Viewpoint

THE BLURRING OF THE AIR AND SPACE DOMAINS – PERSPECTIVES OF THE PHYSICAL, MORAL AND CONCEPTUAL IMPLICATIONS FOR THE ROYAL AIR FORCE IN ITS SECOND CENTURY

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'The profile of the Space Domain is growing as our dependence upon it increases and the boundaries between air and space become less distinct'[1]

Air Chief Marshal Sir Stephen Hillier,
Chief of the Air Staff (CAS) 2017

INTRODUCTION

The application of twenty-first century technology is increasing the blurring of the Air and Space domains, and this effect has significant implications for the Physical, Moral and Conceptual Components of Fighting Power and especially for the Royal Air Force (RAF). As Defence is exposed to effects delivered from space and dependent upon space-based capabilities, each Service needs to address the impact upon its warfighting roles. The RAF, however, has the greatest stake in this debate. Physically, the Air domain is the only conventional warfighting domain that borders space. Air and Space are therefore contiguous domains with increasing interdependencies. CAS now has the Defence lead for space operations and this gives the Service a mandate to explore multi-domain and multi-dimensional operations across the span of both domains as well as their interface. Conceptually, every airman and woman needs to understand the physical, conceptual, and moral implications of the blurring of air and space power to address the inherent challenges and maximise the opportunities for both domains in an almost seamless manner. So, in an era reminiscent of the seismic changes that occurred in air power's infancy, the RAF should again lead the charge to understand, develop, and capitalise upon the efficiencies and practicalities of this naturally blurred environment.

This essay provides a **personal** perspective of the Air-Space context. Further analysis will be required to develop our thinking and activities. It therefore poses questions rather than delivers answers. It will use extant doctrine and conceptual thinking to illuminate a path that could be taken to facilitate the production of novel operating concepts, which could be debated and adopted as future doctrinal practice. Accordingly, this essay seeks to stimulate debate and deepen thinking across the Service. It uses the author's deductions for air power taken from Joint Concept Note (JCN) 1/17 'Future Force Concept'[2] along with perspectives on a variety of doctrinal texts to guide the way. It will offer some insights as to how the Air and Space domains could be exploited, as conjoined entities, to the best military effect.

THE REALITY OF BLURRING AIR AND SPACE – THE DAWN OF THE AEROSPACE DOMAIN?

Boundaries. There are various approaches to qualifying the boundary between Air and Space; the most widely accepted of these is known as the Kármán Line, which sets the interface between the two domains at an altitude of 100km above sea level. However, the reality is a gradual transition from our atmosphere of air into a space devoid of air molecules.[3] The blurred boundary between the Air and Space domains

is especially evident in the context of doctrine and the realities of modern practice. It would, nevertheless, also be correct to say that each represents a discrete domain from which military effects can be delivered and upon which the other conventional warfighting domains are increasingly dependent.[4] However, following the recent announcement of CAS as the lead for Space operations, it is also correct to infer that this brings some significant challenges and, more importantly, opportunities, to deliver effects across both domains in a more consistent fashion. So doing will increase the fusion of Air and Space effects to support the delivery of outcomes below the surface, on the surface, and above the surface of the Earth from platforms and capabilities that operate in the air, from space, and across the air-space continuum. CAS' vision, aligned with the emerging National Space Strategy, is reminiscent of the vision and drive expressed by Marshal of the Royal Air Force Lord Trenchard during the formative years of the RAF. So, while all three Services may be focused on relatively geographic 'hot-spots' of activity at sea, in the air and on land, the RAF will also be put to the test simultaneously over the greatest horizontal and vertical range and more so than it has experienced in recent years. This is because of the reality that the Air and Space domains have the greatest physical horizontal and vertical spans. These domains are also increasingly vital to both our national economy and national security. While Maritime doctrine correctly identifies that a significant proportion of our national trade effort utilises the seas and the oceans, I contend that 100% of our trade is affected or enabled by either access to, or enablement from, the Air and/or the Space domains. Therefore, access to and control of both domains will undoubtedly become one of our top national security challenges. Such challenges may require us to review our current perceptions of the attributes of both Air and Space Power and adapt to the way in which these environments and any ensuing battlespace is commanded and managed. Is the RAF up for this challenge? If so, what needs to change in the way it thinks, prepares, acts, and fights over the coming decades, and in which areas does it need to focus its investment?

