset Yeomanry but had been attached to the RFC since November 1914 and worked his way up

the Staff Officer ranks.⁷³ Smith-Barry's instructions were clear, as was his reporting line, which was reiterated to him. 'Your duties will be to assist and advise the American Aviation Service in regard to Flying Training, *always subject to the instructions given by Brigadier General Lee.*'⁷⁴

Smith-Barry would see out the war in America and be transferred to the unemployed list early in February 1919.

History Repeated: Smith-Barry and the Second World War

A very telling episode in the Second World War raises further questions about Smith-Barry's character and reputation, but perhaps more importantly, also casts doubt on the veracity of materials used to justify his contribution to First World War training. Shortly before the second war, in July 1939, Smith-Barry took an Instructors Course at Brooklands.⁷⁵ The course did not lead to an immediate role in the RAF, and he wrote to Commandant CFS, Group Captain James Robb begging him, 'In God's name, give me something to do, in uniform or out of it.'⁷⁶

Smith-Barry wrote to Robb again later the same month, enclosing two pamphlets he claimed were exact reprints with no further additions' of his materials from the First World War.⁷⁷ Robb, in turn, reached out to ex-No. 60 Squadron Harold Balfour, who was now Under-Secretary in the Air Ministry, stating, 'I received the attached yesterday from Colonel Smith-Barry, together with a private letter which makes it appear that he has not had very much good luck.'⁷⁸ Enclosed was a booklet entitled, '*Notes on Teaching Flying for the Instructors' Courses at No.1 Training Squadron, Gosport.* Several reasons suggest that Smith-Barry constructed this document for his 1939 proposal rather than it being an authentic document from 1917. He rather too neatly articulates almost all of the improvements throughout the School of Special Flying's life yet claimed it has been in operation for just '16 weeks'. Working backwards using Smith-Barry's timings implies a start date for the school of January 1917. While Smith-Barry returned to head No.1 Reserve Squadron at that time, the School of Special Flying was not approved until August 1917.⁷⁹ There is also the document's title, 'for the Instructors' Courses at No.1 Training Squadron' – there was no Instructor's Course at that time. Smith-Barry's pamphlet also claims, 'As both officers and men prefer to have the evenings free to any other part of the day, it has been made a rule here *during the summer months* to shut down every evening unless absolutely unavoidable.'⁸⁰ Such a claim is inconsistent with a document allegedly written in May, i.e. before the summer months.

Does any of this matter? At face value, such embellishments might seem trivial. However, such a re-writing of history matters for two reasons. Firstly, it was this retrospective document, along with two portraits, that was sent by Anne Smith-Barry to the CFS in 1950.⁸¹ Anne claimed that was all that remained of Smith-Barry's work.⁸² Air Commodore A.D. Selway, in a 1952 letter to Anne, stated, 'You know, of course, that Robert Smith-Barry is one of our household gods at CFS, and it is around his name more than any other that the tradition of the teaching of flying instruction revolves.'⁸³ The second reason is that Tredrey, and consequently, the historiography, has relied upon it as an authentic record of Smith-Barry's 1917 thinking.

The second pamphlet enclosed to Robb in 1939 was entitled '*School of Special Flying, Gosport. Results (Elementary Section), Miscellaneous Letters, c. November 1917*'. It contains eleven documents purported to have been written by Smith-Barry or his associates between November 1916 and November 1917.⁸⁴ Again, there are reasons to believe that this may be an edited edition of Smith-Barry's thinking despite the historiography also relying upon it. For example, he includes a document, 'Instruction of Scout and Other Pilots – Written in France, 10th November 1916,' which again rather too neatly articulates improvements that would later be made in training pilots. Curiously too, there is a footnote that reads, 'Added 21st November 1916 – On second thoughts, it appears to the writer that the best way to make use of the above principles would be to start a School for turning out Instructors in Flying, with the idea of all Instructors eventually going through it.' This research concludes that such uncanny foresight of what RFC leadership did a year later is staged. Smith-Barry's November 1916 memorandum survives in the National Archives and has no such addition adding further weight to evidence that this is retrospective.⁸⁵

Some of the documents included in the second pamphlet can be substantiated against archival sources, and the evidence Smith-Barry used to demonstrate the success of the Special School of Flying is one element that can be examined. His evidence is preposterously weak to substantiate claims that his school was producing miracles. First, it is for the period 3 September 1917 to 11 November 1917. In other words, barely two months. The results are for 'elementary' training only and take no account of higher training. Finally, the accompanying statement, 'none of these officers had flown in any Machine whatever, except some who had done so as Observers,' has already been proven false.⁸⁶

If there were any lingering doubts about when this material originated, there is no argument when a letter from Anne Smith-Barry to Bell-Irving of 4 September 1958 is considered. She indicates that she has mailed him copies of these two booklets. She states they are: 'The only things Bob said he had ever written about flying, also what he called his Puff Book with quotations about himself that he had printed. He did this in order to get a job in the last war.'⁸⁷ Tredrey placed absolute reliance on these documents in writing his book. In turn, Tredrey's book has become the source of almost all comments on training in the RFC during the First World War. The 'puff book' was sent to the CFS. Ultimately, a significant aspect of our understanding of First World War training has been built on documents created for Smith-Barry's job application in 1939.

From correspondence that year, it is clear that Balfour and Robb did ask Smith-Barry to send a proposal on training. While still in the process of constructing his proposal, the chances of it being a success were dealt a blow when his sponsor Robb was sent out to head training in Canada. Thanking Robb for his help, Smith-Barry wrote: 'I owe you a debt of gratitude for hospitably receiving me at the CFS and for all your help which has really started me going again. Without it, I should be on the bottom rung [...], and indeed, now you are gone, that is probably where I should find myself.'⁸⁸

Robb had attempted to coach Smith-Barry, advising him to submit a proposal for 'intermediate and advanced training' only. However, Smith-Barry ignored him and submitted a proposal that included all training. Smith-Barry's proposal, 'Memorandum on Flying Training,' was submitted on 10 October 1939.⁸⁹ The proposal is not dissimilar to Smith-Barry's 1917 submission on large flying schools. It is again long on 'statistics' and short on self-awareness. For a start, his data is 20 years old, and his proposals regarding efficiencies, even to the untrained eye, sound painfully naïve. However, Smith-Barry was pleased with it, and two days after submission, he wrote to Robb again thanking him for his assistance and enthusing, 'Balfour [...] was quite pleased with it and has forwarded it to Portal.'⁹⁰

Charles 'Peter' Portal had begun the First World War as a dispatch rider in the Royal Engineers and was commissioned in November 1914. Bored, he sought a transfer to the RFC in July 1915 as an observer. In early 1916 he began flying training, was appointed a pilot officer in April 1916 and in May, joined No.60 Squadron at a similar time to Smith-Barry. They departed for France together on 25 May 1916. Their time in the squadron together was, as Portal's earlier letter had said, relatively short, and in July 1916, Portal moved to become a Flight Commander in No.3 Squadron. Unlike Smith-Barry, Portal remained with the RAF and rose swiftly through operational and staff positions. In October 1939, when Smith-Barry's proposal landed on his desk, he was at the Air Ministry as Air Member for Personnel.⁹¹

Smith-Barry's proposal was already in trouble. Again, as in the previous war, this was entirely due to his own failings. The events are captured in his letter to Robb on 24 October 1939. He confirms to Robb that he submitted his proposal on the 10th but now calls it 'a very hurried inaccurate version.'⁹² It was forwarded to Portal the following day. Unsurprisingly, Portal forwarded it to other officers, no doubt for comment, including Arthur Longmore, who headed RAF Training Command and Lawrence Pattinson, who led No.23 Training Group, which included the Central Flying School. Smith-Barry had a series of uncomfortable meetings with the two of them. Leaving aside his questionable statistics, it transpired that in order to complete his proposal, Smith-Barry had made a series of unauthorised visits to Training Squadrons to obtain data. He had even written to Balfour directly and told him, 'I have obtained permission to visit several Flying Training Stations at each of which I have asked the same series of questions with a view to finding out what economies could really be made.'⁹³

Now Smith-Barry's lie had embarrassingly come home to roost. He had never been granted such permission, and it got worse. To obtain access to the squadrons, Smith-Barry claimed that his friend, Robb, heading the CFS at that time, had granted him the approval, even putting such in writing to Balfour. Robb leaving for Canada left Smith-Barry's subterfuge embarrassingly exposed. He apologised to Robb, telling him, 'I told him (which was the case) that though you and I had indeed discussed making such visits, it was unfortunate that I had darted off and made them without your final sanction' and that 'I hope no harm will come of my excess of zeal & of your hospitality'. Again, on the 26 October, he wrote to Robb, 'I say I hope

I did not let you in it with those dam'd visits.⁹⁴ He concluded, 'As to the thing being seriously taken up, I should think it's more than doubtful.'⁹⁵

On 23 November 1939, Smith-Barry met with 'Portal, Pattinson & another of Pattinson's rank and 18 or 20 others.'⁹⁶ The meeting must have been a sobering experience. His proposal was shot down in proverbial flames. They had, he said: 'Not the least difficulty in proving that an economy of 50 per cent in aeroplanes was impossible. Nor was it thought necessary to discuss the possibility of any lesser economy.'⁹⁷

Early in 1940, Smith-Barry wrote to Robb, not so much admitting defeat but blaming the recipients of his proposal for not appreciating it. He stated: 'As to my training schemes, though it would certainly be to the country's interest to carry them forward, I can think of no individual to whose personal interest it would be, so I think I've established a right to be left at peace in that quarter.'⁹⁸

In December 1942, Smith-Barry wrote of these 1939 events in a letter to Bell-Irving: 'Do you want a copy of the rubbish? [his report] There is one - Balfour had it on Oct 10, just before he left. He flung it at Portal's head and told him it was a masterpiece & he was to do something about it. Portal and Co saw at once on which side their bread was buttered & decided to drown the kitten. But as it was such a distinguished kitten, let it be drowned with a band playing.'⁹⁹

In the event, Smith-Barry joined the RAF in April 1940, not in any training capacity but as a ferry pilot. This activity was cut short by the previously mentioned October 1940 accident, which earned him a stay in the famous Guinea Pig Hospital in East Grinstead.¹⁰⁰ As suggested, even this accident was not what it seemed. While C.G. Grey wrote that 'he landed [...] when his engine quit on him,' Vincent's private letter to Bell-Irving reveals that: 'The poor old boy was caught in low cloud and high trees while delivering a Bristol Blenheim, which was too heavy and fast for him, not really knowing the blind instruments etc., and he tried to keep in visual conditions, but he and the cloud and the trees all met up together, and that stopped his delivery trips.'¹⁰¹

His 'retirement' in 1943 was also not without controversy. In August that year, Smith-Barry wrote to Bell-Irving telling him, 'In June I retired according to plan and am now a civvy in a houseboat on a lake.'¹⁰² However, in 1945, he told a personal friend, Ramsay, 'Leigh Mallory sacked me so quick - he never said why.'¹⁰³ The truth was that Smith-Barry had been sent to India as a ground instructor after recovering from his accident. After his crash, he was expressly grounded. The story recounted by Smith-Barry's friend and former colleague in India, Duncan Stone, too late for Tredrey's book in 1979 was that: 'It was not long before Smith-Barry asked for an aeroplane to fly. The Air Ministry, by then, had proclaimed him Non-general duties, which we were all aware meant that he was not allowed to pilot one of His Majesty's aircraft. [They phoned around asking what to do, and a Flight Commander said] if Smith-Barry wished to have an aircraft, the flight was on no account to be entered in the Flight Log Book. [...]

When he flew, he always refused to wear a parachute but kept an old brown cushion embroidered with fading red initials SB on one side, which he kept in his office [...] usually no helmet or goggles so that no one could get in touch with him from the ground.¹⁰⁴

Whether Leigh-Mallory caught wind of his antics is unknown, but according to Stone, when Smith-Barry pestered London to create an Indian Flying School, and it was turned down, he retired. To the end, Smith-Barry could not deal with authority.

A Short Reassessment of First World War Pilot Training

If that is the story of Smith-Barry, what is the truth regarding pilot training in the First World War? The historiography is largely unanimous. Between 1914 and 1917, it was 'insufficient', 'inadequate', 'reprehensible', and even 'murderous'.¹⁰⁵ In 1917, the consensus goes, with the arrival of Smith-Barry, training significantly improved, lives were saved, and directly as a result of his input, things were much improved in 1918. The research on which this article is based demonstrates that the reality is much more nuanced.

When war came, the RFC had prepared well for mobilisation overseas. It also practised many tactical deployment aspects at a comprehensive gathering, a so-called 'Concentration Camp', in June 1914. Despite this practical preparation, due to the expectation that war would be violent but short-lived, there was no consideration given to how to grow and train the Corps. Consequently, when the RFC departed to join the British Expeditionary Force, it left behind an organisation bereft of both aeroplanes and manpower. Further, while the RFC had a lengthy waiting list of applicants from both the infantry and civilians, there was little of a training system for them to pass through. Barely more than twenty men had completed a Central Flying School course in the seven months before the outbreak of war, and it took several weeks before the RFC in Britain could obtain a few pilots from France to assist in training new reserve squadrons.

The RFC were the victim of their own success. They had proved their worth in weeks, and consequently, Field Marshal French demanded more squadrons.¹⁰⁶ With few resources and lacking an organisational plan, early training efforts were confused and haphazard. A combination of the CFS, reserve squadrons, and service squadrons was called upon to train new pilots and aid expansion. Whilst the actions of the RFC in Britain were pragmatic in their approach, the lack of clarity regarding how big the force would need to be, coupled with aeroplane supply issues beyond their control, would dog the force for over a year. With casualties low and growth manageable, however, the RFC found a way to train its pilots.

As the growth of the force accelerated, the RFC's training efforts improved radically with the arrival of John Salmond in early 1916. He, and his Chief Staff Officer, Guy Livingston, were quick to deduce that the training standards and policies were no longer fit for purpose. The first set of minimum training standards was agreed upon in a March meeting that included Trenchard and other senior officers.¹⁰⁷ With these in place, structure was added to the organisation, and a

new certification process was introduced that logically broke the training into three parts. The first of these parts was classroom-based instruction, and new schools were opened at Reading and, three months later, Oxford to accommodate the activity. A new syllabus, new exams and stringent oversight by the CFS were also added, and within a month of Salmond and Livingston's arrival, the future training architecture had been implemented.

A new minimum of fifteen hours solo flying time was introduced in this new standard. Historians have criticised the number as way too small. However, the standard introduced after this March 1916 meeting was never an end goal. The minimum number was increased feasible to twenty in November, and archival records show there was a desire to increase this further as soon as possible.¹⁰⁸ Ultimately, this proved not to be the case in 1916 due to a lack of aeroplanes. As the RFC scrambled to expand in the face of demand from France, the lack of training aircraft limited the number of men that could be pushed through the system. Under pressure from Haig, demand for men in France remained Trenchard's principal focus. On occasion the only way to achieve this was to squeeze the training system. That said, while the historiography's conclusion is overwhelming - that the system responded by sending inadequately trained men to France – many records do not support this view.

Unsuitable men were weeded out of the force rather than pushed on to France. Appraisal reports and new exams were tools to prevent the incapable from being sent overseas. The training was continued in squadrons in France if needed, where paternal commanding officers ensured that men received as many days of additional training as possible before they flew an active mission. Finally, when men did slip through the net and arrived in France without adequate skills, complaints were made by officers in the Field. These complaints were not met with platitudes by the training organisation. In all cases found, they were followed up vigorously and occasionally pointedly until reasons for the failure were ascertained. Where an issue was systemic, processes or syllabi were changed to prevent reoccurrence.

Of course, it is easy to sit back in judgement with the benefit of 100 years of history and to declare training in this period was 'inadequate' or 'insufficient'. Were fifteen hours solo too little? Twenty? No one can answer that, but it was the best minds in British military aviation at the time that decided upon this number. It was a recognised compromise that balanced pilot competency with the demand from the British Expeditionary Force (BEF). Had training hours been extended, the BEF would have gone short of the support it needed. Such a solution would have handed the German Army a huge advantage and was never seriously entertained.

On 1 January 1917, the RFC decentralised its Training Brigade. Three new regional administrative centres called Group Commands were created and headquartered at Adastral House in London. Northern Group Command was established at York, Eastern in London and Southern at Salisbury. In August of that year, the Training Brigade became the Training

Division. Effective 1 April the following year, on the creation of the RAF, the Directorate of Training came into being. In truth, this organisation had been operating for some time before the announcement, concerning itself with questions of policy and standardisation given the impending changes. On 28 April 1918, a conference was held to discuss the transition of heritage organisations. Consequently, effective 8 May, the training brigades and group commands were rearranged again so that their units now fell into one of five new Areas.

The Areas were given significant autonomy, each to be commanded by a Major-General, directly responsible to the Air Ministry. These Areas began to take over the myriad of administrative responsibilities, which from 20 May would include the allotment of aeroplanes and the posting of pupils for elementary instruction. The allocation of pupils to special schools was managed directly by the Directorate of Training at the Air Ministry. The administration of the training infrastructure was significant, and the management and recording of personnel as they travelled through the organisation was vital. Daily telegrams were demanded from each school, detailing who was under instruction and the likely duration of their stay. Similarly, daily wires were required from each Area detailing the number of places they required at each school.¹⁰⁹

Throughout much of 1917, the RFC had arguably its most capable administrators in their best roles, yielding a level of planning and efficiency that greatly enhanced the capabilities of the training establishment and the RFC in general. Livingston astutely noted in his autobiography after the war: 'It was found that a good flying officer was frequently only a tolerably good flight commander, an indifferent Squadron Commander and a bad Wing-Commander, due to the fact that the characteristics necessary for fighting in the air are very different from those required for executive command in the Field. [...] it presented a very real difficulty in providing squadron and wing commanders to meet the requirements of our rapid expansion. The administrative work necessitated our keeping in constant touch with the various Army Commands throughout the country and working in close liaison with them.'¹¹⁰

However, the RFC and later RAF were blessed, or downright lucky, to find themselves with some extraordinarily effective administrators. John Salmond, who had commanded the Training Brigade since July 1916, became General Officer Commanding (GOC), Training Division in August 1917. Salmond's star was very much in the ascendency. He was to move briefly to become the Director General of Military Aeronautics at the War Office on 18 October 1917, replacing David Henderson. Then, in January 1918, he took over from Trenchard as the GOC RFC in the Field.¹¹¹ It is implausible that Salmond would have ended up commanding the RAF had he not been viewed at the War Office to have done an exemplary job in helping grow and equip the Corps.

Throughout Salmond's role in training, he was ably assisted by his Chief Staff Officer, Guy Livingston. Livingston followed Salmond to London when the latter was promoted. Sefton Brancker, who had worked tirelessly since the start of the war, became Deputy

Director-General of Military Aeronautics in February 1917. Though he wished to command operationally, when he did so, his position as Commander of the RFC in Palestine was short-lived. He soon returned to London, where his organisational ability was better used. First, he became Controller-General of Equipment and, finally Master-General of RAF Personnel. Thus, Salmond, Brancker and Livingston provided command continuity throughout a significant period of the war.

The training organisation was also assisted by the addition in November 1917 of experienced Wing Commander Edgar Ludlow-Hewitt, who had returned to England in a newly created role as Inspector of Training at the Training Division. He was later promoted to GOC Training Division, but this appointment proved unhappy due to the series of political machinations involving Smith-Barry. In Ludlow-Hewitt's place, John Hearson, who had succeeded Livingston as Chief Staff Officer at the Training Division in October 1917, provided much-needed continuity, taking over the command of the Training Division for the remainder of the war.

Before leaving the Training Division, Livingston undertook the RFC's first strategic planning and forecasting exercise. Uniquely, he gathered together all elements of aeroplane and manpower demand and supply, factored them into a single plan, and widely shared it across the Corps. As can be imagined, in a paper-based world, this was a monumental but arguably well-overdue task. It required someone of Livingston's organisational nous and tenacity to complete it. He involved the aircraft manufacturers, the Ministry of Munitions and operational leadership in England, France and the Middle East. From the bottom up, he calculated aircraft availabilities with suppliers, manpower numbers and pilot output from the Training Division to produce a detailed deliverables timeline. Thus, when a change was demanded from the Field, or a delay happened at a manufacturer, the effects could be factored into the plan. Called simply the 'Programme of Development', the output was a detailed picture of future requirements and delivery dates.¹¹² When the Royal Naval Air Service (RNAS) and RFC merged in April 1918, the RNAS's requirements were similarly built into the plan, initially inherited by Brigadier General John Hearson and later the office of the Master General of Personnel.

Hearson played an active role in late 1917 and 1918 in increasing the effectiveness of the training machine.¹¹³ He did this through the widespread and accelerated adoption of the Training Depot Station system. These 'All-Through' squadrons, so called because the Elementary and Higher training took place in the same unit, were aggressively pushed. Instructional improvements, some of which were initiated by Smith-Barry, were adopted. Salmond and Hearson oversaw the ending of the chopping and changing of instructors, allowing a more settled relationship between instructor and pupil. The number of pupils allotted to each instructor would be 'slowly reduced' to a maximum of six.¹¹⁴ Each instructor would have a mix of pupils at the various stages of instruction, so no instructor had more than half of his pupils undertaking dual elementary instruction at any time. This instructor would now be responsible for a pupil throughout his entire instruction, building more trust and a better relationship.

During the latter years of the war, the vast majority of pilots were civilians, and the creation of the Cadet Brigade was an important development. Initially created as the Officer Cadet Battalion in February 1916 to train selected officers from the Infantry, the Battalion was expanded to become a Wing in its own right with four squadrons of one hundred men each in October 1916. At this point, the RFC announced that all non-officers joining the Corps, whether from the infantry or civilian life, would join this new Wing.¹¹⁵ Here they would learn the basics of military service, including drill and map reading. Though drill was rarely popular, most men recall that instruction was interesting and challenging.¹¹⁶ The scheme was deemed a significant success, with men moving on to the Schools of Aeronautics better prepared for future training.

While the RFC had been able to choose recruits carefully through much of the war, by 1918, things were markedly different. The academic abilities of new cadets became such that in the summer of 1918, the RAF went so far as to recruit several schoolmasters to the Cadet Brigade to lecture arithmetic.¹¹⁷ At this stage, the Directorate of Training decided to opt for a character-based assessment of cadets rather than relying solely on academic ability for officer selection. Consequently, cadets would be measured on their sporting prowess, aptitude for leadership, character, keenness, and technical proficiency, as well as academic ability. The merger of the RFC and RNAS in April 1918 required the unification of much of the cadet's training curriculum. Brigadier General A.C. Critchley was seconded from his role leading training in the Canadian Corps to take command of the RAF Cadet Brigade.¹¹⁸ With significant personal experience and joined by some of his trusted administrators, Critchley was a useful addition to the team in Britain.

The last eighteen months of the war saw the creation of a myriad of specialised schools to assist in the training of pilots. Perhaps the most pressing training development need throughout the war was in the use of gunnery. The concept of fighting for aerial supremacy in the air pre-dated the war. As aircraft capabilities improved, the first School of Aerial Gunnery opened in late 1915. There has rightly been criticism of the RFC for not adding additional gunnery schools in 1916.¹¹⁹ However, this research found that the RFC did attempt to build a new site at this time, but a poor site selection led to the project ending in expensive failure.

Consequently, the RFC remained with only one gunnery school at Hythe until January 1917, when a second at Turnbury was finally added. The new school became dedicated to the training of scout/fighter pilots. One hundred and fifty pilots a fortnight were to be sent to the school after they completed their Higher Training. Following the opening of this second school, the first focussed on the training of observers, or 'aerial gunners' as they became known. Another school of gunnery was added at Aboukir in Egypt in April 1917 before, in August, a third British school was formed near New Romney airfield on the Kent coast. A month later, the RNAS added its first dedicated gunnery school at Frieston, Lincolnshire.

Schools of Aerial Gunnery should not be confused with Schools of Aerial Fighting though their purposes are complementary. While the former focussed on the ability to use, aim and fire the

machine guns, the latter focused on the latest tactics regarding manoeuvre and fighting. The first concrete steps towards improving the training of fighting in the air came on 17 September 1917 with the approval of a School of Aerial Fighting at Ayr Racecourse, just down the coast from the Turnbury school. No sooner had the operation for 150 pupils begun than it was clear that demand for places would outstrip this school too. On 11 October 1917, approval was given to form the No.2 School of Aerial Fighting at Drifffield, Yorkshire, which became operational on 28 February 1918.

Whilst gunnery and fighting schools were being added, Smith-Barry's school, the School of Special Flying, was approved in August 1917. The profound change that emanated from the Special School of Flying, that would have revolutionised capabilities had the war continued into 1919, was the recognition of the importance of training the trainer. Thus, the essential Smith-Barry improvement became the seeds sown for the standardisation of instructor abilities through their dedicated training. All instructors, whether an experienced combat pilot back from France or a rookie who had just qualified, had to pass through an instructor's course at Gosport. Over time, the School of Special Flying was renamed an Instructor's School, and in the latter months of the war, others opened in each RAF Area.

Following Smith-Barry's removal during April and May 1918, the two existing fighting and gunnery schools were merged into Schools of Aerial Fighting and Gunnery.¹²⁰ At the end of May, the schools simply became No.1, 2, 3 and 4 Fighting Schools, respectively. Also in May, the Gosport School of Special Flying became the No.1 School of Special Flying as a second was added at Redcar. Further regional instructor schools followed in July and August. The work done at these schools, whilst essential, came too late in the war to significantly affect its results. The amount of time a man spent in training meant that improvements would only have been truly felt in 1919.

The pilots who flew the reconnaissance and artillery observation aircraft that comprised the bulk of the RFC and RAF are often ignored. Their training also benefited from the opening of new dedicated schools. Wireless capabilities, predominantly regarding the learning and transmitting of Morse messages, had been taught at Schools of Aeronautics since their creation in late 1915 and early 1916. This instruction had been complemented by a Wireless School, which in October 1916 became known as the Wireless and Observers School at Brooklands. No further progress was made until November 1917, when a new school was spun out of the existing Brooklands school, becoming the Artillery & Infantry Co-operation School. The following day, 8 November 1917, No.2 Wireless School opened, and in January 1918, further specialist training was concentrated at a new School of Navigation and Bomb Dropping formed at Stonehenge.

An 18 October 1918 memorandum from Director of Training John Hearson shows that the RAF training system was meeting the demand for service squadrons and that planning was in full swing to increase throughput by a further 60 per cent to meet 1919 estimates.¹²¹ In June 1916,

the RFC produced some 203 pilots for active service. In March 1917, this figure rose to 388; a year later, in March 1918, 1,082 new pilots were produced. In the final month of the war, 1,220 new pilots completed training.¹²² The intake capacity of the system had become 3,000 cadets a month.¹²³ To support this throughput, the size of the training organisation had become immense. The RAF operated Training Depot Stations out of almost 70 airfields across Britain, which employed 2,800 officers, 22,700 other ranks and 11,800 women. Together, they had a training capacity of 9,500 pilots, and almost 3,800 aeroplanes were at their disposal.¹²⁴ The system had expanded sufficiently by 1918 to allow men to spend ten to eleven months in training. It was rare for any man to head to France with less than 50 to 60 hours minimum flying at the war's end.

Conclusion

This article explored the role of Smith-Barry in the First World War. When Smith-Barry returned to Gosport to head No.1 Reserve Squadron at the beginning of 1917, Salmond and Livingston sought to solve the manpower crisis by finding efficiencies within their organisation. No doubt Smith-Barry's ideas regarding training efficiencies and new methods would have played well with these senior officers. Initially, the new entity was to be named the School of Special Flying 'to teach specially selected pilots all the tricks and aerobatics in flying which have proved of use in aerial fighting.'¹²⁵ This soon changed, and the school focussed on instructors. This aspect is the most important of changes that emanated from this school but there is little evidence that he initiated the change, and indeed as this article has shown, it did not align with his ambitions. Repeated papers show he hoped to lead new enlarged schools that incorporated all aspects of training on the ground and in the air.

To briefly address the remaining BBC points, Smith-Barry did not produce a 'training manual', though his Gosport notes were distributed in late 1917. Two RFC manuals were produced in 1914 and 1915. They were replaced by a significant numbers of official training pamphlets. Smith-Barry was not responsible for any of them. The 'Gosport Tube' was developed by a combination of efforts led by Capt. Alan Scott.¹²⁶ Finally, half of all pilots did not die in training. Other research connected with this article has shown that actual figure is closer to half of that and was no worse than training in the Second World War. There is also no evidence that Smith-Barry's initiatives saved training lives. In fact, more aggressive training probably increased the peril but produced better trained pilots who could face the perils of France.

This research also concludes that Smith-Barry was a man entirely unsuited for senior command. His ideas may have improved British pilot training, but he was unfit to lead a large organisation. As Livingston wrote: 'Other qualities besides a genius for training pilots were required for such a command - in particular, knowledge of Staff duties, power of organisation etc., and it must also be realised that Smith-Barry was a comparatively junior officer.'¹²⁷

While Smith-Barry may have inspired loyalty from many of those he commanded, his inability to accept his limitations ultimately soured his legacy in the RAF. His decisions in both wars

to go around his senior officers, ignore command structures, deliver proposals different from those requested, and not accept no for an answer marked him down as untrustworthy.

Ultimately, no one man taught the world to fly. As this article has shown, Smith-Barry was one cog in a gigantic training wheel, a wheel that required management by skilled administrators. In later years, Smith-Barry disclaimed having made the system himself, saying he had ‘only done the donkeywork, others improving on it. I merely wrote the alphabet’, he said, ‘others wrote the classical works.’¹²⁸ He was, he said, ‘only a drag on the wheel at Gosport’ though he added no doubt with a smile, ‘Never mind. I got most of the credit anyway.’¹²⁹ His legacy as the ‘man who taught the world to fly’, appropriate or not, lives on for now.

Notes

¹ ‘Blue Plaque for WWI Pilot Robert Smith-Barry in Gosport’ available at <https://www.bbc.co.uk/news/uk-england-hampshire-26952538>, 9 April 2014.

² F.D. Tredrey, *Pioneer Pilot: The Great Smith Barry who Taught the World How to Fly* (London: Peter Davies, 1976), p. 113.

³ ‘A Reunion of Aviators - ‘Gosport’ Pilots – Reminiscences at Brooklands’ in *Hampshire Telegraph* (15 July 1938, p. 20).

⁴ Article in the *Roundel*, a Canadian magazine found in RAFM:B3310 - *Correspondence and research docs re AD Bell-Irving’s proposal for book on Smith-Barry 1937-1963*.

⁵ For example, ‘Father of Flying Training’ in *Forfar Dispatch* (2 May 1940, p. 4), *Shields Daily News* (2 May 1940, p. 3), *Londonderry Sentinel* (2 May 1940, p. 6), *Belfast Telegraph* (1 May 1940, p. 5), and *Portsmouth Evening News* (1 May 1940, p. 4).

⁶ *Ibid.*

⁷ RAFM:AC71/9/18 – *Correspondence and articles relating to career of Lt Col RR Smith-Barry 1912-1963*, Central Flying School – 40th Anniversary 1912-1952

⁸ *Ibid.*, Letter from Lowry Coles to Group Captain G.T. Jarman, CFS, 22/9/1950.

⁹ G. Lewis, *Wings Over the Somme 1916-1918* (Wrexham: Bridge Books, 1994 [1976]), p. 80.

¹⁰ N. Macmillan, *Into the Blue* (London: Duckworth, 1929), p. 8.

¹¹ N. Macmillan, *Into the Blue* (London: Grub Street, 2015 [1969]), p. 193.

¹² NA:AIR 1/2397/265/1 – *Report by Captain Gilchrist on the Special School of Flying, Gosport*.

¹³ *Ibid.*

¹⁴ *Ibid.*

¹⁵ G. Livingston, *Hot Air in Cold Blood* (London: Selwyn & Blount, 1928), p. 99.

¹⁶ N. MacMillan, *Sir Sefton Brancker* (London: William Heinemann, 1935), p. 138.

¹⁷ A. Boyle, *Trenchard: Man of Vision* (London: Collins, 1962), p. 202.

¹⁸ Tredrey, *Pioneer Pilot*, title page.

¹⁹ RAFM:X003-7892/071 – *Memoirs of Major SE Parker*.

²⁰ RAFM:B3310 – Letter from Alan Duncan Bell-Irving (ADBI) to Tredrey 9/7/1962.

²¹ *Ibid.* Letter from ADBI to Tredrey 9/7/1962.

²² *Ibid.* Letter from ADBI to Anne Smith-Barry, 29/5/1958.

²³ *Ibid.* Letter from ADBI to Quentin Russell, 9/6/1958.

- ²⁴ Ibid. Letter from Anne Smith-Barry to ADBI, 22/6/1958.
- ²⁵ Ibid. Letter from Charles Portal to ADBI, 23/7/1958.
- ²⁶ Ibid. Letter from Anne Smith-Barry to ADBI, 4/9/1958.
- ²⁷ Ibid. Letter from Stanley Vincent to ADBI, 15/4/1959.
- ²⁸ Ibid. Letter from ADBI to Tredrey, 9/7/1962.
- ²⁹ Ibid. Letter from Tredrey to ADBI, 12/2/1965.
- ³⁰ A.J.L. Scott, *Sixty Squadron R.A.F: A History of the Squadron from Its Formation* (Oxford: Casemate, 2016 [1920]).
- ³¹ RAFM:DC74/181 – Duncan ‘Bunny’ Stone *Personal Memories for Dr J Tanner of The Late Col RR Smith-Barry*.
- ³² Oxford Directory of National Biography at <https://www.oxforddnb.com/display/10.1093/ref:odnb/9780198614128.001.0001/odnb-9780198614128-e-72242> and Tredrey, *Pioneer*, p.3.
- ³³ Database of 1914 officers created from names listed in W. Raleigh, *The War in the Air: Being the Story of the part played in the Great War by the Royal Air Force: Vol. I* (London: Hamish Hamilton, 1961[1922]).
- ³⁴ T. Henshaw, *The Sky Their Battlefield II: Air Fighting and Air Casualties of the Great War. British, Commonwealth and United States Air Services 1912 to 1919* (Barnet: Fetubi, 2014 [1995]), p. 359.
- ³⁵ Findmypast, *Service Records 1912-1920*, Robert Raymond Smith-Barry.
- ³⁶ RAFM:AC71/9/18 – *Further Remarks on Instruction in Flying - Written in France 10th December 1916*.
- ³⁷ Tredrey, *Pioneer Pilot*, p. 52.
- ³⁸ Ibid.
- ³⁹ NA:AIR1/2397/265/1 – Gilchrist.
- ⁴⁰ NA:AIR1/2126/207/77/3 – Copy of Pamphlet, ‘General Methods of Teaching Scout Pilots’.
- ⁴¹ NA:AIR1/2397/265/1 – Gilchrist.
- ⁴² RAFM:AC71/9/18 – Notes on Teaching Flying for the Instructors’ Courses at No.1 Training Squadron, Gosport – May 1917.
- ⁴³ NA:AIR1/2126/207/77/3 – General Methods.
- ⁴⁴ NA:AIR2/12/87/Schools/174 – *School of Special Flying RFC. Gosport: Formation and establishment*.
- ⁴⁵ Ibid.
- ⁴⁶ J. Laffin, *Swifter than Eagles: A Biography of the RAF, Sir John Salmond G.C.B, C.M.G, C.V.O, D.S.O* (London: William Blackwood, 1964), p.80.
- ⁴⁷ NA:AIR1/2126/207/77/3 – General Methods.
- ⁴⁸ RAFM:AC71/9/18 – Notes on Teaching Flying.
- ⁴⁹ It is worth noting that many other suggestions were not taken forward, for example, the abandonment of minimum flying hours before qualification.
- ⁵⁰ Findmypast, *Service Records 1912-1920*, R.R. Smith-Barry.
- ⁵¹ RAFM:X003-7892/071 – Parker.
- ⁵² D. Winter, *The First of the Few: Fighter Pilots of the First World War* (London: Penguin, 1983)

[1982]), p. 32.

⁵³ Salmond would replace Trenchard as GOC RFC in the Field in January 1918.

⁵⁴ NA:AIR1/720/35/17 – *Report on Flying Schools (French) and the Economy in Personnel they Effect.*

⁵⁵ Ibid.

⁵⁶ Ibid.

⁵⁷ Ibid.

⁵⁸ NA: AIR 1/720/35/16 – *Report on Proposed Large Flying Schools.*

⁵⁹ NA: AIR 1/14/15/1/49 – *Schools of Aeronautics and Cadet Brigade – Conferences of Commandants and Chief Instructors.*

⁶⁰ NA:AIR2/12/87/Schools/174 – School of Special Flying.

⁶¹ Tredrey, *Pioneer*, p. 79.

⁶² Ibid. p.81.

⁶³ RAFM:X003-7892/071 – Parker.

⁶⁴ Boyle, *Trenchard*, p. 264.

⁶⁵ RAFM:AC71/9/18 – Correspondence and articles.

⁶⁶ RAFM:X003-7892/071 – Parker.

⁶⁷ Boyle, *Trenchard*, p.266.

⁶⁸ Ibid.

⁶⁹ RAFM:X003-7892/071 – Parker.

⁷⁰ Ibid.

⁷¹ Ibid.

⁷² NA:AIR1/402/15/231/43 – *Directorate of Military Aeronautics' Records – Vol. XIII.*

⁷³ Findmypast, *Service Records 1912-1920*, Charles Frederick Lee.

⁷⁴ Author's emphasis. NA:AIR1/402/15/231/43 - Records Vol. XIII.

⁷⁵ RAFM:AC71/9/18 – Correspondence and articles.

⁷⁶ Ibid.

⁷⁷ Ibid.

⁷⁸ Ibid.

⁷⁹ Findmypast, *Service Records 1912-1920*, R.R. Smith-Barry.

⁸⁰ Authors emphasis. RAFM:AC71/9/18 – Correspondence and articles.

⁸¹ RAFM:AC71/9/18 – Letter from AVM EJ Kingston-McCloughry, HQ 38 Grp, RAF, Upavon to Group Capt. G.T. Jarman, CFS, 22/9/1950.

⁸² Ibid.

⁸³ RAFM:AC71/9/18 – Letter from ADBI to Stanley, 30/7/1958.

⁸⁴ RAFM:AC71/9/18 – Correspondence and articles.

⁸⁵ NA:AIR1/997/204/5/1241 – *Training of Pilots and Observers 25 Oct 1915-22 July 1917.*

⁸⁶ RAFM:AC71/9/18 – Correspondence and articles.

⁸⁷ Ibid. Letter from ASB to ADBI, 4/9/1958.

⁸⁸ Ibid. Letter from Robert Smith-Barry to Robb, 'Late October, 1939'.

⁸⁹ Written by Smith-Barry and his former chief mechanic Dundas Heenan.

⁹⁰ RAFM:AC71/9/18 – Letter from RSB to Robb, 12/10/1917.

⁹¹ <https://www.rafweb.org/Biographies/Portal.htm>. In October 1940, Portal would become

Chief of the Air Staff.

⁹² RAFM:AC71/9/18 – Letter from RSB to Robb, 24/10/1939.

⁹³ Ibid. Letter from RSB to Private Secretary, HM Under-Secretary of State for Air, 1/10/1939.

⁹⁴ Ibid. Letter from RSB to Robb, 24/10/1939.

⁹⁵ Ibid.

⁹⁶ Ibid. Letter from RSB to Robb, undated but filed under 1940.

⁹⁷ Ibid.

⁹⁸ Ibid.

⁹⁹ Ibid. Letter from RSB to ADBI, 13/12/1942.

¹⁰⁰ <https://www.eastgrinsteadmuseum.org.uk/patients/robert-smith-barry>.

¹⁰¹ RAFM:B3310 – Letter from Vincent to ADBI, 14/4/1963.

¹⁰² Ibid. Letter from RSB to ADBI 29/4/1943.

¹⁰³ RAFM:AC71/9/18 – Letter from RSB to Ramsay, 17/2/1946.

¹⁰⁴ RAFM:DC74/181 – Duncan Stone Memories.

¹⁰⁵ For example, see S. Douglas, *Years of Combat* (London: Collins, 1963), A.G. Lee, *No Parachute* (London: Arrow, 1969[1968]) and *Open Cockpit* (London: Grub Street, 2012 [1969]), R. Barker, *The Royal Flying Corps in World War I, From Mons to the Somme* (London: Robinson, 2002 [1994]), R.A. Morley, *Earning Their Wings: British Pilot Training 1912-1918* (MA Dissertation, University of Saskatchewan, 2006) amongst many others.

¹⁰⁶ NA: AIR 1/143/15/40/316 – *R.F.C. expansion policy - completion in personnel and material of 1,7 and 8 Squadrons, and authority for formation of 9 and 12 Squadrons.*

¹⁰⁷ NA: AIR 1/131/15/40/218 – *Pilots sent to Expeditionary Force with insufficient training. General training of pilots.*

¹⁰⁸ NA: AIR 1/131/15/40/218 – Letter from Brancker to Lt. Col. Burke, March 1916.

¹⁰⁹ NA: AIR1/676/21/13/1840 – *Notes on Flying Training at Home.*

¹¹⁰ Livingston, *Hot Air*, p. 105.

¹¹¹ Effective 1 April 1918, this became GOC RAF in the Field. Trenchard moved to head the new Independent Force which focussed on long-range bombing.

¹¹² Livingston, *Hot Air*, p. 103 and NA: AIR1/31/15/1/156 - *Training programme of development.*

¹¹³ NA: AIR1/676/21/13/1840 – Training at Home.

¹¹⁴ Ibid.

¹¹⁵ H.A. Jones, *The War in the Air: Being the Story of the part played in the Great War by the Royal Air Force: Volume Six* (Naval & Military Press, 2002 [1936]), p. 298.

¹¹⁶ For example, R. Vee, *Flying Minnows: Memoirs of a World War One fighter pilot* (London: Naval & Military Press, 2019 [1935]), p. 21.

¹¹⁷ NA: AIR1/14/15/1/49 – Conference of Commanders and Instructors.

¹¹⁸ NA: AIR2/114/RU4041 – *Cadets General Classification and Procedure of Cadet's Course Canada.*

¹¹⁹ NA: AIR 2/9/87/7661 – *Enquiry into the Administration of the R.F.C, 1916.*

¹²⁰ See Appendix Three.

¹²¹ NA: AIR1/33/15/1/196 – *Training Depot Stations establishment of, and output of pilots from.*

¹²² NA: AIR1/683/21/13/2234 – *Précis.*

¹²³ NA: AIR1/686/21/13/2252 – *Statistical data.*

¹²⁴ Compiled from NA:AIR1/452/15/312/26 Vol. I & Vol. II.

¹²⁵ NA:AIR2/12/87/Schools/174 – *School of Special Flying*.

¹²⁶ Duncan Bell-Irving credited A.J.L Scott with the development after earlier experiments by NCOs.

¹²⁷ Livingston, *Hot Air*, p. 136.

¹²⁸ 'A Reunion of Aviators-'Gosport' Pilots – Reminiscences at Brooklands' in *Hampshire Telegraph* (15 July 1938).

¹²⁹ RAFM:B3310 – Letter from RSB to ADBI, 18/7/1937.

Article

The RAF's Leading Role in the Development and Application of Synthetic Training Equipment

By Dr Trevor Nash

Biography: Trevor Nash is an independent scholar. He holds a BA (Hons) in modern history from the Open University, and MA in Air Power Studies from the University of Birmingham. He has recently completed his PhD at Birmingham, that concentrated on operational training within the RAF's bomber force/Bomber Command between 1922 and 1945. He was previously editor of Jane's *Training and Simulation Systems* and The Write Partnership's *Military Training & Simulation News*.

Abstract: The Royal Air Force has long been recognised as one of the leading proponents of Synthetic Training Equipment (STE) for aircrew training. Along with other mature STE user nations such as the US, Australia, Germany and France, the modern RAF invests heavily in simulation and sophisticated training devices to fulfil a number of training ambitions. These include better preparing aircrew for time spent in the air, enhancing safety, saving money, undertaking mission rehearsal and more recently, reducing the Service's carbon footprint. It was also found during its early adoption that STE provided a repeatable and scalable training medium that enabled more efficient 'training transfer' when compared with purely flying training. Much of this STE expertise was gained in the run-up to, and during the Second World War with Bomber Command at the innovative leading edge.

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Introduction

In discussing the use of Synthetic Training Equipment (STE) to enhance training within the RAF, there has been a tendency for historians to mention the ubiquitous Link Trainer in passing and ignore other training systems or training methodologies that used STE.¹ The importance of the Link Trainer should not be underestimated and it certainly was not by the former RAF Director of Training, and later RCAF Chief of Air Staff, Air Marshal Robert Leckie, who said that '[t]he *Luftwaffe* met its Waterloo on all the training fields of the free world where there was a battery of Link Trainers!² But it was not all about the Link Trainer, as by 1942 'no less than 200 training devices had been invented and put into use' by the RAF with some of the most sophisticated of these being used by Bomber Command.³

As well as the invention and development of these training systems, the RAF was making significant intellectual investment in examining how STE could be used to improve operational training at the individual and collective training levels; the latter being especially important in considering the seven-man crew of the heavy bombers that begin to enter service from 1941. As will be seen below, the adoption of what were considered by some as unproven technologies to improve training and assist in taking pressure off an increasingly overworked training pipeline were, with few exceptions, broadly accepted by the Air Ministry and the operational Commands. The aim of this paper is to highlight the role that STE played in enhancing operational training by considering how it assisted in closing a number of training gaps and provide an innovative training medium that was repeatable, scalable and safe. The paper will also argue that the use of STE marked a major evolution in the way organisations such as Bomber Command conducted operational training and, as such, was one of the key drivers in developing new training methodologies that had a long-lasting impact on the RAF's approach to training. The paper will firstly consider the context of STE and then examine how STE policy was developed, how STE was procured and managed, and how synthetic training devices were used by Bomber Command to support operational training before concluding that simulation was a key element that helped to drive the overall success of operational training in Bomber Command.

Returning to the Link Trainer, the great misconception surrounding this device is that it was the first ground-based training simulator that was ever used for pilot training. Baarspul described the Sanders Teacher and Eardley Billings training devices of 1910 as 'aircraft attached to the ground' and mounted on a 'universal joint' to enable pilots to experience the effects of elevator, rudder and aileron or wing warping control.⁴ The problem with these early devices was that they were reliant on wind strength to make them function and therefore their use was limited. Later in 1910, this limitation was overcome by the French Antoinette trainer that featured the pilot sitting in a cockpit that had been crafted from a half wine barrel fitted to a swivel mechanism.⁵ A horizontal bar was located on the front of the cockpit and, through the use of his controls, the pilot had to keep the bar on the horizon as instructors on the yaw, roll and pitch axes moved the cockpit by means of poles to alter the status quo. What the

Link Trainer did achieve during its development between 1927 and 1929 was to provide a pneumatically operated 'efficient aeronautical training aid' that could be operated by a single instructor and the student, which was not dependant on wind strength.⁶ Patented in 1930 by the Binghamton, New York-based Link Company, the Link Trainer's 'roll, pitch and yaw movements were initiated using pneumatic bellows for actuation. The various control valves, operated by the stick and rudder, were fed by an electronically driven suction pump, mounted on a fixed base.'⁷ The Link Trainer formed the basis for a number of different training device variants that were used for operational training but in its basic form, the device was used for elementary and intermediate flight training as well as continuation training. One example of the latter saw a device installed at HQ Bomber Command to allow pilots carrying out staff functions to retain key airmanship skills.⁸ The Link Trainer's importance is that when it entered service with the RAF it was at the forefront of simulation technology and subsequently provided the catalyst and inspiration for the Service's further investment and interest in STE following the adoption of training systems in the period before the Second World War.

STE in Context

Before considering the policy, procurement and management, and application of STE within Bomber Command and the wider RAF, some terms and parameters need to be defined; primarily, why the use of STE became so prevalent? This can be mainly attributed to the increasingly technical nature of the modern bomber, the roles that it had to undertake, the sheer throughput of students that required training and logistic issues. Addressing training issues facing the US Navy in 1941, but no less applicable to the RAF and Bomber Command in 1938 and beyond, Dawson said that 'the traditional training methods... were incapable of providing the thousands of newly trained personnel...' that were required due to a lack of training aircraft and other resources such as airspace, airfields and ranges.⁹ Rolfe and Bolton reinforced the 'shortage of training resources' argument for the growth of STE when they stated that: 'By 1940 the pattern of the war in the air was such that difficulties were being realised in finding aircraft and flying hours for training. Moreover the training task was growing. The need to replace airborne training was seen to be an important requirement.'¹⁰ STE became a method of supplementing those conventional live training processes by allowing students to learn in a virtual environment, albeit, when compared with modern STE, frequently crude.

One of the other catalysts for the increased adoption of synthetic training was the growing complexity of modern combat aircraft, the so-called 'technical revolution' in aircraft.¹¹ This 'training gap' could be seen when considering the Hart and Whitley bombers, both in service at the same time during the late 1930s.¹² The Hart differed little from aircraft flown during the First World War while the Whitley featured retractable landing gear, a cantilever wing, constant speed propellers and variable position flaps.¹³ This 'training gap' is exemplified when considering the differences between the Second World War Spitfire and the Lancaster and the First World War SE5 and DH9. The latter fighter-bomber combination could be flown

by a 'universal pilot'; while the former aircraft were technically far more complex, therefore requiring training specialisation.¹⁴ The result was an increased emphasis on cockpit drills, especially as far as single-pilot aircraft were concerned. Issues such as taking off with course pitch selected or landing without lowering the under carriage were costly in terms of pilots and aircraft. This particular training requirement led to the development of the Hawarden trainer for use by Fighter Command.¹⁵ This was a fuselage trainer that allowed pilots to practise cockpit and emergency drills and, by the end of 1940, the use of these type of trainers was growing such that, by May 1941, there were shortages.¹⁶

Despite the emergence of ground based training aids, the RAF had a 'marked preference for giving as much instruction as possible in the air'.¹⁷ Air Ministry policy was that such systems were 'to assist but in no way replace aircrew training in the air'.¹⁸ Given the preponderance of pilots filling senior staff appointments during the interwar years and the general pilot-centric approach of the Service, this was hardly surprising. Although this policy worked well up until the acceleration of the RAF's expansion schemes where the throughput of trainees threatened to overwhelm the training system.¹⁹ The relatively small size of the inter-war RAF and the 'peace-time [*sic*] economy complex' meant that the output of pilots to feed the service did not require a particularly sophisticated training pipeline.²⁰ In 1933, for example, the RAF was training 300 pilots a year; by the end of 1941, this figure had risen to 22,000 pilots and 18,000 other full time aircrew trades.²¹

The importance of synthetic training systems to Bomber Command was highlighted by the Air Officer Commanding (AOC) No.6 (Training) Group, Air Commodore MacNeece Foster, during a visit to No.10 Operational Training Unit (OTU) at RAF Abingdon by members of the Aircrew Training Conference on 28 January 1942. After telling delegates that the RAF should be sending its best pilots to Bomber Command in light of the complex nature of the four-engine aircraft types that they operated and the need to fly long range missions at night, he moved on to discuss a topic that he referred to as 'half-true':

One such slogan is, 'Nothing can take the place of hours in the air'. That is...true, but is at the same time quite untrue. You cannot give the hours in the air necessary to give every member of a crew his full training. Consequently, you have got to use every ingenuity on the ground so that when they go up in the air, they have reached that acquaintance with their subject which ensures they can take full advantage of their air training.²²

Today, the use of complex digital simulators is quite common both for military and commercial airline pilot training. The fidelity of the modern simulator is so great that commercial airline pilots can undertake conversion training to a new familial type of aircraft in the Full Flight Simulator (FFS) such that the first time that they fly the actual aircraft it will contain fare-paying passengers.²³ From a modern military perspective, a number of established air forces now conduct 50% of their training in the flight simulator with the German Air Force seeking to undertake 95% for its Airbus A400 flight crew in the near future.²⁴ A simulator is defined as

‘a device that imitates the dynamic behaviour of a real system’ to give ‘the illusion...of responding like the real system...’²⁵ The simulator can therefore be described as an holistic training device capable of high-fidelity replication that draws together sub- or part-task training events. Such a sophisticated and all-encompassing solution was not available in the period before and during the Second World War and the terms trainer, training device and synthetic trainer or synthetic training device were more common than simulator. These training devices were clearly not carrying out the full spectrum of training that would be the case in a modern FFS and so they are best considered as Part Task Trainers (PTT). The word ‘simulation’ was used initially by the RAF to describe the collective use of such training devices, but then replaced by ‘synthetic training’ from May 1940.²⁶ According to Director of War Training & Tactics (DWTT), the term ‘synthetic training’ was first coined by Air Vice-Marshal Ludlow Hewitt in 1940.²⁷

As the pressure built on the training pipeline, in parallel with subsequent expansion schemes in the lead up to the Second World War, the RAF rapidly turned towards the increased use of synthetic training to download specific training tasks from the aircraft, or to improve training transfer. The latter can be defined as ‘the degree to which trainees effectively apply the knowledge, skills, and attitudes gained in a training context to the job and maintained over time.’²⁸ As previously discussed and as policy dictated, synthetic training was not designed to replace time in the air, at least theoretically, but to make the time in the air more productive and thereby improve efficiency and reduce training costs. This idea of STE not replacing time in the air was perhaps semantical in that if a student pilot in a Link Trainer could master flying from Airfield A to Airfield B in instrument conditions, he would, *de facto*, require less time in the aircraft to do it for real. In other words, time in the Link Trainer had reduced time in the air. The other key benefits afforded by synthetic training were that training could be undertaken in all weathers day and night; this meant night and instrument flying could be carried out on a bright sunny day or when inclement weather or training aircraft availability prevented flying. Training could be made scalable in that the difficulty of the training task could be increased in line with the pupil’s growing proficiency; and finally; that the training was repeatable such that training tasks could be reproduced using the same parameters.²⁹ This would allow students from the same cohort to receive exactly the same lesson so instructors could undertake comparative analysis as well as repeating exactly the same exercises for students that found initial assimilation difficult. It is also a truism, as Caro has stated, that the real aircraft provided a ‘poor learning environment’ and that the training device was better ‘from the transfer-of-training standpoint.’³⁰ This ‘transfer-of-training’ was not only relevant to the individual but was also vital in respect to training large crews to work together, as in the case of heavy bombers.

The RAF fully understood the benefits of STE from before the war, but this was made clear from the collective training standpoint as it affected Bomber Command in early 1942. As this statement in the RAF’s *Illustrated Catalogue of Synthetic Training Devices* highlighted: ‘Synthetic training is the exercising on the ground of air crews in their different roles in

conditions as similar as possible as those met in the air. The object is to avoid unproductive time in the air by first making crews as conversant as possible with their air duties on the ground'.³¹

The first major steps in adopting flight simulation in the RAF were taken in October 1935, when the Director of Training, Air Commodore Tedder, sent three officers to the United States to examine US Army Air Corps (USAAC) training methods with an emphasis on the Link trainer.³² The cost saving benefits of the Link Trainer, that 'ingenious American invention,' were not lost on Lord Swinton, Britain's Secretary of State for Air between 1935 and 1938.³³

'Sitting in a cabin in a room, for the cost of a few pennyworth of electricity, the pupil pilot can sit at the controls and drive [*sic*] his plane [*sic*] on a long journey under artificial conditions which reproduce the conditions he would encounter on a voyage of a thousand miles'.³⁴

The Link Trainer was the turning point in the RAF's recognition of the benefits of using other ground based training devices (examined later) although it was not the first major system to be introduced. The 'Bombing Teacher' was the initial major synthetic training system to be adopted by the RAF and, 'provided an excellent method in training personnel in the use of the bombsight without the necessity of going up in the air, thereby saving time, wear-and-tear on an aircraft and flying hours'.³⁵ It was also fundamental in providing a training medium to counter-balance the shortage of bombing ranges in the UK.³⁶ As far as the importance and future applicability of synthetic training equipment was concerned, the RAF was again quick to realise innovation could assist in training delivery.

Following its visit to the USA to view the Link Trainer, the Air Ministry ordered 51 devices that the Air Member for Training's *Notes on the History of RAF Training 1939-44* said entered service in September 1937.³⁷ By this time the RAF had realised that its standard of instrument flying was poor, there was a shortage of training aircraft; notably with the Don and Magister that were suffering from design issues; and that the formation of the RAF Volunteer Reserve (RAFVR) in 1936 combined with successive expansion schemes had placed increased strain on the training pipeline.³⁸ During a meeting of the Air Council in April 1938, the Air Member for Personnel, Air Marshal Sir William Mitchell, stated that aircraft shortages were impacting training, 'leading to a measure of stagnation'.³⁹ In short, 'training expansion [was] not keeping pace' with the rapidly increasing size of the RAF.⁴⁰ The Link Trainer therefore provided a method of addressing some of these issues but its adoption was not without challenges, particularly as far as how the trainer was to be used, how it was to be maintained, and how the provision of instructors to operate them was concerned.⁴¹ Many of these issues took nearly a year to resolve but this did not stop the RAF ordering another 150 Link Trainers on the basis that 'it was soon found that the standard of instrument flying was being steadily improved as a result of this synthetic device; although it does not assimilate flying conditions in the same manner as an aircraft, e.g. absence of noise, it served and still serves well for instrument flying practice'.⁴² This observation, written in 1944, highlighted the RAF's enthusiasm for the Link Trainer and this appreciation of synthetic training provided the impetus for the development of nearly

200 different trainers by 1942. An exemplar of such enthusiastic innovation and adoption was in the creation of the No.5 Group Bomber Command's Crew Training School (CTS) at RAF Finningley in January 1940 that was designed for crew (collective) training within the Group.⁴³ The formation of the school also highlighted how seriously Bomber Command and the wider RAF viewed synthetic training and how it was contributing to evolving and enhancing operational training.

As this paper highlights, the RAF, and Bomber Command in particular, embraced the use of STE throughout the war. According to Kreipe and Koester, this was not the case with the *Luftwaffe*, although many of the training shortfalls seen in Germany mirrored those of the RAF, such that: '...operational readiness within the flying units was extremely uneven. The most significant gaps in training were those felt by the bomber units, primarily as a result of insufficient training in night and instrument flight.'⁴⁴ As to the use of STE, German *ab initio* flying training schools [so-called A and B schools] 'had fuselage models [mock ups] with which to drill students' and limited numbers of Link Trainers 'for preliminary training in instrument flight.'⁴⁵ Link Trainers were mainly used at the multi-engine, or so-called C Schools.

Unfortunately, there was not enough of these valuable machines [Link Trainers] available. They did have certain defects, of course, and because of this their use was opposed by some, but they were extremely useful in teaching the student to think in terms of his position in space and in preparing him for practical flight training in real aircraft. Their use saved a good many flight hours.⁴⁶

C School students, the majority of which were to be bomber pilots, also used refurbished crashed aircraft that were re-wired 'so that the students could practice all the manual operations required for take-offs and landings and learn to work the landing flaps and tail-gear.'⁴⁷ Indeed, according to Adams, it was the C Schools that provided 'the only instance in which the Link Trainer [was] used in instruction courses for the German air force,' an opinion at variance with Kreipe and Koester's account.⁴⁸ In *Fighter*, Deighton claimed pilots arriving in operational bomber squadrons had 250 flying hours and '50 hours of simulated blind flying on the Link trainer.'⁴⁹ Deighton's source was C.G. Grey, editor of *The Aeroplane*, who visited the *Luftwaffe* in 1935.⁵⁰ The use of STE in the *Luftwaffe* was never exploited like the RAF and that, in part, led to the *Luftwaffe*'s 'generally inadequate training program [sic], that failed due to a lack of, 'uniform guidance and supervision.'⁵¹ In comparison, the RAF used the Link Trainer at every stage of its training process from the Elementary Flying Training School, including during holding at an Aircrew Personnel Reception Centre and in the operational squadron. Typical total Link Trainer hours following the end of an operational tour varied from over 60-70 hours while a pilot, then posted to become an instructor, would expect to accumulate over 90 hours in the Link Trainer.⁵²

In comparison, the lead service for STE in the US was the US Navy and work on the topic was carried out in the Special Devices Section, later to become the Special Devices Division, part

of the Bureau of Aeronautics (BurAe) and the direction that it took was clearly based on the experience of the RAF. Much of the information to enable the development of US Navy STE policy was furnished by a Special Naval Observer attached to the US Embassy in London in October 1941. Commander Luis de Florez had 'the primary goal of studying and observing the British approach to synthetic flight training devices and training methods.'⁵³ Upon his return to the US, he documented his findings in a *Report on British Synthetic Training*. De Florez's observations and his findings greatly influenced the future of the Special Devices Section. In the report, de Florez cited several key benefits of synthetic training. He wrote that: '... synthetic training increased the quality and quantity of training by providing familiarization with operational equipment to the point of instinctive response; allowed instructors to handle large numbers of students and allow them to "freeze" the action to point out student errors; constant practice on the ground trainers permitted crews to be sent into actual [flight] conditions far more safely than other techniques; valuable equipment would not be tied up as training aids.'⁵⁴ The importance of de Florez to the development of US Navy air training policy and delivery can be seen today in the fact that the US Naval Air Warfare Center Training Systems Division (NAWCTSD) headquarters in Orlando is housed in the de Florez complex.⁵⁵

Development of RAF STE Policy

The creation of a coordinated STE policy had its roots in the establishment of the No.5 Group Crew Training School at RAF Finningley that was announced by AOC No.5 Group, Air Vice-Marshal A.T. Harris, on 18 January 1940.⁵⁶ The high-level discussions surrounding the school did much to frame the RAF's policy towards STE and promote the topic to a wider audience. In a typical forthright Harris communication, the AOC No.5 Group was not asking permission from the Air Ministry to establish the new training school but declaring that a 'proposed' Elementary Ground Training Organisation was to be 'immediately introduced within the resources of this Group,' so as to put all crews 'through their individual procedure under realistic conditions on the ground,' before crews reported to their operational squadrons. Harris' aim was to remove the training load from the squadrons and 'to get crews 'pat' with the latest procedure and tactics...'⁵⁷ The drills were to be repeated until every crew was 'procedure perfect'. As part of the Crew Training School, as Finningley was to become known, Harris requested the recruitment of three school masters that have 'the inborne [*sic*] ability and qualities to apply and instil knowledge and that this type of instruction cannot be done by the ordinary RAF personnel who has [*sic*] little or no knowledge in the art of teaching'. Combined with the RAF's established recognition of the benefits of the Link Trainer, the correspondence generated by Harris' Crew Training School circulating at Air Council level led the Chief of Air Staff and Air Officer Commander-in Chief (AOC-in-C) Bomber Command staffs to start to define a policy for the use of STE.

This ground training school was an interesting development in terms of how it reflected the innovation of the RAF at the time. Personnel would recognise a 'training gap' and design and develop their own training aids to fill it. Although a commendable approach, it did have shortfalls, particularly concerning maintaining common standards in training and not adopting

best practice solutions; the latter with the possibility of creating to so-called 'negative training'. Harris' ground training school was not only innovative but highlighted his ability to identify a training problem and then find a solution; for example, using an old Hampden fuselage and a Link Trainer, the CTS provided a collective training environment for the complete crew. In providing an environment to practise individual skills, the CTS was also the catalyst for the training regime later adopted by the Group Pools/Operational Training Units. Each three week course comprised 12 pilots and 12 WOp/AGs and, with a new intake every week, the CTS contained 72 aircrew. Initially the CTS drew considerable support when with the Director of Staff Duties, Air Commodore R.P. Willock, said that 'A.V.M. Harris is well known for producing bright ideas...and that the CTS, should be adopted in Operational Training Units'. Willock finished by saying that '[m]y contention has always been that the more training that can be done on the ground to simulate conditions in the air, the higher standard we shall attain'.⁵⁸

Although clearly a significant concept that addressed the need to coordinate the training of multi-crew aircraft, the CTS faced a number of hurdles. The first of these was ironically provided by Harris who originally stated that the CTS would be staffed from No.5 Group resources but then requested an establishment of 13 officers and 19 other ranks to run the facility.⁵⁹ The second retardant to the project came from No.6 Group – Bomber Command's Group Pool Squadron organisation (Group Pools were renamed Operational Training Units (OTU) in early April, 1940), which was formed on 16 September 1939. The Group considered that the CTS course was 'too complicated and tends to restrict the flow of trainees unduly'. Although somewhat contradictory, No.6 Group also said that it would keep the same training but alter the syllabus.⁶⁰ This was perhaps damning by faint praise, but the third factor casting doubt on the CTS was that the three-week course took place after the Group Pools/OTU phase and thereby delayed even longer, the time taken for aircrew to reach their operational squadrons.⁶¹

Considering these newly formed Group Pools had to evolve to become effective before a working syllabus could be defined, it was clear that No.5 Group's CTS was well advanced in providing ground based synthetic training, but it was not unique in generating innovative STE solutions. At RAF Harwell, for example, No.3 Group Pool, which became No.15 OTU in April 1940, designed a wireless operator training device that was to become known as the Harwell Box.⁶² This provided the wireless operator with 'similar conditions to the aircraft' that included sound effects to provide a realistic environment for him to practise obtaining fixes, using the aircraft's DF loop antenna, operating his radio and conducting fault-finding. Along with the Link Trainer, Bombing Teacher and the Harwell Box, Group Pools/OTUs, gunnery schools and operational squadrons were equipped with different types of turret trainers that fired live rounds on outdoor ranges or indoors using cine films to allow gunners to track targets.

According to Rolfe and Bolton, 'The suggestion was made . . . that Finningley should become the Central School for Synthetic Training. . . [but] . . . The proposal was not approved'.⁶³ Considered on balance, an extra three weeks training; the establishment of 32 personnel to run the CTS and the retention of 72 aircrew in the training pipeline, when there was a major shortage of aircrew

not only within Bomber Command but the RAF in general, meant that the No.5 Group CTS was untenable. What it did achieve, however, was to highlight the need for a policy to try and standardise STE delivery and, to an extent, the design of STE, leading to the establishment of a number of committees to oversee the growing enthusiasm now being shown towards simulation. Harris, however, continued to lobby for his Group's CTS.

In a letter to Willock, Harris offered what was clearly a bribe when he agreed to release, on posting, an officer from CTS, requested by the Air Ministry, in exchange for Willock pushing the 'establishment through, which is held up by some lethargical [*sic*] office wallah in some pigeon hole or another...'⁶⁴ In this letter, Harris made some interesting observations about synthetic training as well as showing much of his character: 'Incidentally, although I do not mind for myself [he clearly did], I would suggest that a word of appreciation on the efforts made here to institute synthetic training and to design and organise the first of the synthetic trainers would surely not be out of place. At the present time, one hears all sorts of sideways references as to the value of these new methods of training, and the ingenuity displayed by those who thought of it and first put it into force. Unfortunately, signs are not wanting that although I originated it in my office, in conference with a few of my staff, and then proceeded in conjunction with the C.O. at Finningley entirely off our own bats to institute the whole business, there are a most astonishing number of claimants in the field already, outside the Group, to having thought of it and instituted it first.'⁶⁵

Harris' comments on 'a word of appreciation' clearly got through as, later that month, Group Captain Maycock, the Station Commander and its parent CTS, received a letter from the Air Council saying that 'their attention [had] been drawn to the noteworthy services which you [had] rendered.'⁶⁶ Harris' initiative may have been recognised but the pressures on the CTS were too great and, perhaps ironically, proceeding the Air Council's letter of recognition, DWTT stated that the CTS could not be established and the training developed at Finningley should be transferred to the bomber OTUs.⁶⁷ This was a major policy decision that began to define the future roles of the newly established OTUs.

Harris's CTS initiative still retained support, at least in HQ Bomber Command. The AOC-in-C Bomber Command, Air Marshal Portal, told the Air Member for Supply and Organisation (AMSO), Air Marshal Courtney, that the CTS 'was quite indispensable at present and I must ask you at all costs to let it be established temporarily,' and that the school had a 'far reaching effect throughout the Air Force,' which provided a stay of execution. Portal argued that closing the CTS would be 'false economy' as it was 'preventing the loss of crews' and 'increasing operational efficiency.'⁶⁸ This appreciation of Harris's efforts and support shown to him is illuminating given Portal's patience with him in the latter stages of the war when Harris attacked the transportation plan in the run-up to D-Day in favour of continued strategic bombing.⁶⁹ Although the CTS worked on using its own resources for a number of months, the subsuming of OTUs within No.6 Group and the adoption of the synthetic training methods developed by No.5 Group within the OTUs gradually reduced the need for the extra training.⁷⁰

Combined with the arrival of more Link Trainers, No.5 Group's creation of a range of other synthetic ground-based trainers, and the disagreements between HQ Bomber Command, DWTT and AMSO on how such training equipment should be used, the Air Ministry decided to create a committee to focus on synthetic training to better define its application and to formalise STE policy. Initially, Ludlow Hewitt, AOC-in-C Bomber Command, suggested forming a separate branch of the Air Ministry to coordinate synthetic training policy, but this idea was subsequently dismissed by Willock as DWTT and it was decided to opt instead for a committee.⁷¹ As a result, the 'Simulation of Air Training on the Ground Committee' held its first meeting on 11 March 1940.⁷² The creation of this committee was a significant step by the Air Ministry and highlighted how seriously it viewed the adoption of synthetic training. With the DDWTT, Group Captain H.G. Crowe, as its chairman, the aims of the committee were defined to:

- a. Study the requirements of aircrew training and determine what training devices could be used, 'including cinematography'.
- b. Prioritise the development of synthetic training equipment.
- c. Issue recommendations on the provision and installation of synthetic training equipment.
- d. Liaise with the Army and Royal Navy concerning their use of synthetic training equipment.⁷³

From the third meeting in May 1940, the committee had grown from 18 members at the March meeting to 27 and had changed its name to the Synthetic Training Committee.⁷⁴ DWTT Air Commodore Willock stated that now the war 'had started in earnest, the necessity for conserving petrol, engine hours, and operational aircraft, was of vital importance' and there was a requirement, 'to make the greatest possible effort towards the introduction of further facilities for synthetic training'.⁷⁵ These 'further facilities' were certainly forthcoming, either as a result of individual or unit innovation to address a specific training need, or through the procurement of synthetic training equipment from industry. In short, 'the diversity of suggestions, ideas, and methods increased steadily'.⁷⁶ It could be argued that the RAF was pursuing the adoption of this synthetic training equipment with single-minded zealotry. The challenge they faced however was twofold; firstly, the manufacture of training equipment 'was on a low priority'; secondly, equipment designed by individuals and units was not standardised and was therefore frequently being 're-invented'. In addition, it did not take advantage of pooled best practise in terms of design knowledge, technology or policy.⁷⁷

The power of the Synthetic Training Committee was boosted from June 1940 with the creation of a new Air Council post, the Air Member for Training, who would now assume responsibility

for the Committee. At an Air Council Meeting of 21 June 1940, the Secretary of State for Air, Sir Archibald Sinclair, said that 'the biggest question of all' faced by the Air Ministry 'was the production of pilots and crews.'⁷⁸ The importance of this task was reflected by the appointment to the Air Council of an officer 'who would be in executive control of training in all its aspects' who had 'direct access to the Secretary of State'. The new Air Member for Training would take over the Air Ministry's Directorate of Training and 'certain branches of DWTT (T.W. 1, T.W. 2, and T.W. 3)'. The position of Air Member for Training (AMT) was officially established by an Order in Council dated 26 June 1940 and Air Vice-Marshal A.G.R. Garrod was appointed to the post by Sinclair on 28 June 1940, in the rank of (Acting) Air Marshal.⁷⁹

In January 1941, the coordination of synthetic training was being managed within the AMT's T.O. 5 branch.⁸⁰ Synthetic training methods were becoming increasingly popular such that the STC meeting in early March 1941 drew 45 attendees, 'many of whom could not get near the table'.⁸¹ As popular as synthetic training was becoming, standards applied to its use were problematic. In his report following visits to Bomber Command OTUs in December 1941, the RAF's Inspector General, Air Chief Marshal Ludlow-Hewitt, said that '[i]t is very gratifying to note how well synthetic training has developed at these OTUs' but warned that 'some are much better than others' and officers that are responsible for synthetic training should visit the better OTUs 'to see how it should be done'.⁸² There were also problems of supply and demand. Priorities and production difficulties limited the amount that could be turned out, either by RAF units or by manufacturers, and the introduction of synthetic training was, in consequence, severely handicapped throughout 1940 and 1941.⁸³

Another example of this shortfall was the use of sodium flares with which to practise night landings during the day. According to Ludlow-Hewitt's report, following his visit to OTUs in December 1941, a shortage of sodium flare training systems, combined with aircraft serviceability issues, were the reasons for, 'the main bottle-neck delaying the completion of the flying syllabus at OTUs...'.⁸⁴ The sodium flare training devices featured the pilot wearing smoked lens goggles that blacked out normal vision less for the sodium flares and the system therefore simulated landing using a flare-path at night. The issues surrounding the paucity of such training systems were already being communicated between April and June 1941. In a letter to Director General of Production – Aircraft Equipment - DGP (AE), AMT Air Marshal Garrod said that 'serious concern is being felt by the restriction on the expansion of our Bomber Force' by a lack of 'sodium flare paths'.⁸⁵ To address these difficulties, the terms of reference for the Synthetic Training Committee were altered in March 1942, giving it greater control over its decisions. The additions included 'laying down policy', to 'approve final specifications and to recommend scales of issue', and to 'direct the programme of work at the STDU [Synthetic Training Development Unit], and the ATDU [Armament Training Development Unit]'.⁸⁶ The result was a tightening of the STC's grip on synthetic training policy and management. The delays in providing STE, in this case, sodium flare paths, also highlighted how easy it was for the training pipeline to be disrupted by what on the surface, was a minor occurrence.