RAF100 – A Legacy. The legacy of the RAF's first centenary suggests to me that it is up for that challenge. The RAF is a multi-domain operator in both character and nature as its outputs transcend operations across all warfighting domains and in all dimensions.[5] Although, as I am reminded by my Army and Royal Navy colleagues, the other Services have an important interest in cross-domain operations too, it can be argued that their multi-domain activities are generally designed to improve the outcome *within* their respective domains rather than to achieve consistent effects across the horizontal and vertical span of an operation or campaign.[6] Their activities, while multi-domain in character, are single-domain in nature in that they invariably seek to generate effects to create advantage within their own domain or for their own component. Conversely, the characteristics of air and space power allow the RAF to reach across all domains to deliver effects across all dimensions in support of all warfighting components to the greatest horizontal and vertical reach achievable. To continue to do this requires agile

and adaptive Command and Control (C2), including multi-domain and multi-dimensional battlespace management that maximizes the combined attributes of height, speed, reach, agility and ubiquity of air power with attributes of perspective, access, persistence and versatility of space power while increasing the permanence of presence and survivability against emerging threats.[7]

CONCEPTUAL COMPONENT

Doctrine. The second edition of Joint Doctrine Publication (JDP) 0-30 'Air and Space Power' was published last year. It is the latest iteration of evolving Air doctrine and is our first attempt to merge air and space power. It also recognises, in doctrine, Space as a warfighting domain in its own right. Underpinned by policy, this doctrine outlines and reinforces the synergies between Air and Space. It also highlights the complementary attributes of both air and space power.[8] Yet it is not surprising that each domain, despite their blurred interfaces, retains a degree of distinction. After all, Space is *space* and Air is *air* – in doctrinal terms at least. The gap between what we can do in both domains is changing, as demonstrated by the Carbonite 2 Project, and the F-35B Lightning and Protector programmes, but none of these has succeeded in rendering the distinction between Air and Space redundant. Indeed, these projects and programmes reflect a somewhat traditional view of both domains. The next Air and Space doctrinal leap must therefore close that gap, through the re-evaluation of the characteristics of both domains, possibly leading to characterisation of 'aerospace' as a future fused warfighting domain. But that requires some more conceptual thinking and some focused experimentation. Setting that strategy must be a priority for the RAF. Yet, as I write this, the DCDC is engaged in revising UK Defence Doctrine and the Defence Operating Concept. It is clear, from our research and the broad cross-Whitehall engagement that informs these publications, that 'Grand Strategy' is making a long overdue return to our doctrinal lexicon. This is partly due to the recognition that today's geopolitical context, and our known national ambition, requires a strategy that addresses the challenges of persistent competition, while the re-emergence of asymmetric, sub-threshold 'attacks', requires a broader definition of national security, national interest and, of course, our strategic goals. Thus, the security of the Air and Space domains will become an increasingly grand strategic, national security priority. Therefore, as the lead for air and space power, the RAF will have a large part to play in any such grand strategy, but this requires airmen and women to think beyond today's technologies and tactics and consider how we get to tomorrow's technologies as quickly as possible. The RAF needs a strategy to do this and airmen and women must learn to think more strategically earlier in their careers – reading Julian S Corbett's seminal book 'Principles of Maritime Strategy' is, somewhat paradoxically, a very good start: just delete 'sea' and insert 'air' or 'space'!

Concepts. This leads very nicely on to JCN 1/17 'Future Force Concept', published almost simultaneously with JDP 0-30 Air and Space Power Second Edition. Both are DCDC products and it is clear there is a high degree of synergy between the two publications.

However, I would like to have seen the Future Force Concept go further and to have been bolder in its ideas especially with the contextualization of domain and cross-domain challenges. In the meantime, I believe that the Air community should undertake a broad review of the Future Force Concept to identify, understand, and address the implications for air and space power. This work should be a joint venture between the Air Staff, Air Capability, the Air Warfare Centre, the Directorate of Defence Studies (RAF), and the DCDC, and this essay outlines some initial thoughts to stimulate such a review.

So What? The RAF of the 1920s was thrust to ever greater heights because of the legacy of the First World War, a realisation of its nascent strategic potential, as well as a shared belief in what the RAF was for, and how to optimise the Service for the future. A similar dynamic is at play today. The RAF represents an agile, forward-poised and persistently engaged, yet precise, conventional military capability, ever-ready to protect our nation and its interests. The RAF's air power credentials are well-founded and it is maturing its Space credentials at speed. The fusion of a solid air power foundation with capabilities from, through, and into space will provide the UK with an effective and efficient way of multiplying that capability and maximising its utility. This means exploiting the blurred boundary between Air and Space, drawing on CAS' vision for multi-domain C2. Our Conceptual Component must drive the development of the Physical and Moral Components, else we risk simply reverse-engineering the rationale for our capability choices and leading our people bravely to defeat.

PHYSICAL COMPONENT

Conventional Perspectives. The Physical Component is the one with which airmen and women tend to be instinctively the most comfortable. It is about the platforms, capabilities, weapons and 'stuff' that, to many, define what the RAF 'is'. This applies just as much to the Space domain as it does to the Air domain, and the best way of achieving this may be to address both domains as seamless entities. In years gone by, the reality of doing just that was limited by technology separation: what worked in space did not work in the air and *vice-versa*. But modern technology – especially with hypersonic engines, pseudo-satellites, high-resolution optics and radar technologies – makes it conceivable that, with appropriate investment choices, future military capabilities could have the potential to be employed in both domains, perhaps even within the same mission. These technological enhancements are also likely to deliver the improvements in speed, reach, persistence, coverage, survivability, and precision necessary to provide an increased range of options for military commanders and political masters alike. But to embrace this new technology will undoubtedly require us to change our preconceived ideas of air power as being delivered predominantly from manned, fixed-wing, air-breathing platforms which operate at relatively low altitude. The blurring of the Air and Space domains allows us to translate our experiences of inner-atmosphere aviation into even higher vertical limits and far greater ranges of effect. In the remaining paragraphs of this section, I will explore what I believe to be the four

greatest technological developments that will allow us to transform air and space power over the next 30 years.

Hypersonic Engines. At a glance, hypersonic engines may appear to be a 'silver bullet' which will unleash air and space power in the twenty-first century. This field of technology shows great promise, and much is possible within the next couple of decades providing there is investment in the emergent technology. So, what can hypersonics offer the Air environment? A good place to start would be to look at what Reaction Engines Limited (REL) has to offer with their experimental Synergetic Air-Breathing Rocket Engine, or SABRE.[9] Initial work looks incredibly exciting and could give rise to a working platform by 2030 that is capable of Mach 5+ and offers high cadence space access as well as long range inner-atmosphere flight. Such technology also appears promising because it purportedly offers 'speed as the new stealth' and potentially increases the survivability against an array of current and anticipated anti-access systems. Furthermore, while the technology claims to enable space access it can also, in theory at least, provide a vehicle from which a space payload could be launched. But hypersonic technology is not limited to just platforms. It can be applied effectively to weapons: air and ground-launched, offensive and defensive. Whatever the manner of its employment, hypersonic technology has the potential to provide significant benefit to all operating domains – a true force multiplier. Thus, even at this relatively early stage in its programme, hypersonic technology represents a very strong candidate to address the physical aspects of the blurred Air and Space domains. While there are numerous hypersonic technologies under development, SABRE is novel, it is British, and therefore offers a sovereign capability with all the accordant benefits for our national prosperity agenda.