Procurement and Management of STE

The majority of the STE to enter service with Bomber Command was domestically made and to address issues of standardisation, the RAF began to issue Synthetic Training Committee Papers (STCP) that could be used by units to build devices to a common design. This initiative was supplemented by the creation of the Navigation Synthetic Training Development Unit (NTSDU) that was collocated with the Phillips & Powis factory at Woodley aerodrome in April 1941. Comprising three officers and seven civilian draughtsmen, engineers and a secretary, the organisation was tasked with designing and building training devices for map reading, dead reckoning navigation, astro-navigation and 'incidental devices'.⁸⁷ A number of devices were designed by the unit and these included the Air Navigation Instructor, the DR Instructor, the Celestial Observer Stellascope, the Practice Drift Indicator and Pictorial Britain; not all were accepted by the RAF. The NSTDU changed its name to the Synthetic Training Development Unit (STDU) in early 1942 where its role was broadened to reflect a growing need for STE.⁸⁸

The STDU had three main aims: to develop synthetic training devices for aircrew, with the exception of armament, signals and radar; to examine and filter new ideas and assist in the development of those approved; and, finally, to standardise training devices 'as far as possible'.⁸⁹ The STDU's efficiency was questioned due to a failure to prioritise training system development and its role was subsumed within the Ministry of Aircraft Production and the Training Aids Development Unit was established at RAF Cardington in April 1943.⁹⁰ The real issue faced by the RAF, with this rapid adoption of synthetic training equipment, was a lack of knowledge as to the manpower requirements involved in terms of maintenance support and the provision of instructors. This issue was highlighted with the Link Trainer where these challenges – along with the scale of issue of trainers - were addressed in late 1938, but it took until 1942 for the challenges to be fully resolved.⁹¹

Although the STC was providing STE policy, the management involved in controlling production, standards, testing and quality assurance was clearly lacking. This applied to both the unit manufactured devices contained in the STC Papers and the more formal manufacturing processes seen with the NTSDU/STDU organisation, and later, when it was subsumed into the MAP TADU conglomerate. Although UK process had clear issues that impacted how STE was managed and procured, Dawson has argued that it had advantages over the US 'sequential design, test, redesign' approach before 'manufacturing and procurement' started.⁹² Although the British process was more risky, de Florez decided to adopt it in the US Navy's Special Devices Section, 'to save time' and foster innovation.

One key factor to affect overseas procurement concerned the growth of the US Army Air Corps (USAAC) and its subsequent call on the Link company for synthetic training equipment. It is highly likely that Roosevelt's policy, 'that powerful United States Air Forces must be created and maintained and that every appropriate aircraft built in the United States should be manned and fought by American crews,' also had an impact on STE.⁹³ Already successful in selling Link Trainers around the world to countries such as Japan, Germany, the USSR and

France, a growing focus on the home US market meant that the RAF suffered increasing supply issues.⁹⁴ By early 1941, the RAF's adoption of the Link trainers was being retarded by a lack of spares and a failure by the Link company to meet deliveries.⁹⁵ The issue of Link prioritising US orders over those of the UK can be seen with the development of the Link Crew Trainer – initially referred to by Link as the Starglobe.⁹⁶ Again, Harris played a central role through his assistance in procurement of this device following his posting to the US as the head of the RAF delegation to the British Military Mission following commanding No.5 Group and holding the post of DCAS.⁹⁷ This device, also referred to earlier by the RAF's preferred nomenclature, the Celestial Navigation Trainer, was developed by the Link Company in conjunction with the RAF and was designed to train pilots, navigators and bomb aimers in long range navigation – a critical skill as part of the strategic bomber offensive as well as in ferrying aircraft from the US across the Atlantic.⁹⁸ Service trials on the device were conducted at No. 31 School of Air Navigation at RAF Port Albert in Ontario.⁹⁹ In his covering letter to the trials report, head of the British Air Commission, Air Marshal Sir Roderic Hill, highlighted the need to place orders before factory output went to the US Navy and US Army Air Corps. 'The necessity for placing an early order for these Trainers cannot be over emphasized in view of the fact that it is understood that 90 of these Trainers are being ordered by the U.S. Army and Navy'.¹⁰⁰

The report itself was highly supportive of the device and stated that it was 'an ideal instrument for the training of air observers and crews. Its immediate adoption in the RAF is most strongly recommended'. The report continued that, 'a large proportion of the air observer training may be carried out better in this instrument than it can be in the air' and that the device will 'improve vastly the quality of graduates and will enable their training to reach a standard that has hitherto been impossible'. With the Celestial Navigation Trainer 'dramatically' reducing flying time and reducing 'considerably the cost of training,' it is perhaps surprising that the device was not bought in larger numbers; here, financial pressure and poor project management were at the root of the problem.¹⁰¹

The RAF dithered in ordering the device for a number of reasons. The major issue was the 'prohibitive cost' of the device at £80,000 each (this equates to £5.17 million in 2023 prices).¹⁰² In his Minute Sheet comments, Air Commodore Huskinson, Director of Armament Development (D Arm D), the initial Air Ministry procurement authority for the Link Crew Trainer, also highlighted an 18-24 month delivery schedule and that such a timescale would mean that the device, in D Arm D's mind, would have 'missed its usefulness as far as our war effort is concerned'.¹⁰³ This comment was clearly loaded with the foresight that it did not merit. Further negativity was added with the comment that 'the U.S. Government will probably obtain priority' for the devices. Here another reason emerges for failure to procure the devices earlier.¹⁰⁴ In support of D Arm D's views, a cipher from the British Air Commission in Washington to the Air Ministry in February 1941 had stated that the US Army and Navy were about to place an order for 70 Link Crew Trainers, further adding to the idea that the RAF 'had missed the boat'.¹⁰⁵ This caused little alarm within the Air Ministry as in March 1941 MAP had refused to sanction orders until the trial had been completed in Canada.¹⁰⁶ This risk-averse view was

not universal. AMT, Air Marshal Garrod, sent the Head of RAF Staff in Washington, Air Vice-Marshal Harris, a cipher in August 1941 recommending ordering the devices and saying that he was looking for a funding stream for procurement.¹⁰⁷ In September, Harris wrote to Air Commodore Cochrane, the Director of Training under AMT, to inform him that he was attending a meeting and that it was 'most urgent' that he be told how many devices the RAF required. Harris continued that he needed an 'immediate decision' but 'feared it might already be too late.'¹⁰⁸ The response again highlighted financial issues: 'it is not practicable to give speedy decisions. Haven't got two-and-a-half million dollars'. The Air Ministry went on to say that 'if they are to be obtained at all' it will have to be through 'lend-lease arrangements'.¹⁰⁹

The lend-lease requisition, BSC.6464, was filed by the BAC for 100 Link Crew Trainers on 21 October 1941. The first deliveries were expected to commence in June 1942 and proceed at a rate of five per month.¹¹⁰ This number was later reduced to 60 with the first device not being fully ready for training until early 1943.¹¹¹ The problem was that of output as the US had placed requisitions for 87 for the US Army Air Corps and 34 for the US Navy.¹¹² According to Rolf and Staples, not all of those devices destined for the UK entered service with some passed back to the US under the terms of reverse lend-lease.¹¹³

Application of STE

Before the Bombing Teacher entered service with the RAF, the Service was using the camera obscura during the First World War and it remained in-service up until 1939. According to Pattinson, '[the] pupil flies over the camera obscura which throws an image of his aircraft on to a table. He makes a bomb dropping signal [normally a light or radio signal], and that is plotted in the camera obscura office, and the man operating the camera obscura will tell the pilot where his bomb would have gone.'¹¹⁴ The Operational Record Book of No.12 (Bomber) Squadron, highlights that camera obscura exercises would normally last a week.¹¹⁵ To achieve correction for wind direction and strength, the camera obscura operator marks 'the point at which the image of the machine appears on the chart at the time of the signal is noted' before calculating the aircraft's height and speed along with wind strength and direction.¹¹⁶ Being such a small and portable device, camera obscura were frequently located in towns to make the training exercises more realistic.¹¹⁷ Although the device remained in service up until 1939, STE, such as the Bombing Teacher, and later, Celestial Navigation Trainer, overtook the earlier device. Larger bomber crews also meant that the need arose to conduct collective training that involved the complete crew.

In that regard, one of the most significant training exercises to emerge from Finningley and that was later to be adopted by all bomber OTUs was the Ground Operational Exercise (GROPE).¹¹⁸ GROPEs took place in a Crew Procedures Trainer (CPT) that comprised cubicles for each crew member and frequently a Link Trainer for the pilot. The cubicles contained the main equipment and instrumentation for each discipline, with hydraulic and electrical power being provided from 'external sources'. The exercise was managed from a control table at which sat the exercise controller, a signaller and a plotter. GROPE exercises featured sound

effects, navigation plots shown on an epidiascope and bright lights to simulate searchlights. Throughout the exercise, engine noise as well as that of simulated flak where appropriate, was fed into the cubicles via speakers. Each exercise was conducted with what is now referred to as a Master Events List (MEL) that drove the scope of the exercise and crews went through the whole process of pre-flight briefings, the flight itself and then post-flight debriefings. The introductory briefing paragraph of GROPE No. 5 is shown below and describes the scope of a typical exercise.

As in the case of Ground Operational Exercise No. 4, Grope No. 5 has been designed primarily for training crews in the location of targets at night. The normal navigational problems are included in the exercise, particular stress being laid on the plotting of loop bearings obtained in conjunction with the re-diffusion loop trainer. Four examples of the plotting of astronomical bearings are also included, so that those trainees who have received instruction in this form of navigation may have practice, and the normal operational identification procedure, etc., is provided.¹¹⁹

This instruction to GROPE No.5 makes reference to the loop trainer and indicates how by 1942, the RAF was using a range of different individual synthetic training devices before using collective trainers such as the Crew Procedures Trainer.

Conclusion

As this paper has shown, the RAF had a pragmatic appreciation of the benefits of STE and integrated numerous training devices into its operational flight training syllabi in the period running-up to the Second World War and during the war itself. It can be seen that STE saved fuel and wear-and-tear costs in comparison to using real aircraft. Its adoption also added another layer of air safety by aiming to increase a crew's preparedness before they undertook exercises in the air. Although the RAF always maintained that the use of STE would not reduce actual flying hours, the ability to practise on the ground ensured that time in the air was not wasted. In short, the adoption of such devices provided improved levels of training transfer and, in the case of multi-crew aircraft, an excellent collective training environment where individual crew members could work together. In addition, training devices, such as the Link trainer, offered a relatively high fidelity level of training in the period of expansion when training aircraft and airspace were at a premium. The wartime RAF was at the forefront of using STE in an integrated training environment and must be considered as the premier exponent of STE during its expansion and early war years especially when compared to the *Luftwaffe's* minimal use of such technologies. The RAF's STE policy and application was also the catalyst for the development of synthetic training in the US Navy as evidenced by the de Florez report.

Another observation on the use of STE by the RAF centres on the enthusiasm shown by individuals and units for its adoption. This is epitomised by organisations such as No.5 Group's CTS at RAF Finningley and 15 OTU at RAF Harwell where innovation, initiative and a desire to improve training delivery came together to provide a driver for the RAF's approach to STE,

especially as far as its policy, procurement, management and application was concerned. Despite some difficulties surrounding procurement and domestic manufacture, the use of STE by Bomber Command was a major boost to the effectiveness of its operational training and its adoption and growth were significant catalysts for the delivery of improved training as the war progressed.

Notes

¹ TNA AIR 10/5551, *Flying Training Volume 1, Policy and Planning*, p. 27. As to the US use of the Link Trainer see for example, K.P. Werrell, 'Flying Training: The American Advantage in the Battle for Air Superiority against the Luftwaffe', *Air Power History*, Vol. 61, No. 1, Spring 2014, p. 37.

² <https://comoxairforcemuseum.ca/heritage-team-project-link-trainer/>. Accessed 15 February 2021 and taken from L. Kelly, *The Pilot Maker* (New York: Grosset & Dunlap, 1970), p. 68.

³ TNA AIR 41/4, AHB, *Aircrew Flying Training 1934-1942*, p. 563.

⁴ M. Baarspul, 'A Review of Flight Simulation Techniques', *Progress in Aerospace Sciences*, Vol. 27, No. 1, 1990, p. 7.

⁵ R.L. Page, *Brief History of Flight Simulation*, paper delivered at SimTect Conference, Feb 2000.

⁶ Baarspul, 'A Review of Flight Simulation Techniques', p. 8.

⁷ *Ibid.*, pp. 8-9.

⁸ TNA AIR 2/3940, Letter from AOC-in-C Fighter Command to AOC-in-C Bomber Command discussing the joint servicing of the devices at Bentley Priory and Uxbridge, 26 May 1939.

⁹ P. Dawson, 'Luis de Florez and the Special Devices Division' (PhD Thesis, George Washington University, 2005), p. 86.

¹⁰ J.M. Rolfe & M. Bolton, 'Flight Simulation in the Royal Air Force in the Second World War', *RAeS Aeronautical Journal*, October 1988, p. 315.

¹¹ TNA AIR 10/5551, *Flying Training Vol. 1, Policy and Planning*, p. 8.

¹² O. Thetford, *Aircraft of the Royal Air Force Since 1918* (London: Putnam, 1976) provides service details of the aircraft.

¹³ *Ibid.*, p. 15.

¹⁴ TNA AIR 20/1347, *Notes on the History of RAF Training 1939-44*, AMT, January 1945.

¹⁵ TNA AVIA 15/1428, Minutes of the 5th Meeting of the Synthetic Training Committee, 6 September 1940.

¹⁶ TNA AVIA 15/1428, Minutes of the 13th Meeting of the Synthetic Training Committee, 2 May 1941. For the growth of such devices, see TNA AIR 20/1348, Minutes of the 7th Meeting of the Synthetic Training Committee, 8 November 1940.

¹⁷ TNA AIR 41/4, p. 560.

¹⁸ TNA AIR 20/1347, *Notes on the History of RAF Training 1939-44*.

¹⁹ RAFM. A look at the Air Force Lists during the inter-war and early war years shows that pilots were undertaking all key staff functions.

²⁰ TNA AIR 20/1347, *Notes on the History of RAF Training 1939-44*, refers to the reduction in the training organisation to the minimum and subsequent lack of investment.

²¹ TNA AIR 10/5551, *Flying Training, Vol. 1, Policy and Planning*, p. 8.

- ²² TNA AIR 20/1334, Aircrew Training Conference, Minutes of the Opening Meeting held in the Air Council Room, on 23 January 1942, p. 4.
- ²³ T. Nash and G. Ebbutt (eds.), *IHS Jane's Simulation & Training Systems 2018-2019* (London: Jane's, 2018), p. 357. Referred to as zero flight time training and conducted on a FAA Level D full flight simulator.
- ²⁴ <https://www.shephardmedia.com/news/training-simulation/premium-new-a400m-simulator-opens-network-opportun/>. (Accessed 19 March 2021).
- ²⁵ JSP 822, Part 2, *Training and Education Glossary*.
- ²⁶ TNA AIR 20/1347 contains the Minutes of the Air Ministry's Simulation of Air Training on the Ground Committee.
- ²⁷ TNA AIR 2/8644, Minute Sheet, DWTT to ACAS(T), 20 February 1940.
- ²⁸ <https://research-methodology.net/forms-of-training-transfer/>. (Accessed 23 March 2021).
- ²⁹ Nash and Ebbutt (eds.), *IHS Jane's Training and Simulation Systems 2018-19*, pp. 16-18.
- ³⁰ P.W. Caro. 'Aircraft Simulators and Pilot Training', *Human Factors*, Vol. 15 No. 6, 1973, p. 6.
- ³¹ TNA AIR 20/6058, *Illustrated Catalogue of Synthetic Training Devices*, AMT, May 1942.
- ³² V. Orange, 'Tedder and the Air Ministry', P.W. Gray & S. Cox (eds.) *Air Power Leadership – Theory and Practice* (London: The Stationery Office, 2002), p. 230.
- ³³ H. Montgomery Hyde, *British Air Policy Between the Wars: 1918-1939* (London: Heinemann, 1976), Appendix III.
- ³⁴ Lord Swinton, *I Remember* (London: Hutchinson, undated), p. 124, quoted by Orange in 'Tedder and the Air Ministry'.
- ³⁵ TNA AIR 20/1347, *History of RAF Training 1939-1945*.
- ³⁶ L.A. Pattinson, 'The Training of a Royal Air Force Pilot', *RUSI Journal*, 83 Feb/Nov 1938, p. 16.
- ³⁷ TNA AIR 20/1347, *Notes on the History of RAF Training 1939-44*, p. 272.
- ³⁸ TNA AIR 6/33, Minutes of the 117th EPM of 15 March 1938.
- ³⁹ TNA AIR 6/33, Minutes of the 121st EPM of 12 April 1938.
- ⁴⁰ TNA AIR 10/5551, *Flying Training Volume 1, Policy and Planning*, p. 28.
- ⁴¹ TNA AIR 2/3940, contains considerable correspondence between the Air Ministry Director of Training, 26 Group, Commands and the Under Secretary of State for Air dated between October and December 1938 concerning the establishment and support for Link Trainers. A conference was held at the Air Ministry on 14 November 1938 'to discuss the basis of establishment of link [sic] trainers'.
- ⁴² TNA AIR20/1347, *Notes on the History of RAF Training 1939-44*, p. 272.
- ⁴³ TNA AIR 2/8645 and AIR 2/8646 contain correspondence between AOC No.5 Group, HQ Bomber Command, Director of War Training & Tactics and CAS.
- ⁴⁴ Kreipe and Koester, *Pilot and Aircrew Training in the Luftwaffe 1921-1945*, p. 47.
- ⁴⁵ *Ibid.*, p. 134.
- ⁴⁶ *Ibid.*, p. 234.
- ⁴⁷ *Ibid.*, p. 311.
- ⁴⁸ J.E. Adams, 'The Luftwaffe', *Flying Magazine*, March 1944, p. 51.
- ⁴⁹ L. Deighton, *Fighter* (New York: Alfred A. Knopf, 1978), p. 109.
- ⁵⁰ NAL, C.G. Grey Papers, Section 11, letter to General Milch, 1935.

- ⁵¹ Kreipe and Koester, *Pilot and Aircrew Training in the Luftwaffe 1921-1945*, pp. 282-3.
- ⁵² Pilot Flying Log books for Flt Lt J. Cox, Sqn Ldr M. Beetham and W/O C. Goff <https://internationalbcc.co.uk/history-archive/digital-archive/>. (Accessed 15 January 2021).
- ⁵³ P. Dawson, 'Luis de Florez and the Special Devices Division' (PhD Thesis, George Washington University, 2005), p. 99.
- ⁵⁴ *Ibid.*, p. 100.
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- ⁵⁷ TNA AIR 2/4168, Letter from AOC No.5 Group to HQ Bomber Command, 18 January 1940.
- ⁵⁸ TNA AIR 2/8645, Minute Sheet comments by DSD, 5 February 1940. This minute sheet comment referred to a letter from HQ Bomber Command to No.5 Group, dated 1 February 1940, giving authority for the CTS.
- ⁵⁹ TNA AIR 2/8646, Letter to Air Ministry from HQ Bomber Command, 25 May 1940.
- ⁶⁰ TNA AIR 2/8646, Letter from HQ Bomber Command to Under Secretary of State for Air, 18 May 1940.
- ⁶¹ TNA AIR 6/33, Minutes of 149th EPM held on 11 January 1939.
- ⁶² TNA AIR 41/40, pp. 14-15.
- ⁶³ Rolfe and Bolton, 'Flight Simulation in the Royal Air Force in the Second World War', p. 316.
- ⁶⁴ TNA AIR 2/8646, Letter from AOC No.5 Group to DSD, 2 June 1940.
- ⁶⁵ *Ibid.*
- ⁶⁶ TNA AIR 2/8646, Letter from Air Council to OC 106 Squadron, RAF Finningley, 26 June 1940.
- ⁶⁷ TNA AIR 2/8646, Letter from DWTT to HQ Bomber Command, 19 June 1940.
- ⁶⁸ TNA AIR 2/8646, Letter from AOC-in-C Bomber Command to AMSO, 26 June 1940.
- ⁶⁹ Harris, *Despatch on War Operations*, p. 23.
- ⁷⁰ TNA AIR 41/4, *AHB Narrative, Aircrew Training 1934-1942*, p. 238. The term OTU replaced Group Pool from April 1940. No.6 Group took over responsibility for Group Pools, later OTUs, from September 1939. See TNA AIR 2/4168 Loose Minute from DSD to HQ Bomber Command, 9 September 1939.
- ⁷¹ TNA AIR 2/8644, DWTT comments on Minute Sheet, 20 February 1940.
- ⁷² TNA AIR 20/1348, Minutes of the Simulation of Air Training on the Ground Committee, 1st Meeting held on 11 March 1940 in Harrow.
- ⁷³ TNA AIR 20/1347, *Notes on the History of RAF Training, 1939-1944*.
- ⁷⁴ TNA AIR 1348, Minutes of the Synthetic Training Committee Meeting, 16 May 1940.
- ⁷⁵ *Ibid.*
- ⁷⁶ TNA AIR 41/4, *AHB Narrative, Aircrew Training 1934-1942*, p. 562.
- ⁷⁷ TNA AIR 20/1347, *Notes on the History of RAF Training 1939-1944*.
- ⁷⁸ TNA AIR 2/4550, Notes of a Meeting Held on the 21 June 1940, 24 June 1940.
- ⁷⁹ TNA AIR 2/4550, Order in Council, 26 June 1940.
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- ⁸¹ TNA AIR 2/8645, Memorandum T.O.5 to S.2.A., 10 March 1941.
- ⁸² TNA AIR 20/2769, RAF Inspector General Report No. 218, Visits to Operational Training Units in Bomber Command, 15-23 December, 25 December 1941.

⁸³ TNA AIR 41/4, *AHB Narrative, Aircrew Training 1934-1942*, p. 563.

⁸⁴ TNA AIR 20/2769, RAF Inspector General report No. 218, Visits to Operational Training Units in Bomber Command, 15-23 December 1941, 25 December 1941.

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⁹⁰ Rolfe and Bolton 'Flight Simulation in the Royal Air Force in the Second World War,' p. 316.

⁹¹ TNA AIR 2/3940, Notes on a Conference Held at the Air Ministry on Monday 14 November, 1938, to discuss the basis of establishment of link [*sic*] trainers, 14 November 1938.

⁹² Dawson, 'Luis de Florez and the Special Devices Division,' p. 101.

⁹³ 'The American-British Memorandum of Agreement dated 21 June 1942 – The Arnold/Towers/Portal Agreement.' <https://history.state.gov/historicaldocuments/frus1941-43/d299>. (Accessed 9 March 2021).

⁹⁴ Baarspul, 'A Review of Flight Simulator Techniques,' p. 9.

⁹⁵ TNA AVIA 38/769, Secret Cypher from BAC to MAP, 21 March 1941.

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⁹⁷ H. Probert, *Bomber Harris His Life and Times* (London: Greenhill Books, 2006), p. 116.

⁹⁸ TNA AVIA 15/38, Secret Cypher from BAC to MAP, 25 August 1941.

⁹⁹ TNA AIR 20/4113, The Link Celestial Navigation Trainer - Report of a Trial done at No. 31 School of Air Navigation, RAF Port Albert, Ontario, 1 September 1941.

¹⁰⁰ *Ibid.*

¹⁰¹ TNA AIR 20/4113, The Link Celestial Navigation Trainer - Report of a Trial done at No. 31 School of Air Navigation, RAF Port Albert, Ontario, 1 September 1941.

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¹⁰³ H. Probert, *Bomber Harris – His Life and Times* (London: Greenhill Books, 2006), p. 117 and 420. Harris was Head of British Air Staff in Washington from 27 May 1941 until 22 February 1942. Harris worked closely with the British Air Commission, the purchasing agency for US aircraft and equipment that represented MAP.

¹⁰⁴ TNA AIR 20/4113. Minute Sheet comment by D.Arm.D., 25 April 1941.

¹⁰⁵ TNA AIR 20/4113, Secret Cipher from BAC to Air Ministry, 15 February 1941 and Secret Cipher from the US Air Attaché to Air Ministry, 15 February 1941.

¹⁰⁶ TNA AIR 20/4113, Minute Sheet comment by A.D.T.O., 6 March 1941.

¹⁰⁷ TNA AIR 20/4113, Secret Cipher AMT to Head of RAF Staff BAC Washington, 27 August 1941.

¹⁰⁸ TNA AIR 20/4113, Secret Cipher Head of RAF Staff BAC Washington to DOT, Air Ministry, 17 September 1941.

¹⁰⁹ TNA AIR 20/4113, Secret Cipher Air Ministry to Head of RAF Staff BAC Washington, 20 September 1941.

¹¹⁰ TNA AIR 20/4113, Secret Cipher from BAC to MAP, 27 November 1941.

¹¹¹ TNA AIR 2/8785, Agenda for 33rd Synthetic Training Committee Meeting, March 1943.

¹¹² Ibid.

¹¹³ Rolf & Staples, *Flight Simulation*, pp. 26-27.

¹¹⁴ L.A. Pattinson, 'The Training of a Royal Air Force Pilot', *JRUSI*, 83 Feb/Nov 1938, p.16.

¹¹⁵ TNA AIR 41/39, *The RAF in the Bomber Offensive Against Germany – Vol 1, Pre-War Evolution of Bomber Command 1917 to 1939*, p. 44.

¹¹⁶ Wonders of World Aviation published Part 22, 2 August 1938,

<https://www.wondersofworldaviation.com/mobile/auxiliary.html>. (Accessed 9 March 2021).

¹¹⁷ For example, 57 Sqn undertook bombing exercises between 17-19 October 1932 over Northampton, Portishead and Cardington. <https://57squadron.wordpress.com/between-the-wars/>. (Accessed 8 March 2021).

¹¹⁸ TNA AIR 20/6056, *Bomber Command Synthetic Training Manual*, published 1943.

¹¹⁹ Ibid.

Article

UK Space Power: Contextualising the Need for Space Control

By Squadron Leader James Payne

Biography: Squadron Leader James ‘Buzz’ Payne is an Air Operations (Systems) Officer who has previously served at UK Space Command, RAF High Wycombe. As a direct entrant into the Service, he has completed his higher education part-time, most recently his CAS Fellowship for an MA in Air Power in the Modern World with King’s College London’s War Studies Department.

Abstract: The modernity of space enterprise brings great innovation and benefits globally, but with it comes additional congestion and competition in the Space domain. Dependency on space for economies as well as national security has driven development of Space Control capabilities to not only protect a Nation’s own assets but also to deceive, disrupt, deny, degrade, or destroy a potential adversary’s space systems. Thus, there is a need for a shift in both attitude and mindset toward Space and its importance to give it the attention and credence in the face of the evolving threat. This article will contextualise the need for space control by providing a potted history of UK Space Power as well as an overview of the development in global counter-space weapons and the threat today.

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Introduction

The diversification and proliferation of capabilities and services derived from space grows with each passing year and with it comes a renewed focus on the domain's importance - not only for military operations, but also UK prosperity. During the Cold War, the first space age was intrinsic to the ideological struggle between the superpowers and its enormous cost meant that it was ruled by only a few nations. The 21st Century by contrast has seen the success of private enterprise, or 'New Space'; companies such as United Launch Alliance and SpaceX operate rockets for launching spacecraft into orbit and there are a plethora of companies offering other services such as imagery, communications, commercial Signals Intelligence (SIGINT), and weather monitoring. What is more, these services can be bought at a relatively low cost, so ownership of satellites and launch capabilities is not necessary for nations and non-state actors alike to access products derived from space.

In December 2019, the United States took the bold step of establishing the world's first independent space force. Coming under the Department of the Air Force, the United States Space Force (USSF) is responsible for the organising, training, and equipping its personnel to 'conduct global space operations that enhance the way our joint and coalition forces fight, while also offering decision makers military options to achieve national objectives.'¹ Also in 2019, NATO's approach to space changed; Allies adopted a new Space Policy and recognised it as an operational domain alongside land, sea, air and cyberspace.² Though the RAF has 500+ personnel employed in Space related duties such as the Ballistic Missile Early Warning System (BMEWS) at RAF Fylingdales in North Yorkshire and the Space Operations Centre (SpOC) at RAF High Wycombe, the UK does not have the resource or the capital to start its own independent space service. Rather, it established the joint UK Space Command at RAF High Wycombe on 01 April 2021, under the command of Air Vice-Marshal Paul Godfrey. It is the defence lead for space operations, space workforce and space capability and is responsible for protecting and defending the UK's interests in space. The publication of the National Space Strategy (NSS) followed on September 27, 2021, and brings together civil and defence policy to set out the government's ambitions for the UK in space. The subsequent Defence Space Strategy (DSS) was released on 01 February 2022, and sets out how Defence will support national efforts to become a meaningful actor in space. The UK's Space Power doctrine has also been decoupled from UK Air Power doctrine into a standalone document, Joint Doctrine Publication 0-40.

To emphasise the importance of education, UK Space Command then delivered on establishing the UK Space Academy, which declared its Initial Operating Capability in September 2023 to deliver space training. In November, it was confirmed that the Space Academy will be based at the Defence Academy of the United Kingdom, near Shrivenham in Oxfordshire. The following month, AVM Godfrey announced at the Defence Space Conference that UK Space Command's two operational units have been awarded squadron status, with the SpOC being renamed Number 1 Space Operations Squadron, and BMEWS No.2 Space Warning Squadron.

Historical Background

In 1946, a British Interplanetary Society member Ralph Smith put forward a proposal for a crewed suborbital spaceflight mission using the 'MegaRoc' rocket, which was a design that adapted a V-2 missile that had been seized from the Nazis. Though this spacecraft may have been capable of carrying human beings into space, the submission was rejected due to cost and the UK being essentially bankrupt after the war.³ The V-2 would however go on to form the basis of both the US and Soviet rocket design programmes, most famously from Operation Paperclip where the German Rocket scientist Wernher von Braun and his team were relocated to the US to lead the development of America's Saturn rockets.⁴

The Space Race started on 30 July 1955, when the US announced its intent to launch artificial satellites for a global scientific project called the International Geophysical Year (IGY) and the Soviet Union responded just four days later with their own declaration to launch a satellite. This competition between the two Cold War rivals became part of the ideology of the time and demonstrations of the technological advantage garnered by superior spaceflight capability was an absolute necessity for national security. Albeit, reaching for the stars involved overcoming great technological and scientific problems and also created new political and legal questions that needed to be answered. Of particular concern to US President Dwight D. Eisenhower were the legal ramifications and the potential reaction of the USSR to an American surveillance satellite passing over Soviet territory. Unlike the operation of an aircraft, that are subject to national jurisdiction and sanction, no rules or procedures had yet been established for the global over-flight of spacecraft. There was not even an agreed international definition of where *airspace* ends and *outer space* starts. The upper limit of airspace is not defined in *The Convention on International Civil Aviation*, signed on 07 December 1944, that established the rules of airspace, aircraft registration and safety. The best definition the *Chicago Convention* can offer is inferred in Annex 7, which defines an aircraft as any machine 'that can derive support in the atmosphere from the reactions of the air.'⁵ Thus, if an aircraft is able to fly, then it must be aloft in airspace. For the purposes of the application of air law, the upper limit to a state's rights in airspace is defined as above the highest altitude at which an aircraft can fly and below the lowest possible perigee of an earth satellite in orbit.⁶

Eisenhower's concerns would turn out to be short-lived. The Soviet Union successfully launched the world's first artificial satellite to establish an orbit around the Earth on 04 October 1957. Named Sputnik 1, this satellite overflew many states and realised the ability for spacecraft to pass over any territory completely unrestricted by national boundaries.⁷ Following this momentous achievement, the Soviet Union went on to claim the world's second satellite launch with Sputnik-2 on 03 November 1957. This was also the first spacecraft to carry a living creature to orbit, the ill-fated space dog named Laika. The US became the second nation to establish an orbiting satellite with Explorer 1, launched on 01 February 1958. To this day, there is still no universally agreed upon boundary or legal delimitation for the '*edge of space*', even though this very topic has been added to the agenda of the Committee on the Peaceful Uses of Outer Space, or its Legal Sub-Committee, every year since 1959. Wherever space may start,

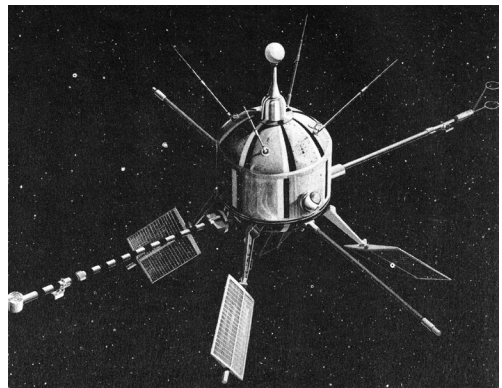
it should be treated as global commons much like the oceans and polar regions. The Outer Space Treaty (OST) of 1967 states that space 'is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means.'⁸

UK Space Power

The success of Sputnik 1 demonstrated a technological advantage held by the Soviet Union and, to a degree, it invalidated the defensive significance of the oceanic barriers surrounding the US. Indeed, if the Soviets could launch a satellite into space, could they also attack America with a missile-based nuclear weapon. This defence concern amid the American administration and the US general public was known as the 'Sputnik Crisis' and triggered a period of uncertainty over a perceived technological gap between the superpowers.⁹ Britain and the US both started to develop missiles that could reach targets within the USSR, and the UK named theirs Blue Streak. Capable of delivering a nuclear warhead, sixty Blue Streak missiles were planned to be stored in underground silos across the east of England but, owing to the UK's small size, these would inevitably be located near towns and villages and thus leave the local population vulnerable to nuclear attack. Combined with soaring costs, Blue Streak, as a missile, was cancelled in 1960 before the silos were built.¹⁰

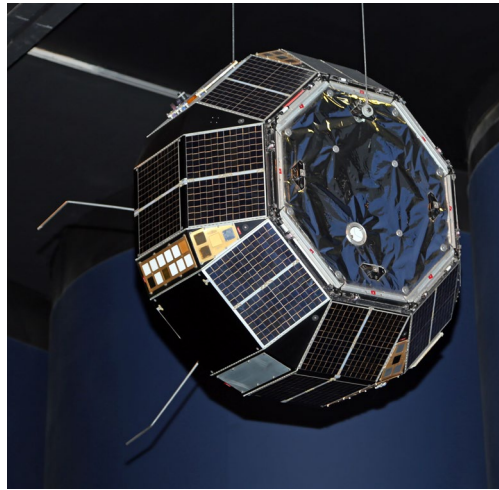
In 1962, the UK would become the third nation to operate a satellite with the launch of Ariel 1. Named after a spirit from William Shakespeare's *The Tempest*, Ariel 1 was launched from Cape Canaveral on a Thor-Delta rocket, on 26 April, and was designed to gather information on the Earth's ionosphere and of sun-ionosphere relationships.

However, to say Ariel 1 was UK 'sovereign' would be misleading as it was only partially British. The UK did not have its own space technologies during this period, so Ariel 1 was developed and built in the US by NASA's Goddard Space Flight Center in a US-UK agreement reached in 1960.¹¹ Another five Ariel satellites were launched between 1962 and the 1980s as part of the programme. The biggest shortcoming for the UK, and what diminished its status as a space power, was its dependence on the US for both spacecraft manufacturing and space launch.¹² In part to save face and investment, the development of Blue Streak continued at Spadeadam to modify it into the first stage of the Europa rocket under a collaboration with the European Launcher Development Organisation (ELDO) to launch satellites. Blue Streak was first launched from the Woomera test site in South Australia in 1964 and had a comparable success rate to the US Saturn V rocket.¹³ Also in 1964, the UK began development of its own launch system, known as Black Arrow. Four of these rockets were produced between 1969-



Artist's impression of the Ariel 1 science satellite.
(Credit: NASA, Public Domain, via
Wikimedia Commons)

1971, though the first and third launches resulted in failure. The first success came with the fourth launch and was a landmark in UK history; on 28 October 1971, Black Arrow launched from Woomera and the Prospero satellite was inserted into orbit. Britain became the sixth nation to achieve this by means of an indigenously developed carrier rocket, following the USSR, USA, France, Japan, and China. Prospero (named for the protagonist of *The Tempest*, keeping with the theme of Shakespeare characters) conducted a series of experiments to study the effects of the space environment on communications satellites and remained operational until 1973. It remains the UK's first and only endeavour to successfully place a satellite in orbit.



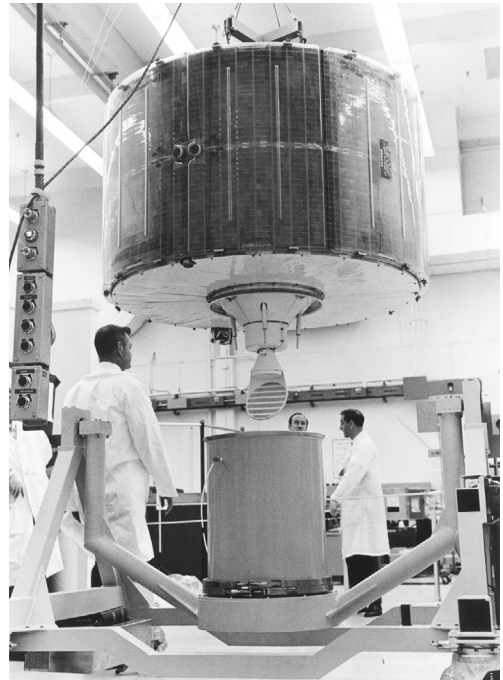
Prospero X-3 satellite flight spare.
(Credit: London Science Museum, Public Domain,
via Wikimedia Commons)

Black Arrow would have also inserted the next UK satellite, Miranda (again, a character from *The Tempest*), into orbit if the rocket had not been cancelled. Both Black Arrow and Blue Streak were abandoned for political and economic reasons in 1971. The Ministry of Defence (MOD) had decided it would be cheaper to use US rockets as NASA had offered to launch UK payloads for free, but this offer was retracted after the cancellations.¹⁴ The UK is the only nation to have successfully developed and then subsequently terminate a satellite launch capability. Miranda was instead launched on a US Scout-D rocket in March 1974 and was used as an engineering test bed for gyro systems.

With its attempts to keep pace with the larger space powers, Britain would eventually claim its own world's first with the launch of Skynet 1, the first Military Satellite Communications (MILSATCOM) system successfully established in a geostationary orbit (GEO).¹⁵ Skynet was designed to maintain communications links between Britain and the Middle and Far East and to meet the requirements of a defensive, reactive war against a numerically superior enemy. Skynet 1A was built by the US firm Philco Ford then launched on a Thor-Delta rocket from Cape Kennedy's Complex 17 on 22 November 1969. Despite the UK's reliance on the US for its space endeavours, the British telecommunications and engineering company Marconi was involved in Skynet's development process in order to gain experience. After approximately 18 months of operation, Skynet 1A ceased to function due to its Travelling Wave Tube Amplifiers (TWTAs) failing under thermal cycling because of poorly soldered high voltage electrical joints.¹⁶ Skynet 1B was launched in August 1970 but was destroyed when its internal Apogee Kick Motor (AKM) exploded during the insertion into GEO. Skynet 1 was operated by the RAF's No.1001 Signals Unit (1001 SU) located at RAF Oakingham in Hampshire and was responsible

for supporting MILSATCOM for HM Armed Forces worldwide. 1001 SU was made up of four sub-units: Space Operations, Ground Operations, Telemetry and Control, and Support.¹⁷ Space Operations was responsible for operating Skynet with C2 traffic being passed from one of the three ground stations.

Despite the initial setbacks of Skynet 1, the MOD resolved to continue the MILSATCOM programme with the development of Skynet 2, a more powerful satellite than before and built by Marconi itself. Despite some reliance on US technology, Skynet 2 was recognised as the first European-built communications satellite.¹⁸ Skynet 2A was launched in January 1974 in the same manner as Skynet, but this time the Thor-Delta's second stage rocket malfunctioned, and it was initially assumed that Skynet 2A was lost. However, it was subsequently detected in a very low elliptical orbit by the US early warning missile system. Incredibly, Skynet 2A was still functioning, but attempts to boost its orbit by firing its AKM failed, and it ultimately burned up in Earth's atmosphere. Skynet 2B was launched on 22 November 1974, and was a complete success; it was in service up until 1988.



Skynet 2 satellite being packed for shipment.
(Credit: USAF photographer, Public Domain,
via Wikimedia Commons)

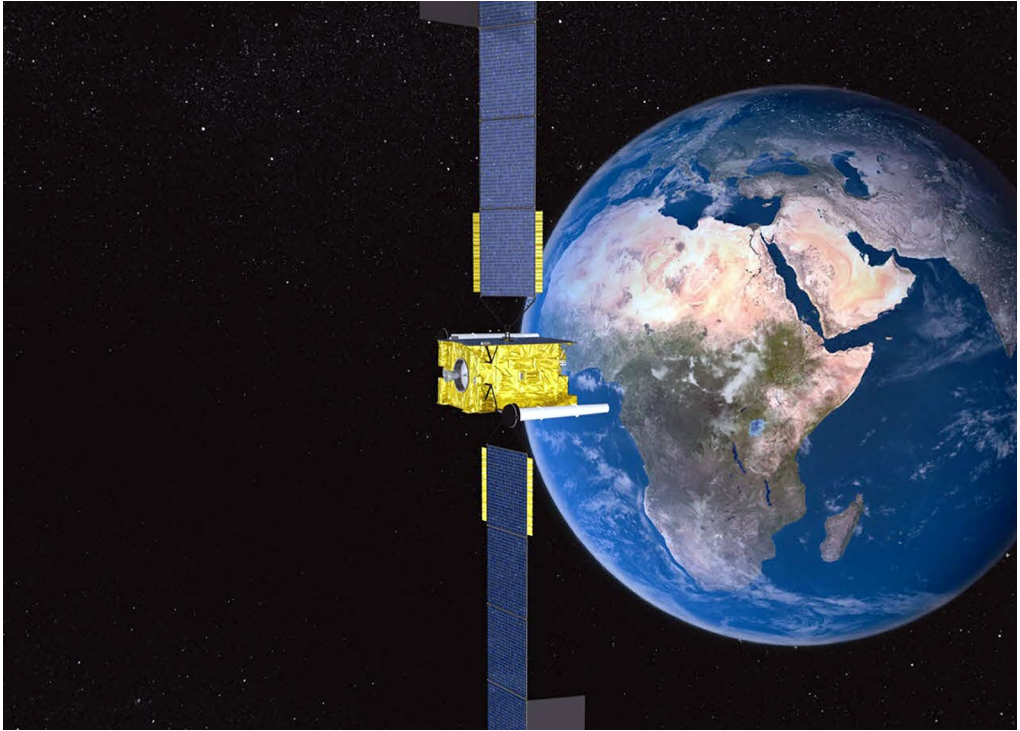
By 1975, Marconi had completed its studies for a further enhanced Skynet 3, but the Labour government decided to stop funding an independent MILSATCOM as part of its defence review. Instead, it opted to rely on the US Defense Satellite Communications System (DSCS) II and other NATO satellites.¹⁹ The interruption to development in UK space industry resulted in many problems and, by the late 1970s, it became apparent that the US/NATO systems were inadequate for Britain's capacity needs. Also, reliance on the US was not cheap as leasing charges had progressively increased throughout the late 1970s. Thus, the development of Skynet 4 was authorised in 1981 and the Falklands Conflict in 1982 validated this decision; though Skynet 2B was operational, it was beyond its planned life and its footprint ended at 23° West, far short of the Falklands at 60° West. Royal Navy ships and some merchant vessels were equipped with Satellite Communications Ocean Transportable (SCOT) that were designed to be compatible with other systems including DSCS, but the UK had to use spare DSCS circuits (though at times, the flow of signal traffic threatened to exceed the circuits' capacity). The Falklands Conflict had exposed the problems faced by UK forces and the need for flexible, expanded capacity communications when operating outside of the NATO region. The House

of Commons Defence Committee reported that this situation could not be allowed to happen again. Also, during the Falklands conflict, it was difficult for the Government Communications Headquarters (GCHQ) to gain access to the US National Security Agency (NSA) signals intelligence satellites to monitor Argentine communications within an appropriate tasking window. Thus, it was decided to produce a UK designed and built space-based capability intended to intercept Soviet radio and other signals. The satellite was to be called Zircon and was planned to be launched using NASA's Space Shuttle under the guise of Skynet 4 in 1988. However, it was cancelled in 1987 due to cost. In fact, secrecy surrounding the project's costs, that were hidden from Parliament, led to the 'Zircon Affair'; investigative journalist Duncan Campbell had learned of Zircon and believed the plan violated a 1982 government agreement on informing the House of Commons of military projects over a certain amount. Campbell published an account of the project through the *New Statesman* magazine ahead of a BBC programme that resulted in an injunction as well as Special Branch police raids on BBC and *New Statesman* offices and the homes of Campbell and his researchers.²⁰

Skynet 4 was designed to have a greater power capacity in order to meet the requirements of man-portable operations and have the ability to change the satellite's location as needed for out-of-area requirements. The Initial funding for the programme was £200 million with British Aerospace (BAe) as the prime contractor for the platform and Marconi as principle sub-contractor for the communications payload and antennae. The Royal Navy picked up 80 percent of the budgetary allocation owing to the continuing importance of MILSATCOM to UK naval forces and operational control was via the Skynet terminal at RAF Oakhanger. In 1987, Skynet 4 was selected as the NATO 4 satellite, beating the US DSCS-3, and two vehicles were procured in a contract worth £100 million, 75 percent of which going to the two British contractors.

RAF Oakhanger was closed in 2003 and all support to Skynet was transferred from the RAF via contract to a Private Finance Initiative (PFI) partnership between Paradigm Secure Communications and the Astrium subsidiary of the European Aeronautic Defence and Space Company's (EADS). Following company restructuring, Skynet 4 and 5 satellites were operated by the rebranded Airbus Defence and Space division, the latter spacecraft being based on the Eurostar E3000 bus design. In 2017, the MOD opted for the non-competitive route with Airbus to replace the Skynet 5 network, partly in order to maintain domestic space capabilities. In July 2020, a contract between Airbus Defence and Space and the MOD was signed to extend and enhance the Skynet fleet with the development, manufacture, cyber protection, assembly, integration, and testing of Skynet 6A, which passed its Critical Design Review (CDR) in July 2022. It is planned for launch on a SpaceX Falcon 9 rocket in 2025.²¹

Also of great importance to the UK is Position, Navigation and Timing (PNT) services derived from a Global Navigation Satellite System (GNSS), such as the US owned and operated Global Positioning System (GPS). A GNSS is an 'invisible utility' that underpins the UK economy; for example, without the timing signal from GPS, many day-to-day services would be severely



A computer-generated image of the Skynet 5D satellite in orbit.
Credit: Astrium via Defence image Library)

disrupted as it enables the synchronisation of computer networks, financial trading, transport systems, electricity transmission, etc.²² Indeed, PNT is so important that it listed on the UK's National Risk Register despite the UK not owning or operating its own GNSS capability and thus relying on GPS.²³ Redundancy would be preferable to relying on one system, but a GNSS capability is extremely expensive; GPS is a constellation of 24 satellites operating in Medium Earth Orbit (MEO) – an altitude of around 12,000 miles – with the initial constellation costing \$12 billion to put into orbit in the 1990s. Thus, the UK entered into a consortium under ESA for the development of the Galileo GNSS in the early 2000s. However, Galileo also features an encrypted signal capability called the Public Regulated Service (PRS) intended for military and government agency use, but with a condition for access of being a European Union (EU) member state. With the UK's withdrawal from the EU, negotiations over future involvement in Galileo broke down, and the UK opted to leave the programme in November 2018. This was done in spite of the UK's investment of £1.2 billion and the fact that the free and open signals remained completely accessible.²⁴ The UK Government then announced a £92 million investment of Brexit readiness money for plans for an independent UK GNSS, with the UK Space Agency (supported by the MOD) undertaking the necessary analysis, design and engineering studies to develop options for an assured PNT service.²⁵ The concept was widely questioned for being overly ambitious and some senior civil servants pushed to abandon the

'unaffordable' £5 billion project. In a surprising turn, the UK then announced its £400 million stake in the failed satellite firm OneWeb, who went bankrupt in March 2020 when attempting to deliver a broadband competitor to SpaceX's Starlink system. The winning \$1 billion bid came from the consortium led by Indian conglomerate Bharti Enterprises, with the UK government owning a 45% equity stake.²⁶ In addition to a comms service, compelling lobbying convinced the government that OneWeb could offer an alternative PNT system by redesigning some of the satellites to host a navigation payload. However, this poses significant challenges, even if it were possible at all. One industry executive stated that it 'would be like trying to build a hybrid of a Formula 1 racing car and a dump truck.'²⁷ Recent updates on a LEO-based PNT capability have gone quiet and it appears that the UK Government has not been particularly committed to the idea beyond it being a talking point during Brexit. In any case, OneWeb and Paris-based Eutelsat announced a \$3.4 billion merger in July 2022 which puts a dampener on the possibility for a UK PNT capability.²⁸ OneWeb's 1st generation broadband constellation in LEO has however been completed, making the UK 'one of the world's largest satellite operators' and supporting the NSS Pillar One: Unlocking Growth.²⁹ The UK has also recommitted to its close collaboration with ESA in support of the NSS Pillar Two: Collaborating Internationally.

The UK has also sought to gain its own space-based Intelligence, Surveillance and Reconnaissance (ISR) capability; the MOD invested £4.5 million in a small-satellite EO technology demonstrator with Surrey Satellites Technology Ltd (SSTL), owned by Airbus, that launched in 2018. Known as CARBONITE-2, it offered the RAF a demonstration of low-cost video-from-orbit solution designed to deliver 1m resolution images and colour HD video clips with a swath width of 5 kilometres.³⁰ Since 1981, SSTL has built and launched over seventy satellites and has also as provided training and development programmes, consultancy services, and mission studies for ESA, NASA, international governments and commercial customers, and the Galileo GNSS (before the UK left the programme). Also in 2018, the first all-British Synthetic Aperture Radar (SAR) imaging spacecraft called NovaSAR (developed by Airbus and SSTL) would return its first radar images from space.³¹ Later, at the June 2019 Air and Space Power Conference, the MOD announced its new and ambitious space programme, committing £30m to fast-track the launch of a small satellite demonstrator under Team ARTEMIS and that the UK would become a partner nation to join Operation Olympic Defender, a US-led international coalition to strengthen deterrence against hostile actors in space.³² Also, an RAF test pilot would be seconded to Virgin Orbit's small satellite launch programme with the intent to launch from Spaceport Cornwall. Separate to this, the UK Government would push ahead with Airbus's Project Oberon (also from Shakespeare, a character in '*A Midsummer Night's Dream*'), that would build on research from NovaSAR and also invest in state-of-the-art antennas from Oxford Space Systems (OSS).³³ The ISR initiatives would ultimately be succeeded in the 2022 DSS with £968 million of Defence spending for a multi-satellite system for global ISR operations known as the ISTARI programme. Another £61 million was made available for laser-based communications technology and £145 million for Space Control activity. Unfortunately for Virgin Orbit, a failure of its LauncherOne rocket in January 2023 from Spaceport Cornwall would result in the company ceasing all of its operations

permanently, filing for bankruptcy and auctioning its main assets in April 2023. Virgin Orbit recovered just \$36 million, barely 1% of the company's value of \$3.5 billion in late 2021.³⁴

Anti-Satellite Weapons

For nearly as long as there have been artificial satellites in orbit, there has also been the need to counter an adversary's space-based capabilities. Though Skynet is considered to be the 'jewel in the crown' of the UK's space capabilities and, as such, has been allocated £5 billion in funding over 10 years in the DSS, space control activities have only been given £145 million over the same period.³⁵ The UK has committed itself to promoting the responsible use of space and does not possess a hard-kill Anti-satellite (ASAT) weapon system, such as an Aegis-equipped destroyer.³⁶ Therefore, to discuss space control systems, the capabilities of other nations must be considered. For the four countries that have been able to successfully destroy their own satellites in ASAT tests – America, Russia, China, and India – comes not only national prestige but also a demonstration of their ability to contest the control of space.

In August 1959, the United States Air Force (USAF) Ballistic Missile Division began preliminary development for a planned Satellite Interceptor (SAINT), though subsequent reviews descope the programme to the development of subsystems only, forbade flight testing, and references to a satellite 'kill' capability were removed. The restriction of SAINT operations to rendezvous and inspection also brought with it a new name of 'Satellite Inspector' as the Eisenhower Administration was opposed to the development of a weapons system that may contest the principles of freedom in space, preferring to preserve the right of unobstructed passage of reconnaissance satellites.³⁷ Albeit, the Soviets had made public statements hinting at the value of having space-based nuclear weapons for military operations, or at least the mention of them was meant to intimidate the West. The US and Soviet Union led the development of ASAT capabilities as a defensive measure or as an asymmetric counter to a technologically superior rival. Between 1957-59, USAF was conducting a strategic weapons development programme called Weapons System 199 (WS-199) for Strategic Air Command. Under this programme, the prototype Bold Orion missile, or WS-199B, was developed as an air-launched ballistic missile (ALBM), with the Boeing B-47 Stratojet used as the delivery platform. Bold Orion's final test launch was to trial its capabilities in the ASAT role; conducted on 13 October 1959, the missile was launched from a B-47 at an altitude of 35,000 feet and guided toward the perigee of the Explorer 6 satellite.³⁸ Bold Orion passed its target at a range of less than 4 miles at an altitude of 251 km and, if the missile had had a nuclear warhead, Explorer 6 would have been destroyed. A satellite in LEO is travelling at approximately 17,500 miles per hour, nearly twenty-three times the speed of sound, making it an extreme technical challenge to achieve a hit. Instead, the concept of detonating a nuclear warhead close enough to the target satellite to destroy it by means of the energy emitted by the weapon's electromagnetic pulse (EMP) was employed, rather than the use of a precision weapon.

Following the election of John F. Kennedy in 1961, Robert McNamara was appointed as new Secretary of Defense. In 1962, in response to Soviet threats against US satellites, McNamara

had adopted an eye-for-an-eye policy, telling USAF to 'get on with the SAINT program' and he also approved testing of the US Army's Nike Zeus Anti-Ballistic Missiles (ABMs) for use as ASAT weapons.³⁹ Named Program 505, tests of the Nike Zeus satellite interceptor revealed that the missiles were limited to a max altitude of approximately 200 miles and, come 12 September 1962, USAF leaders had submitted a preliminary plan to use Thor Intermediate-Range Ballistic Missiles (IRBMs) as satellite interceptors. These much larger rockets had a greater capacity for interception than Nike Zeus and would later be based on the Johnston Atoll in the Pacific Ocean (a small island approximately 750 nautical miles southwest of Hawaii) for a series of high-altitude nuclear tests under the codename Operation Fishbowl. Though previous high-altitude nuclear explosion (HANE) tests had been conducted, they were hasty and inconclusive, so Fishbowl sought much clearer outcomes. One of these tests, named Starfish Prime, took place on 09 July 1962, and came with unexpected consequences, its immediate effects being felt for thousands of kilometres. A Thor rocket was launched with a 1.4 megaton yield thermonuclear warhead which was then detonated at an altitude of 400 km.⁴⁰ The explosion generated an EMP that disrupted electricity transmission networks; in Hawaii, hundreds of streetlights were blown and there were widespread telephone outages and disruptions to the power grid. There were also radio blackouts and electrical surges on airplanes. The large amount of charged particles further caused unintended damage to many operating satellites, both from the initial blast and later as the energetic particles remained trapped in the Earth's magnetic field, forming an artificial radiation belt that persisted for many days afterward. One of the effected satellites was Ariel 1 which had sustained damage to its solar panels and resulted in a degraded performance.⁴¹



The explosion of Starfish Prime. Unlike the characteristic mushroom cloud shape of a terrestrial nuclear explosion, HANEs are spherical. (Credit: Defense Atomic Agency, Public Domain, via Wikimedia Commons)

The results of Operation Fishbowl, and similar tests conducted by the USSR, demonstrated that the aftereffects of nuclear detonations in space are too wide ranging and indiscriminate, causing damage to friendly and adversary spacecraft alike. Coupled with increasing unease amongst the public regarding radioactive fallout, the future testing of such explosions, as well as nuclear testing underwater and in the atmosphere, was prohibited by the 1963 Partial Test Ban Treaty (PTBT). However, the PTBT only bans the testing of nuclear weapons; it does not ban their procession or use in operations. Indeed, the United States' cautious approach to ASAT programmes was abandoned when McNamara cancelled the SAINT programme in 1962, and then approved Program 437 in late 1963 which aimed to have Thor satellite interceptors

on 24-hour alert at the Johnston Atoll. These would be launched two at a time (for redundancy), each with a 1 megaton yield nuclear warhead with a 5-mile kill radius. The max altitude was 700 nautical miles and a cross range of 1,500 nautical miles of the Johnston Atoll. Development of Program 437 was smooth with successful test launches with simulated warheads; it was declared fully operational on 10 June 1964.⁴² Come 1970, Program 437 was reduced to standby status and the missile and warheads were removed from Johnson Atoll. Launch and ground facilities were also shutdown with a 30-day reactivation period, and Program 437 was eventually terminated on 01 April 1975. Though Programs 505 and 437 were both declared operational, they were only deployed for a brief period and on a limited scale.

Although Program 437 was on a standby status in 1970, the US DoD and USAF had a continuing interest in an air launched ASAT and the Soviets had developed and tested their own interceptor which used a conventional high-yield warhead to destroy a satellite. Without a counter, the US reconsidered the concepts laid out by Bold Orion with the proposal of Project SPIKE; a homing missile equipped with either a nuclear or conventional high-explosive warhead or a camera, launched from a F-106 Delta Dart aircraft. SPIKE ultimately would not be developed but it did lay out some basic design features of an air-launched ASAT.⁴³ Following approvals from President Gerald Ford in 1975 to start work on an ASAT that could be launched from an F-15 Eagle, the fully developed ASM-135 missile was released on 13 September 1985, and destroyed the Solwind P78-1 satellite at an altitude of 555 kilometres.



Motor ignition of the ASM-135 ASAT launched from an F-15 Eagle approximately 200 miles west of Vandenberg Air Force Base, CA. (Credit: Paul E. Reynolds, Public Domain, via National Archives Catalog)

It would be more than two decades before the next successful direct ascent ASAT test would take place (that is known of) when China destroyed its Fēngyún-1C (FY-1C) weather satellite on 11 January 2007. Terrestrially launched from the Xichang Space Launch Center (XSLC) – or nearby – the kinetic kill vehicle achieved the intercept of FY-1C in a polar orbit at an altitude of 865 kilometres. However, the Chinese government would not confirm that the test had taken place until 23 January with a statement from Foreign Ministry spokesman Liu Jianchao, who also insisted that China was committed to the ‘peaceful development of outer space’ and opposed ‘the arming of space and military competition in space.’⁴⁴ Liu Jianchao also stated China had notified the US and other countries about the test in advance. Following this, the US would destroy a non-functioning National Reconnaissance Office (NRO) satellite (USA-193) in a decaying orbit on 14 February 2008. A DoD statement confirmed that the USS Lake Erie, a US Navy AEGIS warship, fired a modified tactical Standard Missile-3 that hit the satellite at an altitude of approximately 247 kilometres.⁴⁵ USA-193 would have re-entered Earth’s atmosphere on its own, however there were concerns that its fuel tank would have survived and it contained approximately 1,000lbs of frozen hydrazine, a highly toxic propellant. The DoD further stated that the ‘debris will begin to re-enter the Earth’s atmosphere immediately,’ and ‘nearly all of the debris will burn up on re-entry within 24-48 hours and the remaining debris should re-enter within 40 days.’⁴⁶ Albeit, some commentators have speculated that USA-193 was instead the US ‘flexing its muscles’ following China’s ASAT test the year before. India would become the fourth country to demonstrate a successful ASAT test with Mission Shakti on 27 March 2019.

Both the UK and the US have accused Russia of an ASAT test that occurred in July 2020 when a weapon-like projectile was sent from Cosmos 2543, a satellite purportedly for survey and inspection. This was the first time that an accusation of an on-orbit weapon has been fired and that the Kremlin had actively hidden the operation. What is more, on 15 November 2021, Russia successfully tested the System A-235 PL-19 Nudol ASAT weapon when it destroyed the Kosmos 1408 satellite, receiving much criticism from the UK and US. The direct ascent Nudol missile can strike a satellite in a much shorter timeframe than a co-orbital ASAT and represents a departure from the ‘traditional’ Soviet approach.

A different type of ASAT to direct ascent weapons are ‘*co-orbital*’ systems, which were favoured by the former Soviet Union. The 1967 OST only bans the stationing of Weapons of Mass Destruction (WMDs) in space, and therefore does not prohibit the development of space-to-space weapons systems, or indeed any kind of conventional weapon, in orbit.⁴⁷ The Russian Istrebitel Sputnikov (IS) system (meaning ‘satellite destroyer’), and its successors, began its development during the 1960s before being declared operational in 1973, and then upgraded to IS-M in 1976. The ASAT worked by being carried to orbit by a launch vehicle and reaching its target only after one or two orbital revolutions before achieving the interception by means of a conventional explosive.⁴⁸ Though the IS was tested extensively and supposedly achieved a higher degree of flexibility than the early US systems, the orbital trajectories it could reach was limited. The latest iteration was IS-MU that was declared operational in 1991, yet it was

reportedly withdrawn from service in 1993. However, the USSR had started developing a follow-up system in the early 1980s called Naryad; also a co-orbital ASAT, Naryad was designed to reach altitudes on 40,000km, and so could threaten satellites in GEO.⁴⁹ The present status of Naryad is not currently known, but the Russian Federation continues to benefit from the former Soviet Union's rich history of developing and operating ASAT weapons. The core of the two confirmed co-orbital ASAT systems is technology that allows for Rendezvous and Proximity Operations (RPO), a type of orbital manoeuvre where two spacecraft arrive at the same orbit and approach at a close distance. Russia has been undertaking a series of secretive RPO activities since 2013; on several occasions they have manoeuvred space objects and conducted proximity operations in both LEO and GEO, indicating a revival of Russian efforts in co-orbital counterspace technology development.

The problem of debris

Destructive ASAT weapons do not come without consequences, chief among them is the resulting debris that is created. As space is a near-vacuum, objects travel at extremely high velocities and even the smallest of items can damage or destroy space systems. For example, a window of the Cupola module of the International Space Station (ISS) was chipped by something as unassuming as a fleck of paint!⁵⁰ Orbital debris is made up of all sorts of space junk, including small items like bolts and tools, to larger objects such as damaged spacecraft, defunct satellites, and rocket segments. Thousands of missions have been launched since the start of the Space Race in the 1950s and the risk of collisions increases as more and more space objects add to the existing junk. At altitudes below 500 miles, atmospheric drag will cause these objects to deorbit and burnup in Earth's atmosphere within a few decades. However, as the effect of Earth's gravity is weaker at greater distances, objects at higher altitudes may remain in their orbit for centuries.⁵¹ The 2007 Chinese ASAT demonstration, at an altitude of 865 kilometres, created around 3,000 pieces of trackable debris in LEO whereas the Indian test at 282 kilometres created about 400 pieces, some of which reached as high as 2,222 kilometres and may remain in orbit for years.⁵² The more recent Russian PL-19 Nudol test resulted in over 1,500 trackable objects (and much more besides that are also a threat) which forced the seven crew members of the ISS (which included two Russians) to take shelter multiple times. Across all artificial satellites in orbit, hundreds of collision avoidance manoeuvres are performed every year.

The ultimate doomsday scenario for a build-up of space debris was theorised by NASA scientist Donald J. Kessler in 1978 and is named for its originator as 'Kessler syndrome'; it describes a situation whereby the density of space debris reaches a saturation point where a cascade of collisions exponentially creates more debris and increases the frequency of further impacts.⁵³ The result could render an effected orbit completely unusable for years if not centuries. Indeed, space is already so congested that a deliberate act is not required to contribute to the problem of space debris; the most severe fragmentation in space (so far) was the accidental hypervelocity collision of US communications satellite Iridium 33 with Russian defunct communications satellite Cosmos 2251 on 10 February 2009. Over 1,800 pieces of debris of a

size approximately 10 cm and larger were produced with some of the fragments predicted to remain in orbit through to the end of the century.⁵⁴ A dramatized depiction of the catastrophic potential of Kessler's syndrome is shown in the opening scene of the 2013 movie *Gravity* when the astronauts are conducting repairs of the Hubble Space Telescope. They are warned of an approaching debris field created by the Russians after striking one of their own spy satellites, and that this field has already destroyed multiple spacecraft and rendered communications inoperative. On attempting to return to the Explorer space shuttle, the astronauts are bombarded with this debris that then destroys their spacecraft and renders them stranded.

The problem of space debris does, however, have a positive effect, by reason that the risk threatens all spacecraft in an orbit, including any assets belonging to the owner of a destructive ASAT. Thus, this 'mutually assured vulnerability' inherently abates the probability of the use of kinetic kill weapons. Indeed, the Obama Administration sought to enhance diplomatic efforts to protect space assets and suggested that 'globalized entanglement' could substitute national autonomy to protect space functions by means of collectivisation.⁵⁵ Further benefits include avoiding a potential arms race and the weaponisation of space, coupled with a perceived political escalation and potential retaliation. It is then perhaps preferable to achieve space control through non-destructive or soft-kill systems to harm – or threaten harming – an adversary's access to space. Soft-kill systems may be characterised as capabilities that can dazzle a satellite's sensor with Directed Energy (DE), jamming its link segment, or cyber-attack.⁵⁶ For the latter, the UK's National Security Risk Assessment identifies cyber-attacks as a Tier One risk, and also the possibility of a deliberate attack on Tier Two that disrupts the information received, transmitted or collected by satellites.⁵⁷ As soft-kill methods may also be reversible, they give the fighter the ability to effect Critical National Infrastructure (CNI) below the level of actual conflict and be disruptive without causing any physical damage. This allows for states to operate in the 'grey zone' or 'sub-threshold' warfare.⁵⁸ The potential normalisation of ASAT capabilities means that space-based systems may come under attack from a range of actors, therefore space should not be considered any kind of sanctuary.

Though the UK does not possess its own space control capability, the space domain is special in that it can also be influenced by cross domain effects. As any space capability is comprised of three distinct components – the space, link and ground segments – an attack on any one of them can disrupt, degrade, deny or destroy a capability. For example, a conventional air strike can be prosecuted against an adversary's ground installation that controls a satellite, or a cyber-attack / electronic jamming directed at the link to cut off communications. The UK can also utilise its diplomatic and economic instruments of national power under UK Defence Doctrine (UKDD) to exert influence and control in the international system.⁵⁹ For example, in response to the alleged Russian in-space ASAT weapon, the UK introduced UN resolution in 2020 on security in space in an attempt to halt a dangerous re-energising of the space arms race and also lead the global discussion in responsible space behaviours.⁶⁰ To solidify this commitment and promote the notion further, the UK pledged to not test any direct ascent

ASAT missiles in October 2022 by agreeing to a UN Resolution on the matter introduced by the US in April 2022.⁶¹ As of April 2023, the Netherlands, Austria and Italy signed, joining the US and UK along with Australia, Canada, France, Germany, Japan, New Zealand, South Korea, Switzerland to bring the total number of nations to thirteen.⁶² However, these types of covenants are only as good as the signatories agreeing, ratifying, and conforming with their content. Indeed, there are views amongst some scholars, chiefly the realist school, that any such international agreement is merely part of a never-ending struggle between states for power and security, and that war is an inevitable end to this struggle.⁶³

Orbital Clean-up

After decades of build-up of space junk, LEO is on the verge of becoming much too crowded. This problem is also set to get much worse due to the rise of '*mega constellations*' that require thousands of satellites, such as SpaceX's Starlink which, as of July 2023, has 4,519 satellites in orbit. As such, satellites operators have responsibilities for their spacecraft and, in October 2023, the US government Federal Communications Commission (FCC) issued its first ever fine. A penalty of \$150,000 was awarded to Dish Network for failing to move an old EchoStar-7 satellite far enough away from other spacecraft.⁶⁴ Debris removal is a global priority, though there is no set consensus on how it could be achieved. In 2018, SSTL launched its RemoveDEBRIS research project to demonstrate four debris removal technologies – a net, a harpoon, vision-based navigation using cameras and LiDaR, and a de-orbit dragsail – at low cost.⁶⁵ It was deployed to the ISS in a cargo transfer bag on a SpaceX Dragon spacecraft and



Astroscale COSMIC ADR Mission. (Image courtesy of Astroscale)

deployed from the station's Kibo module via robotic arm. Its targets were two CubeSats that the RemoveDEBRIS deployed itself. Following a successful demonstration, RemoveDEBRIS burned up in Earth's atmosphere on 04 December 2021. Furthermore, the NSS released in 2021 set a strategic priority for the UK to lead the global effort to clean up space and, in September 2022, the UK Space Agency awarded a total of £4 million to ClearSpace and Astroscale to design missions to remove space debris. Further funding could be made available to realise the 'UK's first national space debris removal mission launch in 2026.'⁶⁶ £1.7 million of the funding awarded to Astroscale is for designing a satellite servicer that can remove multiple retired or defunct satellites in a single mission. The Cleaning Outer Space Mission through Innovative Capture (COSMIC) will employ Astroscale's RPO and Active Debris Removal (ADR) technologies and is due to launch in 2026.

The UK is not the only nation with an orbital clean-up programme. For example, on 24 October 2021, China launched its Shijian 21 (SJ-21) space debris mitigation satellite from XSLC into a geosynchronous transfer orbit (GTO). China's state media described SJ-21 as an On-Orbit Service, Assembly, and Manufacturing (OSAM) satellite that would 'test and verify space debris mitigation technology.'⁶⁷ In November 2021, SJ-21 deployed a second, smaller satellite that the USSF's 18th Space Defense Squadron (18 SDS) categorised as a discarded AKM, which SJ-21 subsequently appeared to be conducting sophisticated RPOs with. Further suspicion was drawn in December when SJ-21 disappeared from its orbital slot to rendezvous with a defunct Beidou G2 navigation satellite in GEO. After matching its orbit and docking with Beidou G2, SY-21 then dragged it to a graveyard orbit 3,000 kilometres away before releasing it and returning to GEO.⁶⁸ It was commercial space domain awareness from ExoAnalytic Solutions that monitored and reported on SJ-21's activity and has been visualised in an openly available YouTube video. What is of concern with SJ-21 is that the Chinese did not declare its launch or confirm its mission until it had actually done so. With no issued notifications, China has attracted criticism to its lack of transparency and led speculation as to the true purpose of SY-21 and that it could be a space weapon. This is described as a 'dual use' system and use refers to a technology that can be used in defence applications as well as non-military purposes. This distinction can be used as a means to keep a capability in the grey zone and operate outside of military norms.

The term dual use is perhaps not a particularly helpful description as, in reality, almost anything could be considered as dual use if one were imaginative enough. In fact, some military professionals have described the term dual use as being beyond definition, such as Brigadier General Morgan on the disarmament of Germany following WWI: 'Is a field-kitchen war material? Or a field ambulance? Or a motor-lorry? All three are capable of civilian use. When are you to 'call a spade a spade,' and when should you call it an entrenching tool? The list of 'optical' war material, from periscopes to range-finders, alone ran to fifty-two items.'⁶⁹

Regarding space technologies, cameras on Earth Observation (EO) satellites can be used for planning infrastructure, understanding the effects of climate change and disaster relief just as

well as monitoring an adversary's activity and informing the planning for military operations. Civilian assets are now capable of producing images that match the quality of products previously only offered at a classified military level. Where a scientist sees a laboratory, the military professional sees a battleground; while the former wants to understand it, the latter seeks to dominate it, and the technology to do so is largely the same. Albeit, it has been estimated that at least 95 percent of space technology is dual use.⁷⁰ At the opening of Astroscale's manufacturing facility, Managing Director Nick Shave stated that the company aims for 'debris removal and in-orbit servicing to be part of routine operations by 2030'. Astroscale had previously successfully demonstrated the world's first commercial debris removal mission by means of the magnetic capture technology in a mission launched in 2021.⁷¹

Dual use with regards to space weapons is nothing new. One type of co-orbital attack system that has been suggested uses a manipulator arm that could be repurposed to physically manipulate or damage a target in space. Indeed, in the 1980s, the Soviet Union believed that the US Space Shuttle – which was operated by the civilian space agency NASA – could be classified as an ASAT because its robotic arm could have been used to grab non-cooperative satellites out of their orbits.⁷² Though the Space Shuttle programme came to a close in July 2011, there is a new American capability in development that has a striking resemblance to its forebear, the highly secretive space plane known as the X-37. Though the style of its lifting body and its landing profile are like that of the Space Shuttle, the X-37 is one-fourth the size and is uncrewed. Development of the X-37 Orbital Test Vehicle (OTV) started under NASA, but it was passed to the US military which established the X-37B variant. The secrecy surrounding



The Boeing X-37B is a highly secretive robotic space plane.
(Credit: USSF SSGT A Shanks, Public domain, via Wikimedia Commons)

X-37B and its payloads has generated rumours that it could be a sort of space weapon of some sort, though some experts says that it is likely 'too small and not manoeuvrable enough for such work'.⁷³ On 12 November 2022, the X-37B landed at the Kennedy Space Center in Florida after completing a record 908 days in orbit.⁷⁴

The Chinese have also flown a mysterious spaceplane that is likely similar to the X-37B, itself completing nine-month spaceflight in May 2023. With China's space programme being closely linked with its military, there is speculation that this spacecraft could also be a weapon. According to a Center for Strategic and International Studies (CSIS) report, the vehicle released an object into orbit sometime in October 2022 that then seemed to disappear in January, only to 'suddenly reappear on satellite tracking radar in March'.⁷⁵ Furthermore, Jonathan McDowell, an astrophysicist at the Harvard & Smithsonian Center for Astrophysics, has stated that the Chinese 'have been working a lot with robot arms in other contexts, like the Chinese space station' and, if that is also the case for this enigmatic space vehicle, it could indicate that it has some sort of satellite removal capability. Such is the perceived threat from China that the CSIS Space Threat Assessment 2023 states that China is continuing to 'develop and deploy a robust arsenal of space and counterspace Capabilities' and is progressing toward its aim of becoming the world leader in space. China is expanding its space and counterspace assets, maintaining its status as the second most capable space nation after the US, with latter officials regarding the country as a significant counterspace threat.⁷⁶ China's RPO technology has been demonstrated in LEO and GEO and, although not weapons tests, they display the technology necessary for this type of attack. China also maintains a sizable kinetic ASAT capability, most notably demonstrated by its debris-creating test in 2007 test, as well as 'numerous subsequent non-intercept tests in the years since'.⁷⁷ Non-kinetic counterspace weapons, such as directed energy weapons, are not publicly known to have been tested.