Pseudo-Satellites. This field, especially when partnered with quantum radar technology, also offers great potential, particularly for communications, Intelligence, Surveillance, and Reconnaissance (ISR), and as a novel way of producing a recognised air and space picture. Like hypersonics, there are many aerospace businesses that are exploring the potential of high-altitude pseudo-satellites (HAPS). Airbus's 'Zephyr' is but one. This offers high altitude (inner atmosphere), persistent (months), loitering, and re-usable technology to enhance communications and ISR coverage. Although currently limited to a 10kg payload, this is likely to double in the next decade. This could allow the addition of a quantum radar capable of maritime sub-surface surveillance. So, Zephyr sits on the edge of space, can observe or relay communications across multiple dimensions and all warfighting domains, and offers precision and persistency over a selected area at any specified time – this is more than most current satellites can offer. It therefore hints at a capability that capitalises upon the blurred Air and Space domains to the potential benefit of all warfighting domains. It certainly looks a very strong candidate to provide persistent maritime sub-surface cover for a vulnerable carrier strike group, and then to cue appropriate responses. It can also contribute a significant amount to any recognised air, land, or maritime picture.

Quantum Technologies. Quantum science has the potential to derive multiple quantum-based technologies with very significant military applications in cryptography; communications; position, navigation and timing; radar; sensing; and imaging.[10] These latter three quantum technologies could have much utility, and very disruptive effects, not only across and within the Air and Space domains but all other domains too. Imagine being able to detect contemporary stealth aircraft at will, submarines below the surface of the oceans, and activity in subterranean passages on land. Such potential means that a quantum competition for first-mover advantage is well underway. It is one that airmen and women must understand because it will impact on the way we will fight in Air and Space.

Directed Energy Weapons. The application of Directed Energy Weapons (DEW) to air and space operations is also likely to be significant. Whether the DEW is of the Radio Frequency variety (which employs electromagnetic radiation against sensitive electronic sub-systems) or a high-powered laser form (which uses electromagnetic energy to damage equipment through its thermal effects), the applications are many and varied, with technological development now so advanced that they are soon to be a reality on operations. In our blurred context, it will be technically possible to direct weaponised energy from the surface of the earth into space, and from objects in space to the surface of the earth. Most acute in the Space domain is the emergence of proximity operations between satellites, where directed energy can be used to disrupt, damage or even destroy in a very harsh operating environment where it is also very difficult to understand cause and effect, and therefore to attribute responsibility.[11]

The Supercharged Digital Revolution. The falling costs of gaining access to space, fueled by the commercial lead in the application of digital technologies has significant implications for the so-called Fourth Industrial Revolution that is defined by data. Space-derived Big Data, and its application, has the potential to be very significant in the Air and Space domains. For the same reason it is the greatest opportunity for trade and simultaneously gives rise to a significant security challenge. Today, farmers are using this data to manage their crops, governments to manage their response to flooding crises, and tomorrow, militaries will be using it to increase their understanding of the battlespace.[12] This digital revolution is key to realising the opportunities of the blurred Air and Space domains and maximising the benefits this can offer for national security.

Next Steps. But these are technological solutions to today's and tomorrow's problems. The immediate challenge – and one to which the RAF has already risen – is the need to improve the way in which it commands and controls space operations. The recent reformation of 11 Group as a multi-domain operations group is an exciting initiative designed to bring about seamless C2 for Air and Space domains. The operation of 11 Group will, in effect, cease to see the Air and Space domains as separate warfighting entities. While much work still needs to be done to codify procedures and linkages,

it appears to me a bold and appropriate step towards taking the lead and clarifying the blurring of Air and Space and maximising operational outputs. An air and space operations centre, capable of directing, commanding, and controlling air and space activities – at home and abroad – from the UK and/or a forward deployed Air Component headquarters is a large step forward for the projection of air and space power. But to be effective it will require significant investment in the Physical, Conceptual, and Moral Components of Fighting Power, to ensure interoperability with other domains, allies and partners; resilience from the effects of potential physical and cyber-attack; but also the ability to think and act strategically while delivering tactical and operational outcomes. This is key and requires a fundamental shift in mindset from single-domain technology and tactics, to a multi-dimensional and strategic approach that synergises activity across domain boundaries.