Conclusions

As the UK becomes ever more dependent on space derived products and services, not only for its armed forces but also day-to-day life, its potential adversaries are increasing their counter-space systems. Thus, the UK and its Allies must Protect and Defend its interests in, through and from space against acts of hostility. Critical dependencies with regards to national security are perhaps best summed up in the following extract from the US Center for Strategic and Budgetary Assessments (CSBA): 'In the opening minutes of conflict, [the enemy would] seek to render US and allied forces 'deaf, dumb and blind' by destroying or degrading US and allied Low Earth Orbit (LEO) ISR, Space-Based Infrared System (SBIRS), third-generation Infrared System (3GIRS) sensors and communication satellites. This would be accomplished by employing directed-energy weapons, direct-ascent and co-orbital anti-satellite weapons, or terrestrial jamming, in concert with coordinated cyber and electronic warfare attacks'.⁷⁸

What is more, the Mitchell Institute for Aerospace Studies issued a report on 26 June 2023, stating that the USSF needs new offensive weapons and more sophisticated defences to counter China's rapid deployment of space arms. It also warns that China views the

vulnerability of US satellites as its strategic advantage and that the Biden administration's renewed emphasis on diplomacy and seeking norms of space behaviour will not be enough to deter conflict with Beijing.⁷⁹ It is perhaps surprising that such statements have been made open source, unless it is a ploy to secure funding for space control capabilities. Albeit, if taken of face value, it does not bode well for the UK if the USSF itself is not fully prepared to counter orbital threats.

UK Space Command should seek to develop suitable systems that focus on soft-kill techniques such as an anti-satellite jamming, dazzling, or cyber-attack. As the UK seeks to expand its portfolio of space-based assets, it must remain cognisant that ASAT capabilities are also proliferating; protecting space assets and ensuring continued access should be UK Space Command's primary goal to secure freedom of action. To maintain competitive advantage, the UK must not stagnate on developing these capabilities. An attack on any of the space segments – space, link or ground – can disrupt, compromise, degrade, or even destroy a capability, so equal attention should be given to the protection of all three components. On the same token, conventional forces have atrophied and the Defence budget is stretched with other advanced procurement programmes, so Defence must also balance its growing ambitions with its fiscal means. Recognising that it cannot afford to match the spending of the US or China, the UK should cut its cloth accordingly. Indeed, many UK space programmes throughout history have been threatened or ultimately cancelled for budgetary, technical, or political reasons, including Skynet itself, so realism must be employed throughout.

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Viewpoint

Artificial Intelligence – Is the RAF ready?...Are you?

By Squadron Leader Andy Webb

Biography: Squadron Leader Andy Webb joined the RAF as a Fighter Controller, specialising in the human and technical systems which assure our surveillance of air and space. In 2015 he retrained as Aircrew, flying Reaper on Operation Shader. After a tour at the Military Aviation Authority, responsible for Aircrew Regulation, he has now joined No. 54 Squadron (the ISTAR¹ Academy) to lead Protector training. Andy is currently studying for a PhD, assessing how Artificial Intelligence (AI) affects organisational design.

Abstract: Continuous advancements in AI have led to the emergence of Large Language Models (LLMs) that utilise generative AI technology, and have the capability to effectively synthesise existing material, resulting in significant public interest. Increased interest has naturally led to substantial academic investigation, discussion, and investment. It is imperative to thoroughly analyse the ramifications of the current increase in AI for various organisations, such as the Royal Air Force (RAF). This viewpoint argues against the notion of AI being perceived as a comprehensive, all-powerful, or all-knowing solution, in contrast to the exaggerated tales that dominate conversations about its potential. This viewpoint will show that AI application requires an organisational plan for implementation to increase adaptation. The paper will cover AI preconditions and human-machine teaming to determine what modifications are needed, why RAF needs to change, and how the RAF as a human-focussed organisation may transition to an AI-enabled future.

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Introduction

Artificial Intelligence (AI) is in vogue. The development of Large Language Models (LLM) derived from neural networks - which enable impressive articulation of pre-existing information - have captured the public imagination. Such popularity inevitably drives considerable study, comment, and investment. But what does that mean for organisations? What does it mean for the RAF? This short viewpoint argues that AI is not the apocryphal, omnipotent, omniscient answer-to-all-things that more ardent commentary may have us believe. Nor is it imminently a threat to our way of life. Instead, this paper will examine emergent research to demonstrate the need for an organisational strategy to unlock opportunities offered by AI applications. To assess what changes might be required, the paper will discuss some preconditions for effective AI and explore the need for effective human-machine teaming. This viewpoint suggests that why the RAF needs to adapt is evident from existing research, but that further research is urgently needed to define *how* we modify our existing human-focussed organisation to an increasingly AI-enabled future.

Previous editions of this journal have included multiple articles about AI. This is unsurprising – analysis of the distribution of academic papers with ‘artificial intelligence’ in the title show an exponential increase in recent years.² But our lexicography for AI is still developing. Referring to AI without adding context is unhelpful. It is akin to saying that this journal has featured articles about warfare, or papers about aircraft. This might be helpful in narrowing down the subject area a little but does not go far enough to be useful. Across various media, we see a wide spectrum of what is meant by AI. In *Air and Space Power Review (ASPR)* this breadth has ranged from: Wing Commander Ali Morton’s philosophical strategic analysis of a potential revolution in military affairs;³ to Squadron Leader Carolyn Swinney’s technical primer explaining the history, future, and challenges of integrating the technology into our organisation;⁴ and Professor Peter Lee’s outline for an ethics framework.⁵ This paper builds on the content of these papers and other academic literature to explore whether our people, as individuals and as teams, are ready to exploit the potential of AI. To do so, the paper will revisit how we categorise AI, discuss some strengths and weaknesses, and explore potential implications of their introduction into the human-led teams that make up our organisation.

AI Evolution

It is important to recognise that the recent emergence of LLM such as ChatGPT – whilst compelling – is not the first big breakthrough in AI. LLMs use neural networks borne from advances in machine learning mechanisms to allow reasoning based on language. This renders AI capable of passing Alan Turing’s eponymous ‘Turing Test’, first suggested in 1950 – a test of a machine’s ability to be mistaken for a human based on textual interaction.⁶ But plenty of evolution has occurred through innovation over previous decades. An analysis by Lu *et al* into the distribution of academic papers mentioning AI in the title describes the evolution of AI in three key phases.⁷

The First Phase. They identify a first phase from 1956-1980. In this analysis, the 1956 Dartmouth Conference is the starting point for AI; closely followed by development of the first neural network 'Perceptron' in 1957.

The Second Phase. A second phase, the 'Industrialisation' phase, emerged in 1980 until 2000. In this phase, Japan invested \$850m in AI (which, with inflation, would be \$2.7bn today); multi-layer neural networks appeared; companies began widespread adoption of 'expert-systems'; and Deep Blue played chess well enough to beat the reigning human champion – Gary Kasparov.

An Explosion Phase. The 'explosion' phase since 2000 has seen an AI beat the 'Turing Test 2014', Watson and AlphaGo defeating the best human players, and Geoffrey Hinton proposed an AI deep learning training method for AI which did not require direct human supervision. Most recently, these deep learning capabilities have enabled the LLM behaviours that capture our imagination today.

Categorisations of AI - the importance of Data

The current state of the art in AI surrounds the increasingly compelling ability of Artificial Narrow Intelligence (ANI) to complete a given task (or set of tasks) well. Whilst some types of ANI have been around for many years – such as the AI for gaming (eg Deep Blue) - recent breakthroughs in machine learning and 'deep learning' neural networks have enabled the LLMs that are becoming increasingly well known in the public domain. These LLMs can consistently perform better than the average human in verbal and numeric reasoning, in addition to certain professional assessments. Whilst they are vulnerable to limitations such as hallucination (where incorrect responses are provided without any indication that the AI reasoning has produced inaccuracies), risk can be mitigated by the way in which a human interacts with the model – with guides on optimisation readily available and people selling their services in getting the best out of these systems. Another issue with LLMs is that they are poor at distinguishing false information from correct information in their databases because they are not grounded in real-world knowledge. This is a significant vulnerability for networked LLMs, as they could potentially be misled by misinformation. On the other hand applications of ANI which are not focussed on reasoning based on text have existed for longer and continue to proliferate as they develop. Such AI models have the potential to significantly change existing human-based systems – for example, creating a risk-index to enable a virtual command and control facility for the Arctic, or complex traffic management to allow aircraft to route point-to-point without sequencing in airways. Irrespective of type, ANI already exceeds human performance in many applications.

As the timeline in figure 1 shows, breakthroughs in AI performance have been enabled by machine learning algorithms since the 1980s, and deep learning methods since the 2010s. AI designed through a process of 'deep learning' include Convolutional Neural Networks (CNNs) which are critically dependent on the availability of data to allow their training cycle to be

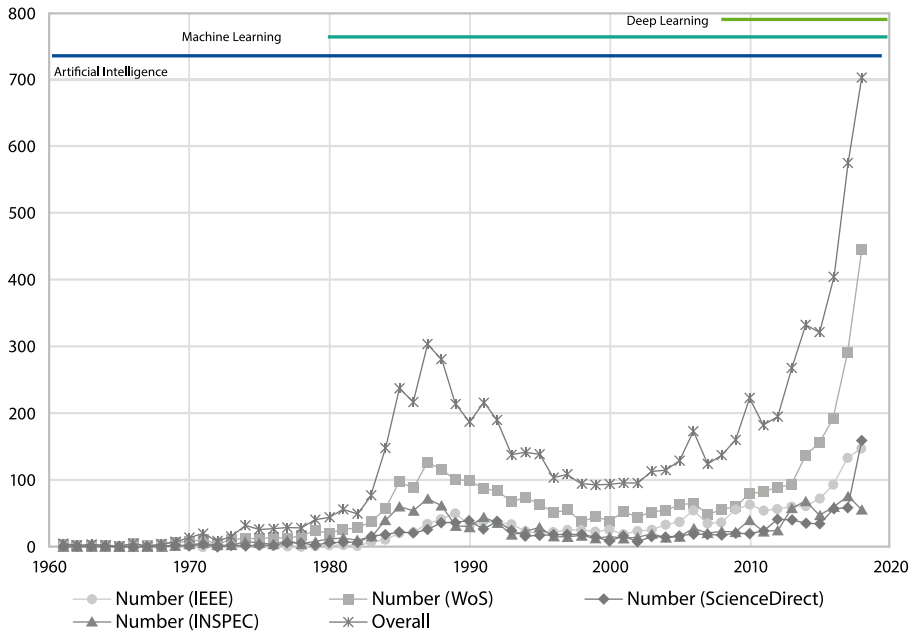


Figure 1 – Journal articles with ‘Artificial Intelligence’ in title (Lu *et al* (2019), overlaid with a broad characterisation of AI maturity (derived from Swinney (2022)).

effective⁸ – although recent research is demonstrating that once a foundational model (such as GPT-4) has been produced, clever application of example data when training an AI might negate some of the need for ‘tuning’ in a particular use-case (few-shot training).⁹ This reliance on data, and an understanding of how an AI is initially training and later tuned, is an important criticality for the RAF and for us. Key questions to scope future training for our people are:

- How many of us are confident in our contribution to effective ‘Big Data’?
- What statistics training have we had to understand what data to capture, how to capture it in a useful way, and how to protect its reliability?
- Where do we draw the line between AI design, and AI use?

One analogy might be the knowledge gap between Aircrew flying an aircraft, the Engineers maintaining them, and the air and space operations professionals advising them. In this analogy data would be akin not only to the charts required for a specified mission, but also the combined knowledge that pilots and engineers were trained in and the fuel to power the aircraft. For AI, data is the essential component that supports all facets of the capability. This means data is both a key vulnerability and opportunity - the organisation needs to be configured to both protect and exploit data. There is consensus¹⁰ that Defence is starting from a disadvantage – classified information, the spread of data across different systems, and a lack of consistent data (in format and in content) present ‘wicked problems’ that are foundational to gaining an advantage in AI development and integration. Finding solutions cannot simply

be the purview of cyber professionals, as the experts in relevant data are those in each of the RAF's other professions - who gather, use, and employ data and information in their operational role.

But what about more sensational claims about AI? Given rapid progression in ANI capabilities and its increasing proliferation, it should be no surprise that there is much discussion in the field about the point at which a capability might be demonstrated that represents an Artificial General Intelligence (AGI). This is not simply the development of programming that can achieve multiple tasks with a single algorithm (this was achieved by the General Problem Solver in 1959).¹¹ Instead, AGI might be described as one which can achieve a fully representative cross-section of intellectual tasks that humans or animals can perform.¹² It is notable that the definition for what might constitute AGI has grown more challenging over time, as various instances of ANI have demonstrated increasing capability and flexibility. Estimates for when an AGI may be available vary wildly with some guessing 2029¹³ and others the year 2030¹⁴ – it is still a wholly theoretical capability which is ambiguously defined. By extrapolation of previous trends, we can expect that as ANI applications develop and become more flexible the behaviour that an AGI must demonstrate to be accepted as such will become more comprehensive. The hypothesised advent of an Artificial Super Intelligence (ASI), which would represent an AGI that surpasses the brightest human minds, is beyond the scope of this paper – as there is scant evidence it will be available during our lifetime. In the absence of a credible timeline for AGI and ASI, any of the effects posited as a 'Revolution in Military Affairs' by Wg Cdr Morton in *ASPR* last year should be examined in the context of the design-parameters for individual ANI and how they interact with existing human teams and organisational design.

The Human-Machine Team – a requirement for flexible levels of human input

Whilst an AGI may or may not be developed within our career-horizons, there is no doubt that ANI will continue to proliferate and increasingly affect all of us. The Ministry of Defence (MOD) has established centres of excellence to drive the strategic development of AI such as the Defence AI Centre. In turn, the RAF has established the Rapid Capability Office (RCO) with an Air Information Experimentation Laboratory (AIX)¹⁵ which innovates with AI technologies. Some units of the RAF routinely use or develop AI in practical applications (such as the GUARDIAN Command and Control system, and 90 Signals Unit respectively). But there is less fidelity on how our broader systems, processes and people in the organisation may need to change – and limited evidence of an organisational strategy to enable it.

The RAF proudly declares itself to be a people-focussed organisation, with valuing people a key part of its overall organisational strategy.¹⁶ I remember being told when I joined the organisation that our training, culture, and meritocracy ensured we were an Air Force that was, 'person for person, second to none'. This emphasis on people is a recognition of the centrality of the human in warfare, and however sophisticated our equipment and communication

networks become, most decisions and judgements that result in success or failure have hitherto been made by a person. In the absence of a significant forcing-function (such as a peer conflict which threatens our way of life), humans are unlikely to be written out of the equation. Legal, moral, and ethical challenges¹⁷ drive a policy of human-on-the-loop system design with 'meaningful human control',¹⁸ to allow a sub-set of decisions to be reserved for a human. Unsurprisingly then, as existing UK doctrine explains, operational advantage is expected to lie with the most effective human-machine teams.¹⁹

Effective human-machine teams will be those that can most effectively leverage the respective advantages of human capabilities and automation. For example, the traditional role of Flight Engineer in aircraft flight decks was removed when it became clear that automation could create efficiencies that made a smaller crew complement credible - but full automation is usually deemed undesirable. At an organisational level, in very broad terms, automation allows for more rapid processing and (if extended to decision-making) action by fewer people. Higher degrees of human control often slow automated processes, but if well-managed could also make it more reliable and adaptable. In contested circumstances with an adversary seeking to disrupt our activity (by making decisions more quickly than we can) the degree to which people are involved in each process is likely to be, by necessity, highly situational. Figure 2 (below) illustrates how our preferred allocation of tasks between human and machine

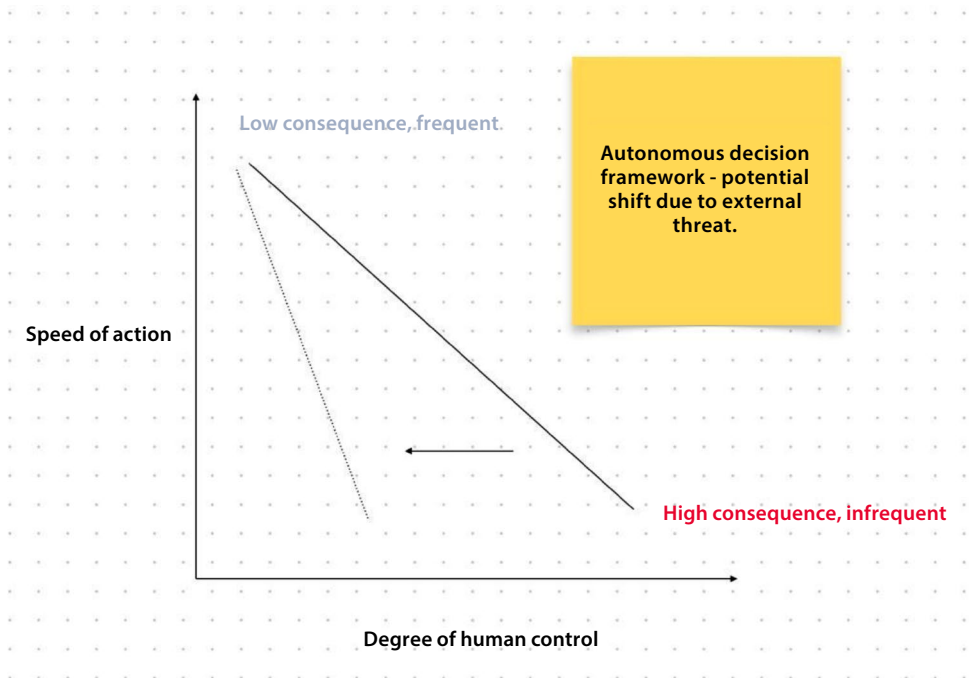


Figure 2 – Conceptualisation of AI autonomy change required as adversary decision cycle accelerates.

may need to shift, if constrained by the speed of an adversary's decision cycle (OODA loop).²⁰ The process and procedure to do this will need to be understood in advance to ensure appropriate decisions are made when circumstances become contested. Where AI systems support different parts of the organisation, this will also need to be coordinated to ensure appropriate alignment between the pace-of-decisions in complementary systems. There will be no point in a lightning-fast supply allocation tool which is constrained by the availability of human movers or a slow system of prioritisation due to misalignment with decision making at an operational headquarters. In turn, this requirement for coherence is likely to require increased mutual understanding of related parts of the organisation – requiring an interdisciplinary approach between the RAF's newly redefined Professions. Furthermore, AI models need to be designed to cater for these shifts and human teams need to be sufficiently informed to accommodate them. This will require familiarity with AI concepts, which do not currently feature in generic professional military education.²¹ Therefore, development of a suitable taxonomy to familiarise RAF personnel with AI must be a priority.

The Human-Machine Team – the transparency paradox

As Swinney explained in her 2022 article, two key technical challenges for AI are bias and variance. These are also human frailties. One way in which human bias overlaps with AI capability is in the extent to which a person is inclined to accept the recommendation or decisions of an AI. Our decisions as humans are conditioned by training, circumstance, and the broader organisational system to which we are exposed. So far, so similar to AI bias. But a key mitigation for human bias is the ability to perceive a pre-disposition due to our understanding of perspective and adjust accordingly. The extent to which an operator can do this in relation to an AI will depend on a knowledge of its training data and an assessment of likely bias or variance in the data. Counterintuitively, there is recent evidence that people are less likely to accept a decision from an AI when they know more about how it works (due to overconfidence) and that this can lead to poorer outcomes.²² It will also be affected by the extent to which an AI is subject to 'social proof' – by including respected peers in development and testing. The siloed nature of hierarchical organisations like the military, and the 'need to know' ethos that underpins classified information management, render teams necessarily more likely to accept 'on faith' assertions that pop out of another bit of the organisation.²³ Without systemic intervention, knowledge of AI design is likely to be held only by those who design the AI – and simply upskilling people may not be the answer – especially if further research provides additional evidence that people tend to be overconfident in overruling AI output. Instead, a systemic approach may need to be defined as part of through-career generic training. Such a systemic approach would need to balance sufficient transparency to allow the flexibility required of human-machine teaming to stay inside an adversary's decision cycle, without allowing for exclusion of AI input because 'I know better' or total abdication of human responsibility. Fundamental to it all would be an ability to understand the importance of, and judge data quality.

Developing a Strategy – estimating workforce changes

If we accept the premise that AI poses a need for us to adapt our human teams (*why*), then the next question is *how*. A logical starting point for a strategy is the front door – who we recruit.

Recent research into the impact of AI on the labour market suggests AI will have a transformative effect on the higher-skilled workforce.²⁴ Analysis of job task descriptions and AI patents suggests that, in contrast to robots and software, AI is directed at high-skilled tasks. If the historical pattern of new technologies substituting for a proportion of human jobs continues, then unlike robots (which disproportionately displaced low-skilled human labour) and software (which most impacted the middle-skilled), AI will displace a greater proportion of the higher skilled.

If we place this in an RAF context, it poses some interesting possibilities. It is likely that this trend could, over time, reduce the proportion of senior officers or experienced specialists within the workforce. Some evidence of this has been seen in the recent Royal Navy Transformation programme which reduced by up to 30% senior ranks and positions. More research could help the Service to plan for a changing workforce, by assessing further demographic variables, including occupational salary (Recruitment and Retention payments), educational level, gender and age. It may also be possible (using an adapted research methodology) to use the Training Needs Analysis (TNA) conducted for each RAF job type under the Defence Systems Approach to Training²⁵ to further refine such an estimate. Where a

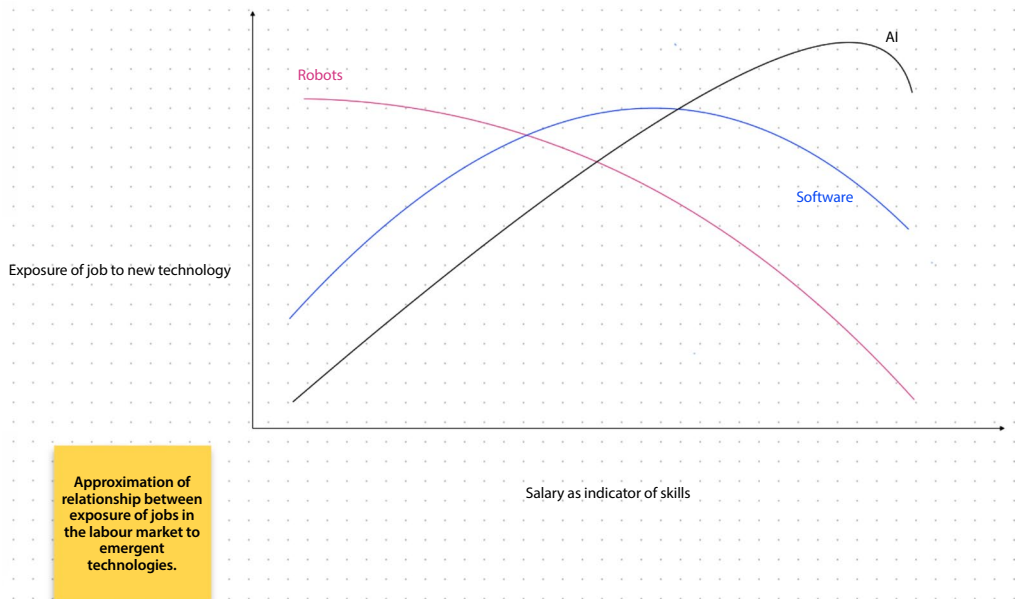


Figure 3 – Approximation of the relationship between salary / skills and exposure of jobs to substitution by robots, software, and AI (derived from Webb (2019)).

TNA is available for both a role in a non-AI system and one which is later AI-enabled, this could also enable the RAF AI strategy to explore and define any delta between optimal (peacetime) and degraded (wartime resilience) requirements.

Developing a Strategy – options for training

If adaption of our workforce is one element of our AI strategy, another must be evolution of our training. In the RAF training is often described as professional (specific to a career field) or generic (applicable to all in Service).

Training is further categorised by Phase – Phase 1 (Basic Recruit or Initial Officer Training), Phase 2 (the first professional training resulting in a certificate of competence in role), and Phase 3 (continued professional development). This framework could help to situate training opportunities for AI-literacy in a familiar context.

One training opportunity is to ensure we have people confident in codifying AI systems in a contextual taxonomy – which is crucial in an ethical context and therefore fundamental to the moral component of warfare. Emergent research into the ethics of development and deployment of AI systems in high-risk domains has emphasised the importance of an established methodology for interpreting AI ethics principles in a way that is consistent with the context in which they are used.²⁶ It is reasonable to expect that the need to rapidly procure new systems during a conflict will require familiarity with this concept. The starting point for training these skills is likely to be familiarity with ethical threats and mitigations, together with fluency in the way the AI system works. In turn, this will require development of appropriate categorisations which will drive a broader taxonomy for their use and level of human control. The practical application of the training would be attribution of a category to a given AI use case and identification of any operating constraints. This management of ethical risk (impact and likelihood) is likely to be necessarily limited to specialists and therefore be a component of professional training – with contributions likely from the Cyber, Chaplaincy and Operations Professions. Given that the degree of exposure to this task will vary by assignment, this might be best suited to Phase 3 training.

More generic training may help aviators to understand the way that AI operates at the level of the system in which AI is an agent. ‘Systems thinking’ is a way of assessing behaviours of a system (and how to influence changes) which may not be evident if we simply look at the component parts. This is likely to have significant advantages for understanding the relationships between human teams that are interacting with AI. As a generic skill, it also offers leaders the opportunity to improve the performance of their teams whether AI is involved or not. Fundamentally, it offers a framework for understanding complex processes.

When we try to understand something, we traditionally engage in reductionism - where we seek to identify all the components of a problem, take them apart to understand them, draw conclusions and then improve them. In contrast, systems thinking is more interested in

relationships and outcomes when the system itself is observed as a functioning entity.²⁷ The theory of systems thinking has emerged from biology, where some characteristics of biological systems can only be observed at a systemic level. Anatomic knowledge of an animal does not allow understanding of its behaviour, nor for the interaction between organs for example. This is particularly relevant to AI, as neural networks are not fully transparent and therefore, we are likely to learn more through its behaviour than simply its training. Furthermore, understanding the AI would not be enough – as we would also need to understand the behaviour of people who work with the AI, and the way in which that affects the overall organisation or domain. In a systems-thinking approach it is not the AI thought process itself that would be examined, but the overall behaviour of the wider system in which it acts as an agent.

Systems-thinking is therefore likely to be a desirable competence for all future aviators - but is currently unfamiliar to most. It might be that this renders it particularly suitable to graduated training which is re-introduced and reinforced in new contexts as people progress throughout their careers. A generic training pathway would provide a perfect opportunity to define the requirement for inclusion in Phase 1, 2 and 3 training. In this way the techniques and models could be introduced in ways that were directly relevant to individuals at that point in their career. Together with data literacy, it could be a worthy addition to generic professional military education. Alternatively, an approach similar to human factors training might be taken – where a Regulation or policy drives a requirement of levels of competence in dealing with errors borne of human factors in human teams or when working with automation.²⁸

Existing Subjects ²⁹	Potential Subjects
Air and Space Power	Air and Space Power
Leadership	Command, Leadership and Management ³⁰
Management	Data Literacy
General Service Knowledge and Skills (GSK)	Systems Thinking
Command	GSK (inc Ethics, International Humanitarian Law)
Force Protection	Force Protection

Figure 4 – Table comparing current / potential future subjects for generic professional military education.

Conclusion

This viewpoint has offered a précis of research which makes it evident that the RAF will need to change and evolve as AI proliferates. The first step to shared and effective understanding is to communicate the distinction between AI types and be clear-eyed about the capabilities of each instance of AI in the organisation. Given that AI is reliant on effective training, and in turn data, the requirement for improved data literacy is urgent. We don't know what level of human input is required in each future application of AI, but evidence shows us that the level of input

is likely to be contextual – and potentially constrained by an adversary or competitor. A means of considering the ethical implications of a given system given its use-case, data-training and design is likely to be an essential contributor to determining the level of human input – and therefore require a professional training pathway. Even when a system is accepted into service and employed, we need to better understand the human factors – just as we do for human teams and Aircrew working with automation. As AI proliferates it will affect the labour market over time – and this might drive changes in the RAF workforce strategy. Development of generic skills including systems-thinking might drive the inter-disciplinary dialogue and a better understanding of AI models influence within the organisation.

Notes

- ¹ ISTAR – Intelligence, Surveillance, Target Acquisition and Reconnaissance.
- ² Lu (2019)
- ³ Morton (2023)
- ⁴ Swinney (2022)
- ⁵ Lee (2019)
- ⁶ Turing (1950)
- ⁷ Lu (2019)
- ⁸ Alzubadi *et al* (2021).
- ⁹ Vinyals *et al* (2016); Sucholutsky and Schonlau (2021).
- ¹⁰ A common theme throughout keynote speeches at AI Fest 5 – DSTL (2023).
- ¹¹ Newell and Simon (1959) as cited by Swinney (2022).
- ¹² Shevlin *et al* (2019).
- ¹³ Kurzweil - Director of Engineering at Google, as cited by Swinney (2022).
- ¹⁴ Brooks - co-founder at Robust.ai (2019).
- ¹⁵ Wigston (2020)
- ¹⁶ RAF (2022).
- ¹⁷ Vohs (2021).
- ¹⁸ UN Office for Disarmament Affairs – Convention on Certain Conventional Weapons (2023).
- ¹⁹ Joint Concept Note 1/18.
- ²⁰ As developed from the ideas of Boyd, see Joint Concept Note 1/20 – Multi-Domain Integration.
- ²¹ AP 7000 v3.1 (2021).
- ²² DeStefano *et al* (2022).
- ²³ Dawes, Cresswell and Pardo (2009).
- ²⁴ Webb (2019)
- ²⁵ JSP 822
- ²⁶ Taddeo *et al* (2023)
- ²⁷ Meadows (2008)
- ²⁸ RA 1440 and MAA Human Factors Training Requirements.
- ²⁹ AP 7000 v3.1 (2021)

³⁰ In delivery, these separate elements from the generic performance statement are *de facto* delivered together at a level set by rank.

Dissertation

Resurgent Russia: What are the Implications for Contemporary Air Power Doctrine?

By Squadron Leader Robyn Mitchell

Biography: Squadron Leader Robyn Mitchell joined the RAF in 2012. After training she was posted to RAF Honington and in 2014 deployed to the Middle East on Operation Kipion. Moving to the Ministry of Defence she served as Staff Officer to Assistant Chief of the Air Staff before becoming Deputy Personal Staff Officer to Deputy Commander Operations in 2018. Following promotion, she worked in Joint Warfare as an exercise planner, and then as Officer Commanding No 2 Counter Intelligence & Security Squadron, after which she was selected as Military Assistant to Assistant Chief of the Defence Staff, Capability and Force Design, a role she departs this summer on promotion to Wing Commander.

Abstract: The performance of the Vozdushno-Kosmicheskiye Sily (VKS) in the Russian invasion of Ukraine has been poorer than anticipated. Eight months into the campaign Russia has found itself amid a grinding attritional conflict, compounded by the domestic pressures of an economy suffering from sanctions levied upon it by Western democracies. Russia has, nevertheless, inflicted significant damage on Ukraine, whose economy has shrunk by circa 45%. If armed conflict escalates, Western forces must be configured to beat Russia at the edge of the Baltic states, and in the battle for strategic advantage air power will be pivotal. Thus, there is a need to better understand Russia as an adversary, in the ways they learn lessons, develop their forces and adapt doctrine. This paper will focus on the implications of a resurgent Russia and what this means for contemporary air power doctrine. Additionally, it will consider ways in which doctrine could incorporate the use of air power, as a strategic asset, in the battle for information advantage.

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Section 1: Introduction

In September 1962, President John F Kennedy said, 'we choose to go to the moon in this decade and do the other things, not because they are easy, but because they are hard, because that goal will serve to organise and measure the best of our energies and skills, because that challenge is one that we are willing to accept...and one which we intend to win.'¹

Russia, the Cold War and the spread of Communism was the challenge of Kennedy's generation, and a similar challenge is now faced again by this generation. The challenge is not one of being able to prove an ability to go to the moon, but a challenge of equipping and configuring Air Forces to combat the myriad challenges they face in a contemporary operating environment. The landscape has changed since the Cold War and adversaries seek to fight in multiple domains, continuing to blur the boundaries of the traditional state vs state conflict for which Western forces are routinely structured. Doctrine is a crucial part of the puzzle and, to reuse Kennedy's quote, is key to organising and measuring the best of our energies and skills to ensure Air Forces can learn, develop and adapt in the fast-paced age of technology. There is now, more than ever, a requirement to out-think and out-smart the adversary, not just out-fight them. In recent years, Russia has demonstrated that it is prepared to seek to increase its sphere of influence regardless of geographic borders or the political and economic costs to its people. The challenges for the Royal Air Force, and other Western Air Forces, will be to understand whether the doctrine that underpins the delivery of air power is suitably equipped to prepare and enable air power professionals to operate and co-ordinate effects to gain and sustain a battle-winning advantage. Ultimately, the question that must be asked (and answered) is whether current air power doctrine configures Western air power for a war it would wish to win? This paper will critically examine contemporary air power doctrine alongside the doctrine and actions of a revanchist Russia. The findings will demonstrate that whilst current doctrine is likely to prepare Western forces for the conventional threat, two decades of fighting in the Middle East has brought about complacency in the key pillars of doctrine due to the familiarity with operating in a more permissive environment. The research question seeks to understand the implications of a resurgent Russia for contemporary air power doctrine and analyse whether current doctrine can prepare Western air forces, and the Royal Air Force in particular, for facing the full spectrum of competition and aggression brought about by a near-peer adversary that is as complex and determined as Russia and one that is also increasingly vulnerable to the risk of strategic miscalculation. Further, the thesis will discuss ways in which the Information Age can be incorporated to encompass the full spectrum of effects that result in aggressions that sit both above and below the threshold of war.

Innovation during peacetime is fundamentally different from adaptation in war: peacetime innovation is driven by perceptions of change in the external environment alongside conceptual hypotheses surrounding technology, organisations and doctrine needed to prevail in future conflict. Wartime adaptation, however, is a direct response to enemy action.² With regards

to Russia, in the post-Cold War era, the West could have enjoyed a period of peacetime innovation when it came to the spectre of conventional state vs state conflict. It was instead focused upon the far more imminent problem of the threat presented by extremist groups that had learned to employ a suite of asymmetric and irregular techniques to challenge the superior size, and firepower, of large Western air forces by avoiding presenting actionable targets. The 'War on Terror' spanned over two decades, embroiling Western forces in seemingly endless conflicts and presenting an opportunity for hawkish states such as Russia and China to watch, learn and understand how to employ asymmetric and hybrid strategies of their own.

In a strategy paper produced by the United States European Command in October 2015, a 'revanchist Russia' was listed as the top threat to European security and global stability.³ Despite the increasing prioritisation placed on the threat posed by Russia, UK air power doctrine has been existing in a state of rapid change; the enduring elements of air power sometimes struggling to remain relevant through the progression from facing state adversaries, to non-state actors, and back again. Through a review of UK air power doctrine and an understanding of Russian air power doctrine, this paper will aim to understand the development of the current roles of air power: Control of the Air, Attack, Intelligence Surveillance and Reconnaissance, and Air Mobility. Assessing the implications presented to the employment of these roles as a result of a resurgent Russia and capturing the requirements for air power to be successful in the contemporary operating environment. Success will be measured against an adversary who will seek to exploit a full range of capabilities and tactics that blur the boundaries and thresholds that have traditionally existed across the spectrum of conflict.

Much research exists around Russia and the notion of hybrid war; however, the recent invasion of Ukraine has demonstrated a Russian willingness to progress from the employment of hybrid tactics to an overt campaign that has resulted in both nations becoming mired in a bloody war of attrition. The Russia-Ukraine conflict underlines the Kremlin's determination to protect and expand its 'sphere of influence'. This paper aims to contribute to some early understanding of the conflict and address how Western air power doctrine may be configured to protect NATO interests and equity as the risk of increasing tensions and strategic miscalculation threatens to draw Europe back into a Cold War it has sought to avoid for over two decades.⁴

Methodology

In order to explore the subject of a resurgent Russia and the challenges the complex operating environment could present for Western Air Power doctrine; this paper has adopted a combination of literature-based sources with support from a key primary source interview. As part of the research, an analysis of official and open-source documents, such as UK air power doctrine and capstone strategy documents, as well as publications from NATO and the United States Air Force, has been conducted. Consideration has also been given to secondary literature and web-based sources to incorporate existing, peer-reviewed, analysis of issues

related to air power and Russia. Traditional think tanks such as the Royal United Services Institute (RUSI) and RAND Corporation have been utilised, in addition to more contemporary outlets such as *War on the Rocks* and *UK Defence Journal*. The purposes of the interview conducted was to fill any gaps in the research and to incorporate the fast-paced developments of the current Russian invasion of Ukraine.

The available literature, which will be expanded upon in more detail as part of the literature review, covers a great deal about Russian behaviour prior to the invasion of Ukraine in February 2022 and is primarily focused upon the notion of hybrid warfare and Russia's application of it. Frustratingly, hybrid warfare has morphed into a catch-all phrase since Hoffman initially caused the term to enjoy a surge in popularity. This has made it challenging for authors and academics to define what is truly meant when air forces use the term hybrid.⁵ Whilst the term has become obfuscated through overuse and political agenda, there is broad support for the argument that air power doctrine does not suitably capture the multiple stages that relationships between states and actors may progress through on the journey from co-operation, to competition, to conflict.⁶ Whilst literature surrounding Russian behaviour and the Western response exists in abundance for actions pre-February 2022, in-depth analysis which considers the period since Russia moved into a position of state v state war with Ukraine, is largely limited to articles and short products produced by think tanks such as RUSI and other foreign policy and defence commentators. Although the developments have challenged the scope of this research paper, it is hoped that this research will provide useful analysis to bridge the gap between the understanding of hybrid warfare and Russia's conduct of total war in the twenty-first century, identifying the resulting implications for Western air power doctrine. It is also important to note that, at the time of submission, the war in Ukraine continues to claim the lives of soldiers and innocent civilians. On the Russian side, many of those soldiers do not fully understand the context in which they are fighting due to limited mission command employment and information flow out of the Kremlin, one of the key reasons behind Russia's continued struggle to gain the operational advantage over their Ukrainian counterparts. Whilst there are developments occurring on a daily basis, for the purposes of this dissertation, the period of conflict from February to October 2022 is covered.

Outline and structure

Churchill previously described air power as 'the most difficult of all forms of military force to measure or even express in precise terms.'⁷ Through the relatively short duration of air power's existence, a number of factors have influenced the development of its doctrine, with air power theorists presenting alternative views and opposing ideas. Although much has changed on the technological front, the spirit of air power is not too dissimilar to the description afforded to it by Billy Mitchell when he stated air power as, 'the ability to do something in the air.'⁸ In order to bound the paper, the research will focus primarily on the structure of UK air power doctrine, examining each of the current air power roles in turn. The initial section of this paper will seek to understand the history and development of UK air power doctrine, linked to the ongoing development of air power theory and the contemporary operating environment.

This will formulate a review of the available literature and demonstrate an understanding of the UK established extant set of air power roles, as featured in Joint Doctrine Publication (JDP) 0-30. Section 3 will explore the notion of resurgent Russia and seek to understand the ways in which they have developed their air power doctrine and the symbiotic relationship the military has with their foreign policy strategies. This section will seek to understand Russia as a contemporary adversary and articulate the ways in which they have used hybrid and conventional tactics successfully in the past, whilst also seeking to understand how a failure to employ air power effectively in Ukraine has resulted in slow progress with a staggering human cost. Sections 4 to 7 will review each of the roles of air power in turn; with some comparison offered to other Western air forces, and NATO, to understand how air power activity is organised to deter threats and meet the demand of homeland and expeditionary operations, above and below the threshold of conflict. The final sections will cohere the analysis conducted in the preceding sections, drawing out the key findings regarding contemporary air power doctrine and the threat faced from Russia as a hybrid state actor that may prompt further thinking and discussion on the subject, particularly as the conflict in Ukraine develops. These findings will answer the paper's main research question and conclude that air power doctrine has, since its inception, faced challenges through the constant evolution of warfare. The four key roles of air power have links back to the formative days of air power and whilst they provide a useful doctrinal framework, they may be too simplistic in the way in which air power effect is summarised. Incorporation of information and expansion upon the importance of integrated command and control might assist further with articulating the contribution air power can make and how it can be organised, co-ordinated and integrated to deliver soft and hard power effects across the full spectrum of competition and conflict. As a concluding point on the scope of this paper, it should be noted that air power is a vast subject and not all elements of JDP 0-30 can be considered within this paper; therefore, space power will not be considered. Whilst air and space power enjoy a number of shared attributes, they are distinct from one another and as such, should be treated as separate domains.⁹

Section 2: Literature Review

'Those who are possessed of a definitive body of doctrine and deeply rooted convictions based upon it, will be in a much better position to deal with the shifts and surprises of daily affairs, than those who are merely taking short views, and indulging their natural impulses as they are evoked by what they read from day to day.'¹⁰ This quote from Sir Winston Churchill demonstrates that doctrine, whilst of huge importance, can only be employed effectively when it is supported by the educational process that transforms it from simply what is written, to a cultural understanding that underpins its daily employment on operations. The challenge that is often presented regarding doctrine is that there appears to be no consensus, amongst Western air power theorists, on what doctrine is or should be and for whom it is primarily intended.¹¹ The supporting literature review for this dissertation will be broken down into two distinct parts; first an understanding of the arguments surrounding doctrine and the academic weight placed behind its importance and development. Secondly, will be a review

of the literature surrounding hybrid warfare and the myriad ways that Russia has sought to undermine Western air power by knowing its doctrine and understanding how it has operated for the last two decades. This section will also highlight the emerging impact of Russian action in Ukraine and how doctrine is vital in order to appropriately position Western forces for asymmetric challenge as well as conventional conflict.

The Utility of Doctrine

In the immediate aftermath of the Royal Air Force's inception, as the dust settled on the First World War, the fledgling Service found itself in the unenviable position of attempting to justify its existence alongside the British Army and the Royal Navy. Influential proponents of air power, such as Trenchard and Douhet, proposed theories of bombardment, technological superiority and air policing that brought to the fore capabilities that they believed could not be rivalled by the other Services. Thus, the notion of what air power could achieve, on the battlefield and beyond, emerged from the First World War as both a doctrinal enigma and a romantic vision of bringing to bear an age of industrialisation. Throughout the RAF's 104 years existence, there are few who have demonstrated an ability to chart the leaps in technology without overpromising for the future; doctrine has been required to attempt to keep pace with these rapid advancements and optimise the capability for use on operations. When considering the utility of doctrine, it is also valuable to understand whether it is representative of the current threats and sufficiently flexible to address contemporary challenges, including those presented by future hybrid conflicts in the Information Age. The challenge with doctrine can often be that it has a tendency to become a single Service manifesto that serves to represent the wars the West would wish to fight and be resourced for, particularly with regards to the funding of associated equipment programmes. This focus on conventional capability can present problems against adversaries who seek to employ hybrid methods in order to undermine Western military mass and might.¹² Supporting this view, Kilcullen suggests that the Western world has placed its faith in the unchallenged supremacy of its own military power.¹³ Further, Olson reflects on a reticence to accept that the nature of war is changing to something more fluid; an adversary that will seek to present an unidentifiable or attributable centre of gravity that can be targeted through the conventional military capability that Douhet, Mitchell and Trenchard envisioned and enshrined in doctrine.¹⁴ Current air power doctrine also appears to lack any meaningful emphasis on the importance of information; according to General Goldfein, 'whoever figures out how to quickly gather information in various 'domains' and just as quickly direct military actions will have the decisive advantage in battle.'¹⁵ Where the adversary is concerned, the influence of information is evidenced in the Russia-Ukraine conflict, where even civilians and non-combatants have demonstrated a viral ability to manipulate the battlespace environment through the invention and re-invention of reality via social media platforms.¹⁶ As information is used, relied upon and manipulated so significantly by all parties in a conflict, perhaps consideration should be given to the reprioritisation of information advantage above the more traditional roles of air power such as control of the air or attack. Yet 'control' and 'attack' are referred to with much greater frequency than 'information' in JDP 0-30.¹⁷

From Hybrid to Conventional: Russia's New Normal?

'The space between war and peace is not an empty one, it is a landscape churning with political, economic and security competitions that require constant attention.'¹⁸ The term hybrid warfare first rose to popularity in 2007 when it was used by Frank Hoffman to describe the combination of multiple modes of warfare, blending conventional capabilities with unconventional and asymmetric methods, irregular tactics and formations, and a range of acts that included terrorism, indiscriminate violence, coercion and criminal disorder.¹⁹ The unfortunate nature of all terms 'in vogue' is that they are often weaponised by single Services and other Government departments; resulting in internal wrangling for finance, public opinion and power.²⁰ As a result of this, the debate surrounding hybrid warfare, what it is and what it is not and Russia's employment of it, has become increasingly complex and politically charged. As Michael Kofman said, 'if you torture hybrid warfare long enough it will tell you anything, and torture it we have.'²¹ The term now encompasses all types of Russian activity; from the propaganda machine through to conventional warfare and everything in between. Thus, unhelpfully, almost rendering the term useless for the purposes of practical application, since any Russian actions can and have been included in it.

There are two key groups of literature that have been considered for this paper in regard to Russia and their modern approach to warfare. The first is the conceptual debate surrounding hybrid warfare and whether it represents the future of conflict, or alternatively, whether it is a tactical buzzword that has distracted strategists from addressing Moscow's ambitions and capabilities.²² Authors such as Colin Gray, William Olson and Rupert Smith are supportive of Hoffman's thesis regarding hybrid warfare and the importance subsequently placed on it as a concept. They have recognised it as a strategy for degrading conventional military power and facilitating the pursuit of strategic ends employing a degree of force that falls just short of overt coercion that would cross traditional thresholds for conventional war.²³ David Kilcullen takes this a step further in his books *The Accidental Guerrilla* and *The Dragons and Snakes: How the Rest Learned to Fight the West* when he suggests that by 2014-15, Russia had become increasingly adept at drawing inspiration from the nonstate actors that had challenged Western military capability. Their sponsorship of militias across the physical domains, as well as in the cyber domain, allied to a willingness to interfere in elections and destabilise adversaries through propaganda and disinformation campaigns, and used in conjunction with the weaponization of energy supplies, all highlighted the ways in which Russia was prepared to adopt the techniques of nonstate actors in order to pursue strategic state objectives.²⁴ This activity was running in parallel to the unveiling of a suite of new and advanced weapon systems that demonstrated Russia was determined to challenge and erode the dominant position of Western powers through a variety of conventional and unconventional methods that were, when combined, arguably hybrid in nature.

Whilst there is much support regarding Hoffman's thesis, others have argued that hybrid warfare is nothing new and that history has continuously demonstrated the employment of

asymmetric and 'hybrid' tactics in order to undermine an adversary and gain an advantage.²⁵ Further, where Russia is concerned, some authors posit that hybrid warfare is simply a series of tactics employed in order to risk manage Russian inability to engage with Western forces, or indeed NATO, in a conventional Article V type conflict.²⁶ Clearly, some of this academic study aged slightly when Russia invaded Ukraine in February 2022 and subsequently bore the wrath of Western diplomatic and economic sanctions, with an apparent lack of regard for the risks associated to their economy and the danger of becoming a pariah on the global stage. A paper by William Courtney, published by RAND, indicated that after Russian response to Soviet soldiers' deaths in Afghanistan, there would be little appetite to move away from the approach of using irregular fighters and engage Russian forces in potentially heavy losses in Ukraine.²⁷ As of the 8th August 2022, after almost six months of fighting, the United States Defense Department believed that as many as 80,000 Russian troops had been killed or wounded since the Kremlin's full-scale invasion commenced.²⁸ It is clear that Russia has now had to make the transition from 'Special Military Operation' to a protracted and painful state-on-state conflict against a Ukrainian adversary which is now feeling the benefits of Western military support; enabling them to utilise a more reliable logistic network and better quality weapons to against the Russian bear.

With regards to Russian doctrine, there appears to be even further challenge, particularly if we consider Gerasimov doctrine. The term Gerasimov doctrine has been similarly as used and abused as hybrid warfare; Mark Galeotti is the architect behind this particular term, and it was born out of an article published in February 2013, by the Russian newspaper *Military-Industrial Courier*. The article contained a reprinted speech by General Valery Gerasimov that referenced the requirement for operating in a modern world and the inclusion of propaganda and subversion as a means for subjecting a perfectly thriving state to 'a web of chaos, humanitarian catastrophe and civil war'.²⁹ 2014 brought about the annexation of Crimea utilising 'little green men', followed up with an organisation of separatists, mercenaries and special forces supported by a barrage of Russian propaganda across multiple social media channels. This action in Crimea caused an almost immediate rise in popularity of Gerasimov doctrine and the belief that he had somehow created a blueprint for conducting a new way of war that presented a significant threat to Western military forces.³⁰ The West largely believed that Russia's model for war would now be characterised as the use of indirect action strategies coupled with asymmetric responses across multiple domains and networks to create an imbalance that conventional forces would struggle to deal with through a traditional application of force. This ultimately does not translate well across to the state of affairs witnessed in Ukraine where the disastrous attempt to seize Hostomel Airport and the brutal reduction of Mariupol suggests that the Ukrainians have potentially been better practitioners of Gerasimov doctrine than the Russians.

The academic debate is convincing and provides many contemporary examples from which to draw evidence; the challenge at present is how the extant academic debate is developed

alongside a conflict between Russia and Ukraine that has become a protracted, grinding war. A war that is very much focussed on the land environment and the taking and reclaiming of territory. This type of attritional state vs state warfare has not been witnessed in Europe since the Second World War and whilst the temptation may be to look back in history for the answers, doctrine will be required to consider all threats, not simply the conventional ones, to ensure it is appropriate and suitable for the present and the future. Hybrid warfare may not be new, but its recent evolution increasingly threatens to endanger international peace and security and the rules-based order upon which the West places so much value. Although much of the literature review has focussed on the topic of doctrine and the overarching concept of hybrid warfare, as employed by Russia, the next section will delve a little deeper into the resurgence of Russia. Reviewing the development of air power as part of their return as a state determined to compete for a greater sphere of influence and a more respected position on a world stage.

Section 3: Resurgent Russia

Until recently, the end of the Cold War and the dissolution of the Soviet Union resulted in Western nations feeling that Russia no longer competed with their positions as great powers. There was almost a sense of hope and optimism that the West and Russia could be partners, as Russia pursued a path to 'normal' by the standards of Western capitalist democracies.³¹ During this period, Russian observers attended NATO exercises and training courses with Western forces; it seemed that the era of the great-power struggle was a legacy of the Cold War. In 2012, President Barack Obama even made light of Mitt Romney, in a Presidential debate, for suggesting that Russia posed a threat: 'when you were asked what's the biggest threat facing America, you said Russia, not Al Qaida... the 1980s, they're now calling to ask for their foreign policy back because the Cold War's been over for 20 years...'³² Russian involvement in Georgia in 2008 and the annexation of Crimea in 2014 sparked debates around Europe and the West, concerned by Russia's military revival and strengthened capabilities in numerous areas, including air power.³³ Russia was, for the first time in decades, demonstrating an increase in technological capabilities that appeared to be underpinned by a heightened sophistication in planning, conceptual and doctrinal development. This pursuit of military reinvigoration and demonstration of what has since been described as 'hybrid' strategies demonstrated to Western air forces that their assumptions that the Russian military could never modernise were fundamentally flawed.³⁴ This section will seek to explore further the notion of a resurgent Russia and understand the technological and doctrinal shift undertaken, particularly in regards to air power, that has caused the West to feel increasingly threatened by the assertiveness of Russia's foreign and military policy. The use of Russian air power in Syria in 2015 will provide useful context for comparison with the way in which Russia has employed air power in Ukraine from February through to October 2022. It is worth noting that this section encompasses two periods, the Russian Air Force (RuAF) and the VKS. The RuAF is now part of the Vozdushno-Kosmicheskiye Sily (VKS) after it was merged, on the 1st August 2015, with the Russian Aerospace Defence Forces. For consistency, Russian air power is referred to as VKS throughout.

Shortcomings in Georgia and Doctrinal Adjustments

During the five-day conflict in Georgia in 2008, Russian air power is considered to have encountered some significant setbacks with the loss of six aircraft. These losses were, in part, due to a failure to appreciate the operating environment and suppress the Georgian surface to air missiles.³⁵ More concerning, however, was the loss of five Russian aircraft to other elements of the Russian war machine; General Shamanov, commander of Russian forces in Abkhazia indicated this was a confluence of legacy Soviet platforms, a malfunctioning Identify Friend or Foe (IFF) system and an ineffective approach to airspace management.³⁶ In the immediate aftermath of the conflict, a military reform was announced by the Russian Ministry of Defence; determined to free themselves from the shackles of Soviet era equipment and begin the development of capabilities that would be suitable for the post-Cold War environment.³⁷

The modernisation programme was conducted at pace; by 2015 more than 310 new aircraft had been delivered from a forecast of 700 scheduled for 2020. In addition to this, improvements had been made to weapons systems with projections estimating that by the end of 2016, more than 50% of the VKS' weaponry would be new and supported by enhanced navigation systems retrofitted to aircraft.³⁸ In conjunction with this technological development, Russian military thought and doctrine was also making progress: strategists such as Valery Gerasimov and Andrei Kartapolov were discussing the concept of New-Type War (NTW).³⁹ NTW as a concept was constructed around integration across domains; allowing Russian forces to manipulate the adversary's perception and influence behaviours at the strategic level without engaging kinetic force at scale.⁴⁰ Whilst Russia's technological advancements would still leave them lacking the advantages enjoyed by Western air forces, the ability to analyse the West's weaknesses through their performance in Iraq and Afghanistan had afforded them the opportunity to develop a new approach to achieving political-military goals.⁴¹ Gerasimov emphasised that a combination of non-military and military measures, at a ratio of 4:1, should be employed with indirect and asymmetric operations working in concert with more traditional forms of warfare.⁴² Charles Bartles underlines in his analysis of Gerasimov's work, that where the West views the non-military measures as ways of avoiding war, Russia views them as part of war.⁴³ Russia's ambition was no longer to focus on conducting operations in the land, sea and air domain, it was to conduct war across all physical environments whilst simultaneously rapidly dominating the information space and influencing or defeating an adversary before engaging the full weight of their combat forces.⁴⁴

Whilst the investment in Russian air power and supporting thought and doctrine seems significant, they were, on occasion, at odds with one another. The requirement to pursue the ability to fight in the information and cyber space meant that Russia did not resolve the enduring challenges faced by their air force. The VKS position in 2015, although infinitely more modern and technologically advanced than it had previously been, was still falling short of achieving parity with Western air forces.⁴⁵ Russia was beginning to realise that the

development of an effective air force is predicated on more than investment and technology; it is about creating a highly trained and technical work force that can manage routine and complex air operations.⁴⁶

Russian Air Power in Syria

The catalyst for Russian intervention in Syria is difficult to pinpoint precisely; however, analysts consider that the trigger was perhaps the signing of the Joint Comprehensive Plan of Action. This particular document contained an agreement by Western powers to be considerate of Iran's special interests in Syria.⁴⁷ This agreement was in direct opposition to the Russian foreign policy strategy attempting to manage the growth of Iran's influence in Syria. As a result, on 26 August 2015 an agreement was signed that would commit Russian military forces to operations in Syria.⁴⁸ Whilst the size of the VKS deployed air wing fluctuated throughout the conflict during the battle for Aleppo, the VKS in-theatre presence consisted of circa 65 combat platforms comprising fighters, fighter-bombers and helicopters.⁴⁹ Although this force is considerably smaller than a traditional Soviet deployment would have been, academics argue that, regardless of scale, the VKS' achievements in Syria would have been near impossible for the Soviet Union.⁵⁰

Syria provided an excellent opportunity for Russia to test and integrate the aircraft, equipment and weaponry they had received as a result of Putin's reinvention of Russian Defence capability.⁵¹ The performance of weaponry and aircraft in the VKS inventory was analysed and improved with problems and defects rapidly identified and ironed out.⁵² Aside from the Research and Development benefits, Syria also acted as a proving ground for tactics, techniques and procedures (TTPs) and the continued evolution of air power doctrine with the ability to work as a joint expeditionary force operating in a joint and combined environment.⁵³ This willingness to operate alongside partners from Syrian, Iraqi and Iranian forces demonstrated an attitudinal shift from Russian operations in Afghanistan where the Soviet Air Force fundamentally distrusted its Afghan counterparts.⁵⁴ Ultimately, these joint and combined operations could only prove successful because the VKS had developed an effective layered C2 structure that acted as a hub and spoke with information and intelligence being shared and co-ordinated at both the strategic and component level.⁵⁵ Most importantly, this C2 network allowed Russia and its coalition partners to deconflict Russian air operations with neighbouring countries.⁵⁶ Whilst Russia may not have been able to fully restore Syria under Assad's regime, they did prevent the fall of Assad and assisted the Syrian government with regaining nearly 57% of the territory of the country.⁵⁷ This was achieved in a very different way to which the West would undertake a similar mission, with the VKS being prepared to use air power to inflict devastation upon opposition forces and non-combatants alike.⁵⁸ This approach was coupled with the VKS using air power to, where necessary, escalate or de-escalate the conflict in support of influencing a particular round of negotiations.⁵⁹ This demonstrated an ability to transform results at the tactical level into a political victory in Syria through the brutal employment of air power being used to coerce and generate more productive negotiations with opposition forces.

Russia's Use of Air Power in Ukraine

The tactical and strategic successes in Syria in 2015 contribute to the surprise that has come from VKS performance in the 2022 invasion of Ukraine. Despite being in possession of an air force that is ten times larger than that of Ukraine, Russia has not been able to achieve control of the air in a way that has proven decisive for the conflict. In fact, over four months of intense fighting in Ukraine have seen Russia's grand offensive strategy descend into an attritional struggle that has, in places, ground to an almost complete halt. There are a number of possible reasons for this: the first being that whilst Syria offered an opportunity for Russian aircrew to hone their skills on operations, it did not prepare pilots for large-formation flying. Equally, the Russian ability to suppress air defences and strike targets deep inside Ukraine has been challenged by the influx of support from the International community; the same community that replenishes Ukrainian weapon stock-piles and other capabilities is simultaneously hurting Russian production of the same through the suite of economic sanctions currently in place.⁶⁰ Finally, a lack of unified command and control of air operations has led to unnecessary aircraft losses and limited effectiveness in support of the Russian main effort to expand deeper into Ukrainian territory.⁶¹

One Russian air power strategy that has made a return in Ukraine, however, is the indiscriminate use of air power to attempt to subdue the population. Whilst in the early stages of the conflict, Russia appeared to be failing to capitalise on targeting key logistics nodes and critical infrastructure; as the conflict draws on, Russia's ability to strike almost indiscriminately has begun to have a detrimental impact on Ukraine's war effort.⁶² Therefore, although Russia has not been able to gain control of the air in the way it would wish, neither has Ukraine; the resultant impact has been large-scale strikes on targets with sufficient persistence that it is beginning to have a noticeable effect on the confidence of the Ukrainian public and the prospects for future security and economic recovery.⁶³ Ultimately, the longer the conflict persists, there is a chance that Ukraine may eventually be worn down through attrition or economic compromise; whilst Russia likely has limited appetite to be embroiled in a protracted war, it would appear that the only way to encourage the Kremlin to withdraw from Ukraine would be to demonstrate that it cannot win through a persistent engagement that exhausts Ukrainian stockpiles and Western resolve.

Overall, Russian air operations in Syria demonstrated the ability and flexibility to deploy an expeditionary force bespoke to the strategic and operational requirement. This adaptable scaling of military intervention allowed Russia to effectively manage the risk of being drawn into a protracted conflict in Syria. Whilst challenges with logistics and multi-national co-ordination undoubtedly existed, the VKS demonstrated capacity to learn from the operational mistakes being made and use air power to great effect in achieving political success through its utility as a coercive instrument and force multiplier. This, with an effective layered C2 structure, proved that the VKS was progressing away from the rigid shackles of the Soviet Union and towards being an adaptive force that could respond to, and operate in, a complex multinational environment.

Whilst the success of air power in Ukraine has not necessarily been what Russia may have wished it to be, there is still the opportunity for them to create a situation in which dogmatic engagement exhausts Ukrainian stockpiles and the Western patience with financing their replacements (to the detriment of their own stockpiles). This section has demonstrated that much of the recent academic analysis has been focussed on the impressive modernisation programme conducted by Russia in regard to their combat-air capabilities. The failure to establish air superiority or deliver significant combat support to the Russian ground forces in Ukraine has, therefore, presented an unexpected development that demonstrates that doctrine should not just be written, it must be implemented. The next section will look at control of the air to further understand its importance as a key pillar of air power doctrine.

Section 4: Control of the Air

'The nation that secures control of the Air will ultimately control the world.'⁶⁴ When British Air and Space Power doctrine, Air Publication 3000, was published in 2009, the aim was to demystify air power by distilling its essence into four fundamental roles, the first and often argued most important role being control of the air.⁶⁵ The section on control of the air reaffirmed that enduring 'doctrinal primacy' and the RAF was keen to emphasise its importance in an era of enduring COIN operations in a largely permissive air environment.⁶⁶ The shift towards joint doctrine saw the publication of JDP 0-30 in 2013. Whilst the four roles of air power, including control of the air, endured, a number of alterations were made to the missions that sat beneath them, creating no less than 37 missions under four overarching roles.⁶⁷ In the updated edition of JDP 0-30, published in 2017, control of the air remained largely unchanged, aside from the inclusion of the NATO agreed definitions of air superiority and air supremacy.

The following section addresses the first sub-question: is control of the air still the most important role of air power? It will also consider whether two decades of Counter-Insurgency (COIN) operations have impacted the ability of Western air forces to gain and retain control of the air against a near-peer adversary. The section will review the existing academic literature and focus on the concepts and issues drawn from those sources. The section will seek to identify trends in the transformation of Western air forces, since the First World War, and understand how multinational operations and co-operation may influence the ability to achieve control of the air. Whilst numbers of aircraft and personnel within the Royal Air Force have dwindled since the Cold War, this chapter shows that multinational co-operation, through alliances and bilateral agreements, have allowed for a greater degree of interoperability. There are, however, challenges that must be overcome with issues relating to national politics and single Service frictions at the strategic level.

The Importance of Control of the Air in a Contemporary Context

Historically, control of the air has been described as 'the most important air power role because it secures our freedom of manoeuvre.'⁶⁸ In the domestic sense, control of the air also protects the UK and the overseas territories from attack and is defined as securing freedom to use a

volume of airspace to achieve the RAF's desired effects whilst also, if necessary, denying or constraining its use by an adversary.⁶⁹ Romanticised following the Battle of Britain, for bringing about the decisive turning point during the Second World War, and immortalised in Winston Churchill's speech in gratitude to 'the few', control of the air was ingratiated as the *primus inter pares* role of air power. Some have since, however, questioned if the role is as important now as it was during those pioneering days of military aviation. In an article for *Wavell Room*, Hannah Whitehill argues that control of the air is not a role of air power, rather a product of air power in all its forms that work to contribute towards its achievement.⁷⁰ The war in Ukraine has brought into sharp focus just how vital control of the air is; when Russian forces flooded over the Russian and Belorussian border into Ukraine, with predictions that the large-scale invasion would see Russian forces pushing Ukraine towards capitulation in less than a week.⁷¹ Those predictions proved to be incorrect and, despite estimates that Russia would establish control of the air within 72 hours, over six months into the conflict Russia has continually failed to achieve such targets. The aircraft losses suffered have undoubtedly hindered their ability to provide air support for the ground invasion; either as close air support or air interdiction.⁷² On paper, Russia held clear advantages both in terms of mass and capability, yet Ukraine with a small and aging force of fourth-generation fighters and legacy Surface-to-Air Missiles (SAMs) has managed to counter those advantages and prevent Russia from delivering an immediate knock-out blow in the early stages of the war. Even if total air superiority could not be achieved, Russia's inability to secure even localised air superiority has resulted in a staggering loss of aircraft and helicopters, with it being claimed that 31 planes, and 30 helicopters, were lost in the first week of the conflict. This, in turn, has meant that the VKS do not have the requisite freedom of movement to provide the necessary close air support to their columns of mechanised forces, allowing Ukraine's network of unmanned aerial vehicles (UAVs) to operate and inflict damage on, or destroy, a large number of Russian vehicles.⁷³ There are a number of reasons for the limited impact of Russian air power on this particular conflict, some which will be unpacked in other sections of this essay; however, where control of the air is concerned, this has been a failure of Russian forces to interpret and employ their doctrine effectively. Ultimately, up until October 2022, they had failed to concentrate effects and execute an effective multi-domain campaign to gain air superiority.

Warden speaks about control of the air being the first and most important mission in any air campaign and that all other operational objectives must be subordinated to its attainment; he goes on to further suggest that no other operations should be commenced if they are going to jeopardise the primary mission of achieving air superiority.⁷⁴ Thus far, Russia has employed a broad range of capabilities spanning the full spectrum of military effects: airborne, land, maritime, air, cyber and electronic warfare. Yet these attacks have failed to be concentrated and co-ordinated to deliver effect on the battlespace, particularly in the battle for control of the air.

The Impact of COIN Operations on Control of the Air

The challenge comes for Western air forces because commanders have grown accustomed to operating in an environment that is facilitated through control of the air being a given.

Allied commanders have been able to focus on the battle at hand with little concern for enemy air forces. From the Gulf War onwards, Western air forces have enjoyed freedom of movement and action in the skies above their Joint Operating Areas; allowing ground forces to progress largely unhindered as air forces focussed primarily on the ability to attack the enemy, at will, from the air.⁷⁵

Air missions in Iraq and Afghanistan afforded Western air power the opportunity to operate small numbers of exquisite aircraft, in highly precise ways, reducing risk to air assets and minimising collateral damage. The requirement for Offensive Counter Air and Defensive Counter Air missions is largely born out of operating in a conventional war environment and it does not, arguably, translate well to a counter-insurgency campaign. Operation Granby, the UK's military contribution to the United States-led coalition to free Kuwait from Iraqi occupation in 1991, provides an excellent example of this. Despite the Iraqi Army being the fifth largest in the world, the co-ordinated use of air power was able to deliver devastating effects on the battlefield. The West's ability to rapidly gain control of the air, and switch focus to counter-land operations against Iraqi ground forces, led to a significant reduction in Iraqi Army combat capability and secured a swift defeat of Iraq's conventional forces.⁷⁶ The challenge for Western forces then came when the adversary transitioned to insurgent warfare and this demonstrated a lack of understanding in terms of how air power could contribute effectively to what ultimately became a counter-insurgency campaign.⁷⁷

The Centres of Gravity concept, when applied to a counter-insurgency campaign, indicates that the root of the problem, and the source from which the adversary draws its motivation and will to fight, revolves around the hearts and minds campaign. Insurgents rally support for their cause through essentially conducting what Western forces would refer to as an Information Operations (IO) campaign.⁷⁸ This can render some of the traditional potent functions of air power as counter-productive with the use of overwhelming military force possessing the ability to undermine the broader strategy that may be focussed upon winning hearts and minds.⁷⁹

Whilst Russia is considered a conventional state threat, they have also demonstrated, as has been discussed in this paper, an ability to wield asymmetric capabilities that seek to negate the overwhelming air power of Western air forces and NATO. It is also important to be aware that whilst the VKS performance in the current Russia-Ukraine conflict has been poor, in particular their suppression of Ukrainian defences through the employment of effective DCA, they have still delivered a significant blow to the future of Ukraine. Cities have been levelled, countless civilians killed, and Western countries are working, at pace, to resupply the large volume of munitions Ukraine requires in an attempt to roll the Russians back.⁸⁰ Whilst the United States Air Force (USAF) never stopped configuring for high intensity missions, throughout the two decades focussed on COIN, the primary question will be for European air forces and their ability to meet NATO's strategic intent in a politically relevant timeline. The Baltic states lack the strategic depth afforded to Ukraine through geographical scale; would Western air

forces be appropriately configured for the first battle?⁸¹ Gaining control of the air and rolling back Russian air defences before they have an opportunity to level cities and engage NATO in a protracted campaign is vital. This configuration leads into the next sub-question of this paper, and whether control of the air can be achieved single-handedly and perhaps, more importantly, without a reliance upon the United States of America?

Can Control of the Air Be Achieved Singlehandedly?

‘There is only one thing worse than fighting with allies, and that is fighting without them.’⁸² The US withdrawal of troops from Afghanistan in July 2021 was accompanied with the withdrawal of British troops after the UK government decided it would not remain in the country without the support of the US military.⁸³ The scenes that followed, with the Taliban rapidly regaining control of Afghanistan, led some to suggest that this had been the biggest foreign policy disaster for Britain since the Suez crisis of 1956 and represented a decline in Britain’s status as a global military power.⁸⁴ Further, concerns were raised over Britain’s ability to operate independently of the United States; particularly in a country without the conventional means or military power available to it that an adversary like Russia, Iran or China has.⁸⁵ Currently none of the European air forces possesses enough capacity to conduct the full spectrum of air power roles, thus a dependency on the United States as a fundamental part of NATO is created.⁸⁶

Whilst the notion of a NATO without the United States is unlikely, consideration must be given to their focus on the Indo-Pacific region and the growing tensions between China and Taiwan.⁸⁷ This is compounded by discussions around limited US military presence in Europe appearing more frequently in recent years, following President Barack Obama’s announcement that the US would primarily focus on Southeast Asia.⁸⁸ This was swiftly followed by the Trump era when President Trump even suggested the possibility of a total US withdrawal from the North Atlantic Alliance.⁸⁹ This dependence upon US air power could be replicated in every section of this paper; with a requirement for support in each of the fundamental roles. Control of the air, however, is crucial to commencing the campaign with enough intensity to defeat Russia in a politically relevant timeframe.

The good news for Western air power is that, in his invasion of Ukraine, Putin miscalculated the strength of NATO. His previous actions in Georgia, Crimea, and with Skripal in the UK, remained largely unchecked with neither national governments nor supranational organisations keen to intervene. On the 24 February 2022, that position changed, and the NATO community was galvanised in the face of the first state on state land war in Europe since the Second World War. Putin misinterpreted the Western ‘forever war’ fatigue as those powers not having the stomach to intervene militarily to defend Ukraine. At a time when Russia’s military is being weakened by a protracted war in Ukraine, Europe in particular is re-investing in military capability to prevent further attempts by Russia to fundamentally redefine the European security landscape. This renewed investment in alliances and relationships should hopefully ensure that Western air forces are adequately prepared for high intensity missions in the future.

In summary, despite two decades of COIN operations creating some complacency around control of the air, the current war in Ukraine has been a clear demonstration of its importance and the strategic and operational-level impacts that are felt as a result of a failure to gain and maintain any kind of air superiority for a meaningful period of time. The greatest implication resurgent Russia has presented for control of the air is a requirement, for Western air forces, to move away from the presumption that they will be able to maintain air superiority in the future without acknowledgement of the growing threat posed by near-peer adversaries. Western air forces need to be sure that they do not dismiss the air war in Ukraine as being solely a case of Russian ineptitude; in some cases, Western capabilities are outclassed and, in some theatres, outnumbered. For those reasons it is crucial that control of the air retains its position as the *primus inter pares* role of air power doctrine, and that alliances and coalitions are suitably configured to gain control of the air as one of the primary missions in any war where air superiority may be an enduring challenge to achieve. Whilst there have been some disagreements about control of the air's position as a role of air power, as doctrine is primarily designed to serve commanders both in the air and joint environment, it is important that its importance is underscored without being dogmatic. All commanders should be aware that the attainment of control of the air is crucial to the successful employment of a full spectrum of joint military effects.

Section 5: Attack

'The power to hurt – the sheer unproductive power to destroy things that somebody treasures, to inflict pain and grief – is a kind of bargaining power, not easy to use but used often.'⁹⁰ Following from the First World War, Liddell Hart wrote a think piece titled, *Paris; or the Future of War*. This work featured Liddell Hart's interpretation of the defeat of Achilles, by his opponent, through the precision strike of a well-aimed arrow. Reminding those who read his work that success in war could only be achieved by attacking an enemy's vulnerabilities, not their strengths. Although this was a concept that had been explored by theorists from Sun Tzu to Clausewitz, the brutal cost of the First World War brought this strategy into sharp focus and many felt that air power and the technology of flight may be what took it from theory to reality.⁹¹ Since then, air power theorists have sought to establish the key vulnerabilities of an enemy nation and attack them in order to degrade their industrial base, their logistics capacity and the will of their people. Although this has not always been successful, as evidenced during the Blitz and numerous campaigns since,⁹² JDP 0-30 still refers to attack from the air lying at the heart of air power's ability to influence the adversary and the course of events in conflict.⁹³

This section will consider two sub questions: whether attack continues to lie at the heart of air power's ability to influence the adversary and achieve success decisively, and how information activities should feature as a sub-set of attack. Further, detailing the balance to be struck between precision and pace, and whether attack can operate quickly enough to roll back a near-peer adversary, such as Russia, at the speed of strategic relevance. The question of mass also plays into this; the RAF operates in very precise ways with limited forces and

against an adversary like Russia there is a requirement to increase availability of equipment and munitions stockpiles. This increase needs to be coupled with a willingness to expend those munitions at pace and scale. Whilst attack remains a crucial role of air power, this section will demonstrate that greater consideration needs to be given to attacking the narrative and that some control may need to be relinquished regarding precision, or lengthy targeting cycles will risk impacting the West's ability to out-pace the adversary.

Information as a Sub-Set of Attack?

JDP 0-30 describes how UK air power is equipped with a broad range of precise technologies that sit across both the lethal and non-lethal spectrum; and that this affords the opportunity to decisively shape and influence the engagement space.⁹⁴ Attack is then further broken down into three sub-roles: strategic attack, counter-land operations, and counter-maritime operations. Counter-land operations are then further sub-divided into air interdiction and close air support, and counter-maritime operations sub-divided into anti-submarine and anti-surface warfare.⁹⁵ The JDP 0-30 section on attack makes repeated mention of attack providing the function that aims to conduct disrupt, deter and deny activity on an adversary's centre/centres of gravity. Similarly, the USAF model of Information Warfare is described in the 'Cornerstones of Information Warfare' as: 'Information Warfare is any action to Deny, Exploit, Corrupt or Destroy the enemy's information and its functions; protecting ourselves against those actions and exploiting our own military information functions.'⁹⁶ Whilst information and the weaponisation of it features in standalone doctrinal concepts such as Network Centric Warfare and Information Warfare it is another domain, similar to air, that transcends all other domains. In order to be effective, it must be understood and integrated effectively with the other vectors for attacking an adversary. If strategic attack is determined by the effect, not the location, distance, type of weapon system or delivery platform, then the weaponisation of information for the purposes of air-delivered information operations should be detailed in more than two small paragraphs. Particularly when state competitors such as Russia use information warfare effectively. It may be observed that the current doctrinal articulation of information operations lacks maturity and depth.

In the build up to Russia's invasion of Ukraine, and throughout the conflict since, information has demonstrated that the media is effectively a battleground for state and non-state actors to spread competing narratives and portray the war in their own terms. Whilst these strategic media and propaganda campaigns are not a new feature of warfare, the shift towards social media as the primary distribution mechanism, and the use of combatants and non-combatants to deliver the message, is beginning to shape emerging narratives and transform how war is waged.⁹⁷ Whilst Russia has previously dominated with an information warfare campaign that has been integral to their wider foreign policy and military strategies, Ukraine has also been able to use social media extensively to portray their version of events and amplify their narrative. This has enabled Ukraine to garner international support for their cause and continue applying pressure to the global community to keep up the raft of sanctions on

Russia's industrial and economic markets, regardless of the mounting costs for the West as winter approaches.⁹⁸

Whilst Western principles have inclined strategic thinkers in democratic societies to reject the idea that information can be weaponised, and instead endeavour to preserve it as a tool of truth, Russian strategy has increasingly enveloped the notion of information confrontation.⁹⁹ Exploiting vulnerabilities in democratic societies, by carrying out cyber attacks or conducting psychological operations campaigns, to frustrate and degrade NATO cohesion and sow doubt and confusion into Western narratives is firmly situated in Russian thinking.¹⁰⁰ In order to turn inside Russia's OODA loop (Observe, Orient, Decide, Act), the West must be capable of exploiting and disseminating information at the speed of strategic relevance; air power can be used effectively in the campaign to prevent the adversary winning the narrative.¹⁰¹ A recent example of the use of air power in information warfare was the United States and other NATO members conducting sorties around Ukraine and along the borders of Russia and Belarus; this persistent monitoring ensured that the Russian military build-up was so heavily documented that the Russian narrative around it merely being for the purpose of an exercise was debunked ahead of time.¹⁰² This effectively limited the Kremlin's options to launch a surprise attack and gave Western nations time to bolster forces in the Baltic states.¹⁰³

Does the RAF Possess Sufficient Mass to Conduct the Attack Role Effectively?

In theory, air power should have been one of Russia's greatest assets in its war in Ukraine, possessing over 4,000 combat aircraft and recent operational experience in Syria, Georgia and Chechnya. Analysts in the prelude to the invasion anticipated the VKS would support the Russian army's deep strike into Ukraine to seize Kiev and destroy Ukraine's military. With a Russian failure to gain air superiority or employ their aircraft beyond territory they control, however, it would appear that they have effectively launched a terror campaign rather than an air campaign.¹⁰⁴ As mass, on this occasion, has been no match for the Ukrainian ability to adapt, some may question whether the size and mass of the Royal Air Force is relevant in the attack debate. Air Marshal Sir Stuart Atha has previously noted that what the RAF lacks in mass, it makes up for in an ability to rinse every ounce of capability out of a platform. The multiple extensions of the Hercules and Sentinel fleets provide good examples of this, in addition to the Typhoon FGR4 which, designed primarily for a fighter role, vice an attack role, now effectively delivers both.¹⁰⁵ The challenge encountered by the RAF and other Western Air Forces has been the doctrine and processes around attack that were developed during two decades of campaigning in Iraq and Afghanistan. Operations Telic and Herrick were centred around precise attack in order to minimise collateral damage; developing increasingly precise methods in order to preserve and maximise limited available force elements and assets.¹⁰⁶ Conversely, however, throughout the conflict in Ukraine, Russia has been willing and able to expend and replace vast quantities of ammunition. Ukraine has found the rate of munitions challenging to match and subsequently replace without significant support from NATO nations frontloading weaponry and other supplies at pace and scale. In previous years, and through multiple strategic security and defence review iterations, Defence and the subordinate

Services have sought to drive efficiency into processes; globalising elements of the supply chain and reducing redundancy and peacetime wastage.¹⁰⁷ The 'so what' of this is an increased requirement for replaceable weapons stockpiles having significant ramifications for Defence Industry. Further, there also needs to be a reflection in doctrine that there is a preparedness to have to expend vast quantities of ammunition should the situation demand it; with a reduction in the planning cycles that favour precision over planning and targeting at a pace that sustains momentum and is capable of concentrating force, in order to strike the most challenging adversaries in the most decisive direction.¹⁰⁸

In sum, the implications of resurgent Russia where the role of attack is concerned, is that there are now multiple levers required in order to maintain momentum and continue to decisively shape the battlespace. The first is the ability to attack the narrative; weaponising information to influence the adversary and outcomes, while ensuring that, simultaneously, the adversary is not influencing the narrative with the domestic public by manipulating the truth and eroding their support to the campaign. Similarly, there needs to be an ability to sustain and maintain the pace of attack through both platform mass and weapon stockpiles. This needs to be married to a willingness to expend munitions stocks and, if necessary, refine and quicken the planning cycle for strikes to move away from the preservation of assets through precision. Jomini referred to 'momentum' characterising an attacker's tendency to remain on the move after a successful attack; the ability to follow up on the initial actions of securing control of the air with an advance and pursuit to gain a decision. Utilising attack to maintain momentum supports both the physical and moral component by exhausting the adversary and arresting their momentum.¹⁰⁹

Section 6: Intelligence, Surveillance and Reconnaissance

The Intelligence Cycle describes Intelligence as the product that comes from the collection and analysis of raw information.¹¹⁰ JDP 0-30 discusses Intelligence, Surveillance and Reconnaissance (ISR) as the means for developing situational awareness in order to generate the understanding required to shape how operations are conducted. Information collected from aircraft and the subsequent processing and exploitation allows commanders to identify trends and threats, ultimately supporting decision making through the identification of an adversary's strengths, dependencies and vulnerabilities.¹¹¹ ISR comprises three linked functions: intelligence, surveillance and reconnaissance. This section will discuss the implications of a resurgent Russia through the lens of ISR, considering the importance of intelligence in a world awash with information. The first challenge that Russia will likely present for the West is the requirement to lead the charge on false information, prebttal rather than rebuttal will be key to winning the narrative both at home and overseas. Secondly, will be the requirement to share intelligence with partners and allies; ensuring that the intelligence contribution of the NATO states bordering Russia and Belarus is not overlooked or mired in bureaucracy that prevents rapid integration into the decision-making cycle of operational commanders. This will be particularly important against an adversary such as Russia, ensuring that ISR is used to guard against strategic miscalculation, rather than being the root cause of it.¹¹²

Information Above Intelligence

'In net-centric war, reality is secondary in relation to virtual... Reality itself becomes real only after reports about it appear in the informational dimension, and therefore, the major factor is control of the informational dimension.'¹¹³ The development in Information and Communications Technology (ICT) may well be one of the most significant societal changes of this generation. Changing both the way in which information is accessed and the understanding of global issues and politics. This has contributed to profound developments in Russia's approach to war, with Gerasimov suggesting that 'information resources have become one of the most effective weapons.'¹¹⁴ Russia's Information Operations until now have allowed them to effectively target the West; resulting in the loss of confidence for democratic processes and supranational organisations such as the EU and NATO.¹¹⁵ The Russian belief being that even if ISR systems and long-range weapons systems were drastically improved or created with greater precision, it still only developed capability in terms of the application of armed violence vice the evolution across warfare in all spheres that information could offer.¹¹⁶ The Chechen wars provide a useful analysis of Russia's progression towards a focus on Information Operations. Following the first war, Russian leaders believed that the loss was due to poor morale and reporting. Russia had avoided using the press during the first war; however, journalists still accessed the area, and this meant that the Russian government had no control over the subsequent narrative with the media exposing casualty rates and criticising the military invasion.¹¹⁷ In the Second Chechen War, Russia prioritised the domestic public opinion over any attempts to win a hearts and minds campaign with the Chechens.¹¹⁸ Despite this, the Chechen's use of the internet to rally support and spread information about the atrocities being committed in Grozny demonstrated that small actors could win the information war, even against a large state who had control over their media.¹¹⁹ The result of these wars caused Russia to double down on developing the means to target their adversaries in the information domain.

The main difference between Russia and the West's perception of information has been that Russia has primarily viewed it as a threat, whereas the West has viewed it as something that should be open and free-flowing.¹²⁰ This distinct difference has made countering Putin's narrative around the invasion of Ukraine relatively easy, with open source reporting rebutting the false flag narratives. The ability to promulgate the truth in advance meant that as soon as Russia disseminated false narratives, they were easy to expose to the public. The information campaign from the West and Ukraine has demonstrated the power of information and the impact it can have on the public; with some arguing that Russia's operation in Ukraine has failed largely as a consequence of their false narrative being exposed before the invasion even commenced.¹²¹

Russia has come a long way in the information space since the Chechen Wars and they have previously performed well in the use of information confrontation and disinformation to undermine an opponent in peacetime, during periods of competition and during wartime.¹²² This weaponisation of information has played a significant role in shaping the course of

strategic competition, influencing the ways in which Russia has conducted military conflict and controlling how it has been perceived globally. As a result, their relentless information and misinformation campaigns will likely always present a challenge for the West to counter. It is important to recognise, however, their struggle in Ukraine has been two-fold; a failure to rapidly fuse information and generate intelligence that can be integrated effectively to shape the campaign but also the speed with which the West and Ukraine have been able to counter their narrative and air power has been essential to this with ISR capabilities, particularly in the early stages of the campaign, providing the feed to discredit Russia's claims that they were exercising vice building forces ahead of an invasion.

Intelligence Integration

Despite Western air forces and NATO possessing highly technical platforms capable of gathering vast swathes of intelligence, this is only useful to a campaign if it is shared at the speed of relevance. Allowing commanders across the JOA to utilise it in order to inform decisions and provide those on the ground with the context to exercise good judgement. The reality, however, has been that until recently intelligence sharing has not been an automatic reflex in NATO; with the organisation lacking a culture of co-operation and trust between many of the members.¹²³ The difficulty with this, as has been seen throughout Russia's campaign in Ukraine, is that an innate lack of trust and preparedness to fuse and share intelligence creates a systemic vulnerability to deception measures.¹²⁴ It also widens the gap between potential and actual capabilities if fusion is not achieved between ISR sensors in order to provide situational awareness to commanders which, left unaddressed, may result in wasting precious resources on inaccurate targets, or worse causing unnecessary escalation.

With 30 members in NATO, soon to be 32 with Sweden and Finland formally invited to join in May 2022, the trust deficit has widened with some member states not trusting others for fear that sensitive information would be passed to a third party. This came to the fore particularly when countries such as Bulgaria, Romania and Albania joined the Alliance with the notion of sharing intelligence on shaky ground.¹²⁵ Whilst intelligence is a valuable commodity that must be protected, Russia's operations in Ukraine have served to demonstrate the critical impact intelligence failures can have. The attempt to seize Hostomel Airport in the opening days of the invasion provides an example of intelligence failures resulting in a force that was not sufficient enough in number or resource to repel a counter-attack from Ukrainian resistance.¹²⁶

In sum, ISR sets the conditions for the collection, exploitation and dissemination of highly valuable intelligence that, when correctly fused, can have a decisive impact on the success of a campaign. Air power sensors are increasingly able to collect at range and for longer periods of time due to advanced platforms and techniques. The problem, however, will be ensuring that this information is shared at the speed of relevance, allowing forces across the Alliance to operate effectively in the face of the Russian state that is, simultaneously, collecting and

disseminating information and misinformation to deceive and discredit. Since the invasion of Ukraine, the intelligence sharing community across NATO has strengthened, with a normally reticent United States keeping intelligence on the movements of Russian forces flowing to Ukraine in real-time.¹²⁷ The key for the West will be capturing this willingness to share intelligence in doctrine, to ensure it survives long after the war in Ukraine. Russia has learned the hard way from their intelligence failures and the West should make every effort to learn from it and avoid a similarly disastrous outcome.

Section 7: Air Mobility

'If you cannot get to the fight and stay in the fight then there is no fight.'¹²⁸ The well-used saying, often attributed to General Omar Bradley, suggests that 'amateurs talk strategy and professionals talk logistics.'¹²⁹ There is a certain degree of wisdom in this demonstrating that militaries, and certainly air forces, cannot fight without an effective and efficient supply chain. The success or failure of major operations, often depending almost entirely upon the ability to supply, and then sustain the resupply of, the front line at pace and scale. Currently JDP 0-30 details air mobility as providing the ability to deploy, sustain and recover personnel and equipment; whilst simultaneously offering the speed and reach of air power that supports the ability to create rapid strategic influence either on operations or when delivering humanitarian aid in response to a natural disaster.¹³⁰ In British doctrine, air mobility is broken down into three constituent parts: airlift which details hub and spoke logistics, aeromedical evacuation, airborne operations and special forces air operations; air-to-air refuelling; and personnel recovery in both a peacetime and combat environment. For the purposes of this section, the focus will primarily be on airlift and the provision of hub and spoke operations, detailing inter and intra theatre airlift as the cornerstone of air operations and delivering personnel and equipment into the battlespace as required. Whilst there are limitations to the volume of materiel that aircraft can carry, these limitations are arguably offset by the advantages offered in terms of speed and reach. Maritime platforms can carry significantly more but at slower speeds, and movement via the land domain is challenged by terrain and contested by the threat environment.¹³¹ That is not to say that air mobility is immune to threats; air mobility aircraft can often be vulnerable to air and ground launched attack; with their size, relative speed and limited manoeuvrability presenting a viable and attractive target to the adversary. This threat, however, can be mitigated when the full suite of air power roles is employed effectively, and support is offered through the use of ISR and enhanced platform and force protection capabilities. Whilst air mobility often features as the last of the four roles of air power, the Russian invasion of Ukraine has highlighted the importance of a robust and effective logistics network and the advent of Advanced Air Mobility as a concept may see air mobility increasingly prioritised, perhaps even ahead of roles previously favoured such as attack.

Rapid Resupply to Rapid Re-deployment

'Our ability to deploy decisive force is foundational to the National Defense Strategy. The size and lethality of the force is of little consequence if we can't get it where it needs to go when

we want it there.¹³² One of the key implications a resurgent Russia will pose for Western air forces will be the ability to move personnel and materiel into, around and out of the JOA. Air mobility will be essential to this with a requirement, particularly with the increasing imperative surrounding Agile Combat Employment (ACE), to prioritise concentrating effects rather than mass. Based upon the threat from adversarial technological advances, pervasive ISR and all-domain long-range fires, it is recognised that large, fixed air bases are at significant risk. Air bases that were previously considered to be sanctuaries are now a prime and achievable target; there is a pressing requirement to complicate the targeting process for adversaries such as Russia. Creating both political and operational dilemmas for the adversary, whilst simultaneously creating flexibility and choice for coalition air forces.¹³³ ACE aims to enable the RAF to operate from a greater number of locations which will provide increased flexibility, resilience and survivability.¹³⁴ The 'so what' of this, however, is the challenge it presents for intelligent logistics and the requirement to deploy to and sustain multiple, potentially temporary, locations. This requires an air mobility fleet (and supporting doctrine) that is capable of delivery at increased range to places with potentially reduced or limited infrastructure, which subsequently narrows the pool of choice across the strategic and tactical air lift fleets. Whilst the objective of ACE is to complicate an adversary's planning, the requirement to resource a network of smaller, dispersed locations will also provide planning complications for an already stretched fleet, particularly where the RAF is concerned. Despite this requirement, the Defence Command Paper, published in 2021, altered the RAF's force structure through the reduction of fixed and rotary wing mobility fleets. Including, but not limited to, the retirement of nine CH-47 Chinooks with no immediate replacement ahead of the in-Service arrival of the CH47F/G airframes.¹³⁵

In addition to an increased number of potential operating locations, there is also the requirement to consider the increased demand signal surrounding people and materiel. This feeds into the point made during the attack section regarding the ability to amass and expend stocks at the speed of relevance. At the height of the fighting in Donbas, Russia was consuming more ammunition in the space of two days than the entire British military has available on the shelf.¹³⁶ The so what of this being that the ammunition, stocks and supplies required to sustain an operational campaign, against a near peer adversary, need to be readily available and air mobility will be crucial to this endeavour.¹³⁷ It is not solely the invasion of Ukraine that has caused Western air forces to pause and consider the strategic requirement for air mobility that can operate rapidly, and at scale. In the summer of 2021, as Afghanistan began falling back into the hands of the Taliban, coalition air mobility crews went from extracting troops and equipment at the close of a two-decade campaign, to a sudden and urgent requirement to evacuate thousands of Afghan nationals in danger of being captured, imprisoned and killed by the Taliban. General Mike Minihan, Commander Air Mobility Command, reflected on the scale of the operation and noted that across 17 days, operating from one runway and under challenging operational circumstances, over 124,000 people were extracted from harm's way.¹³⁸ Air mobility demonstrated an ability to deliver a strategic effect rapidly and if the withdrawal from Afghanistan highlighted the criticality of this pillar of

air power, the invasion of Ukraine has only sought to underline it further. The conflict has provided Western air forces with an opportunity to observe operations with a near-peer threat and, in real-time, develop the lessons the Ukrainians were learning to adapt the ACE concept. For the US Air Force, a key implication of the lessons drawn from the war in Ukraine has been that they initially would be at a numerical disadvantage, relying heavily upon air mobility to rapidly project power into the JOA.¹³⁹ It is noted, however, that ACE is optimal for use until such a time in the operation where sufficient freedom of action can be maintained; acknowledging that if the environment is no longer contested, a centrally controlled, decentrally executed approach for air operations, especially from a logistics perspective, enables simplicity and economy of forces.¹⁴⁰ If it is the case that ACE is to be employed in the initial stages of a campaign, or until such time as the environment is no longer heavily contested, then that links into the next point regarding air mobility and how critical it is to survivability.

Survivability Through Mobility

'The best place to kill an enemy's air force is on the ground. Especially if that air force is postured in bases that are few in number and lack passive... and active defences that can help counter these air and missile threats.'¹⁴¹ As has already been discussed pervasive ISTAR, coupled with the layering of multiple sensors at all levels of warfare, has demonstrated that concealment is increasingly difficult to attain and then sustain for more than a relatively brief period of time. The conflict in Ukraine has demonstrated that forces can deliver effect when concentrated; but this period of concentration must be short, and the force must be sufficiently mobile. In doing this, Ukrainian forces have created challenges for Russia and made it difficult for them to effectively and accurately target the right locations. If forces under observation remain static for too long, they risk detection and engagement, as was the case for Ukrainian Special Operations Forces when penetrating Russian held locations.¹⁴²

Mobility will increasingly become the preferred method of survivability, whilst hardened structures or hasty defences can provide initial and immediate protection, they risk forces becoming fixed and specialist munitions make positions such as these unlikely to survive. Dispersal will mean that forces are not an economical target, with fires not providing sufficient concentration of damage effect. Western Forces will need to prioritise concentrating effects for short periods of time, moving quickly enough to disrupt the enemy's targeting cycle and kill chain and only concentrating mass when the conditions are favourable. These favourable conditions will result from a degree of control of the air having been achieved; allowing the freedom of manoeuvre for concentrated forces of any kind.¹⁴³

In *The New Art of War*, Colonel Geoffrey F Weiss writes that whilst in the air, air forces are the least viscous in the physical domains due to their speed and manoeuvrability coupled with the technical challenge surrounding their detection, tracking and subsequent engagement.¹⁴⁴ It is when they are stationary on the ground that they are increasingly vulnerable to attack

from enemy forces across other domains, with Weiss suggesting the best way to defeat air forces being to attack them on the ground or deny access and basing.¹⁴⁵ Therefore, one of the greatest implications resurgent Russia presents to air power doctrine is the use of mobility to increase survivability whilst supporting the ability to operate with agility, avoiding the concentration of mass that directly correlates to the concentration of vulnerability. Ultimately, Western forces will now need to give precedence to mobility as a vital component of their ability to survive against a near peer adversary.

Section 8: Cultural and Doctrinal Challenges

'Know thy enemy and know yourself; in a hundred battles, you will never be defeated. When you are ignorant of the enemy but know yourself, your chances of winning or losing are equal. If ignorant both of your enemy and of yourself, you are sure to be defeated in every battle.'¹⁴⁶ Whilst single Service, and later joint, doctrine on air power has acknowledged that it both supports and enables all domains whilst directly contributing to operations in the air domain, there are perhaps a number of areas in air power doctrine that may benefit from further review or consideration, and indeed arguably a greater incorporation of doctrine into culture. This section considers some additional factors that present challenge when faced with an adversary as complex as Russia and one that takes a more blended, whole of government approach, to the development and application of doctrine. Firstly, is the consideration of the Western view vs the Russian view. Until recently Western forces have chosen to focus more upon the war they would wish to fight, vice the war they may find themselves in, or indeed are already engaged in. As Keir Giles suggests, 'recent Russian activities in the information domain would indicate that Russia already considers itself to be in a state of war.'¹⁴⁷ Secondly is the importance of integration; given the nature of joint and multi-national operations, doctrine focussed on a single domain is of little operational use unless it can be integrated seamlessly. It is also important to consider the lessons from Russia and their inability to integrate forces effectively.

Western View vs Russian View

The changing nature of war has been a topic for constant discussion in military theory. Few Western studies, however, have truly engaged with how Russia's perception of the nature of war is changing. It is often assumed that the way war is changing, and subsequently how doctrine should change in order to stay in step, is the same for all states; Russian and Western alike. Colin Gray reflected that, 'culture yields us the truths... that we know should guide our decisions and actions.'¹⁴⁸ In the case of Russia versus the West there is a need to be reminded often that countries with vastly different cultures and values can consider the same problem and interpret it very differently. Any doctrinal amendments as a result of the implications of resurgent Russia should be analysed in the context of Russia's 'strong cultural imprint and... strategic culture.'¹⁴⁹ If this is not done, the West is likely to learn the hard way that, 'the real grey zone is "between our ears" in our faulty models and education about what conflict entails.'¹⁵⁰ As Hoffman points out, enshrining our intellectual faults in doctrine based upon crude assumptions of the 'opponent's method' is not enlightening.¹⁵¹

Further to analysing Western doctrine in the context of Russia's culture, it is also important to analyse it in the context of Russia's understanding of it. When Dima Adamsky conducted an analysis of Soviet military publications, they indicated a sophisticated level of understanding, by Warsaw Pact officers, of Western military and technological innovations. Perhaps more concerning was the ability of these officers to understand the innovations against a broader context; arguably reflecting a deeper grasp of the developments than even the West possessed.¹⁵² If the West is lazy in its understanding and application of doctrine, or indeed the understanding and application of Russian doctrine, then it places itself at a disadvantage from the outset. Demonstrating that one of the implications resurgent Russia has on contemporary air power doctrine is that their doctrine and understanding of it (both their own and that of the West) outmatches and outpaces Western air power practitioners and strategic decision makers. Further weight is added to this argument when Russian strategy throughout history is considered; David Glantz offered that the Bolshevik tendency to treat war as a totality of military, economic, political and social measures demonstrated an enterprise approach that differentiated Bolshevik strategy from that of its opponents.¹⁵³

Russian doctrine and the understanding of it is particularly important because it arguably goes much further than Western doctrine, certainly British doctrine. Russian security doctrine, whilst not exhaustive, represents the official view and sets the benchmark for national security planning. The doctrines consider military theory in greater depth as the framework for not only directing the armed forces but how the state organises and configures itself for and during war, across all instruments of national power.¹⁵⁴

Integration Predicaments

Given the nature of Joint and Multi-national operations, some might argue that even the most perfectly crafted single Service doctrine, even if taught well, is of little operational use unless it can be seamlessly integrated into the current structures that exist both within the modern RAF and wider Defence. RAF doctrine has the requirement to be both well represented, and well understood, both internally and externally in order to blend with the doctrines of the British Army, Royal Navy and Strategic Command, as well as coalition partners and NATO. More broadly than those that employ the doctrine, it has a requirement to be thoroughly incorporated throughout both the military and political spheres to ensure it is the golden thread that runs through air operations. The war in Ukraine has demonstrated that the results of not being able to successfully integrate forces in the battlespace can be catastrophic. Russia had planned for a blitzkrieg military operation that would allow the rapid overthrowing of the Ukrainian government in Kyiv; Russia has, however, fallen well short of this main political objective and this comes as a result of significant command and control issues and the ability to integrate forces, particularly the ability to achieve Air Land Integration.¹⁵⁵ After the deaths of over a dozen Russian generals such as Lieutenant General Andrei Mordvichev, Major General Vitaly Gerasimov and Major General Oleg Mityaev, Vladimir Putin appointed General Aleksandr Dvornikov to oversee military operations in April 2022; however Russia has still continued to experience significant command and control challenges throughout its offensive operations in Donetsk and Kherson.¹⁵⁶

Russia has previously demonstrated a closer alignment and integration of its military and government, and its military and non-military means in war than perhaps the West has.¹⁵⁷ With some arguing that Russia has always started from the whole and analysed how the different components fit into that, with war being understood as an instrument of politics.¹⁵⁸ This, however, has not translated well to integration between the levels of war, from the strategic through to the tactical or indeed between forces such as land forces and special operations forces, or the ability to integrate air and land effects. Whilst, as a whole, the Armed Forces of the Russian Federation (AFRF) operate with the notion of jointery, there is a hierarchy to this which place the priorities of the land component above the air and naval elements. Further, the military as a whole is then subordinate to the special services and this has created sub-optimal exploitation of joint effects.¹⁵⁹ These integration failures are then further reinforced by the poor command and control structures which do not allow deviation until orders are changed at higher levels, limiting officers' ability to seize the initiative and co-ordinate rapid advances deep into Ukrainian territory.¹⁶⁰ Despite months of setbacks created through poor command and control, poor communication and poor logistics and supply chains, Moscow has shown no indication that it is ready to negotiate an end to the war. On the 30 September, Putin announced that Russia was annexing Luhansk, Donetsk, Zaporizhzhia, and Kerson oblasts, despite the fact Russian forces did not have full control of the territories. Any losses on the battlefield through a lack of all the factors described above, have been made up for through Russia's increase in missile attacks on Ukrainian cities, aimed largely at targeting the will of the people through power outages.¹⁶¹

In sum, the Russian invasion of Ukraine has demonstrated how Russian culture can present implications for Western air power doctrine. Both in terms of how they organise and configure themselves for war and how they seek to understand their adversaries. Perhaps most concerning, however, is their relentless nature. Despite significant military losses of personnel, equipment and munitions, alongside their economy being laid to waste, Russia is showing no signs of relenting and has instead reverted to what can only be described as savage attacks on concentrated areas of civilians. Ultimately whilst Russian doctrine is, in theory, more all-encompassing than UK and allied doctrine, in that it considers all levers of national power, in reality it has fallen far short of its potential given a failure to successfully and seamlessly integrate at the strategic through to the tactical. As identified, this can be tied to a number of factors, including the failure to train as a cohesive unit and the challenges of operating a majority conscript force.¹⁶² Some could argue that it is potentially only autocratic states who would be truly able to apply a whole of government approach to Defence and security. It is unlikely that policies such as these would survive contact in a democracy, unless the nation in question is able to harness the will of the people around an agreed perspective on an existential security threat. That being said, the Scandinavian approach toward a Total Defence Concept, exercised in collaboration with NATO, offers a great example of this and is directly linked to the Scandinavian perception of the Russian threat. Whilst outside the scope of this paper, further study of Swedish doctrine, particularly in light of their accession to NATO, would be instructive.

Section 9: Conclusion

'It is a truth universally acknowledged that a military force in possession of a mission is also in need of a doctrine.'¹⁶³ War is an inevitability and confrontations and conflicts between people and nations will continue. Air power will continue to be involved with the prosecution of those operations either as part of an individual nation's strategy or in a coalition or alliance, on behalf of the international community. The imperative, therefore, is that the doctrine is an assimilation of trends and implications posed by the West's adversaries. Whilst Russia's approach to war is not one this paper suggests we replicate, the thinking and doctrine of air power could be better developed to more fully integrate political and military solutions. Air power and, more broadly, military power, cannot deliver a definitive resolution for a political problem. The full spectrum of effects in terms of military action and levers of power, inclusive of political and diplomatic influence must be leveraged against an adversary as complex as Russia. Industrial wars against the Third Reich or Japan, who posed clear threats in an identifiable way, are very much consigned to the history books. The threat is about more than territory and dominance; it is about a threat to people, security and way of life. The implications a resurgent Russia poses to air power and the doctrinal structure that sits behind air power operations have been addressed throughout this paper.

The purpose of any air doctrine development process is to encourage review and modification of the doctrine over time; changing factors and operational landscapes require continuous reshaping of doctrine. Whilst doctrine changes slowly, and this research has demonstrated little change in the fundamental roles of air power since the First and Second World War, there is still a requirement to make doctrine responsive to the appropriate influences and develop a commonality in terms of understanding and interpretation. It is this dynamic doctrinal development process that prevents doctrine from becoming dogma.

Implications

During the last decade, the RAF has seen its mission diversify due to threats from both state and non-state actors and in conventional and asymmetric environments. This change requires and demands a doctrine that can appropriately support it. It is clear from the analysis that doctrine by its very nature can be hazardous due to some taking a dogmatic approach to its adherence and others not knowing it well enough to follow it or advocate for it in a joint environment. Whilst there has undoubtedly been a continued shift towards joint doctrine in the environmental domains, of which the publication of JDP 0-30 was an example, the four roles of air power continued to endure even as the RAF re-configured towards contingent operations. There is a balance to be struck; too much doctrinal shift results in those who need to employ it failing to understand it properly.

This research has considered the implications of resurgent Russia across each of the four roles of air power: control of the air, attack, ISR and air mobility, to consider whether two decades of COIN operations had impacted the West's ability to engage in conflict with a

complex near-peer adversary with a greater range of tools at its disposal, including the ability to wage a nuclear war. The implications have considered that the West is no longer able to presume that any degree of air superiority will be granted from the outset and that the attainment of control of the air will be crucial to the successful employment of a full spectrum of joint military effects. Where the role of attack is concerned, Russia presents the requirement to employ multiple levers in order to maintain momentum and continue to decisively shape the battlespace throughout a campaign. Due to the weaponisation of information by Russia, the roles of attack and ISR are increasingly symbiotic; requiring the West to attack the narrative in order to influence the adversary and outcomes, whilst simultaneously ensuring that the adversary is not impacting the domestic narrative through the manipulation of the truth.

To further demonstrate that no one role of air power can exist without the other, air mobility will be vital to support the supply and resupply of munitions stocks that the West must be prepared to expend in order to preserve momentum and follow up on the initial actions of securing control of the air. As the saying goes, quantity is a quality of its own; however, a crucial factor will be avoiding the concentration of that quantity in any one place. Air mobility will also be required to increase survivability whilst supporting the ability to operate with agility, avoiding a build-up of mass that creates vulnerability and leaves swathes of the force exposed to attack. A key factor for Western forces will be the requirement to give precedence to mobility as a vital component of their ability to survive against Russia.

It is important to acknowledge that it is not just in the roles of air power that resurgent Russia can present implications for Western air power doctrine. Russia's culture and their own doctrine, in addition to the Western interpretation of those, can also present challenges. Russia has arguably been better at creating a culture that understands and integrates doctrine across all levels of warfare, from strategic through to the tactical. They have also demonstrated a robust understanding of Western doctrine, conversely the West has struggled to understand Russia because of their concepts, thoughts, actions and doctrine being reviewed through a lens of Western ideals, rather than any understanding of Russian culture. Churchill's idea that Russia is 'a riddle wrapped in mystery inside an enigma' is not true and the West must invest heavily in studying and understanding Russia, rather than glamorising headlines as 'doctrine' as was done with Hybrid warfare.¹⁶⁴ Most concerning of all is Russia's relentless nature, despite overwhelming military losses of personnel (losses it is difficult to imagine Western democracies tolerating) they are showing no signs of relenting in Ukraine, choosing instead to become mired in a grinding attritional campaign.

Ultimately, however, whilst Russia presents numerous implications for Western doctrine, their invasion of Ukraine has in turn presented numerous implications for their own doctrine. They have demonstrated an inability to take their integration of doctrine, across all levels of power, from theory into practice; their inexperienced force has become stifled by a lack of information flow throughout the chain of command and an inability to seize operational

initiatives without orders from above. The speed with which those orders can come is hampered significantly by their inability to integrate intelligence meaning that their all-encompassing doctrine has fallen far short of its potential.

Although Russia has demonstrated an inability to learn lessons quickly in war, they have repeatedly shown an aptitude for learning between wars and moving forward the key consideration for NATO countries must not be whether a specific weapons system or platform can provide an advantage. It must be whether the policies, doctrine and industrial processes exist to facilitate the rapid development, procurement, acquisition and integration of new systems and tactics. An air force where defence procurement and defence sustainment move at a glacial pace is unlikely to adapt at the speed of operational relevance, regardless of the doctrine that supports it.

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Dissertation

Opportunities and Challenges with the Royal Air Force's Adoption of Agile Combat Employment (ACE)

By Squadron Leader James O'Doherty

Biography: Squadron Leader James O'Doherty is a RAF Regiment Officer who has fulfilled a broad range of training and operationally focused roles over his 12-year career. He holds an MA in Air, Space and Cyber Power from the University of Wolverhampton, completed through the Chief of the Air Staff's Fellowship Scheme, and is now serving as the desk-level lead for Agile Combat Employment (ACE) with No 11 Group.

Abstract: While more recent operational focus has been on Counter-Insurgency, adversaries, such as Russia and China, have developed advanced long-range precision capabilities. Western bases, now fewer in numbers, are under threat compounded by an under investment in protection, be that Ground Based Air Defence (GBAD) or Integrated Air and Missile Defence (IAMD) systems. Consequently, air forces have begun to implement the concept of Agile Combat Employment (ACE), with an ability to rapidly disperse aircraft to contingent operating locations, introducing unpredictability for adversaries. Whilst ACE is not new, the knowledge, skills and experience of conducting fast paced dispersed operations has diminished as air forces have become accustomed to operating from fixed, well-founded Main Operating Bases.

The ongoing conflict in Ukraine has re-focussed attention on ACE to reduce vulnerability and increase survivability. This paper will focus on understanding how the threat has changed, necessitating a different approach to the way air operations are conducted. Moreover, the paper will identify the opportunities and assess the challenges associated with the Royal Air Force's adoption of the ACE concept.

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Introduction

The Royal Air Force (RAF), since its formation, has remained committed to the security and prosperity of the United Kingdom (UK) and its allies. Like many other western air forces, the RAF has, in the last two decades, focussed predominantly on Counter-Insurgency (COIN) operations in the Middle East. Whilst these campaigns were demanding, they did not require commanders to consider operating within a contested air environment. In recent years the rapid development of advanced technologies and capabilities by western adversaries has seen a return to Great Power Competition (GPC), placing previously safe operating locations at risk. This has challenged militaries to focus attention on how their respective forces can project and maintain air power within a contested or degraded environment.

Integral to all air operations are the bases from which platforms are operated, refuelled, re-armed and re-deployed. As history demonstrated, airfields can be a critical point of weakness in the prosecution of air operations, given the vulnerability of aircraft when on the ground. The warfighting advantage associated with air power, combined with the multi-role nature of modern-day platforms, their significant individual cost and concentration in set locations, provides potential adversaries with highly attractive targets. With the growing threat from new and emerging adversarial capabilities, western air forces are seeking to adopt alternate methods to increase resilience and survivability. Agile Combat Employment (ACE) is one such methodology which seeks to deter adversary action, through the rapid dispersal of aircraft to alternative operating locations, complicating an adversary's targeting process and their subsequent kill chain.

Section One: The Current Context

Air power is a key component of a nation's military and a crucial element of the combined instruments of national power. As such, air power contributes to a nation's ability to exert influence on the world's stage and project force globally. The capacity to achieve this stems from the fundamental characteristics of air power; height, speed, reach, agility and ubiquity, which provides the capability to shape and influence the operational environment.¹ Naturally, air power will continue to be seen as an indispensable and flexible tool, which a nation can employ in the pursuit of defence and security.² Therefore, maintaining air power's ability to exert influence is an inherently critical factor, to do so requires air assets, be that combat aircraft or otherwise, to have the freedom to access the relevant airspace. The ability to do this has become more complex and challenging, given the technological advancements that countries such as China and Russia have had in developing ways of limiting access to operational areas. As Lee contends, 'these capabilities are increasingly capable of holding forces at risk.'³ The term Anti-Access and Area Denial (A2/AD) is now commonly used to refer to a family of military capabilities which seek to prevent or constrain the deployment of opposing forces into a given theatre of operations and reduce their freedom of manoeuvre once in a theatre.⁴ Instinctively, maintaining the ability to project air power within contested or degraded operating areas will remain the dominant factor for western air forces. Moreover, developing

new and evolving concepts that mitigate the emerging threats will undoubtedly be critical to the successful delivery of decisive air power within the future operating environment. Senior defence personnel within the North Atlantic Treaty Organisation (NATO) and government leaders have identified the evolving threats, which in turn has catalysed action to develop new concepts, such as ACE, to impose dilemmas on an adversary to restore deterrence, preserve capability and maintain the initiative in conflict.⁵ Approaches such as ACE may well be regarded as a re-emergence of previously used procedures from legacy campaigns.⁶ Alternatively the concept may be observed as a natural evolution in the protection of air power and a critical factor to defence, whilst enabling air force freedom of manoeuvre within a contested environment.

To deliver effective air power on behalf of a nation, an air force, like its respective land and maritime counterparts, requires hardware to carry out its function. Air force hardware consists of highly capable platforms, which are fragile, expensive and for most nations, scarce in number. As such, they require a high degree of protection to help mitigate any loss.⁷ Modern day, multi-role, fifth generation combat platforms come at significant cost per unit, for example the individual price of an F-35 is \$110 million.⁸ The majority of NATO nations' defence budgets will only allow for procurement of a limited number of exquisite platforms and would therefore be unable to absorb the loss of even a single aircraft; to do so may have a strategically disproportionate impact on capability. In recent conflicts the threats posed to aircraft have arguably derived predominantly from low-tech weapon systems, which can be countered with a range of active and passive protection measures. However, in operationally contested or degraded environments, where the risk of losing aircraft is assessed as high, the ability to enhance survivability cannot be over-stated. Given the need to operate in such environments in the future, air forces must become accustomed to operating their valuable assets from high-risk locations and develop counters to ensure control of the air and freedom of manoeuvre is maintained.⁹ ACE will therefore become a critical means of complicating a peer or near-peer adversary's targeting process, through the rapid deployment and re-deployment of platforms. Moreover, the concept will contribute to increased survivability rates for aircraft, which may be the decisive edge required to win.

Structure

This paper will seek to explore the ACE concept, a mitigation measure aimed at countering a potential adversary's A2/AD developments, which attempt to deter and degrade western air power advantage. ACE will require air forces to think differently, to re-examine and challenge existing processes and to fundamentally change the way in which air operations are conducted. Adopting ACE will undoubtedly come with a variety of opportunities as well as several complex challenges, which this study will seek to explore. This paper will be structured into five distinct sections; this initial section will introduce the topic, set the scope of the research question and provide wider context by determining the key commonalities which exist within the current literature, government publications and military doctrine.

Additionally, this section will seek to identify any research gaps and provide the reader with a greater insight into the future operating environment.

Sections two, three and four will build on the previous section, to provide the reader with a more detailed argument. Section two will articulate the threat, both in terms of current perceived threats and future operating considerations. This section will also highlight why concepts such as ACE are required against peer adversaries. Section three will explore the unique challenges associated with implementing the concept, whilst section four will seek to identify measures to mature ACE within the RAF, to mitigate the threats to the projection of air power within a contested or degraded operating environment. The paper will conclude by offering consideration as to the benefits of ACE for the RAF, as part of the organisation's attempt 'to be the most operationally successful, agile and innovative air force in the world'.¹⁰ Ultimately, it is the author's intent to provide the reader of this research paper with a comprehensive understanding of the utility of ACE, within the bounds of the contested air operating environment of the future. The study will conclude that the RAF should strive to develop a robust delivery method for implementing ACE, as a means of ensuring a greater degree of survivability. This will arguably not be easy to achieve and will require several radical changes in the way the RAF operates, if the concept is to develop successfully. Clear strategic direction will be required and personnel, at all levels, from across the organisation will need to understand the threats which necessitate change. Continuance of operations in an efficient, just-in-time manner may no longer be a viable option yet switching to a more resilient ACE approach will require the allocation of investment and resources. Equally, extensive training and education of the whole force will be required to manage the shift to a more expeditionary mindset.

Research Challenge

This paper will draw on a variety of academic sources, including national defence policies, academic journals and military doctrine, as a means of providing an empirically and theoretically balanced argument. The majority of the open-source ACE literature has been developed and produced by the US and is inherently US Air Force (USAF) focused. Whilst this does present a research challenge, given the paucity of RAF specific material, it does provide the author with the opportunity to focus attention within an under-researched area and shape the future direction of the topic. Equally, the classification of documents relating to threats and emerging concepts will likely sit at a level which restricts sharing or publication and as such will present a research challenge. Naturally, this will limit the scope of the paper to research that is open source and within the public domain. Although much of the literature is US facing, a greater understanding of partner nations' research and doctrine on the subject will be beneficial given that the UK is likely to be part of a coalition, if engaged in major combat operations. This has the potential to contribute to greater levels of interoperability with key allies such as the US. Equally, this research paper will contribute towards the initial body of academic literature which focuses specifically on the RAF's adoption of ACE, as a means of generating and maintaining air operations within a contested or degraded environment.

Literature

A wide-ranging body of research literature exists, written by an array of government departments, military leaders, think-tanks and academics, all of whom express a vision, assessment or interpretation of what the changing character of conflict and the future operating environment may look like. These thoughts and opinions have been communicated through a variety of media, be that futuristic fiction, podcasts, military doctrine, research papers and government publications, including National Defence Strategies (NDS). Many commentators share similar assertions; the most common reoccurring theme being that future conflict operations will occur within a contested, degraded and operationally limited (CDO) environment.¹¹ A second commonality is that of access, whereby forces arriving in future combat theatres may be faced with advanced disruptive technologies which hinder or prevent access and deny unfettered operational freedom of manoeuvre.¹² Operational access is assessed as not limited to one domain, but will be prevalent across all warfighting domains. Deptula and Gunzinger posit that today the US Department of Defense (DoD) is at a strategic inflection point; their focus on COIN operations has provided states such as China, Iran, North Korea and other competitors with the opportunity to develop capabilities that could threaten access to areas of vital interest.¹³ This period has seen a shift away from US military dominance and the erosion of the competitive military advantage that they have benefited from in recent decades.¹⁴ This has led to the DoD defining this as a period of 'strategic atrophy' in their 2018 US NDS.¹⁵ Instinctively, to reassert US influence, greater focus must now be placed on widening the gap between competing states and their capabilities. An unwillingness or inability to take steps to reverse the current trends could, as academic David Ochmanek noted, 'significantly impact and diminish the role the US plays internationally'.¹⁶ Consequently, investment and development in concepts such as ACE are being implemented to ensure that attempts by adversaries to close the capability gap are mitigated and competitive advantage within a contested environment is maintained.

Both the USAF and the RAF have sought to develop the concept, maturing the intellectual foundations through working groups and briefing papers to identify a future pathway. This has translated into tangible output in the form of ACE exercises at the single service level.¹⁷ Furthermore, the US has begun to capture and cohere initial thoughts, lessons and intent through the development of specific ACE documentation. The creation of a Concept of Employment as well as a specific ACE Air Force Doctrine Note, highlights that this is an area of significant investment for the US military. Similarly, the RAF has developed an ACE specific directive which provides direction and guidance on the development of the concept. It is also clear that the respective service chiefs are acutely aware of the requirement to drive forward the ACE concept, moving away from an over-reliance on well-established airfields, to maintain a competitive operational edge. In 2021 the then head of the RAF, Air Chief Marshal Sir Mike Wigston, expressed the requirement to 're-learn how to disperse by conducting no-notice scatter drills, given the trajectory of an increasing threat'.¹⁸ Similarly, General Charles Brown, the Chief of Staff of the USAF, made clear that the

'operational concepts needed to fight in highly contested environments must be different and that efforts must double to accelerate the changes necessary for future success'.¹⁹ Although the threat is understood and ACE trials and development are progressing, there is a belief that more should be done to speed up the process of maturing this war fighting concept, as the threats posed by states such as China and Russia are manifest today.²⁰ Moreover, in an era of GPC, efforts must be rapidly advanced at an operational scale to effectively win before fighting.²¹

Although the volume of accessible open-source material relating to ACE continues to grow, very few sources have been identified which offer a counter argument to the utility of ACE. It is assessed that this is due to the fact the subject is still a maturing concept as opposed to a unanimous agreement by commentators that ACE is a panacea. Equally, the efficacy of ACE is still uncertain; it is likely to remain so until such a time that it can be robustly tested within the correct parameters. However, one could contend that the initial investment into ACE, both doctrinally and in practical application, points towards a positive outlook. Arguably, one of the only ways to truly measure the effect of ACE would be within a combat environment, however given the nature of the concept this will not be easily achieved. Conversely efficacy could be identified through simulated wargames or during live training exercises.

Whilst ACE is a latent concept which is continuously maturing, there remains a comprehensive amount of open-source material. This research enhances overall understanding of the subject, whilst also providing insight into current and future threats. The scarcity of open-source material focussed on the UK approach has led the author to identify the opportunities and assess the challenges associated with the RAF's adoption of the ACE concept. This paper will seek to add value to the existing body of research in three specific ways. Firstly, the initial section will provide a succinct precis of the current ACE written works, highlighting current thinking and the future direction of the concept. In doing so the sources contained within the bibliography will provide those who wish to broaden their subject knowledge with a useful reference guide. Secondly, the paper will provide a wider understanding of the threat environment and contribute to the debate over the employment and efficacy of implementing ACE into RAF operations. Finally, and most crucially, the research will provide a greater degree of understanding as to the opportunities and constraints the RAF may face as it progresses towards adopting ACE. Whilst this paper will seek to identify ACE challenges, it is assessed that more detailed and comprehensive examination will be required to better understand the broader topic as well as more specific capability challenges. This will undoubtedly sit at a higher classification than 'Official' and as such is out of scope for this research question. Although access to ACE reference material at 'Official Sensitive' and higher has been sought by the author through the relevant RAF departments, only documentation classified as Official will be used throughout this paper.

The unique characteristics of air power will undoubtedly ensure that it remains a critical priority for defence, both now and into the foreseeable future. However, despite the political

attractiveness that air power maintains as an element of the military instrument,²² the requirement to gain access into an operational area to have an effect remains. As illustrated, the security environment has evolved. Assured access is no longer guaranteed and it is now assessed that states will hold the ability to contest and even dominate airspace in many areas in which western forces would need to operate.²³ As such, the development of a range of systems and procedures which increase survivability and resilience for aircraft and bases will become a critical factor.²⁴ ACE is rapidly becoming recognised as a credible solution to the evolving security context. Therefore, one can argue that ACE may soon become a critical proactive and reactive operating concept which requires implementation to meet the challenges of conflict with a peer or near peer adversary. 'Victory Smiles upon those who anticipate the change in the character of war, not upon those who wait to adapt themselves after the changes occur.'²⁵

Section Two: The Threat

Current UK and US defence strategy clearly outlines the characteristics of the future operating environment. The 2021 Integrated Review (IR), which set out the UK government's assessment of the strategic context, highlighted 'systemic competition' as one of the four overarching trends to the changing international order.²⁶ Moreover, the recent update to the IR, highlights 'the pace at which these trends have accelerated over the past two years and how the transition into a multipolar, fragmented and contested world has occurred more quickly and definitively than anticipated'.²⁷ The report also highlights that state threats continue to diversify, with an increased number of advanced weapons systems being developed, tested and adopted.²⁸ The changing threat spectrum of the future operating environment has grown and will undoubtedly continue to do so at pace. The associated risks have been identified, captured and articulated in documents such as the UK's 'Defence in a Competitive Age' Command Plan. Within this report the Ministry of Defence (MoD) highlights that 'the development of long-range precision strike capabilities, combined with increasingly capable early warning radar and integrated air defence systems (IADS), will enable states to contest and even dominate airspace in many areas the UK will need to operate'.²⁹ Similarly, the global policy think tank, RAND, contend that enhancements in the accuracy of cruise and ballistic missiles have led to a profound change in the nature of the threat posed by long-range, non-nuclear weapons, particularly against fixed targets such as airfields and ports.³⁰ It is these systems which will impact, to varying degrees, on an air force's ability to gain operational access to a given area. As noted by Schmidt, 'the term A2/AD and associated capabilities have become noticeably more prevalent in current military documents and assessments over the course of the last two decades'.³¹ These developments in capabilities and the closure of the technological gap between competing states, has provided western rivals with the ability to project power beyond their respective borders and hold at risk those bases that have traditionally been considered sanctuaries.³² Current UK doctrine maintains that air power is dependent on the bases that it operates from; it is here where aircraft are serviced, armed and deployed, as such they are classed as critical enablers.³³ Naturally, basing options will remain a crucial element in the prosecution of air operations.

These often-immovable airfields and an air force's dependence upon them, means that these locations are likely to become priority targets at the start of a conflict. As history and the current conflict in Ukraine shows us 'it is easier and more effective to destroy the enemy's aerial power by destroying his nests and eggs on the ground than to hunt his flying birds in the air'.³⁴ Arguably, Douhet's renowned quote remains just as notable now as it did in 1921.

A2/AD capabilities, combined with the substantial reduction of operational bases,³⁵ due to numerous factors including decreased defence spending and the requirement for efficiency in engineering processes, present air forces with a significant dilemma. This further challenges their ability to project air power and simultaneously concentrates friendly, high value assets, susceptible to potential adversary action.³⁶ Whilst basing reductions and rationalisation was logical in the absence of a credible strike threat, the return of Russia as an active adversary means that NATO air force laydowns consist of comparatively small numbers of fast jets and enabler aircraft on a small number of Main Operating Bases (MOB).³⁷ Ultimately, this relatively dense concentration of highly capable platforms poses significant risk. As Bronk asserts, 'this is a major issue since much of NATO's air power is vulnerable to destruction by Russian long-range precision strike capabilities in the event of a direct clash'.³⁸ Similarly, the US faces a comparable threat from China in the Indo Pacific region, further exploration of which will follow later in this section.

Many NATO countries are cognisant of the impact of A2/AD capabilities and the inherent ability therein to restrict freedom of manoeuvre and challenge control of the air. For example, the US NDS recognises the trend in the evolution of offensive air and missile capabilities and the growing national security challenge it represents.³⁹ US doctrine also notes, to meet this challenge warfighting concepts that emphasize dispersal and manoeuvre to ensure resilience in contested environments, must evolve.⁴⁰ The impetus to regain the competitive advantage, which NATO members have wielded unchallenged for many years, has been championed by various ministers, politicians and senior military commanders. Most notably, the head of the USAF released a white paper entitled '*Accelerate Change or Lose*', in which he strongly emphasized the need to adapt to the changes of the strategic environment or risk losing a high-end fight and the ability to secure the future.⁴¹ Moreover, in 2022 the Secretary of the USAF detailed '*Seven Operational Imperatives*' as part of a roadmap to deter and defeat modern day adversaries, strikingly resilient basing was number five on the list.⁴² By comparison, the British MP, Jeremy Quin, in his keynote speech at the Royal United Services Institute (RUSI) 2021 Combat Air Power Conference, highlighted that a failure to adapt would lead to large parts of the world becoming potentially out of bounds and a failure to outmatch adversarial capabilities could lead to being locked out of the skies.⁴³ Ultimately, the strategic landscape has shifted, the well-established international order is now challenged by persistent political, economic and military competition. The era of GPC has seen China and Russia increasingly assert their influence both regionally and globally.⁴⁴ The subsequent build-up of military capabilities, designed to limit or deny adversaries access, has driven nations to consider how they must adapt to counter new threats. Given the prevalence of the threat and the ongoing

concern over a state's ability to project force, analysis has not been limited to the military domain; academic research institutes now consider the application of air power in contested conditions as a major topic in their current research programmes.⁴⁵ Although a wide body of literature supports the notion that A2/AD capabilities pose significant risk, there are commentators who maintain an opposing view. For example, Roblin, writing in the *National Interest* in 2019, contends that although A2/AD weapons can threaten large areas, they cannot completely 'shut down' access by themselves.⁴⁶ Additionally, the author draws on research conducted by the FOI, the Swedish Defence Research Agency, to assert that 'A2/AD is an overhyped buzzword leveraged to create an excessive sense of vulnerability-intimidating potential adversaries before the match even begins.'⁴⁷ One could argue that statements such as these are unhelpful and only serve to diminish the perception of the threat. Despite the FOI report contending that 'Russian A2/AD capabilities do not create any large impenetrable bubbles, and range and precision claims shrink under closer inspection'⁴⁸ it is still worth considering the fact that Russia has made remarkable gains in A2/AD capabilities.⁴⁹ Equally, the caveats cited in the report must also be considered, these include the factoring in of countermeasures, the political and military will to act and the commensurate allocation of resource to mitigate the threat.⁵⁰ Naturally, an accurate understanding of an adversary's current and future capabilities are critical to providing the strategic direction both politically and militarily. It is these assessments and working assumptions which ultimately inform policy, defence procurement and capability programmes, whilst also driving innovation and research.

Despite the opposing view, there remains substantial literature, including but not limited to UK and US military doctrine, which contends that adaptation is required to counter emerging A2/AD threats. Not to do so risks an air force's ability to maintain freedom of manoeuvre and project force, in turn limiting a nation's ability to influence globally. As Watling, Bronk and Kaushal contend, 'counter A2/AD capabilities are not optional if a nation wishes to retain any pretence of sovereign power projection and deterrence capability.'⁵¹ Moreover, countering these systems has become a basic requirement for expeditionary operations in most operational theatres.⁵²

The development of Russian and Chinese long-range missile capabilities has seen significant improvements over the course of the last two decades, forming part of their respective nations' long-term strategies to comprehensively modernise their armed forces. As a nation with one of the largest inventories of ballistic and cruise missiles, Russia remains a major power in the development of missiles of all kinds.⁵³ Since 2010, Russia has sought to accelerate the modernization and deployment of air, sea and ground launched long-range precision weapons on cruise and ballistic weapons, highlighting their increased importance in doctrinal documents.⁵⁴ Figure 1 provides an indication into Russia's current land-based missiles and their associate ranges. Whilst Russia continues its ongoing modernization programme to produce new variants of ballistic and cruise missiles with significant new capabilities and make major advancements in the field of precision-guided cruise missiles,⁵⁵ it will continue

to pose a threat to the West. As highlighted by Bosbotinis, 'the current array of ballistic and cruise missile systems either already deployed, or under development by the Russian armed forces, will provide a significant qualitative enhancement to Russia's ability to project power'.⁵⁶ Moreover, in the context of a conflict with NATO, Russia can, for example, hold at risk key airfields across Europe which would be critical to countering Russian military operations in the Euro-Atlantic.⁵⁷



Figure 1 - Russian Land-Based Missile Ranges 2021

The effectiveness of Russian precision missiles has been demonstrated during peacetime exercises and operationally in Syria.⁵⁸ The same can be said for the ongoing conflict in Ukraine, whereby Russian forces have highlighted their ability to accurately target adversary depth locations using long-range precision strikes; the effects of which were sufficient to destroy most military objects other than deep subterranean or heavily hardened structures.⁵⁹ The Ukraine conflict, as noted by the US Commander of Army Space and Missile Defence Command, has witnessed the largest use of offensive missile systems in Europe since World War II,⁶⁰ with over 2,800 missiles being employed in the first five months of the War (Figure 2). Arguably the large-scale use of missiles by Russian forces in Ukraine is indicative of their intent to employ them in future conflicts, especially in the opening weeks and months.

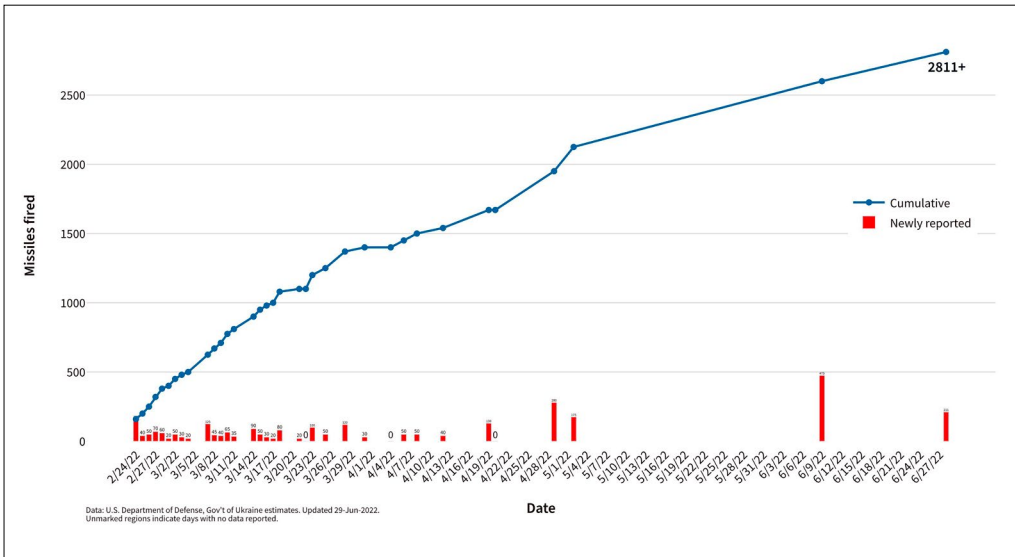


Figure 2 - Russian Missile Attacks on Ukraine, 2022⁶¹

Whilst there are a host of lessons that can be drawn from both sides in the ongoing conflict in eastern Europe, one of the critical lessons learnt by the Ukraine Armed Forces (UAF), which applies to western air forces, is the capability to disperse. The UAF's ability to disperse and maintain aircraft in the field for a limited period, proved critical to survivability, without doing so it is likely that the Air Force would not have survived the opening days of the conflict.⁶² Overall, the use of precision guided cruise missiles is fast becoming commonplace in current operations, becoming increasingly the weapons of choice by states such as Russia to coerce in peacetime and in conflict, representing one of the most underappreciated near-term threats.⁶³ Russia has also sought to invest in the development of hypersonic missiles, further eroding the technological advantage that NATO has historically maintained. Since 2018, Russia has tested at least four new hypersonic missiles,⁶⁴ introducing into service its long-range Avangard hypersonic glide vehicle and Kinzhal air launched ballistic missile.⁶⁵ These emerging capabilities have the capacity to deliver both conventional and nuclear payloads over remarkable distances and at immense speeds, whilst maintaining the prospect of penetrating the most advanced air defence systems.⁶⁶ Given their characteristics, defence systems struggle to defeat them, as their speed decreases adversary reaction time and their manoeuvrability ensures that tracking and engagement is not easily achieved. These advantages not only provide significant standoff range but further complement and enhance existing A2/AD capabilities, thus making hypersonic weapons an attractive option to pursue. As Davis contends, 'the development of hypersonic weapons and the deployment of systems like Avangard are an integral part of Russia's investment in new, modern military capabilities.'⁶⁷

From a US perspective, the People's Republic of China (PRC) has been identified as the most consequential strategic competitor in the coming decades and is seen as a pacing threat to

the DoD, given the increasingly coercive actions to reshape the Indo-Pacific region.⁶⁸ Like Russia, China has sought to develop its military as part of its long-term national strategy, in turn the People's Liberation Army (PLA) have developed a host of conventional capabilities, including the most active ballistic missile program in the world, representing a pacing precision missile threat to air bases.⁶⁹ Figure 3 illustrates the development of China's conventional missiles over the past two decades.

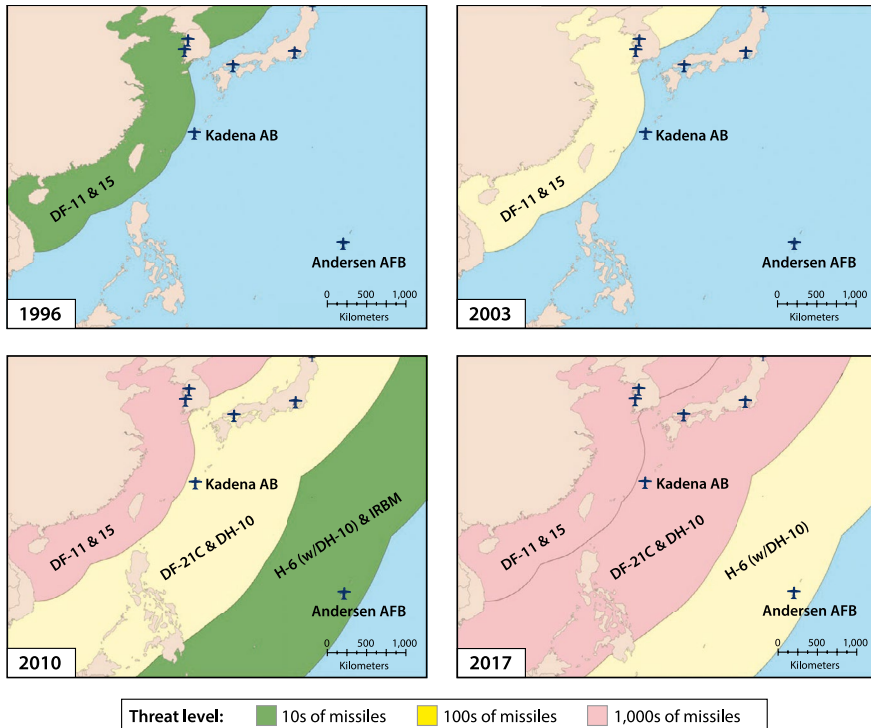


Figure 3 - Development of Missile Threats to Bases in the Western Pacific, 1996-2017⁷⁰

In 2015, as part of a major military reorganization, China upgraded and renamed its Artillery Corps to the PLA Rocket Force (PLARF), formally bestowing full-service level status, indicating its increased importance within Chinese strategy.⁷¹ In recent years the PLARF has continued to advance its long-range modernization plans and in 2021 it launched approximately 135 ballistic missiles for testing and training, more than the rest of the world combined.⁷² As Heginbotham *et al* contend, 'the PLA has made dramatic improvements in the quantity, quality and range of its conventional armed ballistic and cruise missiles over the past 15 years.'⁷³ So much so that these improvements form part of a larger portfolio of counter-intervention or anti-access capabilities that China seeks to develop to challenge the US' ability to project power into the Western Pacific.⁷⁴ Whilst Chinese military doctrine does not specifically cite anti-access as a strategy, it does include tactics with clear anti-access intention

or effect, including consideration of pre-emptive attacks on US forces as they deploy to a region.⁷⁵ As Cliff *et al* posit, 'PLA doctrine specifies attacks against air bases as the most efficient method of gaining air superiority and as a means of preventing or disrupting the inflow of air assets, personnel and supplies.'⁷⁶ Ultimately, China's accumulation and development of significant stocks of accurate conventional missiles, which can contest US access to its strategic air bases in the Pacific region, poses a credible threat to the US' freedom to operate in a critical part of the world.

The growth and advancement of long-range air and missile threats, missile guidance and other related technologies by states such as Russia and China, has demonstrated the relative speed at which the technological gap between competing nations can be narrowed and even surpassed. The capability of systems designed to constrain access to operating environments are likely to persist and will undoubtedly develop over time as adversaries seek to continue to challenge the West. The requirement to continuously operate in a contested air domain necessitates the pressing need to adapt at pace or risk losing in the early stages of a conflict with a peer or near-peer adversary. A2/AD capabilities, focused against air bases, air assets and their associated supporting infrastructures such as runways and fuel supplies, compel western air forces to develop a range of countermeasures to increase survivability in a high-end warfighting scenario or risk losing the ability to gain and maintain control of the air. The key lessons taken from the ongoing conflict in Ukraine, with regards to the necessity to disperse, coupled with the identification of air bases in adversaries' military doctrine as initial priority targets, underscore the imperative of increasing resilience and survivability through dispersed operations. ACE is one such passive defence methodology which may provide a means to mitigate the growing threat.

Section Three: The Challenge

The previous section sought to outline the growing A2/AD threat(s) facing western air powers from increasingly competitive states, namely Russia and China. The significant advances in long-range precision strike capabilities by adversaries now necessitates that air forces adopt robust protection measures to ensure survivability in the early stages of a peer-on-peer conflict. The conflict in Ukraine and the Russian ability to successfully strike 75% of static defence sites in the first 48 hours of the war, reaffirms the notion that there is no sanctuary in modern warfare.⁷⁷ Given the threat, the RAF, amongst other NATO air forces, has chosen to adopt the ACE concept as a means of ensuring resilience and operational effectiveness within the context of the future contested operating environment.⁷⁸

The development and implementation of ACE represents a crucial opportunity for the RAF to ensure its continued operational flexibility and to adapt to the evolving strategic environment. As highlighted in the USAF ACE Doctrine note, 'ACE requires revolutionary change in how the Air Force thinks about and conducts operations within the modern operational environment.'⁷⁹ Undoubtedly, the successful application of ACE will present numerous dilemmas and the following section will seek to focus on identifying the associated challenges which the RAF will need to overcome as it strives to implement ACE.

For the RAF, like many other NATO air forces, the concept of operating aircraft from dispersed locations at short notice is nothing new. During the Cold War for example, the threat to NATO air bases from the Soviet Union led to aircraft operating on emergency landing strips on large sections of the German autobahn, in exercises such as 'Highway 84'.⁸⁰ Moreover, the landing of a Jaguar GR1 on a section of the M55 in 1975,⁸¹ serves to highlight the early beginnings of ACE. A great deal has changed in the years since; whilst at first glance the threat appears similar, today's aircraft, the personnel that operate and maintain them and the procedures and policies that govern their use have dramatically changed. As such, the Chief of the Air Staff's comment that 'the RAF must begin to re-learn the skills of dispersal, not been practiced for some 30 years' is axiomatic.⁸²

Over the past two decades there have been six British defence reviews and in that time the portfolio of military hardware across the three services has changed dramatically.⁸³ For the RAF specifically, defence budgetary constraints and advances in technology, amongst numerous other factors, have seen several fast jet aircraft enter and retire from service. As alluded to, conducting dispersed operations is something that the RAF was historically well-versed in. The retired Jaguar, Harrier and Tornado aircraft all had extensive experience conducting operations away from MOBs in austere or dispersed locations for protracted periods of time.⁸⁴ This is not the case for the RAF's modern-day fighter aircraft, namely the F-35B and the Typhoon; both platforms are highly technical and capable, yet they either lack the experience of operating from dispersed locations, are ill-suited or restricted from doing so. As Bronk explains, the RAF sustainment and maintenance equipment and practices for the Typhoon aircraft are designed around centralised, fixed bases.⁸⁵ Moreover, the platform is designed to operate from relatively smooth runways and is not optimised for short-field landings on rough surfaces.⁸⁶ Equally, the Typhoon's underslung air intake is susceptible to engine damage from foreign object debris (FOD), something which is likely to be present in austere locations.⁸⁷

With these limitations in mind, it can be argued that the Typhoon, whilst highly capable, is not the most agile combat aircraft in terms of the locations it can operate from. Similarly, the F-35B, although a short take-off and vertical landing (STOVL) variant, has limitations on where the platform can operate from due to security regulations and other factors such as access to computer servers.⁸⁸ Herein lies one of the key challenges to the implementation of ACE; the repeated use of well-founded bases has led to the procurement and development of platforms which are restricted to operating from MOBs, ultimately constraining and limiting the RAF's ability to disperse. The perceived benign environment and absence of a direct threat, coupled with the requirement to drive down operating costs has led to the rationalisation of RAF bases. The subsequent consequence is an RAF that has become accustomed to operating from increasingly concentrated small numbers of 'superbases'.⁸⁹ The habitual use of these superbases has eroded the RAF's corporate knowledge and experience of conducting dispersed operations, so much so that when early dispersal exercises took place, it was noted that many of the capabilities required to effectively conduct ACE for combat aircraft had not been collectively exercised or prioritised for a considerable period.⁹⁰ This is understandable

when one considers the high tempo of COIN operations that the RAF has contributed to over the last two decades. However, given the changing security landscape and the lessons learnt from Ukraine, air forces can no longer continue to operate large numbers of aircraft from centralised MOBs.