MORAL COMPONENT

Why we Fight. The final element is the Moral Component of Fighting Power. In short, this component encapsulates 'why we fight'. It can therefore be posited that this Component is the most subjective aspect of the trinity of fighting power. While this is undoubtedly the case, a significant objective element must prevail. That is, where leadership and identity come into play. The two are mutually-supporting and, as airmen and women, we have a natural affinity to the air above our earth and what we can achieve from it. Because the Air and Space domains are blurring, we must widen our aperture to look higher and further to explore how the characteristics of air and space power themselves need to amalgamate as the technology allows us to operate in both domains and within the same mission. While all three conventional warfighting domains will always have dependencies on, and be vulnerable to threats stemming from, space, the RAF has the strongest cultural affinity as well as an identity that is linked to the above-surface dimension, including space. CAS has already started to tackle the challenges of leading the changes necessary for the RAF to embrace space power. RAF100 is a springboard from which we can enhance our thinking towards space, and contextualise the changes required to translate why we fight from the air into why we fight from the air *and* from space. But how do we do that?

Spring-boarding. Earlier, this paper mentioned the need for airmen and women to think beyond the technologies and tactics. Thus, conceptual innovation is key, but it must come from a solid baseline assessment of what we *cannot* do today and why. We cannot afford the luxury of a perpetual innovation-change cycle without firm investment in the consolidation of capability and a rigorous lessons process that spans the tactical, operational and strategic levels. Without these we risk creating and chasing *conceptual fashion*, the result of which is somewhat vanilla and relatively short-lived thinking.[13] We have lost the edge on this front, partly due to two decades of counter insurgency operations and also a rather passive and reactive approach to contingency and readiness (and the fiscally-driven constraints on many activities). The result is that we risk losing

our offensive spirit, and this would weaken our ability to deter – a very strong commodity in this world of persistent competition. This is not, I believe, a trend that threatens only the RAF; it applies equally to the Royal Navy and the Army. But let us not forget that the RAF is no longer responsible for the Moral Component in the Air domain alone. The addition of Space to our portfolio brings an array of new challenges not just on how we meet our own objectives and requirements but how we provide an expanded service to the Maritime and Land domains too – and all at the same time!

SO WHAT? – SOME POTENTIAL INSIGHTS

To kick start that process, I believe that the Future Force Concept highlighted the following key themes which will be critical strands of work to bring clarity to the blurring of the Air and Space domains. The list is by no means exhaustive, but the following paragraphs in this section reflect the challenges and opportunities that need to be grappled with now.[14] Addressing the blurring of the Air and Space domains now will undoubtedly help us to develop better capabilities going forward.

Governance. The UK has recognised Space as a warfighting domain on a par with the Air, Land, Maritime, and Cyber domains and highlights that '*while all domains are equal, the relative start points for integrating across the domains as a joint force are not*'.[15] The inference from this statement reflects the differing needs, as well as constraints, of multi-domain and multi-dimensional operations. Thus, the push and pull of C2 will need to be more dynamic and flexible and the battlespace management architecture more complex and multifaceted. The RAF has been given the Defence lead for C2 of space operations and, as well as the provision of Space Situational Awareness and Space Control capabilities, the development of a cadre of qualified and experienced space personnel. The challenge is, intellectually at least, analogous with that faced by the RAF in its infancy. How should we do this, and what can we learn from others? There is much we can learn from the US approach, but I believe that there is a very British way forward here. In the US, there is much debate over what multi-domain operations constitute. This debate is not necessarily germane to UK Defence business. We have Joint Action as a cornerstone of our warfighting doctrine – and it works.[16] Joint Action – comprising Fires (lethal and non-lethal), Manoeuvre, Information Activities and Outreach – is inherently multi-domain in construct and execution. The US have not had a comparable model that fuses the combined multi-domain capabilities in each of their Services. The US' Multi-Domain Operations (depending on the lens through which it is viewed) is arguably little more than an endeavour to codify a domain-centric approach to Joint operations. While we have similarities with the way US military theorists think, our respective organisations are somewhat different, and our dependencies are also quite different. We should therefore continue to determine what best meets our needs rather than attempt to shoe-horn an inappropriate idea into functioning UK doctrine and practice. Thus, the application of Joint Action, executed within domains, and fused across domains by the appropriate

command and control structure, remains the best way for UK Defence to deliver a multi-domain effect.