One of the other challenges likely to be encountered by the RAF, as it begins to develop ACE, is the use of industry for the purpose of aircraft maintenance; especially when considering the highly technical nature of many modern-day combat aircraft and the requirement for civilian contractors to maintain and support the fleet.⁹¹ Whilst the employment of civilians to support military operations is nothing new, the increasing use of the private sector for aircraft maintenance demonstrates a degree of reliance. This has led to predictions that this will destroy an air force's ability to surge its forces in a crisis, whilst undermining its maintenance infrastructure of equipment and skilled personnel.⁹² Conversely, there are many examples where civilian contractors and military personnel have deployed together in conflict environments. In any case, a crisis could be understood as the immediate requirement to operate and maintain aircraft from multiple dispersed locations for protracted periods of time, within a potentially high threat environment. A scenario such as this would undoubtedly raise several issues for industry partners and civilian contractors, which may include increased cost, significant risk management, substantial training burdens, command and control issues, as well as complex legal and ethical challenges. Ultimately, the RAF will need to consider how industry contractors will support front line maintenance of its fast jet aircraft in an agile combat setting, if at all. This specific challenge has driven the USAF to become more self-sufficient, such that greater flexibility has been created to deploy with smaller packages of personnel, that are not reliant on contractual support.⁹³ To overcome this challenge, the RAF might consider investment in cross-training personnel to carry out engineering and maintenance processes, as well as security functions which would in turn ensure a minimal footprint. After all, ACE requires functional communities to identify how to minimise equipment and personnel to increase dispersal capabilities.⁹⁴

The current processes for aircraft engineering and maintenance may also present an ongoing challenge to the implementation of ACE within the RAF. As noted by the Minister for the UK Armed Forces, '25 years of not having to consider a peer-on-peer fight has impacted on the way the MoD does logistics and enablement'.⁹⁵ The end of the Cold War and a perceived reduction in threat signalled an opportunity to cut back on 'wastefulness' pan defence and adopt more cost-effective supply chains. Following the 2003 *'Streamlining End to End Air and Land Logistics'* report, the RAF began to concentrate forward maintenance at MOBs.⁹⁶ What followed were significant financial savings and the RAF's transformation towards adopting lean techniques at station level.⁹⁷ The rationalisation of aircraft repair post 2004, saw a consolidation of locations where this work was undertaken. Prior to this, repair was conducted at multiple locations to ensure contingent capability was maintained in the event of an attack on one or more of the main operating bases.⁹⁸ Ultimately, the assessment at the time signalled a reduction in the threat, negating the requirement for redundancy and

dispersed repair. The threat environment has now dramatically changed, with the conflict in Ukraine ongoing, one could argue that the logic of co-locating Typhoon maintenance, predominantly delivered from RAF Coningsby by BAE Systems, with Quick Reaction Alert (QRA)⁹⁹ is somewhat flawed. Not only does the current model lack redundancy, but crucially RAF Coningsby could be considered a vulnerability, offering a potential adversary an attractive target in the early stages of a peer-on-peer conflict. Similarly, the perceived lack of threat, the requirement to achieve engineering efficiencies and do more with less, has led air forces to adopt practices such as line maintenance. These processes have evolved to drive down wastage; a prime example being the parking of aircraft side by side to speed up the time taken to perform set maintenance procedures. A logical step to reduce the transit time it takes engineers to move between dispersed locations or Hardened Aircraft Shelters (HAS). Freedman contends that 'in times of low threat this may be appropriate', however questions the 'appropriateness of lean processes for a warfighting organisation'.¹⁰⁰ Moreover, he asserts that the RAF's operating model appears to have sacrificed its resilience in favour of engineering efficiency and would therefore struggle to revert to dispersed operations at scale.¹⁰¹ The drive towards increased efficiency across defence over time has significantly reduced redundancy across the services, which has ultimately impacted on the RAF's overall level of resilience. As Bronk points out, war is inherently inefficient; although efficiency savings result in periods which look more efficient, they ultimately lead to increased fragility and paradoxically create more inefficiencies, particularly in the air domain.¹⁰² Understandably, the defence budget must, like other government departments, make savings where possible, however careful consideration should be given to the removal of redundancy in the name of efficiency savings.¹⁰³ After all, some forms of wastefulness within a military context can be regarded as resilience.¹⁰⁴ For the RAF, there is a case to be made that lean systems of engineering and just-in-time logistics are impractical within a CDO environment. Moreover, given the requirement to operate from alternate locations, efficiency is arguably at odds with ACE. This may require the RAF to reconsider how best to approach processes such as aircraft line and depth maintenance when conducting dispersed operations as part of ACE.

Procedures and processes are yet another area which has evolved within the RAF; one change which stands out above many others is that of safety policy. Arguably the watershed moment occurred in 2006, following the loss of the Nimrod MR2 aircraft in Afghanistan. What followed was the Haddon Cave Report and several changes to the regulation and safety management of aviation activities.¹⁰⁵ In subsequent years safety measures, safety management systems and risk tolerance across the RAF have evolved, leading to what some claim is a culture which focusses on reducing risk, often at the expense of opportunity.¹⁰⁶ As the Minister for the Armed Forces contends, 'the threat over the last two decades has not necessitated that defence be so dynamic'.¹⁰⁷ This has arguably resulted in personnel, both military and civilian, becoming accustomed to operating in as safe an environment as possible, where risk has been driven down to a level that is as low as reasonably practicable (ALARP). Naturally, adjusting to ACE (a high-risk activity conducted in challenging conditions and in potentially high threat environments) will be a significant challenge for the RAF to

overcome. Implementing ACE will require the RAF to adopt a 'train as you fight mentality', conduct live trials and explore the current operating boundaries, all of which may conflict with the current RAF Safety Management System.¹⁰⁸ As the ACE concept matures, additional steps may need to be taken to ensure that the unintended secondary effects of 'safety bureaucracy' do not hamper innovation.¹⁰⁹

Another challenge closely associated with safety and risk, which may restrict or even hamper future ACE activity, is the regulatory procedures which governs the conduct and delivery of air operations in the UK. The early RAF ACE exercise (AGILE PIRATE 2), conducted in 2021 from Stornoway airport, serves to highlight how current regulatory procedures may impede future ACE development. For example, the current policies governing the movement of dangerous goods, explosive safety, airfield driving, armed aircraft licensing and dangerous air cargo, all contributed to additional levels of complexity during the planning and execution phases of the exercise and in certain circumstances stopped objectives being achieved.¹¹⁰ Therefore, reviews into such policies will be required to ensure that both civil and military regulations do not hamper the RAF's ability to develop the ACE concept. As highlighted by the RAF's Air and Space Commander, 'there are very clear rules and regulations for peacetime operations, which for example, limit where a Typhoon with certain weapons loaded can park on certain bases and we (the RAF) need to figure out how to make those policies work to enable ACE.'¹¹¹

Exercise AGILE PIRATE 2 also served to highlight the logistical requirements to support and enable RAF ACE activity. In this instance, it was not possible to move all personnel and equipment to Stornoway for the start of the exercise, in the single A400M (RAF's military transport aircraft) allocated.¹¹² An element of regulatory procedure will account for this; however, the size and weight of the support equipment was also a significant factor. When conducting combat air operations from well-established airfields, the size and weight of support equipment is largely irrelevant. However, attempting to do the same from a relatively austere location, when the equipment inventory is cumbersome and unagile, creates additional complexity due to the increased logistical burden, which is arguably not conducive to ACE. In turn this creates additional dilemmas, requiring the RAF to consider the use of tailored Ground Support Equipment (GSE) that is agile in nature or consider prepositioning materials at distributed operating locations to ensure theatre plans are executable.¹¹³ Both options will come at a financial cost, requiring further analysis to determine which course of action best suits RAF ACE.

Many of the previously mentioned challenges to the application of ACE are underpinned by the RAF's workforce. It is paramount that all personnel, both civilian and military, within the organisation understand the threat, appreciate the pressing requirement to enhance resilience, whilst supporting the development and implementation of the concept as it matures to become part of the RAF's modus operandi. Arguably, an island nation mentality and the geographical distance of the UK to mainland Europe has created a sense of security

and a perception of a benign, threat free environment. One could argue that this mindset has inculcated itself into many areas of the modern-day RAF, leading to a reduction in readiness, agility and resilience. For countries such as Finland, who share a significant border with Russia, their perception of the threat is strikingly different, which has led to decades preparing infrastructure that can be reconfigured to increase resilience.¹¹⁴ Changing perspectives will be a significant challenge and possibly the most important element in achieving ACE, requiring a profound shift in the mindset and culture of the RAF's whole force.¹¹⁵ Key to overcoming this challenge will be education, ensuring all personnel appreciate that ACE is a means to increase survivability in a high-end conflict with a peer or near peer adversary. Moreover, educating the force more widely can contribute to overcoming the complacency that has developed within the home base and support the generation of an agile mindset which has 'faded from corporate memory' since the end of the Cold War.¹¹⁶

Remaining aware of emerging threats will also play a key role in the development of ACE. Given the considerable effort directed toward the Information Environment from both Ukraine and Russia as part of the ongoing conflict,¹¹⁷ it is highly likely that threats from within this environment will present multiple additional challenges to ACE. Stringent operational security by all will be critical to avoid inadvertently revealing friendly forces' locations to an adversary, something that has repeatedly occurred in Ukraine. For example, Russian troops have posted content on social media, which has been analysed to reveal location data used to plan and execute attacks.¹¹⁸ In this arena poor personal and operational security can lead to both the loss of military capability and loss of human life. As Robinson contends, dispersed or agile operations will only be as survivable as its weakest link, requiring personnel to be trained and constantly reminded that there are legions of people who can identify locations from the most innocuous detail in a photo or video uploaded to social media.¹¹⁹ The general public may also pose unwanted additional challenge by inadvertently uploading real time aircraft information to social media sites. The combined information from social media, flight tracking applications and aircraft enthusiast forums could aggregate to undo the unpredictability which ACE seeks to achieve. However, in every challenge there lies opportunity; social media deception tactics could be employed to good effect to introduce doubt and cause increased confusion.¹²⁰

Adopting ACE within the RAF, for the purpose of enhanced resilience, will undoubtedly require a significant effort and be fraught with numerous challenges and complexities. Arguably, the changing security landscape combined with the development of adversarial A2/AD and long-range precision strike capabilities necessitates the need to adapt. Based on the current and developing threats, one might assert that ACE should be a non-discretionary activity for the RAF. This section has highlighted limitations in the RAF's ability to conduct dispersed operations with its combat aircraft and sought to identify the key challenges associated with implementing ACE. Many of these challenges are a direct result of a focus on delivering air power from well-established MOBs over the last two-three decades, free from a direct threat from an adversary. This has led to the procurement of aircraft and equipment geared towards

well founded airfields as well as regulations and procedures that are at odds with agile operations from dispersed locations. Arguably, RAF personnel have become accustomed to a 'peacetime' working environment and now perhaps lack the deployable warfighting mindset that their Cold War era predecessors maintained on a business-as-usual basis. Herein lies what is conceivably the biggest challenge; engendering the correct mindset to enable ACE across the entirety of the organisation. There will of course be many other challenges specific to ACE which require more detailed research, this may include, doctrine, training, command and control, communication and cost. Whilst outside of the scope of this section, the following section will seek to identify some of the additional challenges that have been omitted from this one.

Section Four: The Way Forward

The lethality of long-range precision strike capabilities, apparent in the ongoing conflict in Ukraine, have once again brought the vulnerability of predictable air operations and static aircraft into sharp focus. Whilst some NATO members have ensured their respective air force's resilience through continuous training to conduct dispersed operations, the same cannot be said for the RAF who have predominantly focused on the delivery of air power from fixed, well-founded MOBs. However, in the last two years the RAF has begun its journey to re-learn the skills not practiced since the end of the Cold War, as it attempts to increase its resilience, unpredictability and survivability within the context of a CDO environment. To achieve this, the RAF has chosen to adopt the ACE concept¹²¹ and 'intends to make it the way the organisation will operate and fight'.¹²² In 2023, the RAF internally published its ACE directive which sought to define the concept, illustrate what it means for the organisation, explain the reasoning behind the RAF pursuing ACE and set a timeline for implementation.¹²³ The subsequent development of the concept has followed a crawl, walk, run approach, allowing the RAF to experiment with how it wants to take ACE forward.¹²⁴ Having now achieved the 'understand' phase of implementation, the RAF will progress on to the 'develop' phase before finally testing themselves and proving the concept to achieve operational readiness.¹²⁵ Arguably, the proof of concept of ACE will be an air force that can continue to project air power effects and capabilities within the context of a CDO environment, from a variety of MOBs, civilian airports or austere airfields. In the previous section the challenges associated with implementing the concept were highlighted. In doing so it has become apparent that there are several constraining factors which currently limit the locations to which RAF combat aircraft, namely Typhoon and F-35B, can disperse to and operate from in the event of a near-peer or peer conflict. Building on the identified challenges, this section will seek to highlight the ways and means of developing ACE as the RAF seeks to implement it as an operational concept.

Successful implementation of ACE will undoubtedly require significant effort, investment and innovation not only across multiple groups and headquarters within the RAF, but also from external agencies, be that industry partners or supporting organisations such as the Civil Aviation Authority (CAA). It will necessitate that the status quo is challenged and that

platforms, supporting equipment, personnel and regulatory procedures remain as agile as the concept itself. One of the initial steps to take is the publication of an ACE operational doctrine which codifies the concept and provides a foundation to guide the force to develop best practices.¹²⁶ At the time of writing, the RAF is yet to release any formal ACE doctrine, however briefing notes, directives and a campaign plan have been published, albeit internally. The MoD's think tank, the Development, Concepts and Doctrine Centre (DCDC) or the RAF's Air and Space Warfare Centre (ASWC) may be the obvious organisations to mature ACE doctrine, in a similar way to that of the Curtis Lemay Centre, who produced USAF Doctrine Note 1-21 in August 2022. A specific piece of open-source ACE doctrine, which has linkages to national security policy, would serve to establish a common frame of reference whilst contributing to a greater awareness of the concept more widely in the public domain. Moreover, a focused media effort to illustrate the current threat environment, explain ACE and highlight its benefits would contribute towards educating the organisation's personnel, increasing general awareness, and assist in the overarching change management process. In early 2023, the Curtis Lemay Centre did just that, releasing an easy-to-understand ACE YouTube video which coherently explained the key points contained within the new doctrine note, defined the concept and added context from different perspectives.¹²⁷ Arguably a concentrated effort to educate and develop understanding amongst RAF personnel will be a key factor in ensuring the necessary shift in culture to implement ACE. Education and awareness will undoubtedly play a key role in the implementation of ACE, so too will learning from the experiences of partner nations, especially those well versed in dispersed operations. Sweden is one such nation, who have maintained their ability to operate away from MOB's for sustained periods under realistic combat operations.¹²⁸ The Swedish Air Force's (SwAF) wartime posture ensures they can operate from 11 main, 12 forward and 21 reserve operating bases, as well as utilising civilian highway strips.¹²⁹ Similarly, much can be learnt from the Finnish Air Force (FiAF), who maintain a resilient approach to passive air defence, built upon a hub-and-spoke system which would see aircraft disperse to secondary bases including civilian airports and road bases, in times of crisis.¹³⁰ With 45 operating locations to choose from, 19 of which are strips of highway,¹³¹ the FiAF display a robust attitude towards ACE. The closure of a main highway in Joutsa, Central Finland, for a five-day period in September 2022, to allow its fighter jets to practice landings and take-offs on a reserve road runway, exemplifies the importance of maintaining these skill sets.¹³² Moreover, the acceptance of the disruption caused by the road closure, from the civilian populace goes some way to highlight the understanding of the threat and the need for the FiAF to practice its dispersal drills. Given the significant level of capability the SwAF and the FiAF have in conducting dispersed operations, it is incumbent upon the RAF to continue to leverage the experience of partner nations, achieved through observing and participating in specific ACE focused exercises. This will undoubtedly contribute to maturing the concept at a faster rate by capitalizing on best practice, developing common Tactics, Techniques and Procedures (TTPs) and avoiding known pitfalls, whilst fostering working relationships. Training and operating alongside partner nations will also contribute to enhanced interoperability, in turn leading to the use of additional airfields, providing a force multiplying effect and increased operational resilience. This can be enhanced through

aircraft familiarisation during exercises or operations, working towards formal cross-servicing agreements.¹³³ Whilst current UK regulatory policy may impede such initiatives initially, every effort should be explored to develop them, which may eventually lead to partner nations seamlessly operating and supporting each other's aircraft.¹³⁴ The cross-training of German and RAF versions of the Typhoon, by Luftwaffe engineers in preparation for the Joint NATO Air Policing mission in Estonia,¹³⁵ combined with the refuelling of a UK F-35B by an Italian Air Force KC-130J tanker,¹³⁶ demonstrate the potential benefits and early beginnings of ACE related interoperability initiatives with NATO allies. Interoperability with partners may also provide advantage through resource sharing, leading to the potential of reduced levels of RAF equipment and personnel required to maintain ACE operation. Developing the ability to operate from partner nations' airfields will undoubtedly prove beneficial, although expanding the RAF's own contingency aircraft operating locations within the UK concurrently would significantly increase agility and resilience as the ACE concept matures. However, the ability to operate from a larger network of locations, be that civilian airports or austere strips of motorways, will undoubtedly require significant investment to support them. As noted by the US Pacific Air Force Commander, 'making ACE work entails investment in additional logistics and infrastructure.'¹³⁷ This has led the USAF to invest considerably in the expansion and modernization of more minor facilities to achieve greater dispersion.¹³⁸ Sizeable investment in infrastructure might not be achievable for the RAF; budgetary constraints will likely impose limitations, requiring greater consideration of the level of investment that goes into ACE. Many of the lessons identified during the planning and delivery of early RAF ACE exercises provide an insight into the limitation of combat aircraft when attempting to operate from dispersed locations; these point towards those areas that require specific investment as the RAF pursues its implementation of ACE.

Although certain limitations such as overly restrictive regulatory policy and risk tolerances can be overcome with minimal financial expense, there will be a requirement for the RAF to procure certain capability enhancements and support equipment which will necessitate financial investment. A prime example being the enablement of a GPS based precision approach capability for Typhoon, which would allow the platform to operate from a greater number of austere airfields in all weather conditions, thus increasing agility.¹³⁹ The current limitation of these approach aids has impacted the ability to generate sorties, due to poor weather and incompatibility, whilst at alternate operating sites. The enhancement of this capability would therefore contribute to a more robust combat air ACE capability. Another example where investment will be required to enable ACE operations, is the purchase of additional logistical equipment. Early ACE exercises have highlighted that current GSE, including weapon loaders and handling equipment, are cumbersome and not conducive to dispersed operations at austere locations. Unagile support equipment and highly restrictive regulatory policy, which stops a single aircraft being used for a given ACE exercise or operation is sub optimal. The preferred solution should be a scaled approach in which a single wide-bodied aircraft can carry all the necessary equipment and personnel to enable an ACE deployment. This approach would require the RAF to procure more agile

support equipment in sufficient numbers or consider the alternate option of pre-positioning at multiple stand-by locations. Each option will have its own unique advantages, yet both will require financial investment. Given that the RAF does not have the mass required to commit multiple transport aircraft to a singular ACE deployment, it will have no option other than to invest in additional GSE in the pursuit of ACE.

The refuelling of combat aircraft at dispersed locations is another area which requires further consideration and investment. Whilst there may be accessible refuelling facilities at partner nation and civilian airfields, there may be compatibility issues which impose imitations on its use. Equally, austere operating locations are likely to lack the infrastructure required to refuel military aircraft. To address this the RAF, like many other air forces, utilise a capability known as Air Landed Aircraft Refuelling System (ALARS) which involves the defueling of a fixed wing aircraft into a fuel storage tank (known as a Tactical Refuelling Area (TRA)) or a Bulk Fuel Carrying Vehicle (BFCV), when aviation fuel cannot be moved to a given location by road.¹⁴⁰ Since the drawdown of the Harrier Force the ALARS (TRA) capability has been dormant; although the RAF's Expeditionary Logistics Squadron (ELS) is in the process of regenerating the capability, it is still assessed as immature and is not currently in use.¹⁴¹ The alternative option is the use of BFCVs, however the RAF does not currently own a tactical refuelling vehicle and is reliant upon the use of the British Army's Close Support Tanker (CST) to provide a tactical aircraft refuelling capability.¹⁴² Whilst steps such as the Large Capacity Aircraft Refueller Life Extension Project (LCAR LEP) are being taken to improve the aircraft refuelling fleet of front line RAF stations,¹⁴³ a significant capability gap remains. The ability to rapidly move between a network of aircraft operating locations necessitates a flexible refuelling approach, as such the RAF should commit to developing ALARS (TRA) as the primary method of refuelling combat aircraft within an ACE environment and invest in the procurement of its own tactical refuelling vehicles. This combined approach will provide the RAF with greater agility through the provision of both air and road transportable refuelling options.

Although the RAF's aspiration to adopt ACE will require varying levels of investment to procure new equipment and capabilities, there are numerous other low-cost work-strands that can be undertaken to mature the concept. As previously mentioned, regulatory procedure in a peacetime environment has changed notably, leading to a common perception that current policy is often overly restrictive and, in some cases, obstructive. Whilst safety remains critically important, regulation must not impede the RAF's ability to innovate and adapt to the changing threat. If ACE provides the means to increase the RAF's survivability through rapid dispersal in times of conflict, then surely current policy should make allowances for a warfighting organisation to train as it means to fight? During Exercise AGILE PIRATE 2, the Dangerous Goods Manual (DGM) policy and the Explosive Safety Case (ESC) for the A400M prevented the use of a single aircraft to transport all equipment, personnel, munitions and fuel to the exercise airfield.¹⁴⁴ Arguably the ability to move all personnel and support equipment in a single aircraft is fundamental to achieving ACE. As such, a review of the policies which restrict the development of ACE should be initiated and resolved in consultation with

the relevant agencies. Additionally, the risks associated with conducting ACE activity should be clearly defined and evaluated through the organisation's Air Safety Duty Holder (DH) chain, to ensure the concept continues to mature.¹⁴⁵

The early identification of suitable alternate operating locations, be that existing RAF stations, civilian airports or austere airfields, will also serve as a proactive measure in the advancement of ACE. This action could be completed at relatively low cost through the deployment of trade specialists from within the organisation to create and where required update an ACE specific airfield site survey. This would provide the RAF with a clearer understanding of the level of investment required at each given location, whilst also identifying the most suitable civilian locations. If civilian airports are to be used as potential ACE sites, the RAF would also need to consider obtaining the relevant licensing arrangements to allow live armed aircraft to train and operate. As was seen during Exercise AGILE PIRATE 2, the lack of licencing arrangements and suitable operating areas hampered the ability to employ Typhoon with live weapons during the early ACE exercise.¹⁴⁶

Establishing a network of alternate operating locations in and out of the UK is a key component of ACE; it contributes to disrupting a would-be adversary's targeting process and increases survivability of aircraft. The use of camouflage, concealment and deception techniques are yet another low-cost option which has the potential to significantly increase resilience when combined with other defensive measures.¹⁴⁷ Arguably, the use of such techniques, to obfuscate aircraft and associated support equipment, is a skill that the RAF has become unaccustomed to employing on MOBs. Consideration should therefore be given to the procurement and use of passive protection measures, such as realistic aircraft decoys, given that analysis shows that these methods can significantly enhance force survivability and sortie generation.¹⁴⁸ The repurposing and use of existing HAS on RAF bases, a concerted effort to move away from efficiency-based aircraft engineering procedures such as line maintenance, combined with the use of various deception methods would also introduce doubt and confusion in the mind of an adversary. Thus, distracting and misleading them as to the defenders' intentions, whilst inviting them to waste valuable resources investigating uncertain targets or attacking decoys.¹⁴⁹ The next step in complicating an adversary's decision-making process could be a targeted information operation campaign, similar to that of the USAF's *'reveal to deter, conceal to protect and suggest to mislead'*.¹⁵⁰

Another low-cost option for the progression of the ACE concept would be the development and publication of a bespoke training scenario. This would assist in providing an exercising unit with a more comprehensive understanding of the threat, whilst helping to shape deployment options. Moreover, a realistic scenario, complemented by focussed operational staff work, is increasingly more likely to actively engage the training audience and set the conditions for a cultural shift in mindset. Achieving a workforce that adopts an expeditionary mindset and who understands the threat, which necessitates the need for ACE will require a notable amount of training. As highlighted in US ACE doctrine, the air force must refocus on

the expeditionary skills necessary to operate outside of enduring locations.¹⁵¹ Unlike many of the previously mentioned methods of developing ACE within the RAF, training is likely to be a graduated, long term and high-cost activity. Not only will the RAF be required to train collectively with partner nations to ensure interoperability, but it will also need to consider investing in individual training. Given the agile nature of the ACE concept, equipment and personnel must be kept to a minimum, thus requiring those deployed personnel to be trained and certified in areas outside their primary functions.¹⁵² Achieving this will require the RAF to train differently and move away from traditional training pathways, whereby specific courses can only be completed by personnel from a given trade or specialisation. ACE will require mission support personnel to be cross trained in a variety of skill sets to enable the flexible generation of air power from isolated, unsupported and potentially high threat environments.

Once the ACE concept has been sufficiently developed, in line with the RAF's campaign plan, it ought to be robustly tested and evaluated. This process will contribute to gauging the level of competence of the organisation whilst identifying any shortfalls. Evaluating competence could take many forms, including no notice dispersal exercises, similar to that of the Cold War era Tactical Evaluations (TACEVALS), which were a regular method of assessing a front-line squadron's combat readiness.¹⁵³ Arguably, the evaluation of the organisation's ability to conduct effective ACE operations is a critical step in the crawl, walk, run approach, so much so that the RAF's Air and Space Commander is seeking to use exercises as a means of flushing all challenges prior to an ACE evaluation (ACEVAL) in 2024.¹⁵⁴

This section has sought to highlight a range of options that the RAF could consider as it looks to develop and implement ACE as an operational concept. Ultimately there will be many different methods to achieve this and whilst this section does not offer an exhaustive list, it does highlight that varying degrees of financial and conceptual investment will be required, dependent on the level of ambition. Given the limitations faced when operating from relatively austere locations, the current unagile nature of GSE and the insufficient level of experience of conducting ACE operations, one could conceivably argue that the RAF is in the nascent stage of concept development. As such, the RAF's ability and readiness to undertake an evaluation in 2024 will rest on the level of investment the organisation is willing and able to inject into the concept over the next year. Whilst budgetary constraints and the RAF's operational commitments may reduce the speed of ACE progress, there are several non-material options that can be refined in the short term. Nevertheless, additional logistical equipment or more agile equipment, to support the generation of air power from alternate operating locations, will require financial expenditure. As highlighted by Donovan, 'the feasibility of ACE hinges on continued investment and closing down mission capability gaps to equip an agile forward deployed force'.¹⁵⁵ Achieving a robust ACE operating concept will undoubtedly require a significant level of investment; arguably the focus on the delivery of air operations from MOBs over the last two decades has led to the loss of the RAF's ability to be truly agile. Regaining this capability and experience will therefore take time. Moving forward, the RAF should strive to ensure that agility is rooted into all elements of the

organisation from the offset, be that the organisations future personnel, its equipment and its platforms.

Section Five: Conclusion

Identifying the specifics of the future operating environment will, for the most part, remain unclear and difficult to predict. However, the evolving threats from hostile nations such as Russia and China are evident. The development of A2/AD and long-range precision strike capabilities, which possess a high probability of damaging runways or destroying aircraft on the ground, represent a profound threat to air forces' operations.¹⁵⁶ Moreover, the ongoing concerns of a Chinese invasion of Taiwan and the Russian invasion of Ukraine have necessitated that the US, the UK and other NATO nations plan for high intensity warfighting against a peer adversary.¹⁵⁷ For many years, western air forces have enjoyed the luxury of conducting uninterrupted operations in a relatively threat free environment, from well-established MOBs. This is no longer the case, as much academic research points towards the requirement to project force from and into a CDO environment. In turn, this calls for air forces to re-learn the skills necessary to conduct warfighting at scale against a peer or near peer competitor. Generating and maintaining air operations in a contested environment will not be easily achieved, especially with a finite number of highly capable platforms which are concentrated on a small number of bases. This approach means that survivability of a platform in the air is not matched by survivability on the ground.¹⁵⁸ This problem is further compounded when one considers that the preparation time for military operations has significantly decreased,¹⁵⁹ reinforcing the now Chairman of the US Joint Chiefs requirement to '*accelerate change or lose*'.¹⁶⁰ Adapting the way the RAF conducts operations by building up organisational resilience, which it has arguably lost over time in the absence of a credible threat and the necessity to remove redundancy, is therefore critical to survivability in the future operating environment. With these conditions in mind one can appreciate how rapid tactical mobility, including the ability to disperse and concentrate at pace, will enhance a force's resilience.¹⁶¹ These conditions have led the RAF, amongst other NATO air forces, to adapt to the contemporary operating environment by adopting the defensive concept of ACE. Ultimately, this approach provides the RAF with the ability to increase its resilience and survivability against a peer level adversary in a high-end warfighting scenario, by disaggregating its forces to alternate operating locations. Not only does this decrease the concentration of aircraft on a small number of bases, but it also complicates the targeting process of a would-be adversary through the unpredictable generation of air power.

This paper has sought to identify the opportunity that ACE provides the RAF, whilst assessing the associated challenges and determining ways to develop the approach, as the organisation pursues the implementation of ACE as an operating concept. As illustrated in the previous two sections, implementing ACE across the RAF will not be without its own unique challenges. Some may be overcome with mental capacity alone, others however will require substantial levels of financial investment to build infrastructure, increase quantities of mission support equipment and make equipment more agile, to address the gaps in capability that

have developed over time. Ultimately, the ACE concept provides the RAF with the opportunity to adopt a more substantial defensive posture, deter potential adversaries and achieve greater levels of operational agility. The shift from operations at well-established MOBs to a more dispersed approach will represent a radical change, one which will require a fundamentally different outlook, an expeditionary mindset and a willingness to innovate and question the orthodoxy. This represents arguably the biggest challenge; changing a culture which has evolved over two decades of COIN focused operations. This research paper concludes that concentrating air assets in a small number of MOBs, when facing a peer adversary, is no longer a viable option. It presents a would-be adversary with a highly attractive target which could lead to the degradation and destruction of large swathes of capability. The advances in long range precision fires and the criticality of mobility, drawn from lessons identified in Ukraine, accentuates the decisive need to change the way air forces project and deliver air power effects. ACE offers the RAF a viable and scalable option to reduce the significant vulnerability associated with large concentrations of aircraft on the ground. The RAF should therefore prioritise the development and implementation of the ACE concept, given that mobility and agility will be critical to an air force's survivability if engaged in a high-end conflict with a peer or near peer adversary. Equally, the RAF should commit to appropriately resourcing the concept, providing a dedicated funding stream and invest in addressing the infrastructure, equipment and capability shortfalls which currently limit the organisations' ability to be truly agile. Every effort should be made to remove overly restrictive regulations which inhibits the development of ACE and actions taken to create a network of alternate operating locations both in the UK and abroad. Finally, the RAF should seek to educate its personnel (both military and civilian), industry partners and supporting agencies, on the utility of ACE to engender the required expeditionary mindset, embed the term within the lexicon of the organisation, ensuring that the concept is understood, accepted and championed across the service.

Whilst dispersed operations are embedded within the RAF's DNA, ACE remains relatively embryonic. To mature the concept sufficiently and achieve the required level of operational readiness, in an acceptable time frame, the RAF must allocate sufficient resource, invest appropriately in agile platforms and associated support equipment and experiment to realise its ambition. To not do so leaves the RAF vulnerable and risks the loss of credible deterrence as well as operational advantage. Failure to adapt to the changing environment also increases the likelihood of an inability to achieve effective interoperability with key partners and allies.

Whilst ACE provides a substantial means of increasing survivability, the concept should not be seen as a panacea; rather one of several defensive measures that should be considered, resourced, trained and used in tandem to disrupt an adversary's decision making and targeting processes. The expense associated with long-range precision munitions will limit the production for most nations, as such an air force must endeavour to make itself less of an inviting target; this can be achieved through a combination of dispersal, agility or hardening.¹⁶² Each option will require an air force to adapt and as the newly appointed head of the RAF recently highlighted, 'one of the key strategic lessons from Ukraine is that the side

which adapts the fastest is the side that is likely to prevail.¹⁶³ In a future CDO environment, where technological advancements have significantly improved the lethality of long-range precision strike capabilities, the RAF can no longer afford to remain fixed in any one location. It must ensure that it stays agile enough to create targeting dilemmas for an adversary, in turn achieving greater levels of survivability. In a contested operating environment, ACE may prove fundamental to the continued projection of UK air power.

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Dissertation

Can Uncrewed Aircraft Systems be the Medical Platform Solution in the Forward Environment?

By Squadron Leader Jules McBean

Biography: Squadron Leader Jules McBean is a serving RAF Officer who transferred to the RAF Medical Services from the National Health Service in 2017. She was awarded a CAS Dowding Fellowship in 2020 and gained an MA in Air Power Studies at the University of Wolverhampton. The challenges of providing military healthcare sparked an interest in exploring the use of novel methods, such as the role of uncrewed aerial systems, in the operational patient care pathway. With over 20 years' experience in healthcare, she is currently SO2 Medical Capability Strategy Development at Air Command, RAF High Wycombe.

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Section 1: Introduction

There is a growing body of published work regarding using uncrewed aircraft systems (UAS) in diverse industries for radically novel roles. Tasks previously carried out by helicopters or motor vehicles are being re-evaluated as new technology that disrupts the conventional need for crewed systems has emerged. It has been proposed that UAS could give military medical commanders new options for healthcare delivery which may mitigate known risks and offer solutions to known problems.

Publication series such as the *Global Strategic Trends* and, in particular, *The Future Starts Today* highlight that today's and tomorrow's world have changed, so new ways of working and thinking differently are required to create an advantage.¹ In addition, conceptual thoughts regarding future capabilities consider emerging technology as a source of potential answers to new and old challenges.

When considering uncertainty and what could happen in different types of war scenarios, such as a peer or near-peer war, or for collective defence if Article 5 of the Washington Treaty was invoked, the emerging technology of UAS may offer novel solutions to medical commanders.² This may lead to a scenario where medical demand outstretches limited resources. Medical supplies struggle to get through to the frontline, and helicopter availability to medically evacuate patients becomes scarce as they are required elsewhere. It is not unreasonable to propose that this will result in worse clinical outcomes and adverse health complications for those who may survive their injuries.

If resource capacity is stretched to breaking point by over-demand, those in charge will feel the consequences most acutely. This will profoundly affect the perception of the military medical services, those working in it and ultimately, the trust of those who rely on emergency care provision. Medical provision is essential and is a moral component of warfare but can the existing ways of supporting healthcare provision survive future conflicts?

As medical provision is a support function, reliance on available platforms has never been guaranteed and is a dependency. Most aerial assets provide strategic capabilities, and whilst aeromedical use is prioritised, being tasked over other priorities is avoided but not uncommon. Ultimately Commanders and politicians want to prevent the societal criticism that arises when severely injured or deceased service personnel are repatriated. They will be called to account by the family of the wounded and deceased, and this will be played out to the public through the media internationally as to why alternatives were not brought in earlier.

In western society, whose abhorrence of seeing maimed or deceased service personnel returning in coffins runs exceptionally high during times of conflict, this lack of even investigating alternative capabilities will be seen as a failure of leadership, significantly if other countries have progressed those technologies to the frontline.

Risk to life is present in every military mission that relies on human on board and operated machines. Currently, medical resupply is provided by land-based support function using two-person crewed diesel trucks. The timely logistical resupply of medical goods into the hands of frontline medics is essential to ensure that treatment continues when stocks are depleted. The situation where medical care is either not started or prematurely stopped due to a lack of medical equipment should never occur in modern military healthcare provision. But using the method of two drivers in a road convoy to deliver only a few lightweight items appears wasteful of resources. Plus, the lack of ability to deliver on roads due to unfavourable environmental conditions or lack of civil infrastructures, such as destroyed bridges, further complicates road moves and increases the threat risk.

The importance of emergency pre-hospital care and the establishment of effective outcomes of medical evacuation retrieval on mortality rates has been created through military battles. Military emergency healthcare, particularly in forward combat zones, currently uses rotary assets with highly specialist medical teams onboard to evacuate casualties whilst treating them simultaneously. This was established and proven during large-scale operations such as Operation Herrick and continues to date. However, despite this proven doctrine, there is growing evidence that alternatives may have to be considered, as the assumption that control of the air will always be guaranteed is not a certainty. If operating circumstances change, can emerging technology provide medical services with other feasible options for such risky activities?

This study will look at uncrewed aerial platforms as the potential solution for medical requirements. It is acknowledged that uncrewed methods of other transport also exist and include ground and submersible variants, which may have a role to play in the future; however, these land and maritime operating systems are out of scope in this air power-focused study.

This study will determine through the use of an emerging technology framework whether UAS can be the platform solution for military medical requirements in the forward environment in a future warfighting context. Strengths, opportunities, limitations and threats will be considered to structure the analysis. In addition, key debates regarding UAS emergence will be explored, with relevant literature reviewed throughout the study.

Following this introduction, Section 2 will explain the chosen emerging technology framework and how it features across the analysis. Relevant medical doctrine will be presented to provide context, and clarity surrounding UAS differentiation will also be provided.

In Section 3, one of the fundamental debates, what to term UAS and why it matters, will be explored. In Section 4, the recent developments in the UAS industry and the surge in associated publications, which have created optimism that they will replace helicopters, will be examined.

UAS are being hailed as a panacea for healthcare in the literature, offering solutions to complex healthcare scenarios. What are the reasons for this drone revolution and so-called 'disruptive innovation', and what solutions would this provide medical services?³ These strengths and opportunities will be explored in Section 5.

Whilst an immediate adoption may seem convincing by this point, Section 6 will explore the limitations of UAS and why the threats to their use are significant. Then, in Section 7, the issues around change and acceptance are explored. Finally, in Section 8, the penultimate section, considerations for the future of UAS are investigated before conclusions are offered in Section 9.

Methodology

Existing literature on the topic was reviewed to establish significant themes. The study then used a qualitative interview methodology to provide additional insight into the subject area and literature base. A semi-structured interview format was selected, allowing a systematic way to focus participants on the topic.⁴ Ethical approval was granted from the University of Wolverhampton Faculty of Arts Business and Social Science (FABSS) Faculty following the University's Ethics Procedure 2021-2022 (Taught Masters Level 7 Dissertations).

Interviews were conducted from October to December 2022. Eleven participants were conveniently sampled. Participants were drawn from the commercial drone industry, Defence Science and Technology Laboratory (DSTL), the military science community, the Royal Air Force (RAF) Medical Services (RAFMS), RAF aircrew, Strategic Command (STRATCOM) Capability Programme Management, and the Air and Space Operations branch. An abductive reasoning approach was adopted for this study in order to draw conclusions from limited findings.

In the next section, Section 2, the chosen theoretical framework for *emerging technology* will be explained, plus some background and context information will be given.

Section 2 - Framework

The research on establishing what an emerging technology is by Rotolo, Hicks and Martin was selected to structure this study as it provided a well-matched theoretical framework.⁵ It captured the emergent situation of UAS development and how that may affect medical services. Their work proposed the following definition of emerging technology: 'a relatively fast growing and radically novel technology characterised by a certain degree of coherence persisting over time and with the potential to exert a considerable impact on the socio-economic domain(s) which is observed in terms of the composition of actors, institutions and the patterns of interactions among those, along with the associated knowledge production processes. Its most prominent impact, however, lies in the future and so in the emergence phase is still somewhat uncertain and ambiguous.'⁶

This definition will be adopted for this study as it encapsulates critical elements. In their research, they proposed that these elements could be divided into five attributes of emerging technology. These were termed: radical novelty, relatively fast growth, coherence, prominent impact and uncertainty and ambiguity.⁷ The radical novelty attribute was more specifically described as 'fulfilling a given function by using a different basic principle as compared to what was used before to achieve a similar purpose.'⁸ In this context, UAS is considered a novel alternative to helicopters.

Regarding the attribute of relatively fast growth, the researchers proposed this was the rate derived from comparing to non-emerging technology rates.⁹ Whilst self-explanatory, using open-source publications as a metric evidently omits the body of work in the military domain, which is above official and, therefore, not publishable in the public domain.¹⁰ For national security purposes, that work is undetectable by those outside the military research community. Nevertheless, this is a valuable metric for measuring growth.

Attribute number three, 'coherence', included having the characteristic of 'persistence' plus a particular identity which has momentum.¹¹ Thus, those technologies that were still in a state of flux, therefore, are not seen as emerging.¹² The addition of *persistence* can be seen as helpful, particularly to commanders and policymakers, as this helps distinguish from those which are merely passing fads.

Significantly then, attribute number four, the 'prominent impact' continues the notion of effect, of which the researchers proposed that it must: 'impact on specific domains or more broadly on the socio-economic system by changing the composition of actors, institutions, patterns of interactions among those, and the associated knowledge production processes'.

Medical services would not know which technology to focus on without this effects-based potential. Indiscriminate adoption without justification and rationale would be inappropriate for spending finite public money.

Finally, the fifth attribute is 'uncertainty and ambiguity'.¹³ The researchers (Rotolo, Hicks and Martin) proposed that 'uncertainty' was a crucial characteristic of emerging technology because outcomes may be unpredictable and have 'unintended and undesirable' uses.¹⁴ Furthermore, the word 'ambiguity' was co-selected, as they proposed that meanings of the technology differ by social group.

The study will refer to these five attributes as they underpin the debates surrounding whether UAS can be the platform solution for medical requirements in the forward environment.

Medical Doctrine

Before proceeding, it is necessary to understand elements of the UK medical doctrine. Firstly medical evacuation, often referred to as MEDEVAC, is 'the process of moving any person who is

wounded, injured or ill under continuous medical supervision and care to or between medical treatment facilities.¹⁵ More specifically, forward medical evacuation is 'conducted from the point of injury/insult or a casualty collection point to the initial medical treatment facility'.¹⁶ The other method of moving casualties, 'in a non-designated vehicle without a medical escort', is termed casualty evacuation (CASEVAC).¹⁷ This study does not consider CASEVAC, and the terms are not interchangeable.

The movement of patients, known as the Operational Patient Care Pathway (OPCP) model, underpins the military medical domain. It is central to the research question, showing where the study is focused.

The OPCP model (diagram 1 below) shows the 'continuous, seamless and escalatory increase in clinical care provided to the operational patient'.¹⁸ In addition, the model visually shows medical planners the care provision from the point of injury (POI) back through the medical treatment facilities and return to Role 4.¹⁹

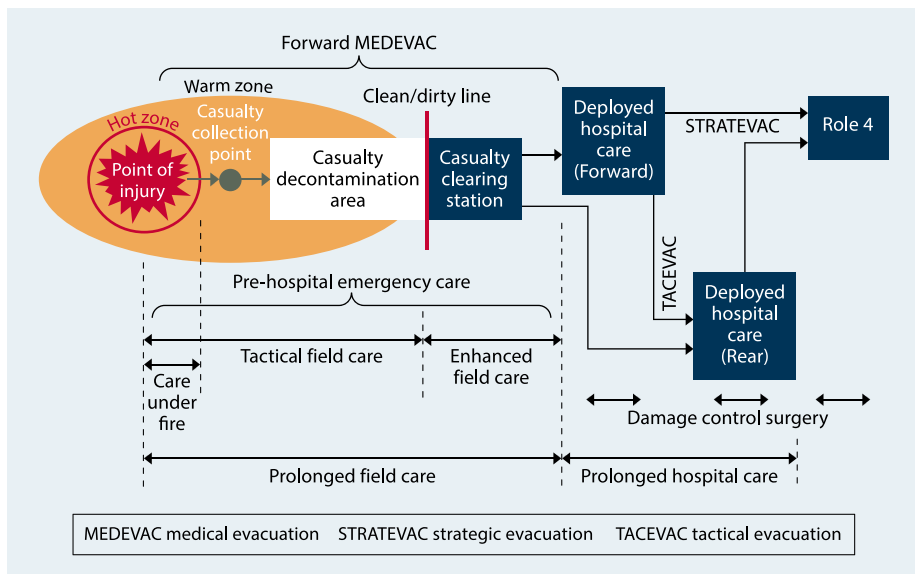


Diagram 1: The Operational Patient Care Pathway Model²⁰

The research question primarily focuses on the forward environment, which spans from the POI to the Deployed Hospital Care (Forward). This is where pre-hospital emergency care (PHEC) is carried out. The Forward MEDEVAC zone is focused on emergency medical retrieval, and quick resupply is essential to sustain medical cover.

All patient movement in a theatre of operation is managed by the Patient Evacuation Coordination Cell (PECC), which is: 'responsible for ensuring the right patient is collected from

the right pick-up point, transported to the right destination in the right platform, with the right medical escort in the right time frame.²¹ As the PECC would select which mode of transport would be sent out, understanding how medical retrieval is initiated is helpful as there is a strategic system for coordinating platform assets being tasked theatre-wide.

UAS Scope

This study focuses on what the industry term small UAS. Illustrative examples of UAS from the literature are shown in illustration one below, which shows a fixed-wing (a), fixed-wing hybrid (b), single rotor (c) and multirotor (or quadcopter).²²

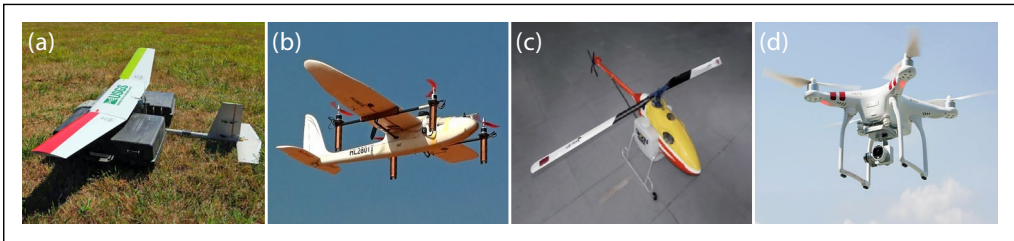


Illustration 1: UAS Classifications

Whilst smaller UAS use similar aviation terms such as fixed wing and rotary, for clarity, the term helicopter will be specifically used when discussing crewed rotary assets. It is necessary to show the difference between these low-altitude UAS and the larger variants to demonstrate the complexity and size differences.

The General Atomics MQ-9A Reaper, shown below in illustration 2, is a medium-altitude military combat UAS operated by a crew of 3 people and capable of holding ordnance such as AGM-114 Hellfire air to ground missiles.²³



Illustration 2: Reaper MQ-9A

For illustrative purposes, the conceptual larger UAS are shown next. Referred to in the industry as electric

vertical and take-off and landing (eVTOL) vehicles, they are, in theory, capable of taking passengers. Next page, 'The Cormorant', which could be used for MEDEVAC, is shown.



Illustration 3: The Cormorant by Tactical Robotics Ltd²⁴

The evolution of the Ambular design, an eVTOL civilian air ambulance concept, is shown below in illustration 4. Finally, illustration 5 shows the concept used as an air ambulance in an urban depiction, offering a possible glimpse of the future.



Illustration 4: Design Concepts for Ambular²⁵



Illustration 5: Conceptual Use for Ambular

These images demonstrate both the technological developments and the progressive passenger number with the corresponding increase in size. The additional space would be beneficial as this creates more capacity.

This section has described the emerging technology framework with its five attributes, explained medical doctrine to provide context and shown some visual examples of UAS to aid understanding that the focus is on small UAS and conceptual larger UAS. The next section will explore the debate about what to call UAS and why that matters when considering its possible adoption by medical services.

Section 3 - Lexicology

The previous section introduced the attributes of emerging technology as a theoretical framework and provided background information. In this section, that framework offers the opportunity to explore the attributes of 'uncertainty and ambiguity' regarding issues concerning lexicology. Understanding how meanings differ by user groups associated with emerging technology is essential, as, without this, a lack of understanding can arise. The recent proliferation of, what the public refers to as, 'drones' in the public market and their subsequent diverse use, particularly in nefarious ways, has created an intense debate about these aircraft. Phrases such as 'drone warfare' and 'killer drones' became popular parlance after their use in counter-insurgency operations to target enemies also resulted in civilian fatalities, all of which raised ethical and legal debate regarding the military use of UAS. This perception of 'killer drones' was further exacerbated by naming them 'Avenger', 'Reaper' and 'Predator'.

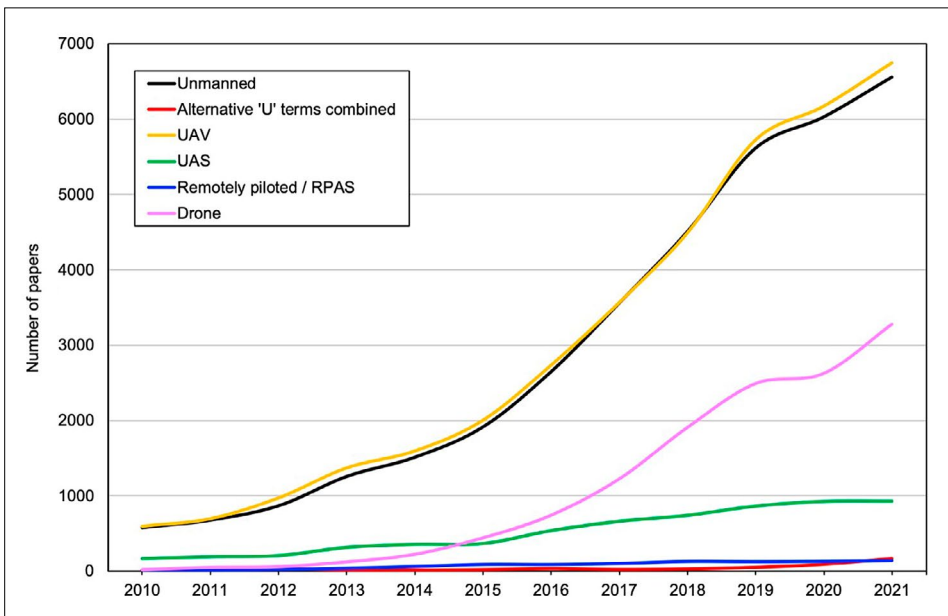
Despite militaries distancing themselves from the term 'drone', the mainstream media have used it consistently. The media's ubiquitous use of the noun 'drone' to describe all these aircraft does not differentiate in their taxonomy. In doing so, with no discrimination of role and purpose, the negative connotation prevails today as everything gets categorised together.

This creates problems as it brushes over the differences between an affordable, commercial off-the-shelf drone, with a simple battery-powered system operated by a single user, with a line of sight flight, used as a hobby, to the other end of the scale, a multi-million-pound, sovereign military capability, operated by teams of trained professionals, carrying out international governmental objectives for political ends. Furthermore, it does not distinguish the role that the aircraft is carrying out. Is it loitering for intelligence, surveillance and reconnaissance (ISR) purposes, delivering an ordnance payload, or taking a wedding photograph? Or is it delivering medicines and pathology samples?

This lack of distinction has led to a growing narrative around the assumption that all drones are ominous and are becoming uncontrollable and too widespread. The public cannot distinguish what is being flown, by whom, where and why.

Fanned by sporadic but high-profile incidents, the term *drone* is, for the public, synonymous with destructive actions and, to many, an unwelcomed addition to crowded and congested skies.²⁶ In addition, campaign groups, such as Liberty, have identified UAS as a threat to privacy rights, further fuelling their negative perception.²⁷ Against this backdrop, how can the military medical services consider these aircraft if they are, by name alone, so unpopular? It would seem sensible, then, that the UK Government, military industry and its operators would distance themselves from the word 'drone', but what are the alternatives?

Currently, there is a myriad of names and acronyms in use. The debate recently resurfaced when the former *Journal of Unmanned Vehicle Systems* changed its name to *Drone Systems and Applications*.²⁸ In an editorial, the authors presented why they were making a stance with another name change. Powerfully, the editorial also included the search terms used to support their justification demonstrating the plethora of different words associated with these types of aircraft.



Frequency of various terms and acronyms used for aerial drones in the titles, abstracts, and (or) keywords of scientific papers published from 2010 to 2021 and indexed in the Web of Science (data last updated 5 October 2022). Precise search terms were as follows: 'unmanned aerial' OR 'unmanned air*'; 'uninhabited aerial' OR 'uninhabited air*'; 'unoccupied aerial' OR 'unoccupied air*'; 'uncrewed aerial' OR 'uncrewed air*'; 'unpiloted aerial' OR 'unpiloted air*'; 'UAV' OR 'UAVs' OR 'sUAV' OR 'sUAVs'; 'UAS' OR 'UASs' OR 'sUAS' OR 'sUASs'; 'remotely piloted aerial' OR 'remotely piloted air*' OR 'RPAS' OR 'RPASs'; ('drone' OR 'drones') NOT ('honeybee*' OR 'honey bee*').

Graph 1: Bibliometric Analysis²⁹

Visually, Graph 1 on the previous page demonstrated the results of their bibliometric analysis, but it also illustrated the ambiguity around naming and the attributes of relatively fast growth.

Around the same time, the RAF aligned to a new doctrinal definition: an *uncrewed aircraft system*. In doctrine, defining and providing classification is necessary; this can help services agree on terminology. However, over the years, many different terms have been used: 'Remotely Piloted Aircraft Systems' (RPAS), 'Remotely Piloted Aircraft' (RPA), 'Unmanned Aircraft Systems', 'Uncrewed Aerial System', 'Uncrewed Aircraft Systems' (UAS) and 'Uncrewed Aircraft Vehicles' (UAV) to describe, distinguish and capture the nuances of these platforms. So why change again?

Diversity and Inclusion

The recently published 3rd edition of *JDP 0-30 UK Air Power* states that the UK uses both North Atlantic Treaty Organisation (NATO) and UK Military Aviation Authority (MAA) terms and classifications (as doctrinal terminology should align 'as closely as possible' with NATO).³⁰ Yet, there is a conceptual divergence within the military sector. To explain, NATO uses the term 'unmanned aircraft' and 'unmanned aircraft system', but the RAF chose to use the word 'uncrewed'. This was because 'unmanned' is viewed as a gendered word, specifically towards masculinity, a primary reason for changing, which is shared with the authors of the editorial article in the *Drones Systems and Applications Journal* and advocated by Joyce, Anderson and Bartolo.³¹

Joyce, Anderson and Bartolo encourage adopting gender-neutral language on the grounds of diversity and inclusion.³² They cite rationale and activity to disestablish the gendered terms within the federal aviation world, a place steeped in male terminology.³³ Currently, the RAF are systematically evolving their inclusive culture by removing phrases and language which unconsciously bias, through masculine gender alignment, to replace with gender-neutral words, and the RAF Chief of the Air Staff is spearheading this re-alignment.³⁴ For medical services with a higher percentage of females, matters such as these may need to be considered for achieving acceptance of UAS. By making UAS not aligned to gender, will more females become active in a predominantly male industry?

Notably, when asked during the interview; '*how we refer to them, does it matter?*' an RAF female participant believed it did 'very much matter' as it should be 'all-encompassing' and 'something that everybody can relate to and understand'.³⁵ The decision to diverge from NATO terminology on gender neutrality was explicitly referred to; she explained, 'we went down the road of getting rid of unmanned because it was gender specific'. This demonstrates an understanding of the rationale behind the change. Commenting on how this language change was established in work, she said, 'I had a boss. He was very particular about not calling it unmanned and would correct me every time I used the word [unmanned], so I've become normalised now into referring to it as uncrewed'.

Doctrinal Definitions

The RAF's capstone doctrine is specific and descriptive in its choice of words, thus defining *remotely piloted aircraft* as: 'An uncrewed aircraft that is controlled from a remote pilot station by a pilot who has been trained and certified to the same standards as a pilot of a crewed aircraft.'³⁶ Significantly, adding a training description separates this descriptor from an amateur who may be self-taught and lack skills and knowledge. It also links, by association, to the esteemed role of pilots, their widely regarded professional capacity and air safety adherence setting them apart from the general public.

Next, defining *uncrewed aircraft* required additional sub-examples to convey meaning: 'An aircraft that does not carry a human operator and is operated remotely using varying levels of automated functions. Notes: 1. Uncrewed aircraft can be expendable or recoverable. 2. Uncrewed aircraft may carry a lethal or non-lethal payload. 3. Cruise missiles are not considered uncrewed aircraft.'³⁷

By providing this layered approach to definitions, UK doctrine reaches its preferred label: 'uncrewed aircraft system': 'A system whose components include the uncrewed aircraft, the supporting network and all equipment and personnel necessary to control the uncrewed aircraft.'³⁸ This definition encompasses the operating elements that set it apart by its complexity. Therefore, referring to UAS as merely a drone would risk rejecting the nuances of the definitions of the air power doctrine.

Drone: Everyday Parlance

Acknowledging that many UK aviators, soldiers and sailors speak and refer to the above terms as set out in UK doctrine, there is no denying that others do not. Confusingly, some use the terms interchangeably. Does this matter when discussing how these aircraft could be used medically? The question was posed during the interviews.

A pilot, operating for more than 20 years with UAS, explained that he had witnessed many terms coming and going. He explained which word, or terminology, was more often context-specific. While it could be broken down technically by industry and academia, he believed that 'people get too hung up on the terminology.'³⁹

Similarly, an aeromedical specialist doctor acknowledged the changing language; he said the word 'drone; it's kinda fallen out of favour.'⁴⁰ Instead, he proposed 'UAV' as a better term to describe the platform's carriage nature, for, in medical terms, this would be a core requirement. This may also be to capture the complexity of the operating system supporting it.

The theme of interchangeable words was similarly mooted by an aeromedical Medical Emergency Readiness Team (MERT) nurse who proposed that referring to drones was often just conversation-led. As a result, those in the know would understand what was being referred

to; as such, the word *drone*, he surmised, was more often used as a generalist word, implying that specialists would know the differences and when to use it.⁴¹

It seems then that, at one level, not having a strong preference to use UAS over 'drones' was becoming the theme. However, as a medical Commander pointed out, the term *drone* has maligned connotations, so 'we should probably steer away from that'.⁴² This is because medical personnel are classified under Article 36 of the 1949 Geneva Convention, so they must not be involved with that type of activity as this would jeopardise their protected status.

Equally, during the industry interview, the participant responded that caution might be required based on the need to establish 'confidence' in UAS, for something known for another role could be called into question over the acceptability for medical use.⁴³ Likewise, the military scientific advisor believed that using the 'wrong terminology' fed into the '*Daily Mail*' rhetoric of 'killer drones' and so argued: 'I think it needs to be very careful in how these are described'.⁴⁴

A civil servant who works in future capabilities for defence pointed out that the debate was socio-culturally driven.⁴⁵ He believed that whilst the public understood the term *drone* and would continue to use it, the military was being 'pushed' to use other terms.⁴⁶ This, he believed, confused, especially over the various changing names.

The above comments highlight attributes of 'uncertainty and ambiguity' and the importance of social acceptance through meanings derived by appropriate naming. This is not academic semantics; medical personnel must be educated about the differences. This way, they can converse with interoperable understanding and, as air specialists, be comfortable with the nuances and explain why this matters, not just from an organisational perspective but from an informed air power stance.

NATO air power research from the Joint Air Power Competence Centre regarding the report, *Mitigating Disinformation Campaigns Against Air Power*, identified that disinformation is a threat to Western air power and UAS are a focus. The authors report that 'the most common themes in disparaging NATO air power is to attack the use of armed RPA, commonly called drones'.⁴⁷ They go on to explain that: 'unmanned aerial vehicles are, and armed drones are, being acquired in large numbers by NATO's armed forces. Because of their versatility and endurance, drones are an increasingly important weapon. Thus, their effectiveness and growing importance makes them a prime target of states and groups hostile to NATO. Drones are a major story in the Western media and are often noted in a highly negative light'.⁴⁸

Considering the above, combined with the public and media's lack of air power knowledge, consistent messaging and terminology use seems very important. This is because it affects familiarity. For example, one study found that '92% of respondents had heard of "drones", but only 59% knew about UAVs'.⁴⁹ Therefore, when considering UAS for medical purposes, they must be termed thoughtfully. Furthermore, whilst the medical services are split over different

front-line commands, personnel should follow what is doctrinally correct linguistically for consistency and knowledge exchange purposes.

Acknowledging industry and public preference may differ, and in seeking not to alienate people through words that have a different meaning to different social groups, the question is: how should this be tackled? The debate appears to have been resolved by Sabino *et al*, who proposed that: 'as terminology had a non-decisive effect on public support, industry, policymakers and users should not waste energy fighting for specific terminology. Instead, they should focus on the most relevant factors to the public, such as with what purpose and by whom the drones will be used'.⁵⁰

Sabino *et al* and Dominique Chabot *et al* proposition that the word 'drone' is understood, whilst the term unmanned can offend, sits well for the public. However, for those in the UK military, the term UAS should be selected to be doctrinally accurate. Whilst many other forms of robotic lexis exist, this dilutes the debate and takes the focus away from other issues.

This section has sought to explain the situation around the lexicology debate, where it has arisen, and why it matters. It has also explored the view of those who may use different terms occupationally. It has been summarised that UAS is the term used for this air power study. In the next section, another debate in the literature will be reviewed, will UAS eventually replace helicopters?

Section 4 - Helicopter versus UAS

The previous section explored how terms matter. In this section, the debate in the literature around whether UAS are a challenge to the status quo of helicopters will be examined. This debate is relevant in this study's context because helicopters are currently the platform used for medical evacuation. This section also demonstrates how UAS can be viewed as a 'radical novelty' through their varied new uses.

Since the helicopter's development in the early 1940s in the United States by Igor Sikorsky and their first use during the Second World War, by 2024, 80 years will have passed.⁵¹ Over this time, helicopters have evolved and become an invaluable platform for performing air tasks, given their unique ability to vertically take off, hover, and carry large payloads without requiring a runway. In the UK, all three services use them for various roles: combat support, logistics, search and rescue, humanitarian, and parachute deployment. Helicopters have established a proven military capability from tactical to strategic, such as the multi-role CH-47 Chinook dubbed the 'workhorse' of the US Army Helicopter Fleet.⁵²

Unlike UAS, helicopters have not suffered from a public relations image despite their attack roles. This may be because helicopters are a known capability and are accepted for their positions in the sky due to their familiarity and recognisable sound. In addition, they have a long history of interacting with the public with diverse roles, from sensory uses to forestry,

search and rescue, passenger transport, and even pleasure flights for tourists. Most importantly, since their creation, helicopters have been used for MEDEVAC.

The first military medical evacuation by helicopter occurred in Burma in 1944 when four injured soldiers were extracted from behind enemy lines.⁵³ This began a long relationship based on saving military lives using helicopter platforms. Only a few years later, the first civilian use (to rescue two people from a sinking boat) happened in November 1945.⁵⁴ But, it was not until the Vietnam War that MEDEVAC, colloquially termed 'dust off', became more widespread in its application and entered the public consciousness.⁵⁵ This was due to undertaking missions which led to crews being awarded medals for acts of courage and bravery.⁵⁶ But, more importantly, it was because mortality rates were being positively affected.⁵⁷

The practice of successfully using helicopters for MEDEVAC continues. The creation of the UK MERT and its high-profile activity during Operation Herrick re-established the importance of having medical capabilities quickly able to become airborne and retrieve casualties whilst treating them simultaneously transiting back to a medical treatment facility.

In essence, by combining air power's enduring attributes (speed, reach and height) with a highly specialist pre-hospital care medical team forward to the POI, the effect achieved was a clinical advantage, especially in the critical early stages of injury, which was lifesaving.⁵⁸

To appreciate the scale of the PHEC helicopter-based capability, illustration 6 (right) illustrates a MERT mission in action. It shows the medical team in August 2010 conducting damage control resuscitation on a single patient (a military double amputation casualty) inside a CH-47. One of the two pilots and an RAF Regiment gunner (providing force protection) can also be seen. Including this image is relevant because it demonstrates the space required for the capability and the number of persons that make the mission possible. How would an UAS be able to accommodate a MERT capability?



Illustration 6: MERT Mission Onboard CH-47⁵⁹

Helicopters, it is argued, are associated with a broad range of unique capabilities doing good humanitarian work and saving lives, unlike *drones*, which are linked to only taking the lives of others. Yet, there has been a prolific number of internet articles with sensational headlines proclaiming that drones will oust helicopters.⁶⁰

An example is offered from *The Daily Mail* which, with a daily circulation of 800,000 readers, can be said to be popular and influential.⁶¹ A particular article reported in 2017 that 'military drones that spy on the public could replace police helicopters in cities across the US by 2025'.⁶² As an example article of the debate, it is worth examining in more detail.

The Daily Mail article is based on little written substance with many pictures, vaguely referring to headline sources as experts, which lacks rigour. The article uses the term 'drone', 'remotely piloted aircraft' and 'aircraft' interchangeably, which, as shown in Section 2, is unhelpful for distinction; likewise, the many pictures of military assets confuse the matter. Most importantly, it reports only about a trial. While it presents some general facts about the drone and military industry, it typically peddles rhetoric that UAS are only military capabilities. The article does highlight a significant limitation with the proposed use, which is prohibitive regulation (this will be explored in more depth in Section 6). Overall, this early article does not credibly support the idea that UAS could replace helicopters but is a good example of the popular debate.

In 2017, a trial with Kent Police was undertaken, the results being published in 2019.⁶³ Their verdict was that UAS were a cost-effective and efficient tool for a broad range of policing activities.⁶⁴ Many of these activities, such as searching for missing persons, would have been performed by helicopter at great expense. Other government departments which rely heavily on helicopters have similarly noticed that emerging technology such as UAS offered cost-effectiveness but admit that 'further innovation' is needed.⁶⁵

What these examples also show are the attributes of 'prominent impact'. Indeed, other industries are looking to use UAS in 'radically novel' ways to reduce reliance on helicopters. For instance, where the cost of a helicopter is prohibitive, commercial off-the-shelf (COTS) UAS with added sensors (such as high-quality cameras) can take aerial photography as well as, if not better, because they are smaller, cheaper to operate, more agile and less intrusive. The offshore oil industry is looking to use UAS over helicopters for applications ranging from inspection to remote monitoring, even gas management.⁶⁶ Building and construction industries are using UAS for safety inspections of civil infrastructure. In urban construction areas, using helicopters because of their size was a danger; UAS are mitigating this risk and improving project costs.⁶⁷ Even sports which used camera coverage provided by helicopters have started to be replaced by UAS. For instance, the sailing world has adopted UAS technology at the cost of £15.2 million, replacing the need for helicopters in the race environment.⁶⁸

Investment

Another measure to gauge if UAS are deemed a challenge to helicopters is by examining the financial investments into that technology. Are helicopter investors worried about the growth of innovation around UAS replacing their market? Not yet, according to *Helicopter*

Investor; whilst the future of eVTOL is looking promising (with pre-sale value for Vertical Aerospace valued at \$5.4 billion), the capability to transport humans is not seen as imminent.⁶⁹ In the civilian medical market, helicopter emergency medical services, known as HEMS, are looking profitable, with investment in those capabilities opening up in new overseas markets.⁷⁰ The UK Ministry of Defence (MOD) £1 billion medium-lift helicopter contract is also progressing towards being awarded.⁷¹ This capability will be required to carry out all of the MOD's eight defence tasks, including aeromedical capability, in 2023.⁷² Will this be the future for MEDEVAC, or will this helicopter platform be tasked with so many other competing priorities that it will never be available for medical missions?

Considering the UAS industry, investment in that industry is healthy too. For example, the UK military has just awarded Leonardo a £60 million contract to trial a large UAS for the Royal Navy. What is to note here is that conventional aviation rotary production companies are buying smaller UAS companies and investing in their technology.

The question was posed to the interview participants as to whether they see UAS as a challenge to the status quo of helicopters. Overall, the views and opinions reflected the literature's central debates. For example, one participant who works with heavy-lift drones said, 'UAS are nipping at the heels of crewed rotary systems, especially for maritime operations.'⁷³ This corroborates with the literature referenced earlier that UAS are taking roles from helicopters. Whilst another exclaimed, 'yes, but in a good way!'⁷⁴ Even, 'yes...I would welcome it.'⁷⁵ And, 'yes, on the grounds of reduced risk to life.'⁷⁶

Whilst of a similar view, another participant viewed it less as a direct challenge and instead more as a 'potential progression.'⁷⁷ One of the participants who rejected the notion of it being an 'all-or-nothing situation' did see UAS as emergent with 'absolute' potential but as 'something complementary', again citing the grounds of putting fewer lives at risk.⁷⁸ Perhaps this view emanates from the benefit of having choices and options. This notion that UAS could be an additional capability and serve different roles was summed up by another participant, 'both could be incorporated' into service.⁷⁹

A similar view proposed UAS as being 'a different capability in the short term...maybe in 50 years, it could completely replace but not in 10 years', demonstrating that this technology is still an unknown entity.⁸⁰

Interestingly, one participant did see their takeover as inevitable 'we [medical professionals] will have to just get on with using them; it will be a challenge to us to adapt to that.'⁸¹ Whilst another clinician proposed, 'nothing is a challenge to patient care if they are demonstrably better.'⁸² Whilst the debate has focused on the aircraft and the risk to pilots, less attention has been placed on passengers or those that work in them (such as medical teams). Altruistically, there appears less concern with what is travelled in and more that it does not set back clinical care.

Uncrewed Helicopters

Whilst the debate has focused on the UAS challenge to helicopters (driven by the media and UAS industry), uncrewed helicopters are another area worth considering. An example of this system, termed the Aircrew Labour In-cockpit Automation System (ALIAS), was trialled by the US Defense Advanced Research Projects Agency (DARPA). They used a Sikorsky UH-60A Blackhawk without a pilot onboard, remotely operated, to carry a dummy casualty and blood products earlier this year.⁸³ Whilst the concept of uncrewed helicopters is not new, in the tactical forward environment, this retrofitted technology removes the risk to the crew, creating a positive operational benefit. However, concerns with carrying persons using this technology were noted even back in 2003 by Chivers.⁸⁴ Yet, if the ALIAS trial demonstrated improvement from earlier technology, could this achieve some of the requirements for medical services, such as the elusive transportation of human cargo?

Whilst the debate seems to focus on either UAS or crewed helicopters, as proposed by participants and studies such as Chivers', this is too simplistic and misses opportunities. The discussion needs to evolve to consider whether platforms are uncrewed by design or retrospectively fitted with technology such as ALIAS. Different stakeholders will have different perspectives, and many ethical questions will be raised regarding human transportation, but it is an important area to investigate further.

The debate's outcome may depend on the purpose, where it is being used, and the industry using it. As UAS technology matures and the choice of platform variety grows, new markets will likely be created. The assumption that UAS will replace helicopters rather than, for instance, land-based vehicles seems too early to judge. The answer is dependent on innovation and growth over the next 10 years. Thus, the question is misleading in many ways. Focusing on what is required and when (or a problem set brought about by a type of warfare) means the correct combination of solutions will be found.

The debate on whether UAS are a credible challenger to the status quo held by helicopters today has been explored in this section. Helicopters have carved a deep-seated impression on society due to their helping roles, which have evolved over the last 80 years. Undoubtedly UAS are impacting some sectors, but as an emerging technology, this comes with 'uncertainty and ambiguity', which makes the debate unfinished. Furthermore, the challenge of how UAS can fit into the existing systems dominated by crewed aircraft and a fixed aviation world hampers a comparison. Currently, helicopter investment is not decreasing, and whilst UAS shows growth and potential for dominance in the future, UAS are not replacing helicopters completely. Nevertheless, the economic factors and reduced risks to life drive continued exploration and adoption of UAS technology. In the next section, the relative strengths and opportunities of UAS will be further explored.

Section 5 - Strengths And Opportunities

In the previous section, the notion of UAS replacing helicopters outright was refuted, with a more nuanced view being determined; UAS have the potential to take over more traditional helicopter roles but not in their current technology readiness level (TRL).⁸⁵ For that reason, it will be argued that small UAS should be considered as separate and complementary aircraft capable of producing air power. In this section, the strengths and opportunities of this technology will be explored from the perspective of 'drones for good'.⁸⁶ Two potential uses will be specifically considered; logistical supply delivery and MEDEVAC. With exponential growth in the literature around UAS, an abductive approach has been applied to extrapolate opportunities, as many reported trials are novel and performed in different industries. The emerging technology attributes associated with this section are 'radical novelty'; 'prominent impact'; 'uncertainty and ambiguity'.

Medium and high altitude UAS are already a component of air power used for attack and ISR capabilities.⁸⁷ However, for this study, the small UAS and, eventually, the larger variants should be considered under one of the other fundamental roles; air mobility-airlift. Airlift is 'the ability to transport personnel and materiel through the air; they can be either inter- or intra-theatre, and they are subdivided into: 'hub and spoke operations; airborne operations; aeromedical evacuations; and special forces air operations'.⁸⁸

UAS can achieve an effect by operating over any topography, including water, snow and sand, to influence the behaviours of actors and the course of events (in this case, medical ends) by utilising speed, reach and height.⁸⁹ These air power characteristics are leveraged by both small and large UAS, which could solve medical service problems that arise in challenging landscapes.

UAS are known for their speed. The exact rate depends on the specification of design factors, such as which model, power unit, and external factors, for instance, payload, but overall UAS speed ranges between 20-120 miles per hour.⁹⁰ Speed is critical in medical emergencies, such as dispatching lifesaving blood or defibrillators and delivering time-sensitive pathology samples.⁹¹ Examples of UAS successfully delivering life-saving blood (since 2016) can be found in the commercial sector.⁹² Indeed in the military community, this is widely recognised as having potential in the forward environment.⁹³

When considering reach, UAS can be easily transported, assembled and pre-positioned before a flight extending their operational range. Once airborne, UAS have variable operating ranges from a few miles to upwards of hundreds. UAS can be used both close to the operator or at a considerable distance; pilots can be based in another country depending on the communication link and type of UAS, as they only require a satellite communication signal to operate. This offers freedom of mobility and the protection of distance. It also offers a solution for covering vast distances in providing healthcare. In Australia, due to their vast, sparsely populated outback, early adoption of UAS

technology for healthcare showed that products could be sent over long distances to aid medical care.⁹⁴

UAS operate in low altitudes compared to aviation but can use a relative height for transiting, which would clear most ground-based obstacles. As a result, they remain invisible to the naked eye, making them less of a target. Their operating parameters can be managed for aircraft avoidance by varying upper thresholds.

No Crew Onboard

As a result of having no pilots or crew members onboard, the risk to life is zero. The fact that this technology can save lives by not putting a life in danger was proposed by Ramiccio as a critical ethical consideration which should support its adoption.⁹⁵ From an American perspective, he argues that UAS should be used in future wars as MEDEVAC to save lives, as choosing UAS over crewed aircraft removes the risk of putting people in harm's way. For example, in a CH-47 MERT mission, nine highly trained, valuable air specialists in a multi-million-pound aircraft could be at risk for one patient. Furthermore, using uncrewed aircraft reduces the number of potential targets or subsequent additional casualties in the forward environment should the aircraft become compromised; only the platform would be lost.

Pilots' skill levels for UAS varies and spans from non-specialists to highly trained professionals, but their training burden is significantly less than conventional aviation pilots. They can also operate multiple drones simultaneously with some autonomous functions in the UAS, reducing the load on their cognitive capacity. Focusing on the smaller UAS, pilots for these UAS can be trained quicker and operate numerous aircraft simultaneously, giving a force multiplier effect.

It is also worth considering that loading and unloading small UAS would not require anything more than short training and no specialist equipment or support platforms. This would offer medical services the ability to resupply multiple locations in whichever logistic model worked for the situation with fewer dependencies.

Logistics

UAS can be deployed in urban, rural and maritime areas. Their landing and take-off requirements are small; they do not need maintained airports, runways or large helicopter landing sites. Their perimeter clearance zones for landing and take-off are small as they don't produce a large down and outwash problem, making positioning beside light shelters feasible. Due to their use of air as a flight method, they can fly over some of the most challenging terrains, from snow-covered tundra to jungle and desert unhindered, making them an attractive resupply option, particularly for supporting prolonged field care scenarios.⁹⁶ Their ability to operate in a broader range of weathers (that may ground other platforms) provides greater scope to use them when there are no other alternatives.

Aerial delivery is relatively free from dependencies, unlike slow, large land-based diesel vehicles currently used for resupply. These can experience multiple mechanical issues, from tyres to engines, that can hamper delivery, especially if, in a military context, they travel in a convoy. Road moves are resource-heavy operations, susceptible to more human error, for example, navigation, or limited by human performance issues and procedures, such as driving hour regulations. Trucks are also vulnerable to attack as they are large, slow-moving targets. Vehicles rely on civil infrastructures such as bridges and roads, and their routes are limited if roads are blocked or mined. Military trucks are also a constant presence, whilst aerial resupply can be a fleeting and less obtrusive presence.

Aerial movement avoids these known problems and could ensure a timely medical resupply gets through to the forward environment if adopted. The benefits of aerial delivery over land-based methods for medical resupply have become increasingly recognised and tested.⁹⁷ National Health Service (NHS) Scotland and a consortium led by AGS Airports secured £10.1 million to establish the first national drone network in Scotland transporting medical-related items using this model of transport over existing delivery methods (road and ferry) and for those who live at a distance from centralised services, they discovered it reduces healthcare inequalities too.⁹⁸

Cost And Affordability

Another strength of UAS is their low cost. An indication of potential operating costs from an American source suggests \$700 per operating hour, compared to \$5,000 for an Army Blackhawk or \$25,000 for an Air Force Osprey.⁹⁹ The ability to procure low-value commercial off-the-shelf (COTS) options for medical services opens up the economy of scale if buying significant numbers, plus this produces the effect of creating mass. The medical services could have their own fleet, which would give resilience.

Another option would be to contract the service provision to a commercial provider. Thus the requirement to buy UAS, train pilots and manage flight plans would become a contracted service. When not needed, the service could be withdrawn or scaled appropriately.

Whilst a built-to-order specification as a sovereign capability could be an option (and in doing so create and generate jobs), the other alternatives, such as partnering with other nations so funding can be shared between NATO (or other Nations), offer advantages such as less spending on research and development plus interoperability benefits.

Assembly, Maintenance and Fuel

Assembly requirements are likely to be minimal and do not require teams of specialist engineers; however, this is model-dependent, and specialist re-assembly may be required depending on the complexity of the UAS. Overall, this engineering burden is significantly less than for rotary or fixed-wing aircraft, which means less time in the bay being fixed (if needed)

and, therefore, less demand on the engineer's capacity. Even UAS tools are currently non-specialist, which considering the other factors, makes UAS considered disposable.

Another significant strength of UAS is that power is generated from an electric battery and does not rely on fossil fuels. It, therefore, can recharge, as such, if used for small packet delivery, its emissions would be up to 94% lower than conventional methods.¹⁰⁰ Recognising that harmful emissions and pollutants need to be reduced and alternative fuels sourced, UAS could provide an opportunity to support the MOD's *Strategic Climate Change and Sustainability Strategic Approach* for future capabilities.¹⁰¹

A second-order effect of being powered by electricity is that the environmental noise impact is significantly less compared to a helicopter. This is also an important health factor, as those who work in and around helicopters are at risk of hearing impairments. Despite wearing hearing protection, the risk of deafness in later life is an occupational hazard. This is a significant area of litigation for the MOD with a compensation scheme in place.¹⁰² Alternative mobility platforms such as large UAS (eVTOL) could reduce noise pollution and the risk of hearing impairment.

Payload and Size

As indicated in Section 2, UAS vary from very small to large. Size matters as the likelihood of becoming a target decreases if the object's size is smaller and hard to spot. The small UAS can carry a 2-3 kilogram (kg) weight, with heavy lift options opening the range to hundreds of kg. Most medical items needed in the forward environment are small and light, meaning they match the payload dimensions of small UAS with no excess waste of resources. Importantly, UAS can also be loaded for return journeys; for instance, medication can be replenished and, when out of date, returned so that stores in the forward environment can be kept lighter and in-date.

UAS usually consist of a modular design; they can be transported, dismantled in stackable wooden crates and re-assembled at the point of use, allowing greater freedom of movement by forward positioning.

Operational Impact

UAS can be viewed as a force multiplier because their adoption would free up people to do other roles, and multiple tasks could be done simultaneously. Importantly, UAS can also perform dull, dangerous, or dirty jobs for humans.¹⁰³ An example of this potential use is chemical, biological, radioactive and nuclear situations where medics could use them to gain a situational understanding of contaminated causalities.¹⁰⁴

Their automation and autonomy offer an operational advantage. As a force enabler, more can be done with fewer people, and as UAS are less complex to operate (compared to helicopters), a pilot can operate more than one at a time.¹⁰⁵ UAS offer resilience and greater

redundancy on a finite resource. This generates options for Commanders when traditional capabilities cannot deliver.

This section has shown the many strengths aligned with the design of UAS and has demonstrated wide-ranging opportunities, from saving money to saving lives if they were adopted. There are many positives, hence the *prominent impact* being felt by the emergence of UAS for medical purposes. Trials and published scientific data provided the most reliable evidence that resupply and light delivery would be the most effective use. As an emerging technology, 'radical novelty' examples offer a glimpse into everyday future uses. However, the next section will explore the omnipresent limitations and threats towards UAS.

Section 6 - Limitations And Threats

Previously in Section 5, the strengths and opportunities of using UAS in a medical context were considered. This section will now focus on the limitations and threats they present. Issues regarding regulation, cyber threats, mechanical constraints, injury considerations, operating concerns, ethical issues and perceptions of usefulness will be explored.

The fundamental problems facing the UAS industry surround regulation and certification.¹⁰⁶ As UAS are an emerging technology, rapidly expanding and evolving, and pushing boundaries, the regulations, which are a slower legally binding process, cannot keep up.¹⁰⁷ As a result, the industry views regulation as limiting emerging technological progression and implementation; conversely, it is the mechanism to ensure safety and allow broader applicability and use.¹⁰⁸ This unresolved paradoxical problem is widely debated across the literature, and government publications, so it is a significant focus for the UAS lobby groups.¹⁰⁹ In addition, regulatory approval to operate will be required for medical use, so it is essential to understand the associated limitations.

Aviation has had over 100 years to learn and develop appropriate standards, policies, procedures and safety compliance. Regulations strictly cover every element of aviation to ensure safety. In the UK, civil aviation matters are managed by the Civil Aviation Authority (CAA), whilst the Military Aviation Authority (MAA) is 'responsible for the regulation, assurance and enforcement of the defence air operating and technical domains'.¹¹⁰ The MAA was set up following the recommendations within the Haddon-Cave Report (2009) following the loss of Nimrod MR2 XV230. The subsequent review called for a 'radical overhaul of military airworthiness regulation'.¹¹¹ The MAA's remit covers all regulations and certifications, operating assurance and enabling functions. Air safety is thus engrained into aviators' ways of working. The MAA has experience with the large UAS, but the smaller UAS present unique new challenges in the military operating domain. These challenges are not unique to the MAA, many apply equally to that faced by the CAA, but the hostility risk is arguably more significant.

Even if one regulator creates a system that works for their air space, this does not imply that the authority can transfer automatically to the other domain. However, if the vision is that UAS

will transport patients one day, albeit in military or civilian aerospace, the same safe carriage standards must apply equally.

Further complicating matters is that different countries have their own regulators and regulations. The International Civilian Aviation Organization (ICAO) work to try to standardise across countries, adding another layer of complication to the global aviation community. All countries must agree on their inclusion in the military domain, indicating the involvement of NATO standards. NATO has indeed attempted to tackle what the use of a large UAS for patient retrieval should have as a minimum, entitled *Safe Ride Standards for CASEVAC Using Unmanned Aerial Vehicles*, but this has not been updated since 2013.¹¹² However, it remains a capstone document on the subject since its publication.

The regulatory process involves multiple stakeholders, often with opposing views and conflicting priorities. It is also costly with competing matters to deal with and personnel resource challenges. With UAS evolving quickly, having multi-faceted designs, unclear and varying potential end uses, and variable operating methods, the potential risks are abundant; no wonder achieving new regulation is a challenge but essential for how society embraces technology and develops its acceptance of UAS.¹¹³ Whilst the document, *The Regulation of Drones: An Exploratory Study*, from the Regulatory Horizons Council, covers the issues comprehensively from a societal perspective, some of the more specific problems which could affect the military medical domain are highlighted below.

Specifically, safety concerns are one of the top concerns for regulators, and until these can be resolved, the potential of UAS will be capped, especially for the carriage of humans. Including safety, the other UAS risks identified by researchers were grouped as; misuse, violation of privacy, malfunction and damages, noise (unwanted), legal liability, emotions and social factors, and professional issues.¹¹⁴ Similarly, but in addition, Johnson *et al* cite mechanical concerns with problems during flight, vulnerability to cyber-attacks, lack of object avoidance, Global Positioning System (GPS) interference, air space integration complexities, hazardous payload management, and injuries from direct impact as areas that may limit broader adoption, especially for medical use of UAS.¹¹⁵

When considering the issues of in-flight mechanical malfunctions first, unlike in aviation, with regulated components, UAS components' airworthiness is unproven. Unlike during aircraft maintenance schedules, UAS parts (and their history) are an unknown entity. This must be resolved before the quality of platforms can be assured, as component failure can lead to mid-air disintegration.¹¹⁶

The non-secure element of UAS operating systems is another limitation. Cyber-attacks against UAS, even in civilian airspace, are a threat which does not require sophisticated equipment to carry out).¹¹⁷ Dalman and Lagrelius's study identified that: 'spoofing and denial of service (DoS)

attacks are the most common cyber-attack types against UAVs, and that hijacking and crashing are the most common results of the attacks.¹¹⁸

Unsurprisingly, counter-UAS (C-UAS) is growing in importance for the military, as is the ability to prepare to counter C-UAS.¹¹⁹ Cyber and electromagnetic warfare understanding has emerged with the growth of UAS but is an area where medical services need more expertise to understand how cyber issues affect UAS.¹²⁰

In Scheau *et al* study, they identified that cyber issues affected the entire 'drone ecosystem', which includes production, distribution and usage and that they are 'all responsible for ensuring the prevention of security breaches.'¹²¹ Therefore, in considering future platforms, the medical service must consider the whole ecosystem of cyber risks. However, engagement with cyber-secure UAS companies and approved electronic components may limit competition and drive-up costs.

Hobby UAS pilots primarily use a Line of Sight (LOS) to fly, with professional pilots obtaining Beyond Visual Line of Sight (BVLOS) licenses; however, the ability to operate in restricted visibility is a limitation regardless of distance. Considering various challenging but common weather conditions (strong wind, heavy rain, fog), a way to keep flying needs to be firmly established as, unlike crewed platforms, pilots cannot use instruments.¹²²

To date, UAS also have limited obstacle avoidance ability, be that a static object like a mast or another airborne hazard.¹²³ An example can be drawn from coverage of cycling races which demonstrates that UAS technology cannot yet contend with the myriad of environmental and human factors a large, long race generates.¹²⁴ Even with a route being pre-mapped for obstacle clearance (which in a forward operating environment may not even be possible), UAS have limited sensory options for collision avoidance.

Signal interference is also a major limitation as UAS use radio frequency or a form of digital communication to operate, so they are vulnerable to disruption.¹²⁵ UAS require a constant communication signal; this can be by radio, cellular networks, or satellite. Adversaries can interfere with these signals, but these can also degrade due to interference such as the surroundings (tall buildings or thick woods), design (unreliable antenna), and atmospheric. Interference can affect GPS and can be actively jammed with relatively cheap equipment.¹²⁶ This would affect how medical services could use UAS and limit where they could operate. The potential loss of a UAS plus its payload would also have to be managed, including poor publicity, loss of confidence in the system, and any adversary advantage minimised. These would be new challenges for commanders to address.

Battery power and length of flight time are other limitations with small UAS and have become a focus of debate in the literature. The longer the battery life, the heavier the UAS, adversely affecting flight duration. The challenge of operating in remote areas and recharging was

considered by Ucgan *et al*, demonstrating that novel ideas are being considered for this known problem.¹²⁷

The ability to recharge electrical equipment on a battlefield is difficult. Electricity is a managed finite resource produced by large, cumbersome diesel generators operated by specialists who support medical services. Additional demand for supply would have to be negotiated as this electricity supply as a constant fuel is not established, unlike long-standing refuelling contracts for aviation gas.

Whilst UAS are lower altitude platforms, air-space integration issues still exist. The ability to safely manage, control and integrate where UAS can fly is a limiting factor widely discussed in the literature and industry.¹²⁸ Although work has started with organising this transportation system, known as U-Space (a designated air space for UAS), this is an ambitious initiative and not designed for the military environment, which leaves this problem unresolved.¹²⁹

Likewise, Merkert and Bushell's systematic literature review identified many critical areas and research gaps in using UAS, but again, the military domain was explicitly out of scope.¹³⁰ Nevertheless, the military will still need to address areas such as the development, operation and maintenance of UAS.¹³¹ Furthermore, whilst the focus has been on developing UAS technology, the tactical considerations and the ability to integrate with other services and networks proposed Johnson *et al* still need more research.¹³² These integration issues, specifically for medical uses, raise privacy, clinical consent and confidentiality considerations with the medical use of UAS, which due to its novelty, must be first understood, and then satisfactorily resolved.¹³³

Medical services would need to address this process through conceptual documents such as the concept of employment (CONEMP) and the concept of use (CONUSE), but these currently need to be created. Whilst the recent *Medical Operating Concepts* acknowledge the potential for using UAS for medical resupply, a cognitive and practical delta between expectation and reality exists.¹³⁴

Whilst the ability to carry payloads is recognised, what needs to be understood is the ability to label and package UAS cargo safely. What if the load represents a hazard in its own right? Many medical products are classified as Dangerous Goods (DG). Will UAS take on international cargo markings or make its own? This limitation was explored in the literature, and it was found that existing legislation was based on conventional platforms, which did not transfer logically.¹³⁵ The study acknowledged how classifying DG for UAS transportation is unknown and, therefore, complex for UAS providers and, ultimately, an under-researched area.¹³⁶ Whilst methods to help were provided, would their findings be implemented, and is it relevant for operations? Indeed, the consequences of getting DG wrong could be catastrophic, with negative media and risks to humans arising.

Another limitation regarding operating around UAS is the risk of direct injuries. Khan and Brown's study on American children injured by 'hobby drones' showed that they have the potential to cause harm, particularly to the head and face region, with lacerations and contusions or abrasions being the most reported.¹³⁷

Using the dropped object calculator, anything with a mass greater than 2 kg dropped at a height greater than 10 metres will result in fatality.¹³⁸ Thus the ability to operate over people currently requires a special license; however, this would be a daily occurrence in the military medical domain. Would continuous risk assessments need to be conducted for every flight? As an emerging technology, the data is missing to draw adequate guidance and procedures.

Regarding larger mobility platforms that may be able to transport humans in the future, there is only one public case to draw upon. *The Cormorant* by Tactical Robotics has '300 hours of flight on their TRL 5 demonstrator', but there is no specific published information regarding the safety of users or passengers except to say it has 'intrinsic safety, high survivability'.¹³⁹ To date, there are only eVTOL company vision statements regarding the assurance of flight safety concerns, as no aircraft has a high enough TRL score to draw comparisons from.¹⁴⁰

The CAA and MAA would need to approve safety records before they could be approved for use, but regulation is made more challenging to achieve with a lack of data. Whilst there have been trials, there has been a lack of human onboard trials raising the question of whether it is even physiologically possible or psychologically tolerable. Testing has included the lifting and transporting of dummies with some basic biometric equipment, but that is significantly short of its intended concept.¹⁴¹ Even when such a point is achieved, the endless what-ifs regarding uncrewed aircraft will likely remain due to its novelty.¹⁴²

Even if UAS are approved for human flight, the whole capability must not create a backward step in healthcare terms, threatening patient outcomes and the credibility and professionalism of those involved.¹⁴³ Reverse-fitting a medical capability to a platform is problematic. The burden is on medical users to adapt to the aircraft, so involvement in design and setting requirements is indicated, but do medical services even know what they want?¹⁴⁴

Acknowledging that personnel can resist technical change is also a limiting factor per se which may threaten innovation adoption. The emergent technology traits of 'uncertainty and ambiguity' can also be perceived as a failure by those who may feel threatened by setbacks, leading to the disillusionment that the technology has failed whilst it is, in fact, evolving. Due to the hyperbole of media headlines, and the persuasive nature of marketing and sales, reality versus expectation can be difficult to grasp, especially by non-technical people or those outside the UAS industry. Medical services could unwittingly procure the wrong UAS with inadequate knowledge.

UAS are also seen as a threat to roles which would have been performed conventionally by people. This has resulted in apprehension that UAS will eliminate future employment from aspiring cockpit pilots to drivers, who will not be required for delivery rounds.¹⁴⁵ Even medical services may see their roles and opportunities reduced if UAS replace the need for a medical person.¹⁴⁶ However, with machines seemingly taking over, this raises new UAS ethical concerns.

Ethics

Unfortunately, due to the limited ethical debate surrounding 'do-good drones', this can be considered a constraining factor in its own right.¹⁴⁷ This is because UAS are an emerging technology and its novel use in good ways is still in its infancy. Whilst studies do exist, they are more often focused on broader society rather than the military population, making comparisons limited.¹⁴⁸ Whilst there has been high-level public debate surrounding the ethics of 'killer drones' used by the military, at this point, academics are only in the early stages of understanding the ramifications and consequences of using UAS for good in both the military and broader society.

The multifactorial considerations regarding healthcare, warfare, human rights, and societal judgements teamed with UAS make this a morally complex area. As a result, there needs to be more ethical and moral guidance on how or if medical services should adopt them and embrace their potential for medical use. Whilst it may be technologically feasible to use a large UAS for CASEVAC or, indeed, MEDEVAC, does this make it the right thing to do? There are some emerging thoughts in the literature where parallels may be drawn from, yet these early studies do not conclusively say they are a force for good, often suggesting more research is required.¹⁴⁹ Focusing on the results of Wang, Christen and Hunt's study, they proposed 11 ethical areas in using humanitarian drones. These were: 'minimizing harm, maximising welfare, substantive justice, procedural justice, respect for individuals, respect for communities, regulatory gaps, regulatory dysfunction, perceptions of humanitarian aid and organisations, relations between humanitarian organisations and industry, and finally, the identity of humanitarian aid providers and organisations.'¹⁵⁰

This work demonstrates broad areas that could be addressed by military medical services, which may serve as a basis for future consideration. Combined with the volatility, uncertainty, complexity and ambiguity (VUCA) of the forward operating domain, substituting or adding military-specific components is required to illuminate unique issues that only medical personnel would know, need to consider and be responsible for. If a way forward is to be believed, to turn the VUCA situation around, creating a vision, understanding, clarity and action are required.¹⁵¹ The next section will explore how this could be achieved.

This section has shown that technical, mechanical, and safety concerns, along with ethical, moral and psychological factors, amount to significant limitations regarding UAS's potential use in the forward environment by medical services. However, combined with the challenges of the military medical forward operating domain and the disruptive nature of the emergent

technology, this analysis has shown that even design constraints are deemed threatening and can be exploited. Furthermore, a disconnect exists between what is possible now and what needs to be technologically resolved, which creates a situation where the what-ifs will always be present. Are the medical services ready, or even willing, to accept that UAS could be a solution or is it too much too soon? The next section will explore this aspect further, using Dr Kotter's *Process of Change Model* as a framework.

Section 7 - Change and Accepting UAS

'In 1903, the possibility of using combustion-driven vehicles to transport casualties from the battlefield was first raised. The idea was met with cynicism. One critic was heard to say, 'nothing has been found to equal the force of the horse for economy and safety. Patients, being probably in a nervous condition, will be alarmed at the idea of being taken off in a motor car'.¹⁵²

Previous sections have led to the assumption that there is an inevitability around UAS being a solution for medical requirements in the forward environment. Still, the last section showed there are significant limitations to overcome. Another debate in the literature suggests that accepting UAS is an issue and requires an attitudinal or societal acceptance change. Therefore, for this section, it made logical sense to ask the interview participants what, in their personal and professional opinion, it would have to take for UAS to be brought into use and accepted in the forward environment, as this will be key in determining factors regarding a change process. Factors raised by participants could have been grouped thematically into elements to do with communication, safety, policy and procedures, psychology, design, scope, education and ethics. Instead, this section will use Dr Kotter's *Eight Steps for Leading Change*, a change management theory, to corroborate findings to structure the section.



(Source: Adapted from Kotter 1996)

Diagram 2: Process of Change Model¹⁵³

After briefly explaining the model, each step will be discussed with literature and interviewee quotes attributed. Additional theoretical considerations not covered by the model are discussed at the end.

Dr Kotter's model was selected as, should UAS be introduced by the medical services, the change would amount to a profound organisational transformation. As many participants alluded to a step-change or iterative progression during their interviews, the model also seemed adept. Dr Kotter's *Eight Steps for Leading Change* work and the adapted *Process of Change Model* (diagram 2 left) were based on identified success factors from organisations trying to transform or introduce changes.¹⁵⁴ The model proposed that each step had to be completed to build successfully upon the next one until the change was embedded.

In step one, Dr Kotter proposed that urgency must be created to start the change process; thus, participants' proposed factors aligned with this situation, such as the lack of alternatives to carry out aeromedical missions in a large conflict (likely at the front of their minds due to the Russo-Ukraine war that had just broken out). As one participant put it, 'survival pressure' driven by war would create a necessity for an urgent capability requirement that could herald in UAS.¹⁵⁵ Even adverse environmental factors were put forward as a reason for looking at alternatives sooner, citing that UAS could mitigate risks and provide a 'Plan B', resulting in rapid capability acquisition. For others, the shift in thinking was brought about more by the emergence of UAS, describing the benefits such as being able to do more and reducing risk to life.¹⁵⁶

In step two, Dr Kotter described that when companies formed powerful guiding coalitions, they aligned with a cause.¹⁵⁷ Here participants referenced other work taking place, such as using UAS within the NHS, or *The Cormorant*, that they were aware of and were interested in the outcomes.¹⁵⁸ UAS use by the civilian population was seen as critical and dependent upon their acceptance.¹⁵⁹ Conversely, using UAS in the forward environment may drive, in turn, societal acceptance, but there seemed a hesitance to be the first to use it. More a willingness to undertake it in conjunction with others (such as the NHS) seemed more acceptable than proceeding alone.

In step three, developing a vision and a strategy, participants identified that there needed to be clarity of purpose and a defined scope of what UAS would do for medical services.¹⁶⁰ In addition, it needed to be made clear who was driving the requirement – industry, technology, or capability shortfall. Of note, a critical factor that would influence adoption, which was imperative by participants, was attaining support from senior defence leaders.¹⁶¹ Leadership support for change is essential for generating capability implementation in a hierarchical military organisation. Whether UAS would be recognised as a priority for leaders was considered a make-or-break scenario.¹⁶² If not supported, using UAS for medical purposes would remain only conceptual.

In step four, communicating for buy-in involves conveying the vision, or as one participant termed it – the need for ‘correct messaging’.¹⁶³ Providing explanations and reasons may help explain why adopting UAS is or is not the solution. Either way, positive engagement with military end users was identified as necessary for understanding what would eventually lead to establishing acceptance of seeking alternative ways of working with uncrewed aircraft in the future. One participant said ‘education, education, education’ would be required to achieve this.¹⁶⁴ Establishing a critical mass of engagement through education could help create trust as people would be better informed, avoiding coming to a conclusion about a matter with no information, which was termed a *cognitive miser*.¹⁶⁵ This process would also help identify the correct requirements as stakeholders would be schooled in the technology, the capability shortfall and the options to address the needs.

Dr Kotter identified the need to ‘handle the concerns and issues of people honestly and with involvement’ during this stage.¹⁶⁶ This was demonstrated when participants expressed concerns about factors regarding safety, especially for the transportation of a human by a UAS.¹⁶⁷ Comments such as ‘people will hold us back’ have been interpreted to mean a lack of trust in UAS technology.¹⁶⁸ The issue of trust and technology adoption is a known phenomenon, which Nelson and Gorichanaz proposed, ‘trust may be more critical to emerging technologies than technologies in general’.¹⁶⁹ They suggest that ‘without trust, it is difficult for society to accept the technology’.¹⁷⁰ Communicating trial outcomes could be part of the education that the MERT Medic spoke of and help create trust in UAS.

Additionally, sharing that an alternative solution is driven by need and that a precise risk-benefit analysis of the many situations where UAS could be used should be carefully examined, and certification and regulation would also assist with this process and that having safety records would objectively demonstrate the number of safe flights and operating hours without incident.¹⁷¹ These measures would convince cynics and bring less *uncertainty*, as *coherence* would be established and the *radical novelty* effect would wear off.

The process and thought that would include safety measures as part of the inbuilt design features would also support confidence in using large UAS. Specific designs and procedures to prevent harm to the patient or users must be clearly articulated during education to demonstrate that advanced safety features have been included as standard specifications.

Certainly, informing the public about the military medical use of UAS may help change attitudes and address the enduring concerns about personal privacy, ethics, safety and security that are the unresolved issues with small UAS.¹⁷² This broader societal change needed regarding accepting UAS as do-good aircraft being nobly used for medical purposes was considered an essential step to achieve this. However, whilst highlighting benefits is important, understating or overlooking risks and challenges by UAS technology developers needs to be mitigated to build the much-needed public acceptance.¹⁷³

In step five, termed empower action, Dr Kotter identified removing obstacles, be they organisational barriers or people resisting change and rewarding those endorsing change and supporting the process.¹⁷⁴ Participants mentioned specific drivers, such as funding, that would empower action.¹⁷⁵ But when considering the difficulties of defence procurement programmes and the commercial and legal parameters of acquisition and procurement, bureaucratic barriers often span many years and present significant obstacles. These set back the chance to adopt innovation quickly, but trial opportunities do exist. Unless medical services are proactive in testing their hypothesis and trialling low TRL designs in future mock scenarios, others will gain an advantage.

Technologists refer to the 'valley of death' when technology companies struggle in the early stages of business before their product or service brings in revenue.¹⁷⁶ Therefore, it is crucial for medical services that wish to use emerging technology to understand the risks facing those businesses. Research and development to shape and ultimately deliver what is needed for medical services need financial investment, but there is no guarantee of a return on investment.

Regarding the comment about people being barriers, the Hullysses *et al* study found that whilst 'younger pharmacists were more aware of and favourable to the use of drones for transporting and delivering medicine', they also discovered that older people were 'more fearful of malfunction and intentional misuse and have lower expectations of potential uses of drones', suggesting that there is also a demographic aspect to be considered.¹⁷⁷ Whilst the perception of the military is that of young men, the age span is actually 16-65 years, so the above point is still relevant to the military population. Additionally, the study found that technological expertise was a factor; those with 'less contact with new innovativeness and receptivity to new technologies are significant factors in determining the attitude toward drones'.¹⁷⁸ For UAS to be considered a solution in the forward environment, the attitude towards emergent technology must be receptive. Will medical services personnel have the prerequisite technical savviness to be open to this emerging technology?

It is also essential to consider the gender influence as 'male respondents expressed greater positive propensity for drones than female respondents'.¹⁷⁹ With females making up a significant portion of medical services, would this negatively impact UAS being brought into service or accepted as the way forward over conventional methods? Again, this may need to be addressed before moving on to the next step of the change process.

In step six, creating short-term wins and capitalising on successes is paramount to elicit change.¹⁸⁰ Of a similar thought, one participant suggested that there could be a natural progression or step-like change to adopting UAS.¹⁸¹ To achieve this, smaller steps would have to be taken, such as developing UAS for forward medical resupply first, followed by introducing larger UAS for MEDEVAC (considered more complex) afterwards. This could build on the success of the former, and the normalisation towards the platform's presence in the theatre

environment could pave the way for the latter. This role extension to eventually transport patients would be seen as progressive; people would be desensitised to the fear of operating around uncrewed systems (but this is many years away with a current low TRL for large UAS).

Whilst not specially identified by the participants, examples which may assist with creating a positive cultural change towards introducing new technology could be greater engagement with industry, academia, research institutions, or even visits to other nations trialling UAS work.¹⁸² Offering to showcase UAS solutions in the UK could be helpful by observing the technology in action; personnel in the medical service may be convinced of its potential if they can see it. Although the process towards adopting new technology can be lengthy, creating short-term wins, focusing on the long game and establishing supportive relationships will help to ensure that disinterest or disengagement does not occur. Step six is, therefore, crucial.

Unsurprisingly, step seven is Dr Kotter's 'don't let up' stage.¹⁸³ Consolidating gains that have been acquired creates continuous improvement needed to sustain the drive. It has been proposed that trust is a vital issue to establish, but stubborn and engrained sceptical attitudes may need to be worked with too.¹⁸⁴ Whilst confidence will come from successful trial work and endorsement of ability through the CAA or the MAA, overall, the sum of all these activities will create faith in the technology.

The final stage, step eight, is termed 'institute change' or 'anchoring change in the corporate culture.'¹⁸⁵ Explicitly, the need here is to ensure that the mantle of support for change is passed from existing leaders to new leaders and receives their enduring support.¹⁸⁶ This is critical in medical services as it takes considerable time to bring in new capabilities. However, personnel turnover can be rapid, with losses of corporate knowledge and changes in priorities resulting in changes in direction. Reactionary capabilities with a loss of strategic future capability focus result in either stagnation or a loss of capability development.

Unsurprisingly, several participants expressed time as a factor; this was taken to mean a passive element or as a by-product of the more active steps and measures that would need to be generated and implemented. Indeed, getting to step eight will take resources, people and time. The issue will be whether the solution can be thought through and developed in time, or because of the pressure of a lack of time, a rapid option will be selected with little consideration of the OPCP. Whichever route is actioned, enduring support will be required.

While Dr Kotter's *Process of Change Model* has been a way to structure this section, and Rotolo, Hicks and Martin's *Emerging Technology Framework* has been used overall, a technology acceptance model (TAM) may have been more relevant. However, those models, often from the 1980s, are questionably dated; for instance, perceived risks were not included in early TAMs, which is a significant limitation as perceived risk is a major modern phenomenon.¹⁸⁷ Due to where this technology could be used and the nature of UAS, it was therefore not deemed an appropriate model. Nevertheless, the recent research in creating

a new TAM concept model may interest medical services regarding the acceptance of UAS for MEDEVAC or even small UAS. Diagram 3 below shows such a conceptual model with the additional elements of perceived benefits, risks and control, which influence attitudes and, eventually, intention.

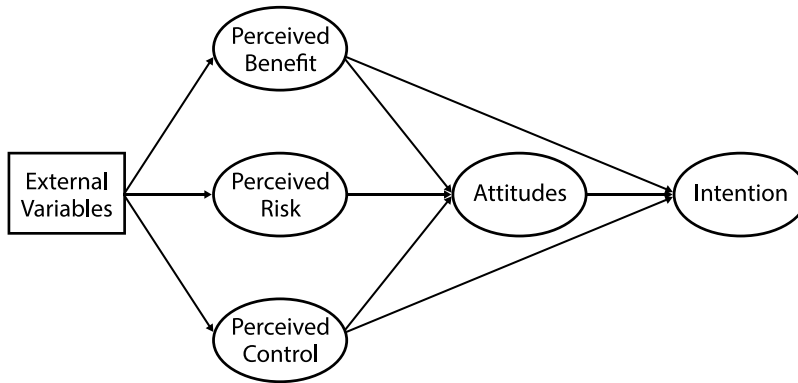


Diagram 3: Conceptual Technology Acceptance Model

Should UAS be selected as a solution for medical requirements, be it for resupply or, eventually, MEDEVAC in the forward environment, this model or one like it could be applied to help facilitate acceptance of the technological change.

This section has explored the theoretical steps towards change and issues concerning accepting UAS. It has used Dr Kotter’s *Process of Change Model* but has layered additional literature throughout to support comments made by interview participants and drawn upon broader societal similarities. Additionally, it has been proposed that a conceptual TAM may be helpful in the future to consider factors such as perceived benefits, risks and control if UAS are chosen to be adopted into the forward environment.

Section 8 – The Future, Limitations And Proposals

The previous section considered steps towards change and acceptance; this penultimate section will consider the future of UAS in the context of the forward medical environment, acknowledge where the limitations of the study were, and offer proposals drawn from the literature and participants’ comments regarding matters that still need to be addressed.

When researching this topic, it was apparent that many sources were focused on the subject from a western perspective. Despite the active selection of internationally based studies, a western view has undoubtedly been presented. Komarova’s research also highlighted that a similar bias in her analysis may have occurred due to the preponderance of American public samples.¹⁸⁸ Despite close military alliances, drawing parallels from other nations’ concepts of operations is problematic as, despite alignment with NATO, the UK does operate differently.

More specifically, its healthcare culture is entwined with British culture and its norms based on the NHS.

The work of the Regulatory Horizons Council, whilst UK-centric, explicitly excludes the military. Nevertheless, it provides a comprehensive analysis of future considerations which medical services would be wise to take note of, for they tackle issues that transcend societal acceptance of technology and offer a way forward through the uncertainty and ambiguity of regulation.¹⁸⁹ Furthermore, the report provides future scenarios with characteristics that allow military commanders to see the consequences of their choices, such as whether they are 'egalitarian', 'NIMBY', 'Luddite', 'libertarian' or 'meritocratic' in their outlook.¹⁹⁰

Despite regulatory challenges, advancements are being made with recent extended and updated support for broader UAS use.¹⁹¹ Hopefully, this will create more data to improve safety and, in turn, support decision-making by the MAA, thus creating plausible options for military medical services to work within. Whilst the exact process may differ between the CAA and MAA, the ideas can be cross-matched. Acknowledging local Air Traffic Control and force protection threat reduction issues will need to be internally addressed as they depend upon multifactorial matters of the operation, not just the location of the operation; having more data to work with will be advantageous for securing their views. Security from potential aerial attacks will always be present, given that unrestricted UAS can present a threat, but if this is managed, it will be like any other known threat.¹⁹²

Being proactive in choosing UAS as a solution early brings advantages, as exact requirements and specifications can be tailor-made, and patient-centric design can be configured. However, achieving this relationship with the industry would mean taking the lead in tackling the issues of gaining regulatory approval, being forthcoming with design-led considerations and being committed to purchasing.

Establishing acceptance of medical UAS should be spear-headed by the medical services. This will require varied stakeholders to work together, and again, education will be critical to achieving this. Medical services' endorsement would inspire confidence in the public, but this must be carefully achieved to avoid the erosion of trust.

Considering UAS for resupply delivery is most favourably indicated by the literature and is supported at an appropriate technological readiness level, unlike the large UAS designed in theory for MEDEVAC. Despite other potential novel uses of UAS, focusing on only two capabilities is indicated as being the most achievable. There remain unanswered questions about exactly how UAS can be integrated and used with existing capabilities that need to be resolved before another novel idea is generated. In addition, establishing precisely what cargo would be carried must be clarified soon as this would provoke much needed thought into the impacts of medical item carriage (especially DG) and medical product carriage regulation.¹⁹³

Engineering advancements mean that previous technical problems are being resolved rapidly, and as this continues, the platforms will get better and more reliable. Communication advances such as 5G and 6G will undoubtedly be advantageous if optimised. Long-standing aerodynamic problems and the issues around battery life are being advanced at such speed that even research produced two years ago is being surpassed.¹⁹⁴ Medical services should avoid tying themselves to assets that would quickly age; instead, choose a system whereby the right aircraft can be selected based on that mission's specific set of circumstances and requirements.¹⁹⁵ As mentioned previously, a contracted solution may give greater scope and flexibility with rapidly developing aircraft.

Regarding larger UAS, over a decade has passed since some early work looking at the future of eVTOL for MEDEVAC in 2012.¹⁹⁶ At the time of publishing, the paper was considered enlightening for medical planners, but has it stood the test of time? Whilst the doctrine of timely retrieval is still extant, and the OPCP has yet to alter, the technology has progressed. Is it now time to review the concept of MEDEVAC, focussing on trials using *The Cormorant*? This could prove emphatically that this UAS would work in the forward environment, with additional modelling of scenarios being the next step for medical planners.

With future climate-related issues, medical services should avoid being a passenger in the drive towards a more sustainable future. Choosing options that have fewer CO2 emissions is indicated, for instance, over fossil-fuelled vehicles, as they do not emit tailpipe emissions, which would make an essential step towards reducing a negative environmental impact – even in the forward environment. However, a full life-cycle assessment should be considered, along with various other measures (such as their planned use, infrastructure needs, and life span) as suggested by the report *Ready for Take-Off? Integrating Drones into the Transport System* to demonstrate their credentials compared to conventional methods.¹⁹⁷ A greater understanding of the impact of UAS compared to conventional methods used by medical services is indicated.

This section has shown that despite emerging technology being future focussed, developments still need to occur equally. Regulatory developments and working with the industry are indicated as ways forward. Whilst technological issues are still present, engineering solutions are remedying problems. Medical services must be proactive in their engagement, specifying particular needs and enabling the design to reflect a patient-centric design.

Section 9 - Conclusion

This study's analysis has concluded that UAS can be a platform solution for medical requirements in the forward environment; however, regarding the two primary roles considered for these uncrewed aircraft, namely, resupply and MEDEVAC, only resupply with small UAS is likely to be feasible. Large UAS or eVTOL remain to all extents and purposes, conceptual and not a viable solution in the near future due to low technological readiness.

The operating domain of the forward environment creates additional complex factors raising security and threat considerations which make the implementation of unproven emergent technology more challenging. In addition, ethical considerations regarding uncrewed MEDEVAC are insufficiently developed.

The selection of emerging technology as a theoretical structure enabled the five attributes (radical novelty, relatively fast growth, coherence, prominent impact, and uncertainty and ambiguity) to be demonstrated throughout the study. The critical debates in the literature were selected regarding lexicology, helicopters replacing UAS, the strengths and opportunities of UAS and, conversely, the limitations and threats. Acceptance, and in particular the process of change, to adopt UAS was examined as this study sought a solution. Despite being framed as an emerging technology, the future of UAS was considered along with proposals for considerations and acknowledgements of some limitations. Relevant literature was entwined and supplemented with quotes from interview participants throughout, collected using semi-structured interviews.

It was found that terminology has changed multiple times over the years, but media, the public and industry have, in the main, consistently used the word drone to refer to uncrewed aerial systems. The military has used many variants but recently has selected three terms – including the chosen one for this study, *uncrewed aircraft systems* – instead of unmanned, based on equality rationale, which is also being recognised and implemented slowly across the western aviation world (though not by NATO doctrine yet).

Regarding the helicopters versus UAS debate in the literature, the media hype surrounding the early adoption of UAS for some roles traditionally carried out by helicopters is still both industry and role specific. Despite earlier predictions, UAS have not replaced helicopters across the board due to the emergent nature of UAS technology and its technical and mechanical limitations; use is restricted to the current technical parameters. However, the pace of technological developments means that solutions to yesterday's problems are being fixed rapidly, but the critical limitations of regulation limit radical novel use, particularly around safety operations and humans. From an economic perspective, both the helicopter industry and UAS are being invested in by the MOD. The future medium-lift helicopter includes scope for aeromedical capabilities whilst trials with new UAS are being simultaneously undertaken. Uncrewed helicopter trials offer a middle-ground solution, removing the risk to life by taking the onboard crew away, but uptake and coverage of this technology are less prevalent.

UAS offer clear benefits regarding the actual and potential reduction and removal of risk to life. Due to their air mobility role, from a logistical perspective, the strengths of small UAS (particularly for resupply) outweigh traditional methods of vehicle delivery if the conditions for road transfers are dangerous. Cost and relative affordability make UAS an attractive choice for budget-conscious procurement. Additionally, regarding small UAS, their design is less technical

and demanding of specialist engineers than other military platforms. Specifically, given the context of the forward medical environment, the size and payload of UAS are matched to small medical items. Due to these qualities and how medical services could employ them in the forward environment, small UAS are force multipliers. They can also be viewed as force enablers as they offer resilience and greater redundancy on finite human and asset resources.

The limitations of UAS were found to be considerable; foremost, regulatory restrictions significantly impact immediate adoption. Safety concerns and security disruption (either intentional or accidental), along with mechanical malfunctions, were identified as shortcomings. Interference of signal and methods to remove from the sky (counter-UAS) has morphed into the need for counter C-UAS. Integration into the operating space is currently inadequate, and payload management is in its infancy.

Despite technological improvements, the inability to avoid objects during flight and restrictions on flight (either via pilot license or environmental conditions) hamper broad application. Small UAS, by design, are limited by size, power and durability, with reliance on electric recharge creating new problems for battlefield operation. Due to the emergent nature of UAS, how to operate, maintain and develop requires more investment and consideration. The specific use for medical purposes raises additional concerns regarding patient rights and ethical considerations. There is limited debate around *do-good drones*, and this hampers more significant thought around the subject. Borrowing from civilian academic work around the humanitarian use of UAS may be a useful starting point for military medical ethicists.

Acceptance of UAS remains a multi-causal relationship tied to attitude towards change. Dr Kotter's *Process of Change Model* was used as a method to show the steps involved towards achieving change and achieving acceptance. The TAM, albeit dated, is another model that could conceivably help medical services understand how adopting UAS would require factors such as perceived benefits, risks and controls to be examined. Attitudinal aspects could thus be encapsulated through this model.

As an emerging technology, UAS straddles both the present and future. A limitation of the study was the reliance on the preponderance of civilian research for small UAS, of which many were US based, and the constraint that larger UAS for potential MEDEVAC is still conceptual, so little literature or data exists. Furthermore, whilst advancements in technology are being made, this study has shown it is how the UAS would be used that may offer the most significant benefit, rather than what aircraft variant it is.

Whilst this study has sought to establish if UAS can be the solution to medical requirements, specifically looking at small UAS first would focus attention on the present and be close to feasibility, whilst large UAS need to improve the TRL figure.

Applying a theory of emerging technology to this study has been a valuable method to demonstrate the causal links with UAS evolving nature and potential adoption for medical capabilities. Using the 'Process for Change' model and potentially a new TAM may provide medical services with solutions to achieving the ends even with the technology still developing.

Military medical personnel need to be far greater informed of what all UAS technologically can offer so requirements can be specific. At the same time, actively considering the broader implications of adopting this technology must be undertaken, given the tremendous societal interest that selecting UAS will generate.

In conclusion, UAS may be the platform solution in the forward environment for some very specific roles, such as medical resupply by small UAS in the near future, but for capabilities such as MEDEVAC, large UAS are currently only conceptually feasible as the technology and society are not ready yet for this aircraft.

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Dissertation

Pathways for Energy Resilience on Deployed Military Operations

By Squadron Leader Zoë Tissington

Biography: Squadron Leader Zoë Tissington is a CAS Fellow, who recently completed the MPhil for Engineering for Sustainable Development at the University of Cambridge. An Aero Systems Officer who has spent the majority of her career thus far enabling Typhoon Jets, she is acutely aware of the challenges the RAF faces in meeting sustainability obligations, whilst maintaining competitive advantage. Recently posted to a position within the Support Capability Strategy team, she will use skills gained in the academic environment to tackle the decarbonisation of RAF Support Capabilities and support Net Zero efforts across the RAF and wider Defence.

Abstract: Climatic events will increase the number of military operations in response to humanitarian and conflict events. The UK Military's current reliance on fossil fuels and host nation energy infrastructure will continue to contribute to Green House Gas (GHG) emissions. To address both capability and accountability of deployed energy use, deployments must become more self-sufficient. The RAF leadership, while looking for technology innovation and novel approaches to deployed energy infrastructure are, nevertheless, challenged by government policy, public funding, and geopolitical events. Using an adaptive dynamic pathway methodology this research aims to show how an operational energy strategy can be developed, and in a military context demonstrate how climate strategy can be enacted. Drawing upon experience from the US Defence sector and humanitarian aid organisations, offers proposals for a preferred pathway to demonstrate adaptive dynamic planning, which can be used by the UK Military to develop a lasting strategy.

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Impact on Sustainable Development

The primary impact of this research will be an implementable strategy to reduce resource consumption and associated CO₂e emissions from deployed operations, and thus support the RAF's commitment to take-action on climate change. However, energy transitions within the Defence sector to reduce its reliance upon fossil fuels will have wider impacts on sustainable development.

Firstly, climate change is expected to exacerbate existing tensions and increase conflict for resources. As an organisation that will be directly involved in both aid and conflict resolution in regions experiencing difficulties, it is essential that Defence organisations are accountable for their actions towards reducing their environmental impact and prevent aggravation of resource pressures when deployed. The future path for respectful implementation of military aid and strengthening peaceful institutions will require a transition towards more responsible and climate conscious operating practices. The impact of successful strategies driving change in the Defence sector will have international ramifications through allied interoperability forums, thus supporting Sustainable Development Goal (SDG) 16. The implementation of a strategy towards clean energy consumption in a complex sector, fraught with barriers to decarbonisation, will help other government departments navigate the application of environmental strategy. Taking action to reduce resource consumption could have knock on effects to wider sectors, supporting UK Net Zero obligations and thus SDG 13, for taking climate action. In particular, the methodology used in this study was specifically chosen for its ability to navigate uncertainty which will be highly applicable to other organisations building policy to tackle their emissions.

Investment in research by the Defence sector is a market driver for clean energy solutions that can be used by any community in austere locations. Policy that drives research, investment and solutions to fossil fuel dependence will support clean and accessible energy production for remote communities globally through the sharing of best practice and technology (SDG 7). Government support and direction on energy production and consumption is essential to incentivise action, investment, and collaboration across all sectors. The continued dependence on fossil fuel provides no incentive for change.

1. Introduction

Anthropogenic climate change is widely considered the single greatest threat to the future of humanity; predicted to have unprecedented impacts on every region in the world. The risks and adverse impacts are expected to increase in frequency and severity, extending across natural and human systems. The compounding of overall risks is anticipated to exacerbate underlying vulnerabilities and political tensions (IPCC, 2023). The increasing complexity of global environmental, societal, and geopolitical risks will have strategic impacts to all military activity as the UK Defence sector responds to the direct and indirect impacts of climatic events (Cox *et al*, 2020) (NATO, 2022).

Environmental emergencies are likely to increase the number of continuous missions to provide humanitarian aid or conflict resolution in austere locations, where local infrastructure may be damaged or restricted, incurring limitations upon logistical support. The existing reliance of the UK Military on fossil fuel to meet its deployed infrastructure energy needs, risks the logistical flexibility and operational capability within these locations. The threats associated with fossil fuel dependence were highlighted by power generation of Camp Bastion, Afghanistan, during Operation Herrick. For every one gallon of generator fuel used by the Forward Operating Base (FOB), a further seven gallons of fuel was required to transport it through high-risk logistic routes (QINETIQ, 2020). Such high value and slow-moving targets posed huge risk during this conflict, costing the lives of over 3000 service personnel and civilian contractors. Seventy per cent of non-aviation fuel utilised by Camp Bastion was used to operate over 250 generators (Arūnas Molisp *et al*, 2012). Furthermore, the electrification and digitalisation of service equipment is expected to increase deployed fuel consumption, which is already 20 times higher per soldier than during the Second World War (QinetiQ, 2020). The evidenced reliance upon fossil fuels will continue to exacerbate the costs and logistical flexibility of Military operations. To maintain capability and limit further pressure upon the resources of an operating environment, deployed energy production must become more self-sufficient (Cox *et al*, 2020).

Simultaneously the UK Military's reliance on fossil fuels and host nation energy infrastructure will continue to contribute to greenhouse gas (GHG) emissions, damaging international credibility and accountability in relation to international Net Zero obligations. Despite emissions from deployed energy infrastructure currently out of scope for Ministry of Defence (MOD)¹ GHG emission reporting (MOD, 2023a), the decarbonisation strategies for sectors, including UK Military aviation, demonstrates a clear imperative for an aligned approach targeting energy requirements for deployed infrastructure (MOD, 2023b).

Scientists for Global Responsibility estimate that the world's militaries and supporting industries combined, contribute to 6% of all global GHG emissions (Ambrose, 2021). To continue current approaches to energy consumption and production, whilst simultaneously undertaking vital roles in international efforts to maintain peace and security, introduces a level of accountability, morality, and urgency for military decarbonisation and the transition to alternative energy solutions.

The MOD Climate Change and Strategic Approach recognises that the Defence sector must act now. However, with consideration of the complex barriers and uncertainties associated with net zero Military operations, it is challenging to create a strategy to address operational energy needs that empowers leadership at all levels to make informed decisions (Nugee, 2021). The need to balance operational capability with more sustainable practices challenges current operating procedures and strategy, creating lock-in between stakeholders as future scenarios are planned for. It is particularly challenging due to the evolution of technology across the energy sector, further obscuring predictions of how technologies will form solutions for

Military problems. In order to create a balanced strategy that supports actions with immediate effectiveness and of beneficial implementation in the future, this paper will explore the use of adaptive dynamic policy tools as a method of addressing the problem of energy resilience on deployed operations.

Energy resilience is critical to successful delivery of deployed activity, with electricity being a fundamental enabler to almost every conceivable military function. For example, electricity is used to support infrastructure such as accommodation, catering, engineering, medical facilities, and planning. Electricity is also used to directly support military equipment. The focus for this study will be specifically tailored to the UK Royal Air Force (RAF), for which the core consideration is that there is 'No air power without ground power' (Gardner, 2019). This research aims to assist decision-makers and RAF leadership understand the uncertainties associated with an operational energy transition and shape an informed approach to strategy and planning.

1.1 Scope

The North Atlantic Treaty Organisation (NATO)² defines 'operational energy' as the energy required for training, moving, and sustaining military forces for military operations (DOD, 2023). This study will focus upon electricity generation for deployed infrastructure, excluding fuel for aviation and ground vehicles. Whilst it is recognised that there is a close relationship between required infrastructure energy and type of platform³ being supported, the focus of this study will be the supporting infrastructure only. Decoupling the two energy requirements will enable a strategy that can be adapted to different platform needs. For example, a squadron of fighter jets will require different quantities of aviation fuel to fly than helicopters and different ground support equipment, which is a logistical and decarbonisation challenge on its own. Whereas there are likely to be similarities between the supporting base infrastructure of a deployment for any platform, which can be adapted for either. Whilst there is likely to be applicable lessons and applications to sectors across UK Defence, this study will focus upon RAF strategy due to data accessibility and potential for collaboration. Furthermore, this study will focus upon RAF activity deployed outside of permanent stationed locations, that utilises temporary or host nation infrastructure and facilities. The boundary is in alignment with the research title and aims to address the issues highlighted in the introduction.

A literature review was used to identify current Military policy and existing applicable research that would shape key research questions for this study. Drawing upon identified data gaps in the literature review and notable frameworks, the methodology sets out how this study will answer the research title. Finally, the methodology is applied using qualitative data and analysed to deliver conclusions and recommendations.

2. Literature Review

This chapter explores both grey and academic literature used to inform the direction of this study. Firstly, UK MOD policy was reviewed to understand the current context of decisions

related to sustainability and operational energy strategy, to identify drivers and barriers for decisions that may impact the direction of the study.

Recognising that operational energy has been a military logistical problem for over a decade, the second section will review key academic studies on the optimisation of energy systems for Forward Operating Bases (FOBs). Literature outside of a military context was also investigated, learning from examples of studies from remote communities hoping to transition away from diesel for electricity. The purpose of this section is to identify potential energy optimisation strategies for remote electricity use, that could be adapted by the RAF and used to inform this study.

The third section reviews methods for assessing the resilience of energy infrastructure to inform and develop the study methodology. Due to global ambitions to better understand energy infrastructure, grey literature from consultancy firms and industry were reviewed alongside academia to maximise understanding of current methodologies.

Finally, it is considered that Military deployments should aim to avoid putting pressure on local resources and infrastructure. The final section explores grey literature published mainly by the humanitarian aid sector, to understand how accountability and environmental risks are being governed by other organisations working in remote and resource scarce communities.

The four areas of literature review are reflected upon to identify literature gaps and resultant research questions.

2.1 Existing UK MOD Policy Drivers and Strategy for Operational Energy

The most comprehensive MOD-wide publication contextualising Climate Change within the UK Defence sector is the 2021 publication '*Climate Change and Strategic Approach*'. Within this publication the MOD has recognised that Operational deployments are required to enhance their resilience. Furthermore, the paper expects deployed facilities to reduce their reliance on local infrastructure to limit the impact to communities who may already be encountering resource pressures, whilst maintaining freedom of manoeuvre (Nugee, 2021). However, beyond identifying the issues associated with deployed infrastructure, there is limited research conducted by the MOD investigating the requirements of a resilient deployment and methods by which it can be achieved. The most recent and compelling body of work tailored to UK Defence operations, was conducted by the Defence Science and Technology Laboratory (DSTL). *The Power Struggle* is a review of energy technologies suitable to Defence applications, exploring the current state of innovations in wider industries, and the quantifiable attributes that each technology offers in a military context. The report highlighted that there are opportunities to understand the trade-offs between adoptable technologies by considering power and energy needs at a system level, rather than by capability basis, to assess and balance priorities. A key conclusion also emphasised that technology adoption alone

would be unlikely to achieve operational goals, and Defence-wide change is needed to adopt new approaches (DSTL, 2020). Overall, the report carefully underlines the complexity of UK Defence's energy needs for the intended audience of Defence leaders responsible for Defence sustainability policy and introduce some key points to build explore further within this study.

Drivers and levers for change can also be found in other published doctrines. The 2021 Integrated Operating Concept, published by the MOD Development, Concepts and Doctrine Centre (DCDC), states that the military must be less dependent on fossil fuels and be more self-sufficient (HM Government, 2021). Furthermore, the report identified that there is a need to create a programme in which operational challenges can be taken to industry and academia to determine suitable technologies for competitive edge (HM Government, 2021). Recognition of a shifting operating environment and the need for innovation is also echoed in the 2023 Integrated Review refresh which determines that energy security is a priority focus to address UK vulnerabilities (HM Government, 2023).

An example of a sector of Defence attempting to align with the published doctrine, is the British Army and its publication *British Army Approach to battlefield electrification*. According to the MOD, the aim of this work is to increase operational advantage through electrification of the operating environment using alternative power generation technologies to reduce logistic need and carbon emissions (MOD, 2021). Despite the differing organisational priorities, the strategy highlights key projects that could be opportunities for collaboration and learning by the RAF.

Driving technology procurement strategies is also dictated by the RAF's 2040 Net Zero Strategy, which sets out ambitions for the RAF to cut its emissions to achieve net zero by 2040 (RAF, 2021). Whilst this research does not specifically intend to account or reduce emissions from alternative energy technologies, it is important to acknowledge that the overarching directive of this strategy will impact potential technology acquisition processes and influence recommendations.

2.2 Optimisation of Energy Systems for Forward Operating Bases (FOBs)

Electricity for RAF deployments is typically provided by diesel generators, individually supporting different infrastructure functions.⁴ Generators are an established technology able to function in diverse weather and operating conditions but are limited by resupply logistics and costs. Katelenich and Jacobson propose a methodology that can be used by an organisation to construct remote infrastructure, that employs meteorological data to incorporate the use of renewable technologies such as solar photovoltaics and energy storage to deliver primary energy requirements. By utilising renewable technologies, installations can reduce and offset the use of diesel generators, cutting carbon emissions, and decreasing resupply requirements. The simulations found that increasing building efficiency, and incorporating rooftop solar photovoltaics and wind turbines can decrease annual diesel

consumption by 75% by remote communities, in all major global climate zones. The key benefit of this study is that inputs are variable and can be customised to the needs of the user, allowing for accurate estimations of load parameters and carbon emission savings. However, a crucial consideration omitted from the study is the logistical viability of such installations. For example, the results showed that 508 batteries, 6,100 solar panels and 774 wind turbines would be required to support the needs of a battalion,⁵ requiring 121 additional shipping containers to position the items (Katelenich and Jacobson, 2021). The authors calculate the emission cost of upfront transportation will be offset by reduced resupply in use, however they fail to acknowledge the logistical burden that such a movement would introduce, impacting upon the speed and flexibility of the deployment. For application to humanitarian aid missions and disaster relief, the ability to rapidly install and operate immediately is an essential requirement of deployed technology.

Microgrids are an energy management option deployed by some military forces primarily to support the energy needs of operating bases in remote locations not serviced by an established power grid. The evolving nature of expeditionary operations and a decade of experience of operations in Iraq and Afghanistan⁶ has resulted in significant research commissioned by the United States (US) Department of Defense, analysing Microgrid optimisation to meet the evolving demands of modern military force deployment (DoD DSB, 2016).

Simulations like Katelenich and Jacobson's are encouraging, however the variability of military missions dictates a range of energy requirements, which is cited in numerous studies as a barrier to implementation of microgrid technology. Van Broekhoven *et al* and Hartranft both state that to plan the most suitable microgrid infrastructure requires well defined parameters, which makes flexible solutions that can be widely adopted in a range of scenarios difficult to achieve (Hartranft, 2008; Van Broekhoven *et al*, 2013). Nevertheless, for semi-permanent to permanent installations like a FOB, there has been practical development by the US Department of Defense (DOD) of microgrid installations within existing base infrastructure. The Smart Power Infrastructure Demonstration for Energy Reliability and Security team (SPIDERS) conducted a four-year demonstration of a microgrid, combining renewable generation and storage with smart grid technologies. SPIDERS demonstrated a three-phase approach that progressively increased installation size and load complexity (Stamp, 2014). This study is still cited and used by the US DOD to inform infrastructure decisions to maintain critical assets in the event of a local power failure. A recent example of successful application of this research is the Microgrid installation on Marines Air Force base Myanmar (Dorsey, 2021).

Building upon the concept of energy resilience for military base microgrid infrastructure, Mallery *et al* propose a methodology to be used by energy managers for different mission scenarios that can assess a microgrid's ability to supply critical loads. The case study demonstrated that when a microgrid is unable to provide the necessary electrical energy,

distributed energy storage and renewables may be added to improve the resilience of the system. The method uses a system-engineering approach to improve the resilience on military electrical energy infrastructure by analysing load requirements of different mission scenarios, and integrating the expected impacts of hazards on the system to reprioritise power distribution to ensure critical loads are served. Whilst the case study was on a fictitious permanent base, it highlighted the benefits of smart energy management and the use of data to allow energy managers to prepare for changing loads prior to a failure, and therefore increasing the understanding and resilience of the system (Mallery, Van Bossuyt and Pollman, 2022).

Humanitarian Aid organisations are also heavily reliant upon diesel generators to service the energy needs of camps in remote locations. Beath *et al* propose a method of integrating solar and battery storage capacity into systems that are usually reliant upon diesel generators to offer efficiencies, energy savings and therefore cost and emission reductions (Beath *et al*, 2023). Beyond choosing appropriate technology, the author highlights that optimisation of the system and how the energy is used is often overlooked when considering microgrids for displaced populations. The concept of increasing the efficiency of energy use is highly relevant to developing the resilience of the system.

To transform the resiliency of operations, there must also be a reformation of supporting logistic mechanisms in parallel to emerging technologies. Major Nicholson advocates for the concept of regenerative logistics, in their paper *Marines need regenerative logistics* published in the US Naval Institute Journal. They state that the concept of regenerative logistics is to ensure deployed forces operate in a closed system with limited logistical support, including for food and fuels, to provide staying power. Ultimately, regenerative capabilities serve to close the loop between operational functions and logistics, reducing logistical limitations and increasing overall manoeuvrability (Nicholson, 2022).

Anaut *et al* also articulates the impacts of a logistics network on a military microgrid in their study *Energy Resilience Impact of Supply Chain Network Disruption to Military Microgrids*. The study takes a system engineering approach to evaluating the resilience of microgrids in disruption scenarios, including disruption to supply chains, and evaluates the risk to operational output because of supply chain disruption. Overall, the study found an overreliance upon back-up diesel generators, which introduced risk and liability to sustained operations in the event of a disruption (Gravio *et al*, 2021).

To summarise, research commissioned by the US Department of Defense dominates the literature investigating optimisation of deployed microgrids. Overall, there is consistent consensus throughout that there is not a 'one size fits all' solution to the optimisation of resilient energy solutions. With consideration of current technology employed by the RAF on deployments, this presents a significant gap in understanding of how the RAF can decrease its own reliance upon host nation infrastructure and current fossil fuel technology.

2.3 Methods for Assessing and Establishing Resilient Energy Infrastructure

The concept of resilience is widely defined as the ability for a system to recover from disruption, the International Energy Agency defines energy resilience as '*the capacity of the energy system or its components to cope with a hazardous event or trend, responding in ways that maintain their essential function, identity and structure while also maintaining the capacity for adaptation, learning and transformation*' (IEA, 2015). In the case of this study, the pathway to resilience is also interwoven with reliance, where the system can operate under a spectrum of condition variations. The purpose of reliance is to minimise adverse effects on missions through outages and sustain output without drawing upon host nation⁷ infrastructure (NAVFAC, 2021). Modelling and evaluating resilience is complex, which has resulted in diversity of literature aimed at identifying different methods of defining and assessing resilience of systems.

Hamborg *et al* argue that a resilience framework must expand beyond the IEA resilience definition, to include consideration of the complexities and interdependencies of social-ecological systems. Whilst recognising the importance of defining a resilient system, it is highlighted that a framework must be capable of identifying variables and feedbacks of externalities to enhance the overall understanding of an energy system, and prevent the obstruction of solutions (Hamborg *et al*, 2020). Importantly, the work highlights the human reaction to interventions; in other words, ensuring the consideration of stakeholder viewpoints to anticipate how personal reactions will affect implementation. Whilst the concept of incorporating human reaction to a disruption is important, there is an element of uncertainty associated with predicting a human reaction, which is difficult to incorporate into their framework. The human reaction risk may be lower for this study due to the hierarchical organisation structure; however, this will likely introduce its own challenges for implementing a strategy for change and will be considered in the methodology.

It is undeniable that understanding resilience in energy infrastructure is complex. Jasiūnas *et al* identified that often the complexity and variability in systems means it is not obvious what indicators and models should be used to analyse a system. Their study of resilience literature breaks down the approaches into two categories, quantitative and qualitative. Quantitative approaches measure the performance of a system before and after disruption, whereas qualitative approaches use conceptual frameworks and expert opinion to inform index criteria. Some frameworks are static, and others incorporate the effect of time on system performance. Ultimately, both approaches are a valid form of assessment and allow for frameworks to be tailored to the system under assessment (Jasiūnas, Lund and Mikkola, 2021).

Haasnoot *et al* proposes a method for planning under conditions of uncertainty that allows for adaptation over time. The purpose of the framework is to allow decision-makers to plan for uncertainties introduced by a multitude of factors, including social, technological, economic and climate change. It recognises the need to design plans that commit to short-term actions

whilst continuing to learn and adapt to guide future actions, by mapping several preferred pathways that would meet the definition of success. If the current pathway is being impacted by previous unknowns and is no longer able to meet the definition of success, planned decision points allow transition onto an alternative pathway. The framework incorporates informed flexibility to decision-making, specifying immediate actions, actions open to adaptation, and a method of monitoring the pathway against the criteria of success (Haasnoot *et al*, 2013). A strength of this framework is that it can be tailored to different infrastructure systems and breaks down complex problems into a simple visual representation for decision makers. Examples are shown in Figure 1 and 2 for flood mitigation options.

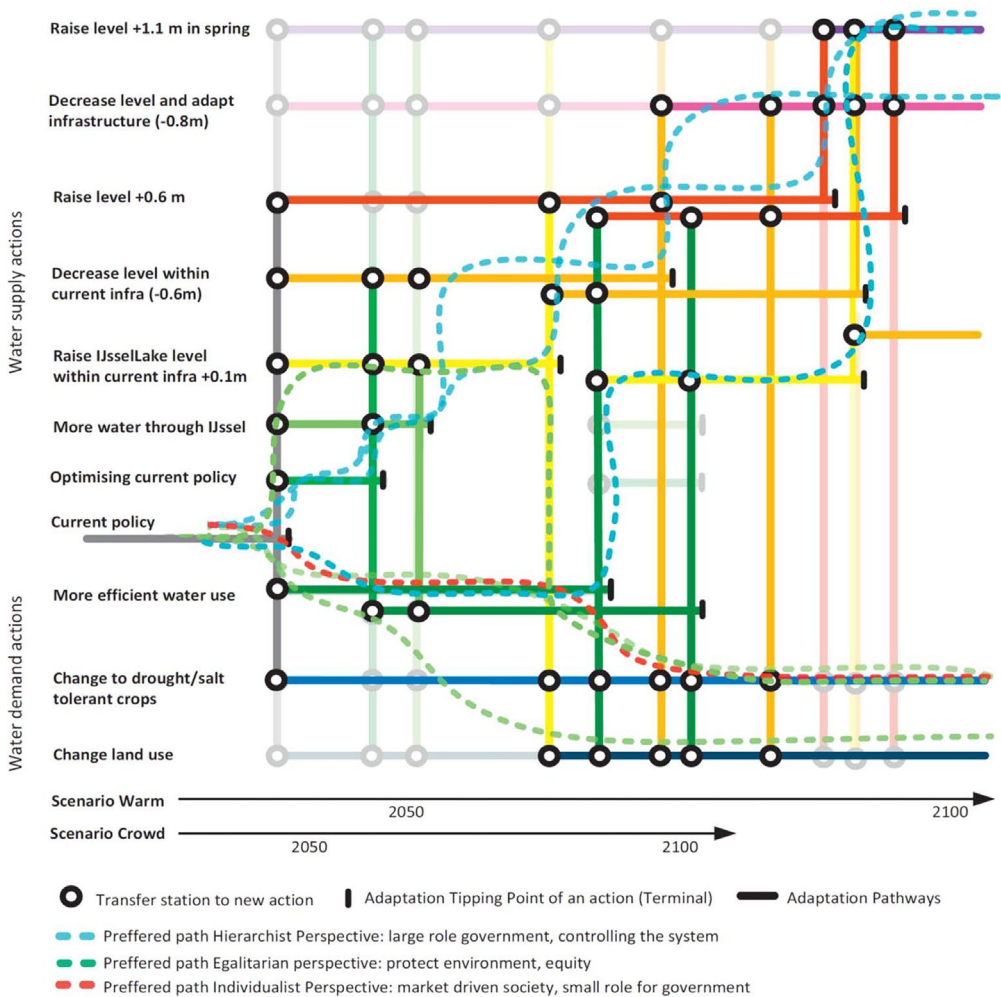


Figure 1. Example of adaptation pathway map (Haasnoot *et al*, 2013)

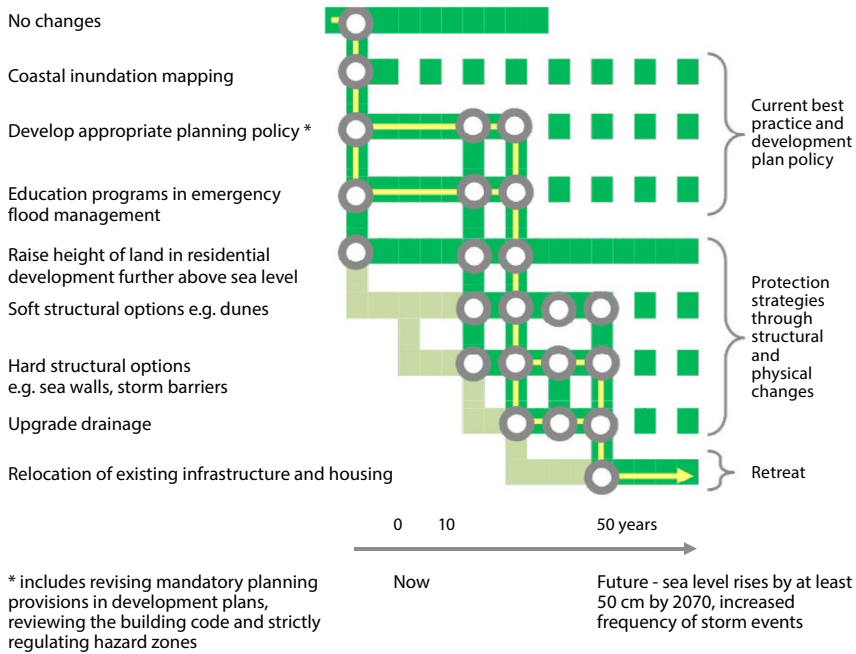


Figure 2. Example of adaptation pathway map (Siebentritt and Stafford Smith, 2016)

Beyond academic research, global organisations such as the International Organisation for Standardisation are seeking to develop clarification on principles, frameworks, and approaches towards energy resilience. ISO/AWI 22366, currently under draft, intends to detail organisational qualities for an energy supply chain required to achieve energy resilience, to reduce adverse impacts following a disruption. However, the scope will be limited to the socio-technical aspects of managing the system and will lack technical engineering details for specific power generation systems such as redundant generators (ISO, 2023).

In response to the growing number of resources related to energy resilience, there are also several published frameworks by established consultancy firms. The Energy Resilience Framework, published by Arup shown in Figure 3, is a tool designed to assess how resilient an energy system is from disruption. The framework has split the assessment into 66 indicators within three dimensions: leadership and strategy, economy and society, and infrastructure and ecosystems. Like the Arup's city resilience index and water resilience framework (ARUP, no date), the energy resilience framework recognises the interdependencies between technical and non-technical factors, and the importance of assessing the system using stakeholders of the system. Using indicators across different dimensions facilitates an integrated approach to the system. In comparison, the literature identified on optimisation of military microgrids focussed primarily on energy consumption only, with little to no consideration of the impact to stakeholders beyond the consumer, such as the host nation.

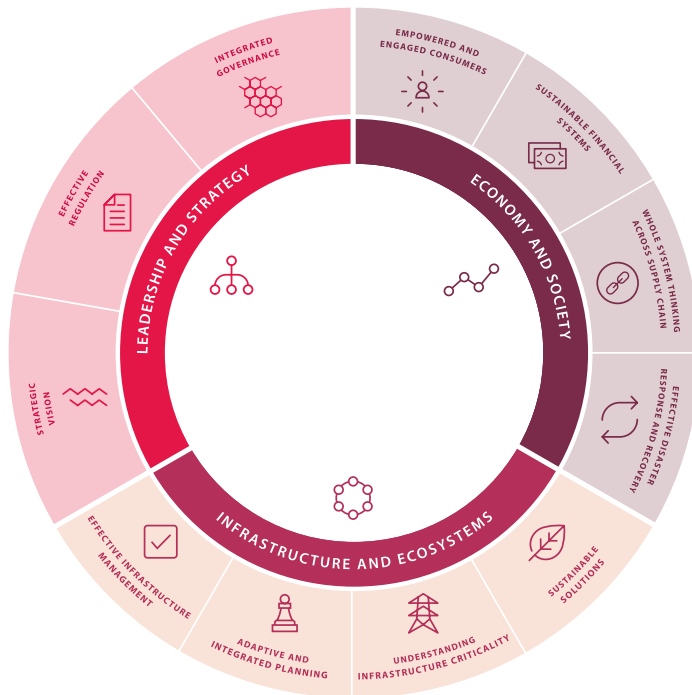


Figure 3. ARUP Energy resilience framework. (ARUP, nd)

The literature review has identified several key frameworks for planning resilient infrastructure systems. To the author’s best knowledge, at the time of writing, there has been no analysis of an RAF infrastructure system with any of the key frameworks identified. The frameworks highlighted will serve as key literature to build a methodology upon for this study.

2.4 Measuring Accountability

Humanitarian action by international organisations, including military forces, are intended to alleviate suffering in a crisis. However, there is growing recognition of unintended negative consequences of relief efforts undermining efforts to support vulnerable communities. For example, a cholera outbreak after the 2010 Haiti earthquake, thought to be the largest outbreak in recent history, was traced back to poor wastewater treatment at a humanitarian relief shelter. Failure to incorporate environmental considerations to humanitarian response endangers the recovery process and may even introduce further suffering (UNEP, 2014). This section of literature review serves to understand how the RAF incorporates environmental considerations into deployment planning, and how other international organisations are approaching mitigations for the environmental impact of relief operations.

Management of environmental protection in Defence is governed by Joint Service Publication (JSP) 418, which provides direction and guidance to ensure compliance with domestic and host nation environmental legislation. There is recognition that operational environments

may pose unique challenges to management of environmental protection, and where policy standards are unable to be accommodated, a robust risk assessment must be conducted (MOD, 2014). Identification of specific environmental policy and auditable processes is positive, however as individual countries enshrine net zero commitments into law, abiding by host nation legislation may become more complex. This is highlighted by Depledge (2023), who writes that armed forces are at risk of reputational damage if not seen to be addressing the environmental impact and emissions of operations. Furthermore, failure to act upon decarbonisation may also lead to denial of access to operate from a base or port due to the carbon footprint of the technologies being employed (Depledge, 2023). Depledge also highlights that regardless of environmental policy, war remains materially destructive and will therefore always carry a high carbon and environmental price. This is a ruthless conclusion, and ultimately should be a driver for fundamental change in how the RAF conducts itself internationally.

A 2014 study by the United Nations Environment Programme (UNEP) sought to investigate the sustainability and accountability of humanitarian action. The initial literature review found that tools to measure environmental impacts existed in the environmental humanitarian domain, but no tool was universally accepted. The conclusions drawn from case studies by UNEP further supported the lack of progress on integrating environmental planning into relief responses. Included in the report's series of recommendations is reinforcement of the principle 'Do No Harm', coherence with the UN Sustainable Development Goals, and quality assurance that places the environment within aid criteria (UNEP, 2014). Following a review of humanitarian actions in Afghanistan, UNEP also concluded that energy considerations should be incorporated into emergency preparedness and response (UNEP, 2016).

'Do No Harm' has long been established as a key principle for humanitarian organisations, and in 2016 the International Red Cross reviewed its own application of the 'Do No Harm' principle to illustrate how it can be applied to emerging contexts, drawing upon tools such as *resilient thinking*⁸ in planning, and implementation of initiatives to minimise adverse impacts (IFRC, 2016). Khaled 2021 advocates for the importance of the 'Do No Harm' principle as a framework to identify unintended consequences of aid response. Khalid finds there is consensus by humanitarian aid organisations that harm should be avoided, however many organisations still lack a policy response to improving accountability for their actions. They conclude that environmental impacts must be incorporated into operational frameworks of aid agencies (Khaled, 2021).

The UN's Environmental Emergency Centres' Joint Initiative is a multi-stakeholder project that aims to improve accountability of humanitarian aid organisations and provide tools to help environmental assessment for aid planning. The tools emphasise the need for engagement and coordination between environmental and humanitarian actors in the delivery of effective relief efforts. For example, the 'Nexus Environmental Assessment Tool', is a screening tool used to highlight environmental concerns before an organisation designs long term emergency

recovery interventions, and the 'Rapid Environmental Assessment' is used to identify environment issues that need immediate attention during disaster relief efforts (EEC, 2017).

2.5 Literature Gaps and Research Questions

In summary a review of policies applicable to the RAF demonstrated a lack of published strategy to address operational energy requirements. Despite overarching MOD directives requiring the RAF to commit to net zero obligations, there is currently no published RAF strategy for delivering on the ambitions and projects within. The frameworks identified for adaptive decision-making present an opportunity for application in this study.

It is also noted that the identification of existing literature investigating alternative energy options and environmental assessment tools in comparative organisations, served to highlight existing practices that could be implemented by the RAF.

Reflecting upon the gaps in RAF strategy and drawing upon the literature on methods for navigating resilience in other contexts, the following research questions aim to be addressed:

1. How can the RAF effectively plan to deliver more resilient deployed energy?
2. What lessons can be learnt from existing research of alternatives to fossil fuels in remote locations, to support an operational energy strategy?
3. What are the barriers preventing the adoption and implementation of alternative energy options?
4. Drawing upon the three key research questions, is there a practical operational energy strategy that can be implemented now?

3. Methodology

This chapter details the chosen methodology and how it aims to address the research questions identified in Chapter 2. During initial scoping, the intended direction of investigation was anticipated to be a case study comparing potential technologies for RAF deployed infrastructure that would reduce fossil fuel dependency and improve energy system resilience. However, preliminary informal interviews and lines of enquiry to senior RAF logistic command cells failed to locate existing data to enable technical analysis to take place; with records for energy and fuel use on deployments limited or unavailable. The literature review also placed the operational energy problem into further context from a policy perspective. The review of MOD policy identified a gap between overarching Climate Strategy for Defence, and a plan for delivering a change within the RAF, specifically in response to fossil fuel dependency by deployed infrastructure. This methodology aims to bridge the gap between MOD strategy and tactical RAF deployed operations, to inform and empower decision-makers to implement an operational energy strategy.

The review of MOD policy highlighted complexities associated with the military directive for Net Zero Policies, energy transitions, and change management. A framework from the

literature review found to handle complexity in strategy development is the ‘Dynamic adaptive approach’. The method is advocated by Haasnoot *et al* in their paper ‘Dynamic adaptive policy pathways: A method for crafting robust decisions for a deeply uncertain world’ (Haasnoot *et al*, 2013), and used by the city of London for climate adaptation and resilience planning (Buro Happold, 2020). This approach systematically breaks down complex problems into actions, identifying decision points and action interactions to develop a strategy, presented as an Adaptation Pathways map, as shown in Figure 4. The framework encourages adaptation over time in response to emergent information and can be considered a living strategy. This dynamic approach is well suited to an organisation like the RAF, which is constantly evolving with government directive, budget, and geopolitical context. The results of this study may demonstrate to other sectors overwhelmed by the complexity of an energy transition, that a similar approach could be taken.

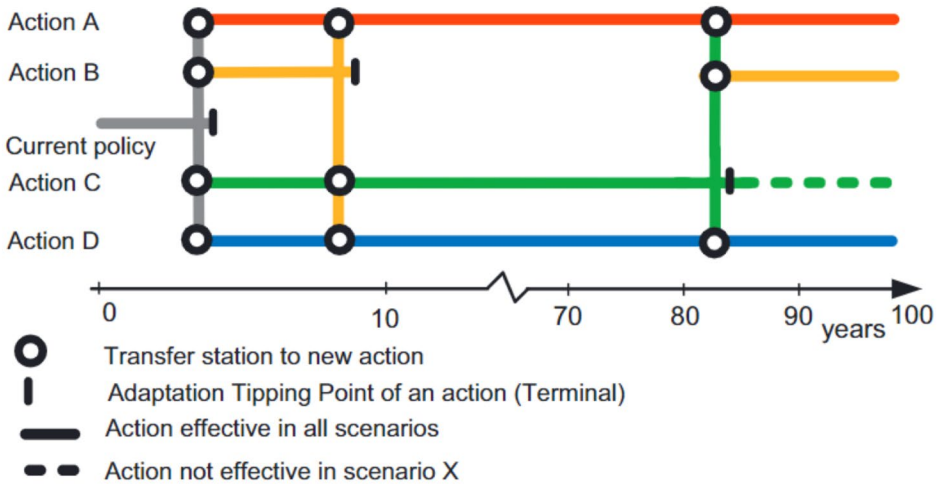


Figure 4. Adaptation Pathways map example (Haasnoot *et al*, 2013)

Figure 5 details the steps for Dynamic adaptive policy pathways (Haasnoot *et al*, 2013).

Figure 6 draws upon Haasnoot *et al*'s methodology and the example used in the adaptation pathways user guide (Siebentritt & Stafford Smith, 2016), to tailor the steps taken to achieve the scope of this study.

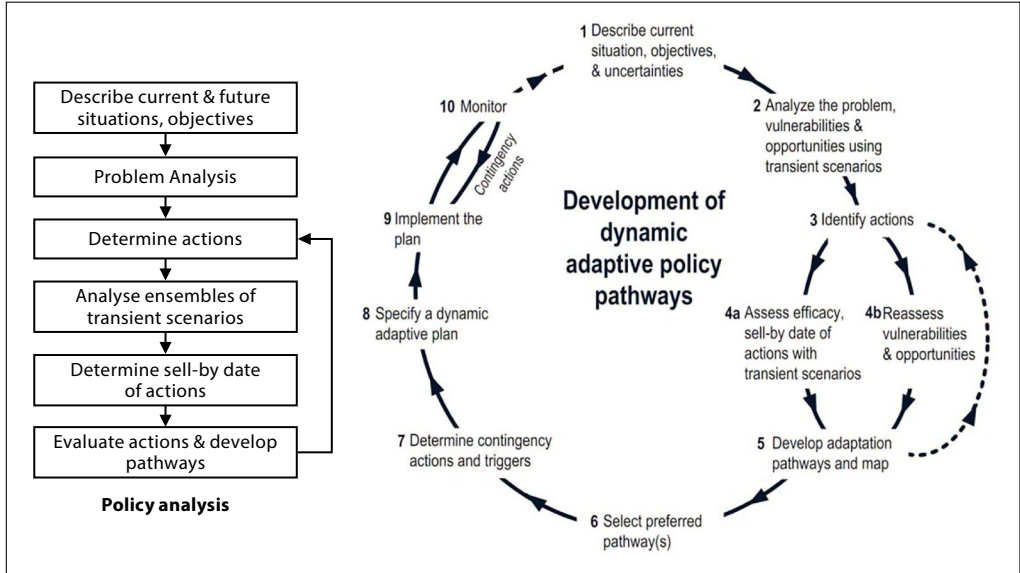


Figure 5. Hasnoot *et al* dynamic adaptive policy methodology. (Hasnoot *et al*, 2013)

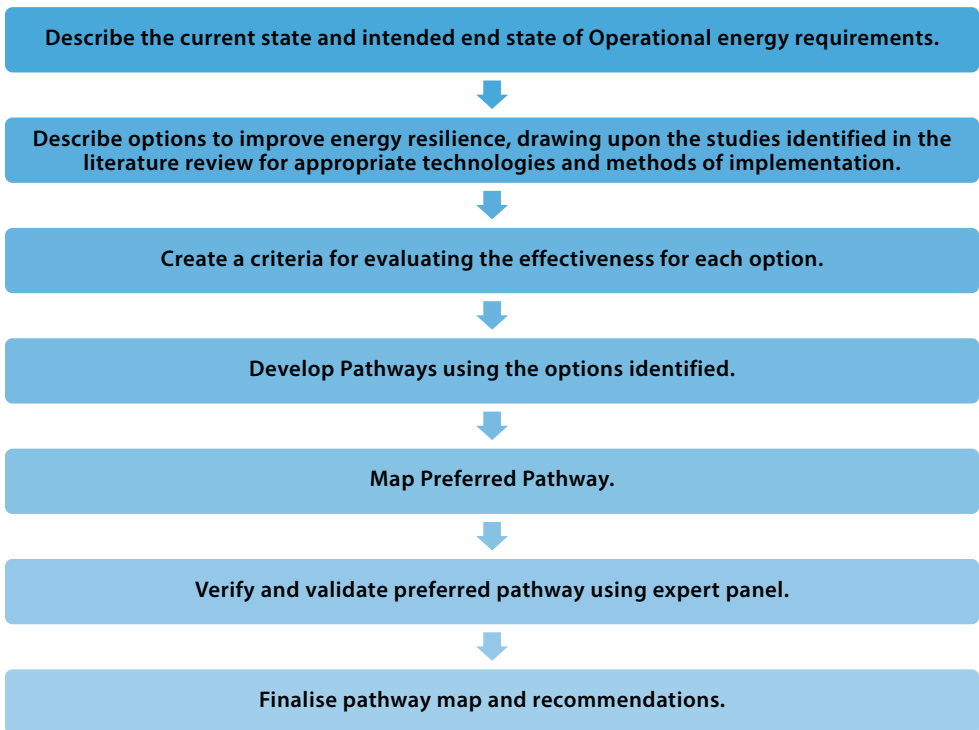


Figure 6. Study Methodology

3.1 What is the Current and Desired End State for Operational Energy?

The first step to developing an adaptive pathway was to understand the current state of energy provision on RAF deployments. The primary intent was to create a baseline of current energy needs from existing data, specifically quantifying the amount of diesel used for deployed generators that are used to power infrastructure and equipment. However, from early enquiries requesting data from the logistical departments responsible for supporting deployments, it became clear that this information was not routinely reported or collated in an accessible format for analysis. This highlighted an initial problem for creating an environment for change, as at present, diesel used on RAF deployments is not quantified in a standardised way across platforms. In addition to disrupting the intended analysis of fuel use, it illustrated further that there is currently no system in place for assessing and optimising operational energy use. Acknowledging the data gap, it was determined that the current state would be dictated by existing literature and policy, with the data gaps also serving to highlight unknowns that could impact potential pathways. Through a combination of existing literature and failed information requests, it was possible to build a 'current state' for the pathway options.

To develop future pathways, it was important to determine a clear vision of what the end state should be, and how success will be defined or quantified. Existing MOD and RAF policy was used to create a strategic end state. Although there is no current policy defining a resilient energy infrastructure, there are supporting policies such as RAF Net Zero 2040 (RAF, 2021), which contain aligning principles that were used to create a desired end state.

3.2 Action Development

This section of the study aimed to specify actions to improve deployed energy resilience. From the literature review, it was identified that the US Department of Defence (DOD) have been leading research into independent energy infrastructure for military bases for over a decade. Delving further into US Defence publications, such as papers on microgrid applications in military contexts, and drawing upon lessons they have learnt, it was possible to identify key actions supporting their progress that could be implementable by the RAF.

Using the current state and desired end state, it was possible to identify gaps in existing policy, and opportunities for alternative actions to be considered for implementation. Due to the qualitative nature of this study it was not possible to create a computational model of potential impacts of an action. However, with reference to existing case studies and strategy, it was possible to identify limitations and opportunities of different actions, which can be built upon and adapted over time.

3.3 Option Criteria and Areas for Key Decision Making

To develop a pathway, the actions were measured against a criterion for perceived success using a scorecard system adapted from Hasnoot *et al's* methodology, shown in Figure 7.

The impact of an action was based upon case studies of similar actions in other contexts and assessed on a scale of positive to negative impact towards the criterion. Scorecard criterion and assessment will be expanded upon following action analysis in Section 4.7.

The analysis of each action considered the conditions under which a decision about that action would need to be made. Conditions provoking a decision are called tipping points, and time limits on an action are called thresholds. The action analysis in Chapter 4 developed an understanding of tipping point dependencies, which helped determine whether the action is implementable now or would benefit from a delay awaiting further data (Siebentritt and Stafford Smith, 2016).

Path actions	Relative Costs	Target effects	Side effects
1 	+++	+	0
2  	+++++	0	0
3  	+++	0	0
4  	+++	0	0
5 	0	0	-
6  	++++	0	-
7  	+++	0	-
8  	+	+	---
9 	++	+	---

Figure 7. Scorecard for actions effectiveness. (Haasnoot *et al*, 2013)

3.4 Map Pathways

Using the criterion scorecard and problem analysis detailing thresholds and decision points, it was possible to design possible pathways by linking action interactions. The result was an adaptation map which summarises logical pathways for which the desired end state can be achieved.

3.5 Pathway Verification

To improve the robustness of the preferred pathway, stakeholder engagement was conducted with an expert panel of RAF leaders who, due to their roles, have an invested interest in sustainability strategy. The interviews were semi-formal to determine the feasibility of the proposed actions and confirm if some of the core findings of the literature review and problem analysis were representative of the current state. A general discussion about the proposed pathway map also occurred to gain feedback on the understanding of the framework in this context. Interviews were compliant with the ethical process approved by the Engineering Department at the University of Cambridge. Chapter 5 details interview format and will evaluate how the expert input is incorporated into final recommendations.

3.6 Pathway Recommendations

Following analysis of the interview feedback, a final map and recommendations were made for a pathway to deliver energy resilience on deployed operations.

3.7 Methodology Limitations

- The author of this study is an employee of the RAF which may introduce a level of bias when interpreting case studies for potential actions from personal experience operating in a deployed environment.

- The interviewees used for validation were limited to availability of personnel and response to interview requests; a larger sample size may have introduced further viewpoints for consideration in the final pathway.
- Only data published in the public domain, or declassified was used in this study which limits the detail to which the actions can be specified and evaluated. This study could be replicated using classified information for increased granularity of results.

4. Operational Energy Decision Analysis

Using the methodology set out in Chapter 3 in Figure 6, the following section will analyse a mix of grey and academic literature to build an adaptation pathway map to improve the RAF's operational energy resilience. The chapter will define key building blocks of the map such as the current and end states, uncertainties, and underpinning MOD policies, using them to evaluate potential actions for consideration.

4.1 Current State

The first step is to identify the current state of energy provision as a starting point for potential actions. Every RAF deployment will have different energy needs, which are currently fulfilled through host nation electricity grid connection or diesel generators. A typical Expeditionary Air Wing deployment⁹ can utilise a minimum quantity of fourteen 40kW generators, plus four lightweight field generators for support functions only. The number of generators required to support engineering functions of different platforms will correlate to the number of aircraft and their maintenance requirements.¹⁰

Key advantages of diesel generators, and reasons they are favoured for electricity generation are listed below.

Interoperability. The RAF complies with the NATO 'One Fuel' policy, which aims to maximise interoperability and simplify the logistic effort (NATO, 1997). This improves access to fuel and standardises mobility. Currently, diesel is the single fuel of choice.

Energy Density. Liquid hydrocarbons such as diesel are preferred over alternatives due to their high energy density (Van Schaik *et al*, 2022).

Availability. Deployed operational RAF bases are often situated in harsh environments; diesel generators are adaptable to any climate (Van Schaik *et al*, 2022).

Resilience of Current State

Installation energy has a strategic value to operational output, which is placed at risk from outages. It is therefore essential that deployed facilities have the capacity to maintain energy supply in response to a disruption (Booth *et al*, 2020a). A detailed resilience assessment of a deployed operational base has not been completed in this study due to

the variability between each deployment, and previously recognised lack of data to enable a comprehensive assessment. However, with consideration of the operational necessity of electricity provision, the following statements summarise the resilience risks associated with current energy solutions.

Host Nation Infrastructure. Mains electricity supply is considered increasingly at risk from disruption from adversaries and climatic events. Furthermore, in an environment where the local infrastructure is under pressure, the host nation may not support the use of its infrastructure (Van Schaik *et al*, 2022).

Diesel Generator. The use of diesel generators is reliant upon availability of fuel, which is vulnerable to logistic chain security (QINETIQ, 2020). Furthermore, the continued use of fossil fuels is politically vulnerable due to its contradiction of the UK decarbonisation strategy (Van Schaik *et al*, 2022).

4.2 Desired End State

The strategy that will be developed in this section aims to deliver a resilient deployable energy system to meet operational energy needs of RAF deployments. This end state aims to reduce reliance upon host nation electricity grids and diesel generators to mitigate logistical and climatic risks, while also fulfilling decarbonisation goals. The strategy should empower leaders to make informed energy decisions that are also aligned with allied forces.

4.3 Uncertainties

Through the literature review of MOD policy, it was possible to unravel the key criteria that will impact the implementation of alternative energy infrastructure options in deployed locations.

	<p>Budget</p> <p>The MOD budget is set annually by the UK government, with additional enhancements due to global events, such as the Ukraine Conflict. Programmes across the Defence sector must compete for funding and allocation of resources (Spellar, Twigg and Goldie, 2023).</p>
	<p>Technology readiness state</p> <p>There are decisions to be made upon trade-offs between bridging the gap of current technologies and emergent technologies, and mapping the readiness state of such a rapidly changing sector is challenging. Dual innovation between civil and Defence Sector could expedite innovation and adoption of alternative technologies.</p>
	<p>Operating environment</p> <p>Operational Military bases are often situated in harsh environments and present specific needs dependent on the geographical location. For example, an energy solution for a cold climate may not be suitable for a desert climate.</p>



	<p>Equipment requirements Power requirements vary between platforms, deployment type, deployed location and fixed infrastructure, which makes the technology requirements a significant unknown. The diversification of energy requirements is also likely to increase the demands upon an operational energy system.</p>
	<p>Governance and directive Equipment acquisition in the Defence Sector is complex, influenced by political, financial and time constraints. Programmes can be abandoned due to shifting strategic and domestic priorities set out in overarching MOD directive. (Brooke-Holland, 2022).</p>

Table 1. Uncertainties of energy transition

4.4 Thresholds for Decisions

When building adaptive pathways, a threshold is defined as a point at which a system begins to operate in a significantly different way, forcing a decision to be made (Siebentritt and Stafford Smith, 2016). For a complex system, in this case the energy resilience of an RAF deployment, there are many events or decisions that may result in a radical change of system behaviour. For example, the current state is so reliant on access to fossil fuels that a shortage of diesel fuel would immediately impact operational capability and drastically reduce deployed resilience. However, this turning point is difficult to predict and to reduce operational risk right now the focus must be on the near-term. For that reason, this study uses current UK Defence policy levers and the near-term goals that they have committed to as appropriate thresholds for an action. Table 2 details UK defence policies that have been identified as key drivers for an operational energy transition.

Document Title	Date	Key Document Commitments
RAF Net Zero Strategy (RAF, 2021)	2040	Royal Air Force to be Net Zero by 2040
Integrated Operating Concept (HM Government, 2021)	2035	'Be markedly less dependent on fossil fuels and be more self-sufficient'. 'Have an open systems architecture that enables the rapid incorporation of new capability, and rapid integration into the network'. 'We need to create a systematic programme in which military professionals can air operational challenges with industry, technologists and academia to determine the most appropriate mix of technologies to provide our future competitive edge'. 'Our effectiveness will be enhanced by driving the tempo of strategic activity in a sustained,

Integrated Operating Concept (HM Government, 2021)	2035	dynamic, calibrated approach that is integrated with other government departments and the international engagement networks of our allies'.
Sustainable Support Strategy (MOD, 2022)	2025	'Platforms need to reduce carbon emissions and the use of fossil fuels. This energy transition will be complex and rapid; its implications will be assessed through a Defence Operational Energy Strategy.' 'Resilience of the global Strategic Base. The support network needs to be resilient to a changing environment, with its vulnerabilities assessed and mitigated.' 'Self-sustainment of operations. More efficient use of resources and different ways of delivering support will deliver greater self-sustainability on operations.'

Table 2. Threshold Identification.

Table 2 Note: All quoted statements are referenced in the 'document title' column.

4.5 Tipping Points

Tipping points are when there is a distinct change in how the system is operating, provoking a review and implementation of a new action (Siebentritt and Stafford Smith, 2016).

For example, a sudden increase in the price of diesel may force a review of alternative fuel options for deployed operations, leading to a series of actions. Those actions could consist of an energy requirements analysis, or a review of available technologies to replace generators, or a transition to a cheaper fuel type. A tipping point should occur before a threshold is met and be frequently monitored to enable decision-makers to direct the next action. Proposed actions will be reviewed for suitable tipping points and methods of monitoring that support decision makers in implementation of a new action. Ideally, tipping points would not be required, and all actions could be implemented at once. However, with consideration of uncertainties like budget constraints that would make all actions impossible to implement immediately, tipping points ensure decision makers are prepared to deliver an action when an opportunity arises.

4.6 Potential Actions

The uncertainties associated with transitioning away from the current state of operational energy use are highlighted in Table 2. The vast gap between current state and end state, in addition to the uncertainties, demonstrates a complex problem for RAF decision makers and leaders to navigate. Table 3 is used to break down the complexity of this problem and evaluate options that could build a strategy to meet the desired end state.

Following the review of a range of academic and grey literature (see bibliography), potential actions were drawn from recurrent themes in recommended findings or aligned to objectives of allied military strategy. For each action in Table 3, the key supporting literature is provided. Limitations and potential tipping points for each action are also detailed in Table 3, which serve as a critical analysis each possible action. Tipping points largely consider what context enables that action to become viable, and the limitations aim to identify barriers or interconnections between actions. For example, a limitation of implementation that can be solved by another action have been highlighted. The interconnectivity will serve to support pathway development in terms of sequencing which actions are most important and should be implemented first.

Action 1: Conduct Deployed Energy Analysis			
Description	Action Limitations	Supporting Literature/Precedence	Tipping Point
<p>The identified data gap in the initial stages of this study highlighted the limited knowledge of RAF operational energy distribution and use. Installation of smart monitoring devices to collect data across different deployments will enhance command and control of energy. Decision makers will then have the knowledge required to mitigate against risks and vulnerabilities with an energy solution that efficiently distributes power to critical assets and reduces logistic complexity. In addition to empowering decisions of leaders in a forward operating environment, this data will enable technical programmes to undertake comparative assessments of alternative technologies to make technology choices for acquisition, and research investment.</p>	<p>Smart monitoring will require a form of connectivity and data storage that may not be accessible in remote locations. In lieu of smart monitoring devices, personnel could input data to a centralised database. Not using smart devices risks introducing a level of human error and a requirement for leaders to understand the need for this information and be invested in ensuring data collection takes place.</p>	<p>The US Operational energy strategy states that the DoD will focus on 'enhancing enterprise-wide planning for energy supply and demand by updating all relevant equipment-level usage characteristics and rates to ensure accurate and timely assessments (e.g, logistic factor files). These efforts will enhance the quality of Joint planning and improve energy resilience in contested operating environments(US DOD, 2023). The US DoD views power disruptions as a significant risk to their operations and have been developing methodologies to measure energy use and the resilience of base infrastructure. Collaborating with the National Renewable Energy Laboratory (NREL), researchers have developed a replicable energy resilience assessment methodology and investment decision tool (Anderson <i>et al</i>, 2020). Such a tool would not be implementable in the RAF without baselining current energy use. When implementing energy solutions such as Microgrids, data for critical loads of equipment being supported is essential for designing the system (Booth <i>et al</i>, 2020b).</p>	<p>Approval of pathway and supporting policy. Data collection on energy use and cost can begin immediately. Information gained will drive decisions and tipping points for other actions.</p>

Action 2: Smart Power Management			
Description	Action Limitations	Supporting Literature/Precedence	Tippling Point
<p>Match power generation to demand and integrate the needs of the platform and supporting infrastructure into one power generation system to reduce waste. Use Microgrids and smart power management to distribute and manage power. Microgrids can operate independently from the electricity grid, increasing the resilience of bases relying on host nation electricity.</p>	<p>Data on energy use is required to ensure that the system is designed correctly. Requires infrastructure planning and trained personnel for implementation.</p>	<p>The literature highlighted some key examples of microgrid technology being successfully employed by military and remote community installations. The confidence in microgrids as an option to improve electricity resilience on military bases has been emphasised by the US Army Climate Strategy 2022, which commits to building a microgrid on all 135 of its bases by 2035 (US Army, 2022). Microgrids provide a networked solution which allows for energy to be distributed to critical assets, increasing overall system efficiency. Microgrids are also more flexible to changing loads, which makes integrating renewables into the energy mix easier to achieve (Booth <i>et al</i>, 2020b).</p>	<p>Operational output risk increased from lack of access to host nation Infrastructure. Limited access to host nation infrastructure risking output and safety will force decisions to be made on how energy is generated and managed. Energy analysis data and equipment procurement window. Improved consumption analytics will create decision points for options such as microgrid design and implementation to align with equipment procurement timelines. Operating environments and logistical burden. Increased deployments to remote locations will drive a decision to implement microgrid methodologies, as demonstrated by the RAF through 'PowerFob' exercises in 2012 (MOD, 2012)</p>

Action 3: Adopt Mature Technology			
Description	Action Limitations	Supporting Literature/Precedence	Tipping Point
<p>Test, evaluate and adopt existing technology for energy generation and management.</p>	<p>Difficult to implement technologies without first baselining energy use. Budget limitations constraining procurement options. Adopting a mature technology may prevent investment in a novel approach. Environmental restrictions on mature technology, such as photovoltaics in the Arctic.</p>	<p>Existing technologies such as solar power and battery storage have the potential to mitigate the usage of diesel generators and are already being exploited for remote infrastructure, such as refugee camps. The case study of Mahama Refugee Camp, Rwanda demonstrated renewable infrastructure can reduce fuel expenditure by 74% over five years under current use (Beath <i>et al</i>, 2023). Whilst awaiting more novel technical solutions, the US Army recognises that integrating energy storage and renewable energy generation is essential to supporting emerging technologies and capabilities (Barry, Army and Santoso, 2022).</p>	<p>Energy analysis data and equipment procurement window. Improved consumption analytics will create decision points to inform a mature technology choice, particularly when equipment requires replacing due to obsolescence. Policy. Best practice from allies, and interoperability concerns could prompt the procurement of a mature technology.</p>

Action 4: Implement Environmental Assessment into Deployment Risk Management			
Description	Action Limitations	Supporting Literature/Precedence	Tippling Point
<p>Incorporate energy and environmental assessments into risk registers to capture the risks of current energy use in order to support a culture shift toward more conscious energy use.</p>	<p>Potential to complicate existing environmental policy. Requires training of RAF leadership to demonstrate the need and value of incorporating energy resilience planning into deployment planning. Pushback due to the additional work required in preparation for a deployment.</p>	<p>US Army has set a target to ensure all Army operational and strategic exercises and simulations consider climate change risks and threats by 2028' (US Army, 2022). The DoD Operational energy strategy recognises that the risks associated with delivering energy on deployment need to be better understood. The department has committed to developing logistics and supportability concepts by using 'Energy Key Performance Parameters' and 'Energy Supportability Analysis' when developing new equipment (US DoD, 2023). Learning from humanitarian aid organisations, the RAF could implement an adaptation of the UN's Environmental Emergency Centres' Joint Initiative's 'Nexus Environmental Assessment Tool', and the 'Rapid Environmental Assessment' used to highlight environmental concerns before designing a deployed base (EEC, 2017). Such tools could be incorporated into existing RAF publications for risk assessment.</p>	<p>Approval of pathway and supporting policy. Policy exists for conducting risk assessments for deployments, an update to include assessment of energy resources can begin immediately.</p>

Action 5: Equipment Procurement Strategy			
Description	Action Limitations	Supporting Literature/Precedence	Tipping Point
Sustainability needs to be a leading criterion, closely followed by interoperability between assets and equipment.	Culture change required to ensure procurement policy encouraging sustainability criterion is a priority.	The Defence commercial toolkit includes sustainability criterion in its procurement charter which must be commented upon during procurement (MOD, 2020). All layers of a supply chain should be educated on principles of sustainable procurement to support application.	Approval of pathway and supporting policy. Mechanisms are in place to support sustainable criterion in procurement and should be publicised widely to ensure application.
Action 6: Provide Training on Defence Climate Strategy			
Description	Action Limitations	Supporting Literature/Precedence	Tipping Point
Create an education package that is disseminated to all personnel on climate strategy and individual implementable actions, such as energy awareness. Publish existing projects, findings and best practices annually to drive innovation and organisational learning.	The RAF have a well-established training structure. To incorporate an energy awareness programme into existing education structures may be met with resistance due to existing training burden.	The absence of well-trained power managers will continue to exacerbate the inefficiency of current power system operations, and hobble the integration of advanced power systems into future Army operations' (US Defense Science Board, 2016). Existing literature has highlighted that change is not possible through policy alone. Personnel need to change their approach to energy conservation and embed sustainability in the mindset of personnel. US Army is including climate change topics in workforce training and increasing the number of personnel with advanced credentials on climate change topics in strategic headquarters (US Army, 2022).	Approval of pathway and supporting policy. Training structure exists and can be adapted to include energy awareness programme.

Action 7: Retrofit Infrastructure to Improve Efficiency			
Description	Action Limitations	Supporting Literature/Precedence	Tipping Point
<p>Improve deployed infrastructure building envelope to reduce overall energy use. Incorporating smart building control systems to reduce or retain heat.</p>	<p>Budget constraints for design and construction costs.</p>	<p>Improved building infrastructure can significantly reduce fuel demand of temporary infrastructure in remote locations (Katalenich & Jacobson, 2023).</p>	<p>Energy Analysis. Improved consumption analytics will create decision points to inform how energy is being consumed by infrastructure, including for heating and cooling. Operating environments and logistical burden. Increased deployments to remote locations will drive the decision to implement improved building envelope to reduce energy use.</p>
Action 8: Partner with Allies for Equipment Development			
Description	Action Limitations	Supporting Literature/Precedence	Tipping Point
<p>Work with allies to share research, recommended best practice and develop technology.</p>	<p>No perceived limitations to partnership</p>	<p>The Integrated Operating Concept recognises the importance of developing doctrine and technology in alignment with allies (HM GOV, 2021).</p>	<p>Energy Analysis. Improved consumption analytics will create decision points to inform research and best practice. Operating environments and logistical burden. Increased deployments to remote locations will require decisions with allies on future options.</p>

Action 9: Direct Technology Research			
Description	Action Limitations	Supporting Literature/Precedence	Tipping Point
Use energy analysis to prioritise the funding allocated to energy diversification and technology innovation. Accurate data will enable direction of research for specific goals.	The RAF are already investing in operational energy projects, and delaying until further data is collected could undermine existing work (RAF, 2023).	The US 2023 Operational energy strategy states that the DoD will pursue pilot demonstration projects that support the generation of alternative energy sources (eg, renewables, SAF, nuclear, hydrogen, others) (US DOD, 2023).	<p>Energy Analysis. Improved consumption analytics will create decision points to inform research and best practice.</p> <p>Operating environments and logistical burden. Increased deployments to remote locations will drive innovation for solutions to specific energy problems.</p> <p>Policy. The UK Government's directive to reduce fossil fuel use across all sectors is likely to drive industry innovation creating opportunity for partnership and innovation (HM Government, 2021).</p>

Action 10: Implement Novel Technology			
Description	Action Limitations	Supporting Literature/Precedence	Tippling Point
Use the results of technology research to test, evaluate and implement novel technology.	The timeframe to develop energy alternatives may exceed the policy thresholds. Technology readiness states is identified in Table 1 as a key uncertainty. Competing budget constraints.	The US DoD has committed to the Operational Energy Capability Improvement Fund (OECIF) and Operational Energy Prototype Fund (OEPF) focused on novel operational energy technologies that will improve Joint combat effectiveness (US DoD, 2023). Modular nuclear reactors, Radioisotope thermoelectric generators, and Space-based PV satellites are all possible future technologies (Barry <i>et al</i> , 2022).	<p>Energy analysis. Improved consumption analytics will create decision points to inform research and best practice.</p> <p>Operating environments and logistical burden. Increased deployments to remote locations will drive innovation for solutions to specific energy problems.</p> <p>Policy. The UK Government's directive to reduce fossil fuel use across all sectors is likely to drive industry innovation creating opportunity for partnership and innovation (HM Government, 2021).</p> <p>Procurement window. The budget for investment in alternative technologies will be impacted upon the age of the equipment being replaced (MOD, 2020).</p>

Table 3. Action analysis

4.7 Action Evaluation of Effectiveness

To help prioritise and sequence the actions in Table 3, a scorecard system has been used. Each action has been assessed for perceived impact on the criteria listed below. The criteria have been influenced by the four areas of the literature review and are deemed important to the aims of this study. The list specifies how each criteria underpin an operational energy strategy.

Criteria:

Energy Usage. A simple way of reducing fossil fuel use is to reduce the demand, by managing energy consumption.

Data Collection. Improved data on deployed energy use will enable informed decisions and the overall strategy.

Organisation Accountability. The literature highlighted tools being used by the humanitarian aid sector to reduce the environmental impact of their operations. Introducing accountability to the score card aids the consideration of second order effects of an action.

Organisational Credibility. The Integrated Operating Concept highlighted the importance of operating and aligning with allies (HM Government, 2021). Each action has been assessed to ensure it does not undermine sustainable obligations.

Table 4 demonstrates the scorecard method. The perceived impact is based upon conclusions drawn from literature in the bibliography. The information generated in the scorecard will be used to assemble pathways for consideration later in this chapter. It is a limitation of this study that only the authors perception is used in this assessment. With more time, stakeholders could individually complete a score card to gain wider perspective of efficacy of actions.

Metric Of Success – Scorecard						
Action	Energy Usage	Data	Organisational Accountability	Organisational Credibility	Score	
Business as Usual	-	-	-	-	-4	
Conduct Deployed Energy Analysis	+	++	+	+	5	
Implement Environmental assessment into deployment Risk Management	+	0	++	++	5	
Smart power management	++	+	+	+	5	
Retrofit infrastructure to improve efficiency	+	0	+	+	3	
Adopt mature technology	+	0	+	+	3	
Update procurement strategy	+	+	+	+	4	
Partner with allies for equipment development	0	+	+	++	4	
Provide training on Defence Climate Strategy	+	0	++	+	4	
Direct technology Research	0	++	+	+	4	
Implement novel technology	++	0	+	+	4	

Key	
0	No Impact
-	Negative Impact
--	Large Negative Impact
+	Positive Impact
++	Large Positive Impact

Table 4. Metric of success - Scorecard. Adapted from (Haasnoot *et al*, 2013)

4.8 Action Prioritisation

Table 5 considers the limitation and tipping point columns from Table 3, to gauge if each action is implementable immediately. The actions not yet considered implementable were deemed to benefit from a pre-requisite action. For, example, smart power management requires data on deployed energy use to ensure that the system is designed correctly. This separation of immediately implementable actions will help sequence the actions later in this chapter.

Action	Implementable now?
Business as Usual	Yes
Conduct Deployed Energy Analysis	Yes
Implement Environmental assessment into deployment Risk Management	Yes
Smart power management	No
Retrofit infrastructure to improve efficiency	No
Adopt mature technology	No
Update procurement strategy	Yes
Partner with allies for equipment development	No
Provide training on Defence Climate Strategy	Yes
Direct technology Research	No
Implement novel technology	No

Table 5. Action timeline

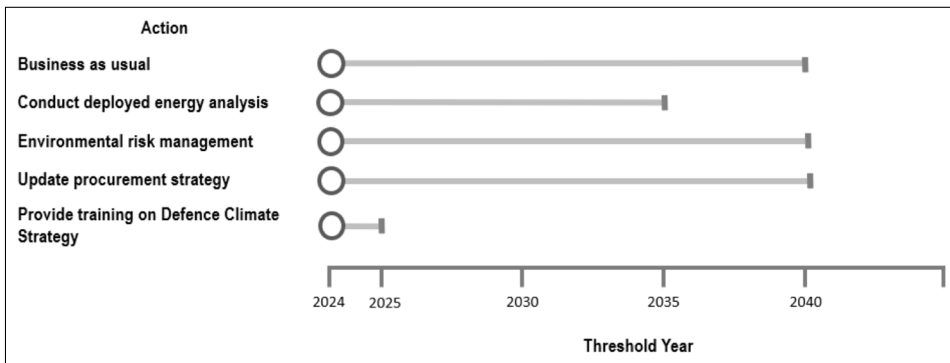
Table 6 combines the results from Table 4 and Table 5 to order the actions in to order of effectiveness with comparison to implementation. This will be used to determine which actions are most effective immediately and should be the first implemented. For example, ‘conduct deployed energy analysis and ‘implement environmental assessment into deployment risk management’ both scored the highest metric of success and are deemed implementable now, so will be prioritised as first actions in the strategy.

Action	Metric of success Score	Implementable now?
Conduct Deployed Energy Analysis	5	Yes
Implement Environmental assessment into deployment Risk Management	5	Yes
Smart power management	5	No
Update procurement strategy	4	Yes
Partner with allies for equipment development	4	No
Provide training on Defence Climate Strategy	4	Yes
Direct technology Research	4	No
Implement novel technology	4	No
Retrofit infrastructure to improve efficiency	3	No
Adopt mature technology	3	No
Business as Usual	-4	Yes

Table 6. Action prioritisation.

4.9 Building a Pathway Map

To begin visually representing the actions on a pathway map, Figure 8 takes the five actions that are deemed immediately implementable and lists them with their corresponding policy thresholds from Table 2. Figure 8 shows that a decision on these five actions can be made now but can be made at any point until the threshold.



Key
 ■ Grey Vertical Line. Threshold for action to meet current policy targets.
 ○ Circle. Key Decision Point.

Figure 8. Immediately implementable actions

Figure 9 details the delayed actions from the scorecard that are assessed as not immediately ready for implementation. The circles on the diagram represent key decision points, where an action may be implementable. Decision points do not correlate to the threshold year axis and may be brought forward or delayed due to emergent information at periodic review. Further detail on decision points will be provided in the preferred pathway notes.

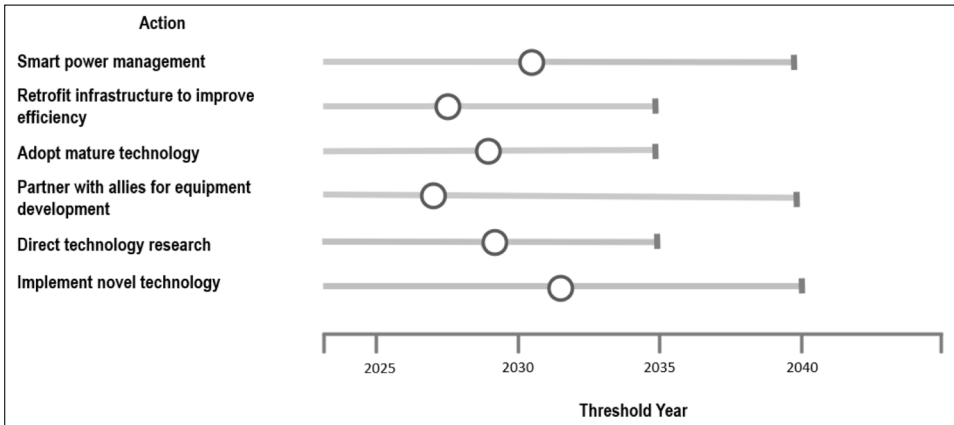


Figure 9. Delayed actions

Figure 10 combines the information from Figures 8 and 9 to show actions available to implement now and actions that are delayed.

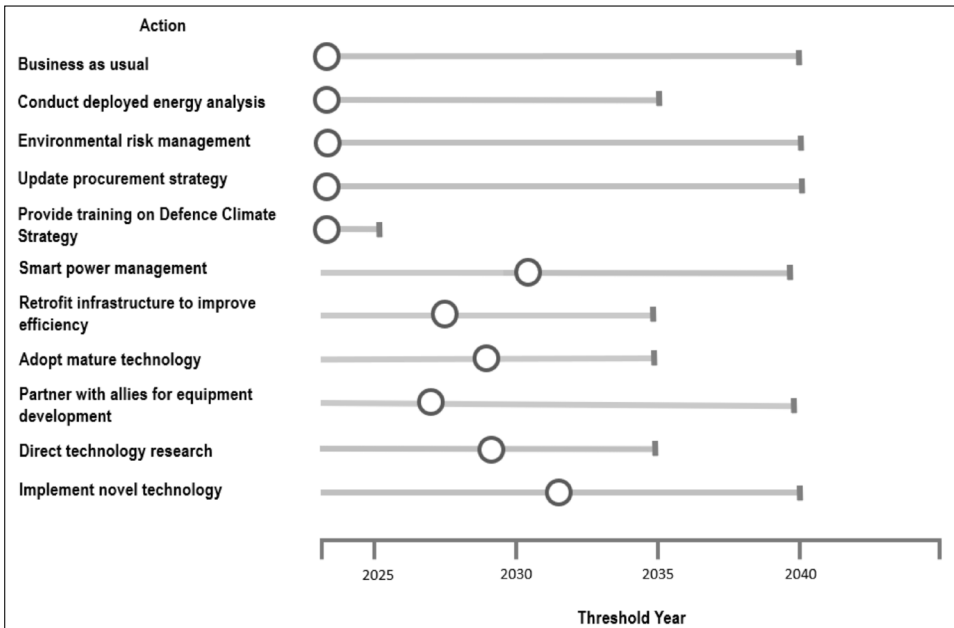
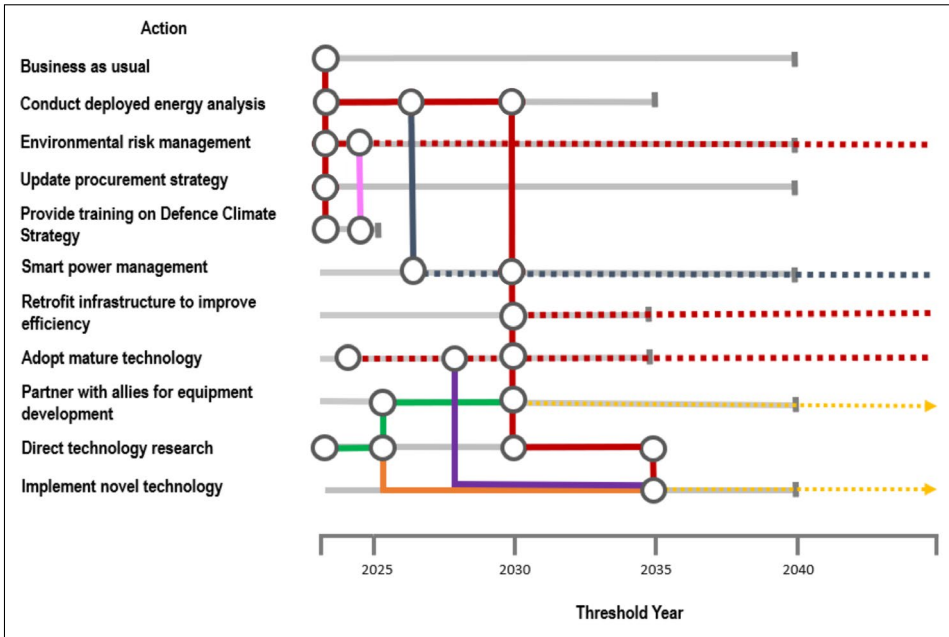


Figure 10. All actions and thresholds

4.10 Scenario Mapping

Adaptive pathway mapping is used to visually represent pathway options, potential lock-ins and path dependencies, to allow decision makers to adapt to new information (Siebentritt and Stafford Smith, 2016). The mapping of several different options is called scenario mapping and is used to show the user that different options have been considered. A scenario map is subjective to the priorities of the stakeholders, with flexibility for almost any pathway between actions to be taken. Different users and stakeholders are likely to have a different perspective upon which pathway will be most successful, and adding each option to the scenario map can be a useful method of highlighting different priorities. Where different pathways converge is a point where discussion should take place for an adaptive plan (Haasnoot *et al*, 2013). Figure 11 shows an example of an adaptive pathway map using the actions from Table 3 in multiple scenarios. ‘Figure 11 Notes’ details how this map may be interpreted. Section 4.11 details how a preferred pathway option has been mapped.



- Key**
- || Grey Vertical Line. Threshold for action to meet current policy targets.
 - Dashed Line. Contributes to an adaptation solution, but only in part.
 - > Yellow Arrow. Emerging Pathway that needs to be further assessed.
 - Circle. Key Decision Point.
 - Solid Colour line. Action considered viable pathway. Multiple Actions can contribute to one pathway.

Figure 11. Scenario mapping

Figure 11 Notes:

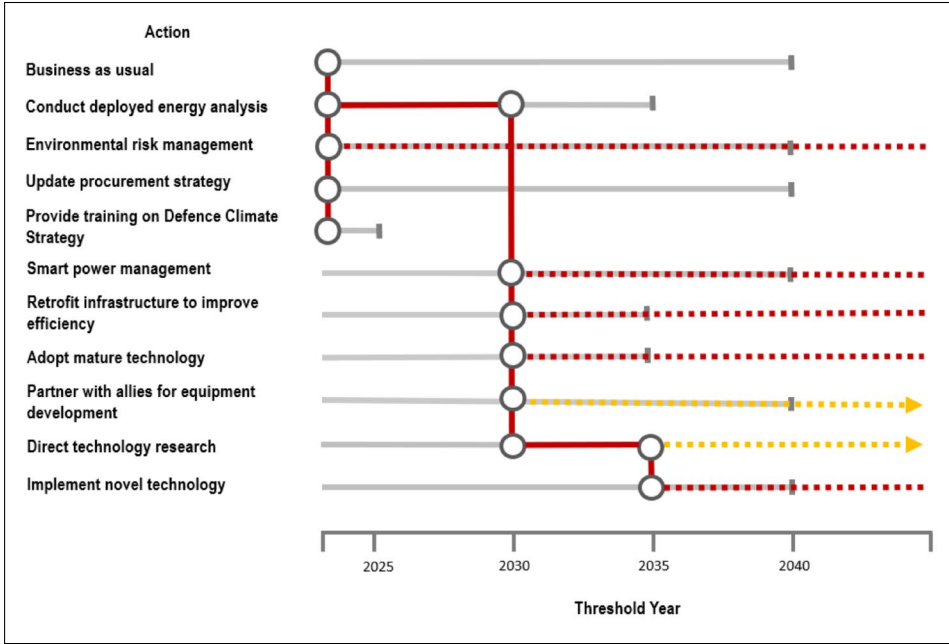
- Each action has a threshold expiration date applied, for which the action expires in relation to current policy detailed in Table 2.
- 'Business as usual' is a key driver for decision making for other actions. Although the threshold is 2040, no pathway has been drawn on this action because it scored negatively on the metric of success scorecard and is therefore not preferred, with alternative actions immediately preferred and implementable.
- The 5 actions that are considered immediately implementable are placed at the start of the pathway, the remaining actions have flexible decision points which do not correspond to the threshold year. Tipping points are individual to each action and are detailed in Table 3.
- Conducting deployed energy analysis was identified as key to driving further decisions on operational energy transition and can be considered a path dependency for many other actions, as shown by the red pathway option.
- The navy-blue line highlights sequencing between 'energy analysis' and 'smart power management' showing how smart power management needs to be based on a decision from deployed energy analysis. The dashed blue line from implementation of smart power management onwards, also shows that this action only forms part of the overall energy strategy.
- Some tipping points may lead to multiple actions, such as 'direction of technology research' may result in both 'partnering with allies for equipment development' and switching to 'implementation of novel technology', which act in parallel. A tipping point on the green pathway, following further emergent information, may result in further direction of technology research. This pathway serves to highlight to decision makers that actions can both be used in parallel and be transitioned between.
- The pink pathway serves to highlight an example of a potential lock-in between actions. For example, although both 'Environmental risk management' and 'Training on Defence Climate Strategy' are both considered actions implementable now, it may be that personnel will be more confident in applying new environmental risk management with the additional support of training, and thus the actions must be completed together.
- The yellow arrow shows emerging pathways that could lead to new actions. Equipment and technology development have been highlighted as actions that are most difficult to predict and are influenced most by the uncertainties of Table 1. Uncertainties of energy transition.

4.11 Preferred Adaptive Pathway

For the purpose of proposing a strategy for the RAF to implement, a preferred pathway has been identified from Figure 11, and illustrated in Figure 12. The Figure 12 notes detail how to interpret the map.

As explained in para 4.10, different stakeholders may identify different pathways that suit their own priorities. In the absence of a roundtable discussion with all stakeholders to agree on a

pathway, a literature based approach has been taken, by incorporating the analysis of Table 3 and Table 6. The preferred pathway has prioritised actions by weighting an action against success criteria, and timeline for implementation, to create the most logical sequencing of actions.



- Key**
- Grey Vertical Line. Threshold for action to meet current policy targets.
 - Dashed Line. Contributes to an adaptation solution, but only in part.
 - Yellow Arrow. Emerging Pathway that needs to be further assessed.
 - Circle. Key Decision Point.
 - Solid Colour line. Action considered viable pathway. Multiple Actions can contribute to one pathway.

Figure 12. Preferred pathway

Figure 12 Notes:

- A preferred pathway has been built using the analysis of actions in Table 3 combining learning predominantly from the U.S Defence sector and UK MOD policy to prioritise actions for an adaptive approach to an operational energy strategy for the RAF.
- The 5 actions that are considered immediately implementable are placed at the start of the pathway, the remaining actions have flexible decision points which do not correspond to the threshold year. Tipping points are individual to each action and are detailed in Table 3. For example, the data from deployed energy analysis may provide

the necessary data to decision makers to immediately implement a micro-grid solution as an 'smart power management' action or a mature technology.

- The priority and order of the six delayed actions will be dependent upon the energy data collected and the suitability of each action as a response to that information. The straight line from energy analysis to each of the delayed actions is to show decision makers that they will have a choice once energy analysis is completed.
- The yellow arrow shows emerging pathways that could lead to new actions. Emergent pathways can occur at any time when new data becomes available. From current literature, technology innovation is the most likely to create an emergent path but is also likely to be impacted by the uncertainties of Table 1.
- Multiple actions deliver the optimum solution and can act concurrently, often complimenting each other. The dashed lines show actions that complement each other and can work together to deliver the strategy.

4.12 Preferred Pathway Monitoring and Implementation

Tipping points for individual actions are imperative to enable decision-makers to act at the optimum time and adapt accordingly. Adaptive planning allows for actions to be ready for when an opportunity arises to implement them (Haasnoot *et al*, 2013), therefore a process must be in place to support the adaptive plan, monitoring the current state and determining if an action tipping point is being reached.

To enable monitoring and implementation, ownership of both the strategy and each action by RAF leadership is required. Due to the uncertainties described in Table 1, a set review point is difficult to dictate. In response to the threshold dates set by existing policy, a six-monthly review is recommended as a minimum.

Measuring the success of developing a resilient operational energy infrastructure is challenging. However, some quantifiable metrics that could be analysed with future data availability are detailed below.

- A measured reduction in diesel consumption.
- A measured increase in fuel diversity.
- Increased number of deployments in off-grid locations as not dependent upon host nation infrastructure.

5. Pathway Validation

The following section details interviews with RAF stakeholders to validate the actions presented in the pathway map and the supporting conclusions drawn from literature. Interviewing RAF experts currently working in decarbonisation and sustainability strategy was an important validation process to confirm preliminary conclusions of this study that informed actions. Furthermore, feedback on the readability of the pathway map is essential for future applicability.

5.1 Interview Format

The interviews were semi-structured, consisting of five predetermined questions. Where time permitted, an informal discussion about the pathway map was also included, to check understanding of the presentation format and relevance of the actions, thresholds, tipping points and uncertainties. The roles of the interviewees are detailed in Table 7. All interviewees are senior officers leading sustainability projects in the RAF and MOD.

Title	Role Summary
RAF DACOS Sustainability	Lead for RAF climate change and sustainability strategy, reporting directly to the Chief of the Air Staff. ¹¹
UK Stratcom Future Support	Civil Servant supporting climate change and sustainability strategy within the UK Strategic Command.
SO2 Eng Plans BSFAI Falklands	Lead for sustainability and conservation in the British Forces South Atlantic Islands, Falklands.
SO2 Aviation and Equipment	Strategist for RAF aviation decarbonisation within RAF Headquarters and the lead author of the Defence Aviation Net Zero Strategy (MOD, 2023c).
SO1 A4 Capability Strategy	Lead Officer responsible for aligning RAF Engineering and Logistics equipment procurement and support, with sustainability strategy.

Table 7. Interviewees.

Four interviews were conducted on the military communication network using Skype, and one interview face to face. To allow participants to speak openly and honestly, interviews were not recorded, and notes were taken by hand. Following the interview, notes were transcribed and sent to participants to confirm the accuracy of the transcriptions.

5.2 Interview Results

The following sections are split into the responses provided for each subject category. The relevance of the topic and reason for discussion is introduced in each section, followed by the summary of responses.

Data Collection for Energy Analysis

The initial stages of this study encountered difficulties with obtaining adequate data, specifically on energy use by the RAF in deployed locations, leading to the recommendation for improved data collection to inform decision makers. All interviewees confirmed that the lack of data in this area has hindered decision-making thus far, and that improved data collection is needed. It was also highlighted that progress is being made from an

organisational perspective, with the requirement for data collection and ownership being raised, and there are ongoing projects to improve data collection.

In addition to initial data collection, interviewees were keen to highlight the need for improved collaboration between platform teams to increase the value of collected data and to deliver solutions for all by creating a single source of information.

Climate and Energy Education for the RAF

The literature highlighted that energy-aware leaders are important to energy management. As an organisation with an existing training structure, the proposed timeline for implementation of this action is very short. However, it is also recognised that buy-in from RAF leaders would be needed to support an additional training package. All interviewees agreed that there is a need for improved climate and energy literacy across the force, and that the existing training structure that personnel are familiar with should be used to maximise reach across the RAF.

One interviewee provided an example of an educational initiative, where an internal study has shown that overall energy demand could be reduced by 10% with a cultural change achieved through training. However, owing to the rapid throughput of personnel the improvements would be unlikely to succeed long-term, unless the training took place systematically across the force.

Current Support for Operational Energy Decision-Making

Decision points on the pathway were informed by the author's interpretation of existing policy and directives. The interviews provided further background on existing support mechanisms in place to assist decision makers and to identify any missing considerations that could be incorporated into the final map. It was highlighted that the imminent publication of a Defence-wide operational energy strategy will help provide guidance on how a deployed base might operate in the future, and equally, how airbases will operate in the UK. A Defence wide strategy will provide opportunities for collaborative problem solving and support to decision making within the RAF.

Whilst the proposed pathway recommends an action for allied partnership for interoperability purposes, three of the interviewees suggested that greater collaboration between parallel government departments would also help align strategies, providing the necessary confidence for innovation and investment into novel technologies by industry. Joined up approaches to similar problems across the UK Government will also help to mitigate costs.

Business as Usual

The literature places a threshold of 'business as usual' in line with net zero targets, but as highlighted in the problem analysis section of this study, there are increasing risks associated with continued reliance upon fossil fuel. Interviewees were asked for their thoughts on the timeframe that current practice will remain effective, to determine if the policy threshold

was appropriate and if any further uncertainties could be included. The response from interviewees were mixed, highlighting some of the complexities of this topic. One interviewee gave an example of equipment, within their area of responsibility, where restrictions were already imposed by fossil fuel reliance. They described how the limitations could be solved using existing renewable technology, and therefore supported the adoption of mature technology now.

On the other hand, another interviewee highlighted that current deployments still have access to the fuels needed to operate, but the reliance upon energy is set to increase, and thus the resilience of the system to disruption must be better understood and planned for.

Allied Partnership

From the literature review, the US defence sector was identified as a key source of case studies which could be exploited, and actions in the pathway map have drawn heavily upon the strategies that are already being implemented in the US military. Whilst the Integrated Operating Concept highlights the necessity of collaborating with allies (HM Government, 2021) it was important to understand from the interviewees whether there is an appetite for collaboration with allies. All respondents were enthusiastic about the opportunities for mutual collaboration on operational energy solutions. Partnerships were highlighted as being a method of unlocking markets for investment, with bilateral relationships and discussion able to exploit mutual benefits of decarbonisation and reducing lengthy supply chains. Existing international forums and working groups, such as the Five-Eyes partnering agreement, already exist for international collaborative working on topics including logistics, which demonstrates the enthusiasm for allied collaboration.

Pathway Discussion

The final pathway map was discussed in detail with each interviewee. A common recommendation was to ensure that the supporting documentation clearly articulates how the plan can be adapted, so that leaders interpreting the information do not assume that the preferred pathway is the only option. It was also suggested that technology research is not delayed, considering current ongoing projects within the RAF. The overall visual representation was positively remarked upon.

5.3 Interview Limitations

Due to time and diary constraints the sample size was limited to five interviewees. Ideally, a grouped stakeholder engagement meeting would have taken place for a more comprehensive collection of viewpoints.

The five interviewees were chosen due to their experience working within the RAF on policy and strategy to meet net zero and decarbonisation commitments, which may introduce a bias, due to their similar views and education to the author. Interviews with leaders who are less educated on net zero strategy could have been useful to see if the pathway was readable and

valuable to them. Opposing viewpoints may have challenged the author to create additional actions to address any unforeseen stakeholder lock-ins.

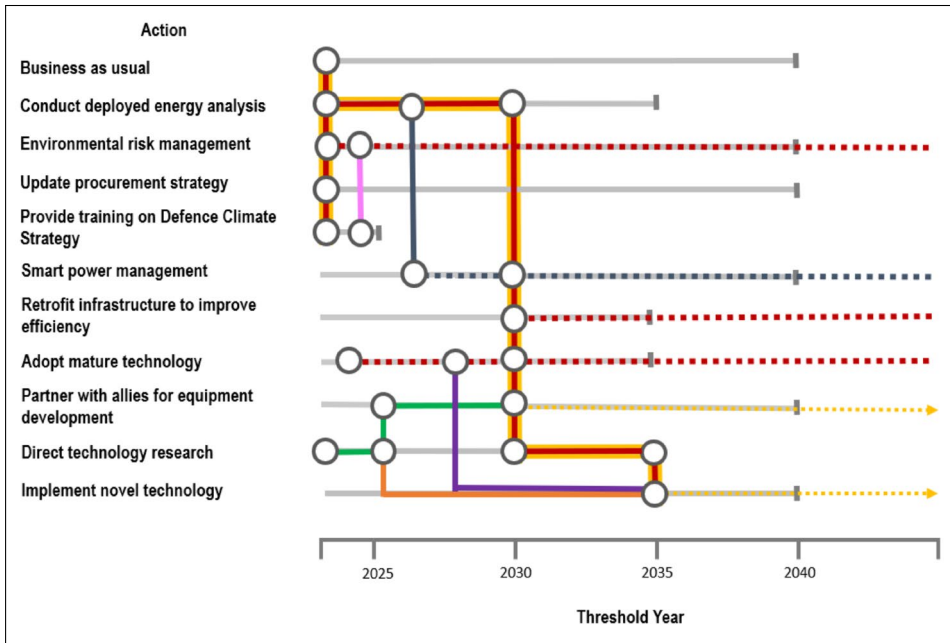
The interview transcripts purposely omitted examples of interviewees individual experiences with specific projects or deployments, to ensure correct classification of this document. Overall, this is not deemed to reduce the output of this study.

5.4 The Preferred Adaptive Pathway Final Map

This section incorporates interviewee feedback into the final map. Importantly the interviews confirmed that the current state and underpinning uncertainties, thresholds, and tipping points were reflective of the RAF's current approach to operational energy, validating the interpretation of reviewed literature.

The interviewees were eager for current work and projects within the organisation to be recognised. Figure 11 of the pathway development represented current technology research on the green lined pathway option, where 'Direct technology research' was not delayed. In the map in Figure 12, presented to the interviewees, only the preferred pathway was shown, thus confusion if other options had been considered.

To ensure decision makers understand that alternative pathway options are available at any time, the final map will include considered pathways from Figure 11. The preferred pathway built from Table 2 will be highlighted as the priority strategy and preferred pathway using the map key. The final adaptive pathway map and key are shown in Figure 13 (Next page).



- Key**
- Grey Vertical Line. Threshold for action to meet current policy targets.
 - Highlighted line. Preferred and recommended pathway.
 - Dashed Line. Contributes to an adaptation solution, but only in part.
 - > Yellow Arrow. Emerging Pathway that needs to be further assessed.
 - Circle. Key Decision Point.
 - Solid Colour line. Action considered viable pathway. Multiple Actions can contribute to one pathway.

Figure 13. Final pathway map

6. Pathway Mapping Discussion

This section identifies the limitations of this study and makes recommendations for future work to improve the results of the pathway map for applicability to the RAF and for broader use by other sectors for energy transition planning.

6.1 Pathway type

Werners *et al* suggest that adaptation pathways planning can be clustered into three different types:

1. 'Performance-threshold oriented pathways', where sequencing is reactive to a measurable response to a future scenario (Werners *et al*, 2021).

2. 'Multi-stakeholder-oriented pathways', where instead of using measurable changes as thresholds, they identify thresholds that are important for local stakeholders (Werners *et al*, 2021).
3. 'Transformation-oriented pathways', where the current system performance is not considered satisfactory and a need for change is identified, intentionally addressing a need to transform governance to enable adaptation (Werners *et al*, 2021).

Following completion of the pathway development process, this study exhibits the attributes of a transformation-oriented pathway, addressing the need for an operational energy strategy. Furthermore, the actions do not react to a measurable response, but instead they use thresholds and tipping points to drive a decision towards change.

Whilst the adaptation pathway process has successfully created a potential strategy for implementation by the RAF, a performance-threshold oriented pathway could ensure a more definitive metric of success and methodology for monitoring tipping points. The uncertainties, particularly regarding data collection, made it difficult to implement a measure of performance in this study, but with improved data collection there could be an opportunity for integration of performance thresholds in the future.

6.2 Pathway Mapping and Prioritisation

Inclusion of stakeholder engagement at an earlier stage of the study could have been beneficial to the development of actions and pathways, particularly owing to the subjective nature of prioritising actions. Using stakeholders in the pathway development process, in addition to the validation phase, would have comprehensively informed the actions on the pathway beyond literature-based solutions, reflecting the needs and challenges of RAF operations from the perspective of experienced personnel. On the other hand, introducing too many stakeholders too early in the process can stifle innovation and delay progress. Even so, within a large organisation like the RAF, involving senior decision-makers in the formulation of the plan from the outset will encourage personal investment and increase the likelihood of implementation. Therefore, there was potentially a missed opportunity in this study to support a cultural shift amongst stakeholders invested in the monitoring of the strategy and increased engagement with the concept of adaptive pathway mapping (Noar, 2023).

The scorecard method of assessing the effectiveness of actions is also acknowledged as a subjective method (Haasnoot *et al*, 2013). Future work may wish to utilise an alternative method of scoring the priority of actions using a quantitative metric of assessment or arithmetic weighting of actions. However, this approach and the resulting scores were validated during the interview phase of the study.

6.3 Collaboration and Organisational Change

Since conducting this research, the MOD have commissioned a consultancy-led Defence Operational Energy Strategy (DOES) and directed a tri-service team to be responsible for the ownership and delivery of the established policy (Bidstats, 2022). The work has yet to be published at the time of writing; however, it should be considered that the recommendations of the DOES report will be implemented by the RAF and may impact recommendations of this pathway map. It would be beneficial to compare this study to the DOES report to identify the parallels and differences. For example, it may introduce thresholds and actions that study has not identified. Ultimately, the publication of the DOES further highlights the need for this body of work and the efforts of the DOES consultation should be used to refine the final actions and map with wider stakeholders. It was also stated in this study that successful implementation of the pathway map will require ownership of actions for monitoring and decision making. Capitalising on the support structure of an overarching DOES will help ensure correct ownership and oversight of the actions, improving the likelihood of successful pathway implementation.

With consideration of Kotters 8 steps for organisational change within an organisation, shown in Figure 14 (Kotter, 1996), the adaptive pathway in this study could compliment the DOES by communicating vision and empowering action within the RAF. The visual presentation of actions through pathway mapping identifies to decision-makers the opportunities for 'quick wins' through immediately implementable actions, and how to sustain the change with delayed actions.

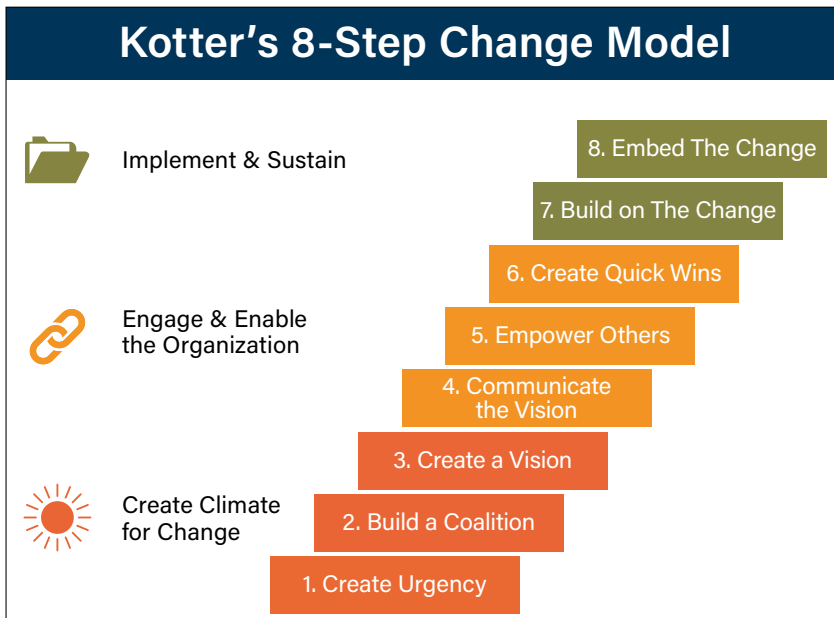


Figure 14. Kotter's 8-Step Change Model. Image credit (Denis, no date)

6.4 Broader Application Opportunities

The scope of this study was limited to the RAF; however, the resultant actions are highly adaptable to any organisation aiming to reduce its reliance on fossil fuels for electricity generation, particularly in remote locations. This study has highlighted significant uncertainties that are barriers to decarbonisation, and a method of proactively navigating the challenges to create a vision for change.

The literature review drew lessons from humanitarian aid organisations also working in remote environments. It is intended that the successful implementation of this strategy will drive investment into technical energy solutions from the Defence sector and subsequently deliver fossil fuel alternatives to wider markets. Increasing access to green technology will support remote communities in a just energy transition and support the provision of clean energy to displaced populations.

7. Conclusions and Recommendations

7.1 Resilience

This study has shown that there is still work to be done within the RAF to assess the resilience of its current deployed energy systems. Data paucity prevents identification and mitigation of risks to critical output from energy disruption, and appropriate planning for the future. In the problem analysis, high level risks associated with the continued use of fossil fuel and grid infrastructure were drawn upon from studies of deployed operations to create a starting point for an alternative strategy. However, to deliver a more comprehensive energy resilience assessment than what could be achieved in this study, there needs to be a greater organisational understanding of how resilient the RAF is now, with consideration of system level risks and vulnerabilities, and what the vision for resilience is in the future. Using the top-level risks of reliance on fossil fuel and grid infrastructure, this study focussed the concept of energy resilience as a reduced logistical demand for fuel and reduced reliance on a potentially compromised host nation grid network. However, the lack of sufficient data has prevented a full infrastructure resilience assessment, using a method like ARUP's energy resilience framework (ARUP, no date), and as a result, the RAF will continue to miss an opportunity to facilitate meaningful resilience analysis and risk management until sufficient data is reported.

It is recommended that a standardised method of collecting energy data is implemented across platforms as a matter of urgency, to support risk assessment and decision making regarding the RAFs dependence on fossil fuel for operational energy.

7.2 Collaboration and Learning

The literature used to define actions in the strategy was heavily influenced by the U.S Defence sector. The significant investment and research into energy resilience on both deployed and permanent U.S bases represents an opportunity to learn from the work that has been

undertaken. This study does not represent all of the research that has been undertaken, instead focussing on solutions that have been deemed appropriate to the U.S Operational energy strategy or trialled in a deployed context.

It is recommended that further collaboration and cooperation is undertaken with international military allies to support interoperability and compatibility in order to incentivise market opportunities for decarbonisation technologies.

7.3 An implementable Operational Energy Strategy

This study has successfully developed a strategy to guide RAF leadership through a transformation of operational energy management. The identification of limitations and uncertainties throughout the process is also beneficial to guide future work. The use of the dynamic adaptive pathway approach embraced the uncertainties and complexities of the problem, to deliver manageable actions to RAF leadership. With competing priorities for resources, RAF leadership must recognise the urgency to act and begin to deliver on the actions defined within the strategy to ensure that threshold targets are met.

It is recommended that the actions identified within the preferred pathway are given appropriate ownership, and the pathway results are communicated to the leaders currently assigned to roles within the DOES strategy implementation plan. The opportunity to align the RAF with the proposed DOES will increase the likelihood of pathway success, by integrating with an overarching directive and eliminating the uncertainty of policy.

The use of the adaptive dynamic pathway approach for energy strategy in a complex sector, sets an example for other government departments as a method of application for environmental strategy.

7.4 Final Remarks

The existing reliance of RAF operations on fossil fuels to meet its deployed infrastructure energy needs is not compliant with emissions targets, placing future freedom of manoeuvre at risk. Facing complex uncertainties, the RAF must implement future approaches to deployable energy that are flexible to emergent information, changing technology and a changing world. Energy informed decision making will be key to developing the energy solutions of the future and using tools like the adaptive dynamic pathway approach will assist leaders in adapting to new information, while making positive strides towards energy resilient deployed infrastructure.

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Notes

¹ UK Ministry of Defence is the government department responsible for UK Security and Defence policy.

² North Atlantic Treaty Organisation is a military alliance of 31 member states, of which the UK is a member.

³ Equipment type, usually aircraft.

⁴ Evidence of typical field support provided by RAF Wittering Ground Engineering Specialists responsible for deploying generators for expeditionary energy use.

⁵ A Battalion consists of multiple companies and can include up to 1,000 soldiers (US Department of Defense, 2023).

⁶ 2001-2014 international coalition of NATO nations led by the USA, invaded Afghanistan with the intent to destroy terrorist organisations. 2003-2011, international coalition of NATO nations led by the USA to overthrow Saddam Hussein (National Army Museum, 2023).

⁷ A nation that receives the forces or supplies of allies nations, to be located on, to operate in, or transit through its territory (*Free Dictionary*, 2023).

⁸ 'Resilience thinking addresses the dynamics of complex social–environmental systems and explores how such systems can be managed in the face of disturbances – it is a paradigm beneficial toward the aims and objectives of sustainable development' (Kharrazi, Akiyama and Yarime, 2018).

⁹ Expeditionary Air Wings are RAF units designed to rapidly deploy to support a platform deployed from its home base.

¹⁰ Evidence of typical field support provided by RAF Wittering Ground Engineering Specialists responsible for deploying generators for expeditionary energy use, and RAF Coningsby Ground Engineering Specialists responsible for deploying ground equipment for Eurofighter Typhoon. Personnel figures for deployments have been removed for this paper.

¹¹ Chief of the Air Staff is head of the RAF and reports to the secretary of state and UK Prime Minister.

Dissertation

UK Securitisation of Foreign Policy to Achieve Development Goals in Nigeria

By Squadron Leader Joan Ochuodho

Biography: Squadron Leader Joan Ochuodho is a People Operations Officer. She is currently the desk officer for Europe and NATO within the Air Staff International Team. Her previous roles have included HR, Infrastructure Management and Finance. She is also a RAF Football Association Board Trustee and the Association's current Football Association Council representative. Her time as the Deputy Chief of Staff, Operation Turus in 2020 sparked her interest in International Relations (IR) and more specifically UK development aid policy in Nigeria where she was deployed. She undertook a taught MA in IR at King's College London in 2022/23.

Abstract: This study delves into the dynamic between the UK's security-oriented Foreign Policy (FP) and development goals, using the case study on the UK/Nigeria. In seeking to answer the question: To what extent has the UK used securitised foreign policy to achieve its development goals in Nigeria? the research looks at how security considerations have been strategically woven into the UK's FP approach towards Nigeria. Through qualitative analysis it evaluates the effectiveness of this approach, highlighting motivations, implications and potential tensions between security considerations and development aspirations. Furthermore, it seeks to establish whether there is a symbiotic alignment or tensions between security imperatives and development goals.

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Introduction

In the complex sphere of International Relations (IR), The United Kingdom's (UK) approach to Foreign Policy (FP) has in recent times amalgamated security considerations with development objectives. The UK's engagement with Nigeria provides an intriguing perspective to analyse this dynamic. This paper delves into how the UK has purposefully harnessed a securitised FP framework to advance its development goals within the Nigerian context. By exploring the complexities of this interplay, we can gain deeper insights into the rationale, efficacy and implications of adopting such an approach on bilateral relations and the development landscape.

1.1 Security as a concept

Understanding the concepts of 'Security' and 'National Security' underpinning this analysis is imperative. Security takes on multifaceted dimensions that have increasingly shaped the strategies and policies of nations in recent times. From realist perspectives, security has historically been limited to what various critical scholars deem a narrow state-centric view, emphasising the safeguarding of state territorial integrity and national interest (Huysmans 2014; Buzan 1983; Baldwin 1997; Wæver 1995). Realists have historically conceptualised security as the absence of military threats and the material capability to defend them (Morgenthau 2005, 434439; Mearsheimer 2001, p 15-20). Critics of this view argue for expanding the concept of security to include individuals and societies (Buzan 2016; Wæver 1995, Booth, Baldwin 1997). Buzan introduces the idea of 'sectors' of security, encompassing various dimensions of human life that can be threatened: political, military, economic, societal and environmental. Threats can arise from political instability, military aggression, economic inequality, social unrest, environmental degradation and identity conflicts. Huysmans (2014) refers to security as an unbound concept. He refers to the ubiquitous presence of language and images of insecurity, referring to issues such as civil wars, crime statistics, global warming, migration, terrorism, etc, making human life defined by multiple dangers, anxieties and risks. The diverse nature of threats highlighted by Huysmans renders security a potentially fluid concept. Bauman (2000) argues that constructing a theory that synthesises security issues gives the impression of a homogeneity that does not exist in the modern conceptualisation of security.

Critical security studies scholars generally explore a socially constructed nature of security. These examine power relations, identity politics and the impact of discourses on the definition of security. In this context, security is about understanding how security discourses shape policy, practices, social relations, and protection against external threats. For this paper, security is defined as the condition in which individuals, communities and states are free from oppression, harm and violence that enable the pursuit of self and national interest. Over and above military threats, it encompasses issues such as gender inequality, social injustice, economic inequality, poverty and other structural sources of insecurity. From this perspective, security is about addressing the root causes of insecurity and pursuing a more just, inclusive and sustainable world order. It considers a broader and deeper conceptualisation of security (Buzan & Hansen, 2009; Huysmans, 2014).

1.2 National Security

National security means different things to different states. Buzan (2016) proposes that considerations beyond security underpin national security. He refers to realist and idealist theories that centralised power and peace in discussions relating to national security. Morgenthau (2005) and Mearsheimer (2001) regarded security as a derivative of power. Actors with enough power to reach a dominating position would acquire security. Idealists considered it a consequence of lasting peace (Kant, 1970).

Whilst still discussed in IR theories now, the concepts of power and peace mostly dominated national security discussions in the Cold War years. Scholarship has developed in the intervening years, arguing for integrating non-military threats into national security considerations. Harold Lasswell, a political scientist, opined that the primary notion of security centres around achieving optimal balance among various FP tools, effectively managing elements such as military strength, diplomacy, information and economic strategies, and ensuring well-coordinated approaches to domestic and foreign measures of policy (Romm, 1993 p 3). Wolfers (1952) referred to national security and national interest as such: 'They may not mean the same things to different people. They may not have any precise meaning at all. Thus, while appearing to offer guidance and a basis of broad consensus, they may be permitting everyone to label whatever policy he favours with an attractive and possibly deceptive name' (Wolfers, 1952). Wolfers highlights that the ambiguity of the concept of national security can lead to potential misunderstanding and conflict between states. Each country may have different interpretations and priorities of what constitutes a threat to its security. The lack of consensus on the definition of national security can cause complexities in IR and diplomatic interactions. Buzan further emphasises the implications of ambiguity and weak conceptualisation of national security. He argues that it offers scope for strategies to maximise power and enable the exercise of considerable leverage over domestic affairs for political and military elites (Buzan, 1983). A comprehensive grasp of security and national security concepts is vital to the ensuing analysis.

This dissertation seeks to answer the question: To what extent has the UK used securitised FP to achieve its development goals in Nigeria? The paper aims to contribute to a body of scholarship combining critical security and development studies and policy development in the political economy of aid as the UK achieves its development goals in Nigeria through development aid. It does so by delving into the motivations, effectiveness and implications of securitised development aid. First, the paper will analyse the concept of securitisation, securitisation theory and the surrounding debates. It will then explain the UK's development goals in Nigeria, establish their significance, and determine whether there is a mutual benefit for the UK and Nigeria. The paper will then analyse securitised foreign policy, exploring the characteristics and the framing of specific issues as security threats to justify exceptional measures, with various examples.

The paper will qualitatively analyse UK policy and drivers detailing National Security and Defence strategies inextricably linked with FP. It will evaluate discursive shifts in development

priorities over the years for the UK, specific to Nigeria, looking at underlying drivers for the UK's choice of goals through a secondary literature review. It will explore the UK's adoption of securitised approaches associated with narratives on fragile states, conflict prevention and stability. It will also compare Nigeria's development goals against the UK's. The choice of a qualitative approach is due to complexities associated with data availability to enable a different analysis of specific projects, categories of projects, what they count for and potential challenges with demonstrating causality that would make a quantitative method successful. The paper will evaluate the effectiveness of securitised actions in achieving development goals, considering both positive and negative outcomes of securitised approaches to development. It will assess the views of Nigerian Stakeholders and UK public opinion regarding the UK's securitised actions.

Finally, it will consider alternative approaches for the UK and Nigeria to pursue, including but not limited to Domestic Resource Mobilisation, Foreign Direct Investment and Trade and Export Diversification. The paper will conclude that the UK has significantly securitised its FP in Nigeria and weigh the strengths and weaknesses of the approach, suggesting further areas to be explored.

African states have diverse political environments and contexts and are broadly divided within former colonial powers' spheres of influence. Therefore, in this paper, the securitisation of development aid is not assumed to be a homogenous notion throughout the continent. It follows a trajectory influenced by particular relationships established based on colonial ties and historical backgrounds. Development aid is also one type within a broad spectrum, including Humanitarian aid, Military aid and Prestige foreign aid (Morgenthau 1962, p 301-303). Morgenthau argues that humanitarian aid is the only one that can be considered non-political, albeit able to perform political functions when operated within a political context. However, the politicisation of aid can be exercised through selective allocation, conditionality, and geopolitical competition; any aid can be politicised. Nigeria offers an interesting case for analysis as an oil producer, the largest economy in Africa (Oluwole 2023), and one of the largest bilateral aid recipients from the UK (House of Lords Library 2022).

1.3 The Political Economy of Development Aid

Understanding how politics, economics, and the interaction of various actors and interests shape the allocation, distribution and effectiveness of development aid is essential for the context of this paper. This includes understanding power dynamics and conditionality, efficiency and effectiveness of assistance, political motivations, and institutional capacity, among other factors. Aid giving is only sometimes altruistic. It often comes with conditions; specific policy reforms may be imposed, or aid-receiving countries may be expected to align with the aid-giver's geopolitical interests. The efficiency and effectiveness of assistance vary, depending on how it is designed and delivered. Policymakers and donors can identify factors that enhance or hinder the impact of support and will allow them to optimise allocation and implementation in domestic and International Politics (Jakupec and Kelly 2015).

Political motivations contribute to the complexities of aid relationships. Aid recipients may use it to strategically secure their political positions, while donors may provide aid for political gain. Domestic and International politics significantly influence the allocation and distribution of development aid. Public support in donor countries is also crucial in determining the allocation of resources; therefore, a good understanding of factors driving public opinion on aid, influencing policy decisions and funding priorities is essential. For example, the UK merged the Foreign and Commonwealth Office (FCO) and the Department for International Development (DFID) to form the Foreign, Commonwealth and Development Office (FCDO) in 2020, overturning what was one of the first actions of the Blair government in 1997 separating DFID and the FCO (Pugh *et al*, 2013). Whether this was an exercise to refine FP and development output as was sold by the government then or a quest to gain efficiencies when the country is under economic pressure will only become apparent in time. In the 2021 Integrated Review, the aid budget was reduced from 0.7% of Gross National Income (GNI) to 0.5%, with only 60% of the budget spent by FCDO and the remaining 'siphoned off' by departments such as the Home Office to settle bills linked to Asylum Seekers in the country noting sensitivities with rates of migration into the UK (The Economist, July 2023). Competing domestic priorities against rising inflation and generally tough economic times necessitated this reduction to 0.5%. The result has been a re-prioritisation of some aid programs. In Nigeria, two programs have been closed: LINKS – focusing on powering economic growth in Northern Nigeria, and FOSTER – aimed at improving oil sector transparency and reforms (HM Government, 2023).

The institutional capacity of recipient countries is vital in determining the positive or negative effects of development aid. Positive effects can include institutional learning, enhanced technical expertise and improved governance and accountability. Negatively, aid dependency can undermine indigenous institutions, encourage distorted priorities and create perverse incentives. It is essential to assess these potential consequences, enabling the design of aid programs that strengthen rather than weaken institutions. A good understanding of the political economy of aid, in general, enables more informed decision-making by all stakeholders, promoting sustainable development and designing effective aid programs. This paper will determine whether the UK/Nigeria case demonstrates a good understanding of the political economy of aid by the UK. It uses securitisation theory as the conceptual framework to conduct the analysis.

2. Theoretical Framework

2.1 Securitisation Theory

Securitisation is the discursive political process through which issues or phenomena are transformed into security matters. It has core underlying concepts – a 'securitising actor' who identifies a specific topic and presents it as an existential threat to a 'referent object'. A referent object can be a state, a society, or an identity. An issue becomes a referent object when framed as an existential threat and requires extraordinary and urgent measures to shift to the realm of security. The securitising action aims to convince a target audience that particular measures

would otherwise be considered outside the realms of routine politics needed to effectively address a threat or specific threats. A 'Speech Act' must gain acceptance from the target audience to become a referent object (Buzan *et al*, 1997, p 25). Traditionally, the state has overtly been the referent object for security and, less overtly, the nation. For a state, survival has historically been about sovereignty and, for the nation, identity. The securitisation approach, however, necessitates a more open spectrum of possibilities on referent objects. In principle, anything can be constructed as a referent object; however, the constraints of enabling conditions mean that securitisation is likely to be more successful with some types of referent objects than others (Wæver *et al*, 1993; Buzan *et al*, 1997).

The development of securitisation theory is attributed to the Copenhagen School (CS) of IR. The CS, led by scholars such as Buzan, de Wilde and Wæver, has been vital in advancing securitisation theory (Buzan *et al*, 1997). Their work has influenced the conceptualisation of the process through which issues are securitised, examining the implications of securitisation on politics, policies and IR. According to the CS, securitisation is a speech act in which an issue is constructed as a security threat that necessitates extraordinary measures beyond everyday politics. The role of securitising actors is emphasised; they possess the power to label and frame an issue as a security concern. Security is not objective; different actors may perceive and securitise issues differently. The securitisation process entails convincing an audience to accept the extraordinary measures and suspend routine democratic procedures to enable a response to a threat. The securitising actor exercises authority and justifies exceptional actions, as securitisation can have profound implications for politics and the allocation of resources (Buzan *et al*, 1998).

Scholarly perspectives on securitisation are divided into philosophical and sociological perspectives, although there is no clear-cut division between scholars who favour one perspective (Soars, 2022). The philosophical perspective draws from the philosophy of language, focusing on the illocutionary nature of the securitising speech act and privileges normative and ethical security aspects. It focuses on what security means and establishes what justifies extraordinary measures. It considers conceptual frameworks and moral principles defining security claims such as protection from harm and the right to life. This perspective finds potential frictions between security imperatives and democratic values (Baldwin, 1997; Booth, 1991, 2002). The Sociological perspective privileges social and political issues. It examines the social construction of security issues shaped by power relations and how these and general securitisation influence societal dynamics. It seeks to understand actors, social processes, and interactions in framing issues as security threats. This perspective focuses on analysing the role of securitising actors, discursive practices, audience perception and the political and social contexts in which securitisation occurs. It explores securitisation and its role in shaping political agendas, policy responses, public perceptions and the distribution of power and resources (Buzan, 1983; Wæver, 1993; Bigo, 2008). The philosophical approach focuses on a more internalist process of language and uptake, while the sociological approach focuses on the external analyses of securitising moves (Balzacq *et al*, 2015).

Empirical researchers have criticised the philosophical view by presenting metanarratives of security and abstractions from the provided theoretical model, which fail to align with realities and only partially reflect real-life experiences (Wilkinson 2007). Rita Floyd (2011; 2016) highlights the absence of a clear distinction between behaviour and language, as the former involves a material aspect essential for empirical research, which the latter lacks. The act of 'enunciating' a security speech is considered a form of doing security based on ontological grounds (Buzan *et al*, 1997, p 22-26), implying that the behaviour during speech is implicitly involved but somewhat overlooked by the philosophical view of securitisation theory (Soars 2022).

Audiences play a prominent role in the CS conceptualisation of securitisation. Since the 2000s, scholars have argued for refinement of the scope and understanding of audiences in securitisation theory. Soares (2022) highlights that earlier securitisation theory works appeared to take the definition of the audience for granted, a significant shortcoming considering the audience's prominent role in the CS. Buzan and Wæver (Buzan *et al*, 1997, p 25) refer to audiences as an aspect of the securitisation process that accepts claims, negotiates with the securitising actor, tolerates violations and determines the success of the securitisation process, needing to be convinced. Balzaq (2005) also dismissed the notion of speeches acting solely by themselves, stressing that the context of illocution and the associated perlocutionary effects are pivotal to the success of securitisation theory. Soares introduces the notion that there was an 'audience turn' from the early 2000s that made room for a more empirical understanding of securitisation and that the sociological and philosophical approaches from then on represented two separate ontological interpretations of securitisation. The sociological view provides the basis of the analysis of the focus of this paper, as it offers a multidimensional framework that enables analysis of social and discursive aspects of security, enabling a deeper understanding of motivations, perceptions and the broader societal context shaping UK FP decisions.

Language is a primary means through which securitisation is undertaken. It is core to the operation of constructing issues as security threats. Language is used as a tool to frame and persuade an audience. It enables the securitising actors to present problems as existential threats requiring urgent and exceptional measures. Securitising actors employ speech acts (Wæver 1995, p 55). This refers to a performative as opposed to a constative aspect of language. Statements do more than merely describe a given reality and, as such, make it difficult for them to be judged as true or false. These utterances realise a particular action. They 'do' things and are, as such, performative. An issue can be labelled a security concern requiring extraordinary measures by using rhetoric, specific vocabulary, metaphors and other linguistic means that evoke the desired emotions from the audience. The key aim is to potentially instil fear and evoke a sense of urgency among the audience.

The choice of narratives, words and discursive strategies is core to shaping audience perception and response to the security issue. An example is a press release published on

14 April 2016 by the FCO and DFID. The then international development minister said, 'Our thoughts are with the Chibok schoolgirls, their families and the thousands of other men, women and children who have been brutally abducted by Boko Haram. The abduction of the girls was a particularly horrific example of Boko Haram's barbaric crimes ...'. 'Tackling the root cause of global problems such as violent extremism, terrorism and poverty is not only the right thing to do but also firmly in the UK's national interest' (FCDO and DFID, 2016). There was a deliberate use of emotive words in the speech.

2.2 Criticisms of the CS

Critics of the CS highlight various shortcomings. For example, nonverbal securitisation can evoke strong emotional responses to shape public opinion. Securitisation theory focuses predominantly on verbal securitisations, whilst nonverbal expressions of threat are under-represented, given their potential effects in real-world contexts. They can include visual media, symbols, and visual representations, significantly influencing the securitisation process. They can provide compelling, vivid depictions of a threat and enhance the credibility of the security claim. They can help with the construction of the identity of the securitising actor and the target of securitisation. Media plays a vital role in disseminating images related to security issues, influencing policy debates and public perceptions.

This paper also acknowledges the shortcomings of the apparent single-dimensional nature of the traditional securitisation theory framework identified by Buzan and Wæver (2009). They place a gap between the middle and system levels of analyses of world politics. System-level analyses deal with securitisation at a global and international scale, examining how security issues are constructed and framed within the international system and interactions between nation-states, international organisations and transnational actors. Topics such as terrorism, nuclear proliferation, and pandemics, for example, have become internationalised, impacting geopolitics and cooperation among states. Middle-level analyses examine how security issues are constructed and framed within particular contexts. These are regional and domestic contexts instead of broader macro securitisation of entire sectors or global issues.

Middle-level analyses delve into processes at intermediate levels of political and social organisation, for example, a government's decision to securitise border control at the national level. In this instance, the government of Country A identifies immigration as a security issue, seeing it not just as a matter of managing borders and migration flows but as a possible threat to its national security and identity. These scholars also highlight the concepts of macro securitisation and security constellations, the interconnectedness and complexity of security issues by considering them as a network of related problems rather than individual isolated concerns. A security constellation entails interaction between multiple actors, threats and associated responses. These are considered interconnected and interdependent. Understanding the concept of security as constellations enables a nuanced examination of the various relationships and dependencies between varied security issues (Buzan and Wæver, 2009). This concept challenges the traditional securitisation theory's focus on the state's and

authoritative actors' role in securitising issues, emphasising the diversity and multiplicity of actors in contemporary politics, including corporations, non-state actors, international organisations and civil society groups shaping security. Acknowledging macro securitisations and security constellations calls for a more comprehensive approach to the analysis of security and securitisation, considering broader contexts and systemic factors instead of isolated analysis of individual security threats.

Wæver *et al* (1993) also propose that according to the CS, securitisation is more difficult to analyse at both the individual level, where the referent object is human beings and the system level, where the referent object is, in some sense, all of humankind. They argue that securitisation is more accessible at the middle level with limited collectivities. An explanation for this perceived success of analysis at the middle level is the self-reinforcing rivalries between referent objects with limited collectivities, with such interactions strengthening the 'we' feeling. The reference to a 'we' is a social construct operative in interactions between people with the criteria of an interpretive community. System-level referent objects are deemed too subtle and indirect to enable the degree of mass identity necessary for securitisation. It is in the context of analysing the gap between the middle and system levels that Buzan and Wæver use the concepts of macro securitisation and security constellations. The gap between the individual and middle level also entails an analysis of human security, which has significantly expanded the scope of security as a concept.

Further criticisms of the CS highlight silences causal explanations and the need to refine the scope and understanding of audiences in securitisation theory. Hansen (2000) uses an analogy of the little mermaid to explain the impact of silence to emphasise the effect of silence on the securitisation theory on gender. He argues that the lack of consideration for gendered security against the backdrop of poststructuralist and critical security studies that have made gender an indispensable part of security analysis is noteworthy. To quote Booth (1997, p 101), 'To talk about security without thinking about gender is simply to account for the surface reflections without examining what is happening below the surface'. Booth echoes several scholars who privilege gender in security analysis (Campbell, 1992; Dalby, 2002; Walker, 1992). Gender roles, power relations and norms are critical in defining security threats and responses. By excluding gender in analysis, securitisation theory may inadvertently perpetuate historical male-centric traditional security paradigms. It marginalises alternative security perspectives that consider human security and feminist viewpoints, encompassing issues such as sexual violence, human trafficking and violence against LGBTQ communities. Key issues such as reproductive rights, gender-based violence and economic empowerment may not be comprehensively explored. The impact may be an incomplete understanding of security issues.

The traditional securitisation theory highlights Various causal explanations as needing to be addressed. These include public opinion and societal influence, structural factors, and ethical and normative dimensions. Public opinion and societal attitudes shape security agendas and can influence the securitised issues and their prioritisation. For the Iraq conflict in 2003,

for example, following President Bush's administration's public declaration of the Global War on Terror supported by the Blair government, Canada and France withheld support for the conflict. Both referred to domestic opposition as a primary reason (Baum & Potter, 2015), although this paper acknowledges that beyond public opinion, broader debates on intelligence failures would have contributed to Canada and France, alongside others withholding their support for the conflict. The CS also focuses on the agency of elite actors and the speech acts they perform without adequately considering underlying structural factors that shape and constrain their choices. Structural elements include historical legacies, power dynamics, institutional constraints and economic interests. Acknowledging the additional perspectives addressing the shortcomings of the CS, securitisation theory is still an excellent framework to analyse the case of the UK's securitised FP in Nigeria.

3. UK Development Goals in Nigeria

3.1 UK Development Goals

The UK deems Nigeria central to its thinking, owing to its position in global politics as a continental leader in Africa, growing economic potential and cultural reach, and will be a vital bilateral partner for the next 50 years (FCDO Policy Paper 2023). In the 2021 IR, the UK set an ambition to sit at the heart of a network of like-minded countries committed to upholding global norms and protecting human rights. Nigeria was considered a co-member of this network (HM Govt, 2021). These groupings of like-minded people include the Commonwealth and the UN, where notably, Nigeria has voted alongside the UK on key issues such as the General Assembly Resolution demanding that Russia ends the illegal use of force in Ukraine (UN Press, 2022).

Development goals in Nigeria are determined by the International Development Strategy, published in 2021 (HM Government, 2022), a sub-strategy to the Integrated Review (IR) (HM Govt, 2021) that was refreshed in 2023 (HM Government, 2023) detailing the alignment of UK aid with IR objectives. Whilst aid and development were not central to the IR, there were priorities identified for UK aid, including supporting open societies, conflict resolution, humanitarian preparedness and girls' education (The UK's aid strategy, 2022). The UK delivers help through Overseas Development Assistance (ODA). According to the UK/Nigeria development partnership (HM, Govt, 2023), the UK's objective in Nigeria is to support a more inclusive, resilient, healthy and prosperous Nigeria. More specifically, UK policy discourse highlights three long-term challenges driving instability and fragility that need resolving: climate change, conflict terrorism and demography. The three challenges are linked to high levels of extreme poverty and broadly consistent with the UK's development priorities over the past decade, tackling extreme poverty, strengthening governance systems and climate change (DFID Nigeria Operational Plan 2011-2015).

The UK has aimed to demonstrate leadership in security, diplomacy and development, conflict resolution and poverty reduction. In 2012, Nigeria's population was estimated at 158 million

people. Nigeria was considered home to a quarter of the African continent's extremely poor; 64% of Nigerians lived on less than £1 a day (DFID Nigeria and OP 2011-2015). Statistics published in 2022 highlight significant population growth for Nigeria, estimated at over 200 million, with roughly 66% classed as poor. The population is forecast to double by 2050 to make it the third largest country in the world (Nigeria (MPI) 2022). In these circumstances, Nigeria offers both opportunities and challenges for the UK.

The large population and a growing middle class offer a market for exports and investments, especially when the UK actively seeks trade opportunities post-Brexit. A strong relationship with Nigeria allows the UK to enhance its regional influence. This is important in the context of regional and international forums, enhancing the opportunity for the UK to exercise soft power as a significant player in international development. Poverty and inequality, evident on a large scale, have historically contributed to conflict and instability. The coexistence of economic strength and widespread poverty in Nigeria underscores the issue of income inequality. A secure and economically stable Nigeria is vital for regional peace and stability. There are broader issues, such as migration and asylum. The UK continues to struggle with migration issues broadly, and Nigeria is one of the significant sources of migrants seeking better opportunities and living conditions in the UK (Dathan, 2022).

The UK has set six strategic development objectives in Nigeria: Governance, social contract and stability; climate change, energy transition and nature; humanitarian goals (including food insecurity and protection of civilians); Health, education and demography; the Lake Chad Basin conflict (HM Government, 2023). Considering the more comprehensive conceptualisation of security, it is easy to see why the UK deems it in its national interest to pursue development objectives in Nigeria. The question is whether this is a symbiotic alignment or a dynamic destined for tension between security imperatives and development aspirations. The Nigeria National Development Plan (2021-25) details priorities broadly consistent with the UK's: initiatives to address fragile economic growth, insecurity, weak institutions, insufficient public service delivery, infrastructure deficits, climate change and weak social indicators (NNDP 2021-2025). The plan aims to generate 21 million full-time jobs and lift 35 million people out of poverty by 2025 and 100 million within 10 years. The following section explores the significance of these goals to both countries.

3.2 Significance of Development Goals to the UK and Nigeria

Given the resources at its disposal, Nigeria should be able to set growth strategies that enable prosperity without dependence on aid. The NNDP (2021-25) articulates an ambitious plan that depends on government and private sector-generated revenue to achieve. Despite being Africa's largest democracy, political power has remained concentrated within an elite group, apparently reluctant to make the necessary transformations that use Nigeria's potential (Dike, 2014). The concept of elite bargains can somewhat explain the lack of impetus to make transformations using Nigeria's economic potential. Nigeria's political power and presidency are hinged on an unspoken power-sharing arrangement mandating that the major political

parties in the country take turns holding the presidency between candidates from the northern and southern regions every eight years. This agreement was solidified during Nigeria's initial two democratic transitions in 1999 and 2007, effectively easing the pressure of southern secessionism developed by leaders from the country's north over years of military rule. Initially, this alternation of power played a vital role in maintaining peace in a nation characterised by hundreds of diverse ethnic groups and over 500 languages. However, it was never intended to be a permanent solution. It has recently been a source of tension rather than a unifying consensus (Siollun, 2017) - the agreement aimed to ensure a sense of equity and balance of regional interests. Closely aligned to this are negotiations over the allocation of resources, oil revenues, access to public funds and control over government contracts.

Nigeria has used elite bargains to manage conflict and security challenges, and the concept of elite bargains is critical to understanding Nigeria's politics. Whilst it broadly enables peace to prevail, its negative implications are corruption, the concentration of power in particular 'hands' and a lack of accountability. The Fragile States Index classifies Nigeria as 15th of 179 fragile states and 11th in Africa (Fragile States Index, 2023). Further, Transparency International lists Nigeria as 150th out of 180 in the corruption perceptions index with a corruption perception index of 24 (a country's score is the perceived level of public sector corruption on a scale of 0-100, where 0 means highly corrupt and 100 means very clean). Above any other African country, Nigeria is said to lose between \$16 and \$19 billion annually due to illicit financial flows. The House of Commons Foreign Affairs Committee Report (FACR) (Lagos Calling, 2021-22), following an inquiry into implementing the IR in Nigeria, determined that despite the challenges with corruption, Nigeria offers potential for the UK owing to strengths such as possession of a young and creative workforce with a strong work ethic, control of a thriving creative arts economy, a government with a firm commitment to tackling environmental issues, possession of plentiful natural resources, a significantly engaged diaspora and potential for multiple investment opportunities. Nigeria has commercial opportunities to gain in financial services, education, agriculture and technology sectors. Beyond the commercial opportunities are issues linked to security and human trafficking crimes that directly affect the UK; a more democratic, peaceful Nigeria is likely to prevent migration and reduce the risk of violent extremism (DFID Nigeria country profile 2018/19). The FACR also detailed that the UK holds a prime position in its quest to exercise soft power in Nigeria to shape the International Order. Through such efforts as in Nigeria, the UK can position itself as a global leader in international development efforts, enhancing its influence in international organisations and diplomatic forums. This is vital at a time when China and Russia, deemed to challenge the democratic international order, exercise significant influence in Africa (Besenyő 2020; ElBadaway *et al* 2022). Perception surveys referenced in the report (British Council Perception Survey 2020) suggested that the UK is perceived as attractive and trusted in the minds of Nigerians compared to other G20 countries.

For Nigeria, the economic development and poverty reduction goals have the potential to lead to improved living standards. Development assistance to enhance governance and

institutional capacity contributes to more accountability and potentially more effective governance structures in Nigeria, promoting stability. Health and Education are also critical targets for UK development aid in Nigeria. Assistance in these sectors can contribute to better access to healthcare, the potential for reducing mortality rates and better education outcomes. The positive impacts span the UK and Nigeria societies' economic, political, social and environmental aspects.

Development aid can also have adverse effects. These include Aid Dependency, where recipient countries can develop a sense of dependency. The net effect may be reduced efforts by recipient countries to mobilise domestic resources to implement long-term sustainable development strategies. Economic Distortions encompassing issues such as fluctuations in domestic currency values and inflation can make commodities and services more expensive in the long run. This can negatively impact local businesses and make for volatile economies. Corruption has also been deemed an endemic issue in many aid-receiving countries. Nigeria is not immune to this, already grappling with corruption that has made the UK prefer engagement with state governments rather than the national government (Lagos Calling, 2021-22). If not well managed with appropriate oversight, funds for development projects can be diverted for personal gain, undermining aid effectiveness. Geopolitical Interests can also influence development assistance, resulting in projects that prioritise the donor countries' interests over the genuine needs of the recipient countries. The UK must consult and collaborate closely with local governments and communities to guard against these adverse effects. Better monitoring and evaluation of the impact of aid programmes is also vital to ensure consistent matching of goals and outcomes. By considering these factors, development assistance can be more effective and contribute to positive and lasting change in the recipient countries.

4. Securitised Foreign Policy and What It Looks Like

FP is a dynamic and multifaceted field with various economic, diplomatic, political, cultural and security-related activities. FP is influenced by a country's economic capabilities, geographic locations, political system, societal values, historical experiences, etc. Broadly, critical objectives of FP include national security and promotion of national interest, diplomacy and conflict resolution, economic engagement, and maintenance of international order and development cooperation. It is executed through various instruments, including participation in international organisations, diplomatic relations (bilateral and multilateral agreements), military alliances, and multiple types of aid. FP is a core aspect of the governance system within the modern state. It impacts its citizens' overall well-being, security, and relations with other countries. It is critical to enabling a government to manage its relationships with the global community and pursue its interests and objectives on the international stage.

Securitised FP refers to governments framing issues, actors or events in the international arena as security threats. Referencing the CS as a framework, noting the development in scholarship since the 2000s to capture broader contexts, core characteristics, if present,

demonstrate securitisation in the conduct of a country's FP. Securitisation of FP is thought to enable the mobilisation of resources and political support to address perceived threats to a country (Mulherin and Isakhan, 2019). These characteristics, when fulfilled, lend themselves to demonstrating the securitisation of FP. The six characteristics described below are not exhaustive but valuable for the context of this paper and explained with varied contextual examples, some going as far back as the Cuban Missile Crisis, to enable a grasp of what determines FP to be referred to as securitised.

4.1 Characteristics of Securitised FP

Urgency and Emergency – FP issues are portrayed as urgent threats that require emergency measures to address them. These are issues that are deemed a threat to the nation's security or national interests. The framing is intended to create a sense of urgency with a need for speedy action. The 9/11 attacks and the follow-on actions by the US Administration at the time provide an example of urgency and emergency; extraordinary measures were implemented in response to what was deemed an emergency. The Bush Administration immediately declared a 'War on Terror' signalling a resolute approach to confront global terrorism. This depiction positioned terrorism as an immediate and all-encompassing peril that justified the implementation of urgent exceptional measures to safeguard the nation. There was an overhaul of Airport Security measures that included the establishment of the Transport Security Administration (TSA) and the implementation of more rigorous screening processes for passengers and luggage. These changes ended up being implemented globally in the case of air transport security, for example, exemplified by the ban on carrying liquids above a certain amount on hand luggage taken on flights. The urgency and emergency also led to the Department of Homeland Security establishment in 2002 aiming to coordinate domestic efforts to respond to terrorist threats (Seegers, 2012; Mabee, 2007).

Rhetorical Framing – Political leaders can use rhetoric and communication to convince the public, a critical audience, that the issue in question needs a security-focused response. They may use fear and specific analogies to strengthen their case. The 'War on Terror' declared by the US following the 9/11 attacks was used as a rhetorical device to securitise terrorism. This created a sense of urgency, necessitating a comprehensive and aggressive response. By using the phrase 'War on Terror', policymakers deliberately invoked the language of war, creating a context of conflict and mobilisation. The use of the term 'War' implies an emergency and necessitates the use of extraordinary measures to deal with the perceived threat. The simple narrative provided a form of moral clarity that galvanised public support. The repetition of phrases and slogans such as 'axis of evil', 'homeland security', and 'War on Terror' became dominant tropes of the UK government and US Administration (Bergen, 2011), and reinforced the securitisation narrative, making it a central part of public discourse. The rhetorical framing of the 'War on Terror' justified the passage of the PATRIOT Act (Uniting and Strengthening America by Providing Appropriate Tools Required to Intercept and Obstruct Terrorism Act) and related legislation that broadened government surveillance powers. It also influenced FP decisions, including military interventions in Afghanistan and Iraq (Cole, 2017).

The phrase itself has also been the subject of broad debate, with scholars arguing that it oversimplifies complex geopolitical challenges and perpetuates a state of war (Chomsky, 2003; Pape, 2006).

Top-Down Decision-Making – Key leaders or governing bodies often drive the process of securitisation. When these actors make decisions within this process, they often bypass normal political processes, legislative oversight, or public debate (Mulherin and Isakhan, 2019). President George W Bush used urgent rhetoric to demonstrate that Iraq posed a grave and imminent threat to International Security. There was strong emphasis from the administration on the need for pre-emptive action to prevent the potential use of WMD against the US and its allies. This issue was elevated to the National Security Council (NSC), a body of high-level officials from various government agencies. The NSC played a core role in shaping the US government's response to the perceived threat. Additionally, when it became apparent that a UN Security Council Resolution sought by the US to authorise military action against Iraq was not forthcoming, the Bush administration proceeded without explicit UN approval, bypassing international diplomatic processes. The securitisation and urgency of the perceived WMD threat from Iraq were used to limit public debate on the matter. Critics who questioned the evidence, even from the Intelligence Community (IC), were portrayed as potentially jeopardising national security (Glennon, 2003; Fitzgerald and Lebow, 2006).

Extraordinary Measures – When issues are portrayed as urgent threats, often this justifies the adoption of extraordinary measures that go beyond the routine political, diplomatic, economic or legal tools used to address them. Examples of such measures can include intelligence operations, sanctions, military interventions, or even increased Defence spending. During the Cuban Missile Crisis in 1962, the US securitised the issue of Soviet Missiles in Cuba. The US framed the issue as a direct threat to national security that required an urgent response. This necessitated the implementation of extraordinary measures to address this. This crisis has historically been considered one of the closest moments the world came to a nuclear crisis during the Cold War. The US implemented a naval blockade officially called a 'quarantine' around the island. This was to stop Soviet ships from delivering additional military equipment and more missiles to Cuba. President John F Kennedy announced publicly that a military response would ensue if the Soviets introduced further offensive weapons into Cuba. The US would see introducing more offensive weapons in Cuba as an act of aggression. He also addressed the American public through television and radio, articulating the situation and possible consequences for America in a bid to seek support for the measures. The crisis resolution relied on secret negotiations, diplomatic efforts and strategic concessions. It underscored the complexities and risks of the securitisation of international issues and the potential repercussions of brinkmanship in FP (Coleman 2016, p 93-99).

Impact on Civil Liberties – The over-emphasis on security characterising securitisation can lead to infringement of civil liberties and human rights. Extraordinary measures put in place resulting from a perceived threat can infringe upon individual freedoms in the name of

protecting the state. An example is the US response to 9/11, where terrorism was portrayed as an existential threat to national security. After the attacks, US Congress passed the USA Patriot Act. The act significantly expanded the US government's surveillance powers that allowed monitoring of electronic communications, access to personal records, and enhanced wiretapping, among other measures. This was often without requiring a warrant or appropriate oversight. This raised concerns about privacy and Fourth Amendment rights' protection against unreasonable searches and seizures (Amitai 2005; Cole 2017).

Policy Instrumentalization – Policymakers often use securitisation to justify actions that may, in essence, be in place to serve particular ideological, economic or political objectives outside of the immediate security concern. This may involve depoliticisation; issues become framed as above regular political bargaining. This often makes challenging the proposed measures difficult. The case of the Iraq invasion offers an excellent example of this. In the run-up to the 2003 Iraq War, the Bush Administration securitised the issue of Weapons of Mass Destruction (WMD), perceived as possessed by the then-Iraqi regime. This securitisation was used as a tool to justify military action and pursue broader regime change objectives beyond what was the immediate security concern of WMDs (Fitzgerald and Lebow, 2013).

The above characteristics are broadly consistent with the CS framework of securitisation. Brown and Grävingholt (2016) further propose that the securitisation of foreign policy can also be conceptualised differently from the CS and its focus on 'speech acts' that invoke a state of exception. From a FP perspective, they argue that securitisation can be observed through changes in institutional structures, aid flows and changes in discourse. According to these scholars: 'Securitisation can be said to occur, for instance, when donors increasingly justify aid in terms of national or international security, when they provide the highest levels of assistance to specific countries and sectors based on security imperatives when security actors such as military forces deliver significant amounts of aid, and when donor governments create new institutional units within their aid agencies or new interdepartmental coordination mechanisms based on security-related motives' Brown and Grävingholt (2016, p 3). This conceptualisation of securitisation acknowledges the broader definitions of security that critics of the CS highlight. Their approach encourages a more critical analysis of the securitisation of FP highlighting agency. They acknowledge that securitisation can involve multiple moves and responses from various actors.

Scholars also propose that the rise of unstable and fragile states such as Somalia and Afghanistan and recent conflicts in the Balkans and the Middle East have blurred the lines between the distinct and 'neat' realms of development and the 'murky' world of national and international security (Wild and Elhawary, 2016 p 42-44). They argue that development, even during the Cold War, was used by superpowers to further their interests. However, more recently, aid instruments have become even more intertwined with complex international operations that have attempted to address development and security simultaneously (Brown and Grävingholt, 2016, p 1). In 2015, Prime Minister Cameron delivered an FP speech at the

lord mayor's banquet, confirming a significant shift in the use of the UK aid budget. At least half of the UK's then £12 bn aid budget was to be spent on supporting fragile and failing states. He likened the battle against Islamist extremists to World War Two against the Nazi regime. He defended hard power and emphasised his willingness to engage with regimes with questionable human rights (Wintour & Watt 2015). Brown and Gravingholt (2016) highlight prevalent donor discussions of fragile countries reflected in the Cameron speech. Duffield (2007, p 1) posits that the phrase 'There is no security without development and no development without security' became monotonous in the mid-2000s during international security discussions and was accepted as truth by policymakers and multilateral organisations such as the UN.

New security considerations have influenced aid strategies, and whole government approaches have been adopted to integrate policy. In July 2017, the government conducted a National Security Capability Review (NSCR) in response to changes in the security landscape. This necessitated a re-evaluation of the 2015 National Security Strategy and SDSR. Changes that contributed to this interim review included terrorist attacks in London and Manchester, the Skripal poisoning in Salisbury, the election of Donald Trump and Brexit. Fusion Doctrine was established to unify national power levers in addressing the wide range of threats posed to the UK and strategies to respond to these threats. The UK's IR 21 cemented an integrated cross-government policy formulation approach that necessitates and exemplifies collaboration to address security issues. It encompassed foreign, defence, security and development policy. Understanding these characteristics helps examine the UK's FP on Nigeria, identifying instances where the UK has used securitised FP and the rationale behind the securitised approach.

5. Examination of the UK's Securitised FP in Nigeria

The 2010 SDSR reinforced the significance of addressing conflict and instability, underscoring the pivotal role of development assistance in tackling security issues (HM Govt 2010). Nigeria was one of the countries chosen for increased development aid in 2011 due to conflict and security challenges (Wild and Elhawary, 2016). Whilst this paper does not provide a complete review of all UK development initiatives in Nigeria, it evaluates some of the practices and themes that have emerged from integrating development and security efforts. DFID whitepaper (1997, p 69) details the centrality of conflict at the heart of the UK development agenda since the formation of DFID in 1997. Subsequent DFID White Papers in the 2000s, 'Making Globalisation Work for the Poor' (2000) and 'Making Governance Work for the Poor' (2006), proposed a security-first approach and a focus on governance, democracy and accountability in development, with priorities shaped by UK and global politics at the time. DFID established a Humanitarian Affairs Department and developed new programmes for security sector reform. These programs needed cross-government collaboration to achieve. A narrative of eliminating poverty carried through from the early 2000s and, coupled with 9/11, gave this trend impetus. In July 2011, the coalition government published the 'Building Stability Overseas Strategy' (BSOS) (DFID, 2011). This was a joint DFID, FCO and MOD publication articulating plans to use the Armed Forces in non-warfighting activities through

development to enable security. The linking of FP and security issues has been consistent in the recent IR 2021 and the refresh in 2023 (HM Government, 2021; 2023).

Abrahamsen (2004) argued that for the British government, the 'war on terrorism' and the 'war on poverty' were two sides of the same coin in the immediate aftermath of 9/11. There was fierce opposition to the UK's involvement in Iraq following intelligence failures that led to the Iraq invasion. Abrahamsen argues that the then Foreign Secretary's use of securitisation of Africa in the war against terrorism narrative was part of a political strategy to unify public and party support for the 'war on terrorism'. This security-development nexus has underscored development aid in UK/Nigeria FP, especially in counterterrorism and counterinsurgency.

5.1 Specific Instances of Securitised FP Towards Nigeria

On the night of 14-15 April 2014, 276 high school girls were abducted by Boko Haram from a remote village, Chibok, Borno State, Nigeria. This issue has underpinned UK FP engagement with Nigeria and associated development aid since. Counterterrorism and Counterinsurgency and associated narratives (Nwankpa, 2020) have been some of the critical drivers of UK development aid to Nigeria as Boko Haram was recognised as a deadly terrorist group. Boko Haram (People Committed to the propagation of the prophet's teachings and Jihad) (Nwankpa, 2015) started officially in 2002. Led by Mohammed Yusuf, they aimed to return northern Nigeria to a purer form of Islam based on strict codes prescribed by Prophet Mohammed. They were involved in establishing Sharia penal codes in several northern states following President Obasanjo's civilian rule in 2001. They clashed with authorities due to what they perceived as a failure to institutionalise their beliefs and perceived betrayal by northern political and religious elites. They undertook public preaching, open criticism of conventional Islamic doctrine and scholars, and some clashes with police forces. Boko Haram has aspired to impose Sharia Law on a secular Nigeria alongside other political and economic agendas. They are now recognised as one of the deadliest terrorist groups, with their sourcing of arsenals shifting from seizing weapons from raids to arms smuggling from crisis torn Libya (Nwankpa, 2015).

The abduction of the schoolgirls triggered an international response in support of the Nigerian Government to rescue them. It also significantly contributed to an inextricable linking of development and security in the Nigerian context. Alongside the US, China, France and Israel, the UK provided support in the form of military surveillance aircraft, Sentinel and Tornado, and provision of Satellite imagery capability. It established an Intelligence Fusion Cell in Abuja where experts from the UK, Nigeria, the US and France processed available Intelligence. The UK had committed to providing Nigerian military, intelligence and development support earlier that year in line with the BSOS (DFID, 2011). On 14 October 2014, Rt Hon Phillip Hammond, then Foreign Secretary, confirmed this in his letter to the House of Commons Foreign Affairs Committee (FCO, 2014), responding to questions raised in the wake of the Nigeria crisis. The military support to Nigeria articulated in this letter included tactical training and advice to

Nigerian forces and support to Nigeria in a quest to bring prosperity and development to the country's Northeast.

In August 2017, the UK committed to a five-year emergency assistance package worth £200 million, unveiled when Boris Johnson visited Nigeria's isolated North-eastern regions (Robertson, 2017; Wintour, 2017). The UK had until then provided military training to 28,000 Nigerian Troops in the fight against Boko Haram, and a small contingent of ~40 UK military personnel had been deployed to Nigeria long-term. Boris Johnson is quoted to have said: 'The consequences of this catastrophe are felt in our country. When you have massive pressures like this – when you have massive tracts of the country under control by terrorists, of course, it drives great waves of migration, drives great waves of refugees to our country'. ... 'They (Boko Haram) played a huge part in causing a political crisis in Italy and other European countries: 'When we fail to cure one sore, infection spreads' (Robertson, 2017).

Johnson acknowledged the additional pressure the UK experiences on its resources when refugees flee from instability and insecurity. Regional and International security is impacted by a lack of action on the root causes of instability, and in the case of Nigeria, a fundamental root cause of instability is Boko Haram. The broader implications in Nigeria are significant deaths and displacement of millions of Nigerians, which exacerbates the country's poverty issue. In 2019, the Foreign Secretary, Jeremy Hunt, visited Nigeria and sought to establish additional aid and military support to Nigeria. He warned then that the crisis caused by Boko Haram 'had the potential to trigger a humanitarian catastrophe on the scale of that in Yemen' (Wintour, 2019). According to the Foreign Secretary, this visit highlighted a need for more coherence between the UK's efforts and the Nigerian response to the issue, predominantly through the deployment of the Nigerian Army. His comments implied a disconnect against a backdrop of the UK providing significant support to the cause. Since the mass kidnapping in 2014, Boko Haram's influence and reach have grown, now thought to be backed by Islamic State (IS). Over 35,000 people are thought to have died, and over three million people were displaced by the end of 2021 (UNDP). Nwankpa (2015) argues that the UK and other allies have prioritised securitised development rather than pursuing genuine peace and prosperity agendas, therefore failing to eradicate the threat of Boko Haram. He also argues that the crisis sustains a war economy that benefits extremist groups, corrupt government officials and armed forces personnel. The conflict is also possibly fuelled by intense political power struggles among Nigeria's major political parties and its northern and southern elites.

Lazell & Petrikova, (2020) propose that the securitisation of UK development aid policy has been underpinned by three beliefs: The first is that underdevelopment and conflict are mutually reinforcing, the second is that instability and conflict in Low and Middle-Income Countries are potentially a source of insecurity for OECD member countries and other wealthy countries (UK included) and the third, that development aid can be used to enhance national security (DFID, 2005 a p 3; Greening, 2015 p 7-8; HM Treasury & DFID 2015, p 13). Their findings, analysing development aid projects in Nigeria as part of a three-country aid-recipient analysis

over the period 2000-2018, established that the UK had spent over GBP 1 billion in Nigeria on aid projects that comprised an equal mix of democratisation and good governance and conflict prevention activities (the other two countries analysed in this study were Kenya and South Sudan). In Nigeria, they determined that DFID did not work with the national government due to high levels of corruption and instead worked with state governments. The following section assesses the extent of securitisation and seeks to establish the approach's efficacy.

6. The Extent of Securitised FP in Nigeria

Lazell and Petrikova (2020) evaluated 144 securitised aid projects implemented in Nigeria, Kenya and South Sudan from 2000 to 2018. They chose these countries due to their strategic interest in the UK. They used four of six OECD evaluation criteria: relevance, effectiveness, impact and sustainability (OECD.Org). UK strategic interest in all three countries was calculated based on refugee flows, arms purchases, and terrorist activity and was relatively high. This was linked to the level of conflict experienced in these three countries over 20 years. Nigeria was generally deemed to experience moderate levels of conflict during the study period. Whilst Nigeria had not experienced a nation-wide conflict over the period examined, instability has been characterised by ongoing tensions in the Niger Delta, conflict with Boko Haram in the country's Northeast, and violence between pastoralist herders and farmers in the middle belt (Omenma and Hendricks 2018). The securitised aid projects mainly included conflict prevention democratisation and good governance projects. In line with the OECD evaluation criteria of relevance, effectiveness, Impact, and sustainability, their findings were as follows:

6.1 Evaluation Criteria

Relevance – the relevance criterion assesses consistency between donor and recipient goals. The main objectives for Nigeria in their Economic and Growth plan for 2017-2022 were restoring growth, reducing corruption, promoting the rule of law and winning the peace (Federal Republic of Nigeria, 2017, p 12). The top development goals of the Nigerian government at this time did not directly match the UK's top goals in Nigeria. The UK's top three development goals were humanitarian and building resilience to crisis, economic development and basic services, building stability and institutions. The top three programs included Northeast Transition to Development, Maternal and Newborn Child Health and Partnership to Engage, Reform and Learn (DFID, 2017). Whilst the goals did not directly match, there were broad consistencies in Nigeria's quest to reform and deal with corruption. Research suggests that recipient countries often deliberately align goals and adjust their priorities to reflect the aid-giving country preferences (In'airat 2014; Clist 2016). An evaluation of the driving factors determining Nigeria's prioritisation of its development goals is out of the scope of this paper. However, it is worth considering that the Nigerian government would ensure some consistency with UK goals to guarantee the inflow of resources from the UK to support the country's development objectives. This means that the outcomes Nigeria needs to develop may not be met given the driving factors behind the prioritisation of goals by

Nigeria and, therefore, development initiatives. It offers a challenging starting point for the UK expending its resources in Nigeria.

Effectiveness refers to the extent to which development project objectives are achieved (OECD Org). The common themes that emerged from Lazell and Petrikova's (2020) research indicated that there were significant failures for donors to achieve their objectives due to incorrect assumptions about the political economy of aid-receiving countries. There was over-optimism and lack of ownership, therefore poor accountability. For Nigeria, inaccurate assumptions regarding the Boko Haram conflict in the North-eastern part of the country hindered the success of DFID projects in the region. An example is given of initiatives focused on enhancing institutional accountability that often took it as a given that formal oversight bodies would align with DFID in combating impunity. However, due to party affiliations and self-interest, these oversight bodies generally failed to fulfil their role as allies in the fight against impunity, with a lack of evident success on this front (Lazell and Petrikova, 2020).

Impact and Sustainability – These criteria relate to positive and negative changes resulting from securitised development projects and the likelihood of lasting changes beyond donors' withdrawal of financial support. In Nigeria, the scholars examined the final goals of projects ranging from increased accountability of formal and informal institutions (including the justice system and the police) to the effectiveness of the country's resources in encouraging growth and strengthening peace and stability (Lazell and Petrikova, 2020). Many of the projects reviewed in Nigeria achieved and, at times, surpassed intended outputs. These outputs, however, did not translate to the expected outcomes for reasons including earlier mentioned over-optimism, lack of ownership by beneficiaries and, in some cases, clear conclusions could not be drawn due to insufficient monitoring and evaluation. Keijzer and Black (2020) propose that without recipient countries effectively taking ownership of development projects, sustainability is unlikely to be achieved.

Lazell and Petrikova (2020) concluded that since 2000, UK development policy discourse has increasingly become securitised. They determined that a significant amount of ODA has been justified by the need to safeguard UK domestic security from threats from fragility and instability in low- and middle-income countries, including Nigeria. Whilst they were specific in their country analysis, scholars such as Wild and Elhawary (2016) analysed the securitisation of development aid by the UK from a broader FP perspective. They highlight the UK coalition government's inclusion of DFID in the National Security Council 2011, which gave prominence to a cross-government stabilisation unit encompassing diplomacy, defence, development and intelligence resources. This also reflected an integrated approach following lessons learnt from the lack of cross government coordination and collaboration during the Iraq and Afghanistan stabilisation efforts. Although much broader in scope, their research is consistent with Lazell and Petrikova's broad assertions on UK FP discourse since 2000. Table 1¹ details net bilateral aid flows and demonstrates a fluid trend with interchanging positions within the top five list

Table 6. Top 20 Country Recipients of UK Bilateral ODA¹
 2015, 2018, 2019

Rank	2015/2018 ^a		2018 ^b		2019 ^c	
	Country	£ m	Country	£ m	Country	£ m
100%	Pakistan	37378%	Pakistan	33096%	Pakistan	30499%
200%	Ethiopia	33878%	Ethiopia	30144%	Ethiopia	29953%
300%	Afghanistan	29993%	Nigeria	29550%	Afghanistan	28977%
400%	Nigeria	26269%	Afghanistan	24870%	Yemen	26042%
500%	Syria	25771%	Syria	23084%	Nigeria	25883%
600%	Sierra Leone	21771%	Congo, Dem. Rep.	20371%	Bangladesh	25600%
700%	South Sudan	20799%	Somalia	19377%	Syria	22294%
800%	Tanzania	20485%	Bangladesh	18990%	South Sudan	20740%
900%	India	18558%	Yemen	16637%	Congo, Dem. Rep.	18466%
1000%	Bangladesh	16370%	Tanzania	15204%	Somalia	17387%
1100%	Kenya	15557%	South Sudan	15131%	Uganda	15377%
1200%	Congo, Dem. Rep.	14272%	Jordan	13815%	Lebanon	14872%
1300%	Uganda	12335%	Kenya	11612%	Tanzania	13716%
1400%	Somalia	12183%	Uganda	10741%	Kenya	13433%
1500%	Burma	11389%	Burma	10026%	Jordan	13121%
1600%	Rwanda	10129%	Lebanon	9648%	Burma	11303%
1700%	Lebanon	9953%	Nepal	9551%	India	10777%
1800%	Zimbabwe	9290%	India	9468%	Mozambique	10388%
1900%	Nepal	8821%	Zimbabwe	9386%	Zimbabwe	9801%
2000%	Malawi	8556%	Sierra Leone	9371%	Sudan	9323%
Total: Country-Specific UK Bilateral ODA		462.213%		449.970%		499.258%
Total: UK Bilateral ODA to Top 20 Recipient Countries		363.757%		340.073%		368.042%
<i>Proportion of Total Country-Specific/Bilateral to Top 20</i>		<i>79%</i>		<i>76%</i>		<i>74%</i>
Total: UK Bilateral ODA to Least Developed and Low Income Countries in Top 20		245.828%		209.800%		237.633%
<i>Proportion of Top 20 to Least Developed and Low Income Countries</i>		<i>68%</i>		<i>62%</i>		<i>64%</i>

Source: statistics for international development

Updated: July 2021

Next update: Autumn 2021

^a As announced in Provisional SID 2020 several minor revisions have been made to 2017, 2018 and 2019 data.

Please see Revision Note 2020 for details.

 Email: statistics@odg.gov.uk

Notes & Definitions

The figures in this table are National Statistics

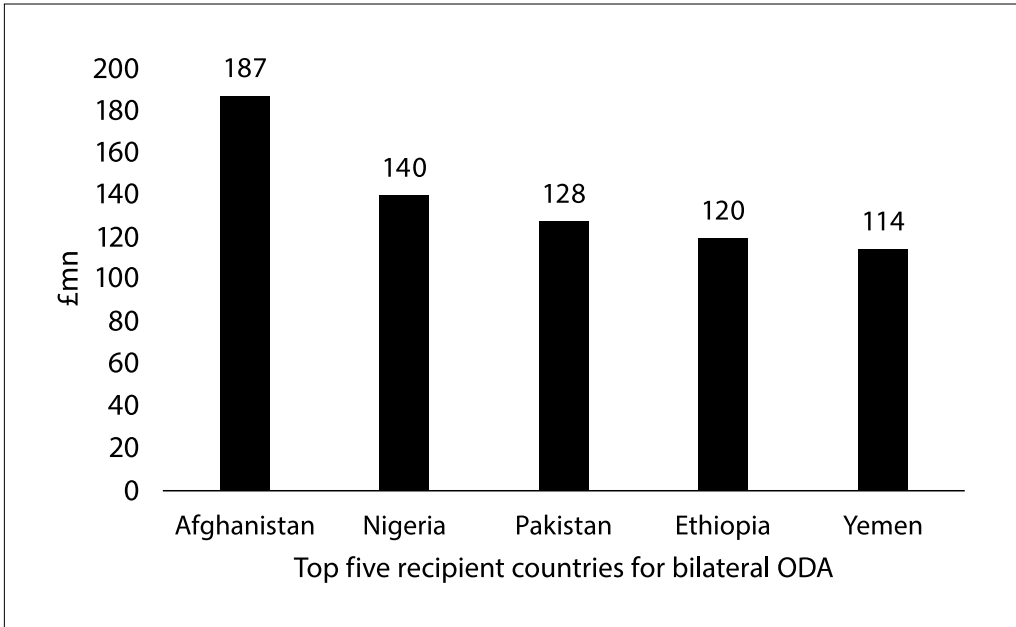


Figure 2: Top Five Recipients of Country-Specific OCA in 2021 (Source: House of Commons Library)

of UK aid recipients. Nigeria has broadly had a consistent presence within the list and was the second-highest recipient in 2021² despite the drop in UK ODA.

6.2 Nigerian Stakeholders and UK Audience

From a securitisation theory point of view, the audience plays a key role, as determined earlier in this paper. It is therefore worth considering, albeit briefly, the perception of Nigerian stakeholders and the UK public on development aid. The House of Commons FASC Report (Lagos Calling 2021-22) engaged with NGOs, groups representing the Nigerian Community in the UK, former Nigerian officials, Nigerian businesses in the UK and academics to establish their views on UK soft power, engagement in and the IR implementation in Nigeria. High Commission Staff within Nigeria noted with positivity the synergies between the UK and Nigerian aspirations, believing that this would translate to greater resources at their disposal to deliver UK ambition for the benefit of Nigeria. However, UK aid to Nigeria was cut from £209.39 million in 2020/21 to £95.12 million in 2021/22 (Lagos Calling 2021), so this belief could be over-optimistic. Academics and Nigerian business owners in the UK were particularly enthusiastic about the UK's development initiatives in Nigeria. However, they broadly felt that the existing framework of development engagement does not enable the achievement of development goals for Nigeria. Many academics and business owners engaged were keen to see financing and investment initiatives in growing sectors such as science and technology. There were views on the potential for growth in the renewable energy sector, an issue that chimes with the UK's Climate change agenda and a key objective for UK/Nigeria development

initiatives. Whilst there was little direct reference to development aid by them, the UK's attention to addressing corruption in Nigeria was welcome. The UK was quoted as fourth in recipients of illicit financial flows from Nigeria. There was a perception that the UK needed to do more to stem the flow of illicit finance from Nigeria and that the focus of the partnership should be from a trade and investment perspective rather than aid (Ikpe and Olonisakin, 2021; PSJ UK, 2021; BABA, 2021).

There have been several documented UK public opinion polls since 2010 on the aid budget generally. In a June 2010 survey, 64% of respondents felt that aid to developing countries should bear the most significant cuts in spending (Harris Interactive, 2010). In 2011, YouGov/Chatham House determined that only 27% of respondents believed that aid contributed to poverty reduction and protected UK security. Cited in Lockwood *et al* (2010), a home survey of the conservative party's prospective parliamentary candidates determined that only 4% felt that International Development should be immune to cuts in spending. Successive conservative governments since 2010 recognised the significance of the 0.7% GNI pledge on overseas development aid as key to underpinning the UK's soft power, diplomatic influence and strategic interest (British Foreign Policy Group (BFPG)). To some extent, the recent temporary deduction to 0.5% of GNI owing to crises in the UK economy and domestic finances reignited the debate on public opinion on aid. The BFPG, in ongoing research, has determined that 17% of Britons do not support UK aid spending. They have most importantly determined that attitudes to development aid by the UK populous are influenced by complex factors such as individual lived experiences, social circumstances and structural economic inequalities within the UK itself, among other factors, and therefore should not be viewed from a simplistic lens. The research determined that 72% of Britons supported reducing or stopping aid spending during the pandemic. Economic insecurity has contributed to negative perceptions. These perceptions are likely to have a bearing on government decision-making, especially noting the turbulence within the British political system over the past seven years and the harsh economic times the UK continues to endure.

7. Alternative Approaches

Mills (2021) argues that development is underpinned by buying and selling goods and services to enable economic growth, not through development aid. However, Moyo (2009) highlights how the Marshall Plan, a significant aid programme, enabled Europe to rebuild post-second World War and contributed to success in East Asian economies. It was a finite injection of support with specific goals that successfully augmented Europe's efforts to recover its economy, demonstrating that the principles underpinning development aid can yield positive outcomes. There has been broad scholarship on the merits and demerits of development aid, particularly in Africa, as the continent continues to lag behind where development and economic growth are concerned. Therefore, it is worthwhile for the UK to consider alternative approaches that could yield more positive outcomes for Nigeria and Africa, acknowledging that African countries' political and economic contexts are different. The aid architecture has evolved and involves multiple stakeholders beyond the UK, other states and multinational

corporations, and the private sector. Therefore, alternative approaches may be achievable by the UK and Nigeria but in concert with other stakeholders.

Prosperous countries have adopted various economic and policy approaches to achieve development success. Those that have attained their development objectives have generally reached a sensible state of macroeconomic stability, allocated resources to the development of infrastructure, healthcare and education, exercised judicious stewardship over their natural resources, fostered a conducive environment for private sector investments, facilitated a pivotal role for the market with state co-operation and steered clear of excessive exploitation by organisations leveraging their ties to governmental entities (Mills, 2021; Dercon, 2023, Moyo, 2009). This paper does not suggest an exhaustive list of alternative approaches. It considers three areas of focus from various scholarly evaluations of where the UK can direct efforts to support the development of Nigeria, other than over-reliance on development aid or even in addition to it.

7.1 Domestic Resource Mobilisation

For most governments, domestic revenue generation is undertaken through resource extraction, taxation and investments to regenerate revenue. For Nigeria, oil provides approximately \$35 billion in annual export income, making up above two-thirds of the country's export income, and the government does not produce anything else that the world finds worth buying (Mills, 2021; Dercon, 2023). For efficient and effective management of its resources, the government needs to have systems in place to ensure resources are not siphoned to individuals and groups. It must reform taxation, encouraging compliance with streamlined processes and incentivising timely payments. It further needs to regulate the oil sector, one of the areas in which the UK has been involved and should continue to be. Oil wealth is a significant attraction for those powerful enough to bargain among civilians and other vital stakeholders. Dercon (2023) asserts that since the advent of the presidential system in 1999, accession to power requires negotiating complicated and expensive elite bargains that involve leaders of different ethnic groups. Until this cycle is broken, it is difficult to see how Nigeria will efficiently and prudently mobilise its domestic resources to achieve economic growth and job creation at the heart of its current NNDP 2021-25, alongside the rest of the critical strategic objectives, irrespective of the volume of development aid the UK gives it.

7.2 Foreign Direct Investment

The lack of opportunities outside of Nigeria's oil sector is partly attributable to the complex business environment that the country is in. Nigeria was ranked 131/190 in the World Bank's table for ease of doing business, with relatively low scores on the sub-theme of trading across borders (partly due to corruption within the ports and transporting containers through the country). This was supposedly a marked improvement demonstrating Nigeria's efforts at economic reform (Doing Business 2020). It was ranked 130/141 by the World Economic Forum (2019) for quality of infrastructure. These are vital factors in instilling confidence in investors.

Dercon (2023, p 4) argues that a development bargain is needed for successful growth and development. This is an underlying commitment to growth and development by the country's elite. For this to succeed, peace and stability are critical. Nigeria would have to find a solution to the instability that Boko Haram (literally, 'western education is forbidden') causes in the north-eastern part of Nigeria and beyond. The current strategies have not yielded the desired result of eradicating the threat of Boko Haram. Further, the UK as a trade partner would need to be willing to invest in areas of the economy highlighted as possessing significant potential for growth; the UK, for example, could focus on investments in science and technology, tap into a dynamic and highly innovative young population that Nigeria has, supporting the structures that underpin innovation and technology advancement such as finance, institutional frameworks, private sector investments, including education institutions that build human capital. These were highlighted in the FACR and should be pursued with a comprehensive strategy underneath it.

7.3 Trade and Export Diversification

Nigeria is reliant on oil as an export commodity. The country faces a challenge of downward pressure on oil prices, a global emphasis on a shift towards renewable energy sources that has seen large oil producers such as the Kingdom of Saudi Arabia working hard to diversify their economies. It, therefore, needs to develop and expand its export industries alongside diversifying the range of products it offers on the export market to stimulate economic growth and reduce oil dependency. Mills (2021) suggests that agriculture is an obvious alternative, given Nigeria's vast arable land and exponentially growing population. It is a sector that has failed to deliver for Nigeria, with its cereal yields well below the likes of South Africa and cattle produce barely hitting 5% of the global average for milk production. Issues that prevent success in this sector include skills, the scale of farms, and access to grazing land, especially noting the friction between pastoralists and herders in the north-eastern parts of the country. Poor packaging, storage and transport management means agricultural products have a high attrition rate before reaching the ports. A post-Brexit UK that has the freedom to negotiate new trade agreements can incentivise Nigeria to grow its agricultural sector for export (Mills, 2021).

8. Conclusion

This paper has anchored its analysis of the UK's pursuit of development goals in Nigeria through a framework rooted in securitisation theory. Through critical perspectives from scholars who champion comprehensive conceptualisations of security beyond traditional state-centric realist perspectives, it has been acknowledged that securitisation can be evidenced beyond speech acts at the core of the CS of securitisation theory. The paper has uncovered a significant alignment between UK security concerns and development priorities in Nigeria, evident in the examination of UK policy, addresses delivered by Foreign Secretaries and allocation of development aid funding in a manner that demonstrates that security imperatives have steered the trajectory of developmental objectives. Securitisation has been a prominent tool within the UK's FP toolbox, guiding its engagement with Nigeria.

The prevalence of the fragile states discourse has influenced policy agendas and played a crucial role in justifying development aid allocation against a backdrop of competing priorities for the UK government.

Whilst acknowledging the significant role securitisation has played, it is crucial to recognise the challenges and limitations of this approach. A securitised FP may inadvertently cause security imperatives to overshadow broader development concerns. It may lead to over-emphasising security solutions, potentially neglecting other socio-economic factors that underpin sustainable development, in addition to adverse effects mentioned earlier in the paper, such as encouraging aid dependency, economic distortions and corruption.

The Boko Haram's challenge to Nigeria is acknowledged and has been front and centre in the UK's support to Nigeria, arguably justifying the securitised approach. However, alternatives should be considered to deal with instability caused by violent extremists, including Boko Haram; alternatives that recognise political consequences and potential extensions of violence that can result from security discourses and practices that embolden the use of armed force (Gelot and Sandor, 2019). Fundamentally, a stable Nigeria is in the UK's interest to enable a formidable regional partner and to deal with issues such as irregular migration and the increasing influence of China and Russia in the continent. This makes it worthwhile for the UK to reconsider its approach in Nigeria, creating a possible blueprint for other states of significant strategic interest to the UK in the region.

The alternative approaches focused on trade, investments, and initiatives outside the aid framework are areas the UK government is already alive to but require a robust engagement strategy to underpin. For these to succeed, there must be an environment that fosters both state and human security, so the challenge is for the UK to balance the security imperatives against development and hold Nigeria accountable for aid funding on this front. Some scholars believe that there is a mutually reinforcing dynamic between poverty and insecurity (Verstegen, 2001), while Ajodo-Adebanjoko and Ugwuoke, (2014), in a study specific to Nigeria, concluded that insecurity affects poverty significantly and that more communities collectively shun violence, the less the numbers that live below the poverty line. Omenma and Hendricks, (2018) argue that the suppression of Boko Haram using armed force is not enough. They propose that the government and its partners in this fight, the UK being a key ally, must move beyond 'war-mode' solutions to consider negotiated settlements and other alternatives to set the conditions that enable genuine development for Nigeria. Some scholars argue that most armed conflicts have ended through negotiated settlements (Omenma and Hendricks, 2018). The shift to a development-security nexus was partly driven by the now widely recognised ineffectiveness of military interventions in fragile states. Short (2009, p 62) details her experience of military intervention, suggesting that military approaches exacerbate problems in fragile states rather than ameliorating them. She points to examples such as the considerable difficulties the coalition faced in Afghanistan and Iraq and that Hezbollah has demonstrated that the military might of Israel cannot suppress it.

The focus on armed force solutions is not yet proving a successful solution to the problem of countering the Boko Haram threat to enable an environment with optimum conditions for trade, investment and other economic growth initiatives to alleviate poverty.

It is crucial for the UK to continuously review the impact of its aid programmes, matching goals against outputs and outcomes. There needs to be more empirical evidence relating to the impact of development aid in general (Jakupec and Kelly 2015, p 6). This could be due to resource constraints, complexities associated with assessing impact, and constantly changing priorities, among other factors. The UK should invest more in impact studies to ensure development aid resources achieve their allocated goals.

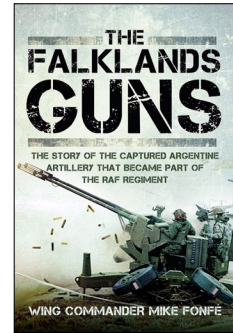
Notes

¹ Table 1 at Appendix A.

² Figure 2 at Appendix B.

Book Review

The Falklands Guns – The Story of the Captured Argentine Artillery that Became Part of the RAF Regiment



Author: Wing Commander Mike Fonfé

Publisher: Frontline Books Great Britain (ISBN: 978 1526774422), 256 pages

Reviewed by Wing Commander David Caddick

Introduction

The Falklands Guns by Wing Commander Mike Fonfé, a retired RAF Regiment officer, is a fascinating read. It tells the remarkable story of how captured Argentinian Oerlikon twin barrelled 35mm anti-aircraft guns, their generators, copious amounts of ammunition and their Skyguard surveillance and fire-control radars were recovered from the Falkland Islands, refurbished to 'as new' condition, and then formed into a highly effective and lethal Royal Auxiliary Air Force Reserve Squadron. This squadron was subsequently expanded to form 2 squadrons and a wing headquarters providing low level air defence to two main operating bases within the United Kingdom, a capability declared to NATO and is in the author's own words a 'boy's own' dream.

The important point of the whole book is that it takes the planets to align to ensure that the right person, with the right skills and the right vision, is in the right place, at the right time to make these things happen. But before we get to the NATO declared squadrons, Mike Fonfé takes us on a journey through the Falklands War. He has produced a detailed and comprehensive study of the air war in the Falklands, looking at the ground based, or should I say surface based, air defence systems from both sides and how they affected not just the air war, but the whole campaign. In particular, he highlights how an integrated air defence system

should work by exposing the failings of the ad hoc integrated air defence system that both the Argentine and British forces put in place during the Falklands campaign. For any student of the Falklands campaign this section of the book is, indeed, a must read.

The subsequent recovery of the weapons system back to the United Kingdom is a fascinating and at times incredible story. Guns had been stripped of optical sights, their spare parts and toolboxes had been 'liberated' as souvenirs, and the guns themselves ended up in various places as trophies, including a well-known museum. The task of finding, identifying, collecting, and bringing together all this equipment to RAF Waddington is a study in ingenuity, inventiveness and quite often a bit of brass neck. This is where the combination of the author's experience as an Instructor in Gunnery, guided missile specialist and formidable staff officer enabled him to navigate the labyrinth of the MOD and single services, often taking an unconventional approach and most importantly building a small team around him who were equally as enthusiastic and formidable in their own specialist areas.

The formation of the Reserve gun squadron again demonstrates Fonfé's agile approach. From the outset he recruited both male and female gunners and trained them as anti-aircraft gunners first. Once they had mastered the guns, they moved on to master the radar control systems and continued to progress until those with the aptitude and ambition could command a complete unit of one radar and three guns - there would be time to learn to march later. He based this approach on the Swiss model of using a conscript Air Force and concentrated on the basics. Of course, he was helped by this in so much that the guns and the radars were manufactured by the Swiss, and the equipment's ability to stand idle for many weeks and then be brought into action by conscripts was built into the design and maintenance of the awesome weapons systems. Having established the squadron and made it an essential part of NATO's order of battle, Fonfé was deservedly promoted and moved on to other duties and there his story really ends.


It would be fascinating to have some insight into the detailed decisions as to why this cost effective and deadly capability was finally taken from the RAF order of battle in 1993, but the end of the Cold War and the overall drawdown of the UK armed forces seems to be the reason. However, a legacy of Fonfé's work lives on. The Skyguard radars are still in use with the Royal Air Force today, although from the reviewer's own experience few people in the RAF know that they were once captured on a battlefield many thousands of miles away, or the incredible story of how they ended up in the service of the RAF.

In summary, *The Falklands Guns* is a fascinating read, and left me thinking if a similar situation arose today would we have the right people with the right skills and vision, in the right place? I would like to think yes, but if we are truly going to be operationally successful, agile, and innovative, then this is a case study for every aviator to read.

The Chief of the Air Staff's Fellowship Scheme provides a fantastic opportunity for RAF personnel of all ranks to undertake sponsored full and part-time postgraduate study at masters and doctoral level. There are a range of Fellowships available including an online part-time MA in Air, Space and Cyber Power, a full-time MA in Security and Strategy and an MPhil in International Relations at Cambridge. Further details, including eligibility criteria, are available in the DIN (2023DIN07-086) but if you or a member of your team are interested in applying then please contact the Directorate of Defence Studies team: CAS-ASDefenceStudies@mod.gov.uk

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