Reliance and Resilience. The RAF (and all of UK Defence, like most Western militaries) has become wholly reliant on access to space-based services to deliver its operational outputs. This has created a single point of failure with little or no resilience. Not only have our potential adversaries noticed this but they have been actively demonstrating how they could deny this essential access. We may consider, therefore, that Space has evolved into a warfighting domain. Acceptance of this is a crucial first stage in addressing a vulnerability, but how we do this, and how we do it *quickly*, is surely a major challenge for us all. We talk of deterrence, but can we deter an adversary from denying us unfettered access to space? Not an easy question to answer as I judge that following 20 years of COIN focus we have forgotten what deterrence is and how to do it. This is the subject of a new doctrine publication but the role for Air and Space power in a deterrence strategy will require some agile thinking and some even clearer action.

Narratives – What We Are For. Since the end of the Cold War, a situation has developed in which attention is focused on what the RAF does, rather than on what the RAF is for. We have perpetuated this disconnect by our own unsophisticated descriptions of air operations. We say, for example, that we have '*dropped a bomb here*' or '*taken a picture of that*'. Instead, we should be explaining the breadth of options that the RAF offers to our Government in pursuit of political objectives, and why the RAF has been selected for a task in preference to other military tools. Similarly, we have not clearly articulated the contribution of air power to campaigns at the Operational Level of War. Instead, we have focused the narrative on tactical actions. But this has too often relegated our contribution to the Joint Force to a subordinate, supporting role. Afghanistan was a Land-centric campaign, but it is rarely acknowledged that it was made possible by the provision of a full spectrum of Air and Space functions and capabilities. Militarily, Libya was a very successful Air-centric campaign, but that success has been obscured by subsequent political failure. The contemporary operating environment is more blurred than ever before with operations being conducted in space and cyberspace as well as below the surface, at sea, on land and in the air. All warfighting components need to be adept at multi-dimensional operations and with complicated and rapidly changing C2 arrangements. Air forces, with their inherent vertical and horizontal reach, and scope for delivering cross-domain, multi-dimensional effect, need to be most comfortable with this. CAS' recent statement of intent for C2 to be enshrined as the fifth pillar of air power plays to this tune, but the strength we seek to exploit is the instinctive way in which we have always sought to manage the battlespace in an integrated and multi-dimensional fashion. We have taken for granted that the public can make the conceptual leap to understand the value of what we do, when instead we need to provide explanations that are both explicit and convincing.

We have not done this effectively for our primary domain, so to do better across both domains will be a considerable challenge. But, unless we do, the public will not comprehend the value for money we offer and the true extent of what we are for. Thus, in simple terms, our unique selling point of '*securing our skies*' should be expanding to become '*securing our skies and space*'. From this, we can then build the evidence and narrative to reinforce the actions and the investment. Sophisticated capabilities such as the F-35B Lightning, a fighting information system that can orchestrate much around it, challenge us to articulate their true campaign contribution, not just their tactical capabilities. At the same time, we need to advocate what can be achieved more effectively by capabilities with increased persistence and reach across the blurred Air and Space domains, such as hypersonic technology and HAPS.

The Fourth Digital Revolution. Developments in Artificial Intelligence (AI) and autonomous technologies may bring about a Revolution in Military Affairs that alters the *nature* of war itself. Our adversaries recognise this, are investing heavily, and may well dispense with the legal and political processes which govern our own approach. With Information Advantage, '*the credible advantage gained through continuous, adaptive, decisive and resilient employment of information and information systems*', likely to be important to the success of future conflict, we must embrace the technologies that enable such advantage and weave them into the way in which we command, control and manage our multi-dimensional battlespace and direct the Air and Space contribution within our Joint Action construct, across all domains and dimensions.[17] Of course, we should tread carefully but cannot be too cautious. Our somewhat risk-averse culture cannot be a handbrake to rigorous and continual consolidation of capability, including experimentation. Rejuvenating our offensive spirit is also key here, and we must take the public with us on that conceptual journey or we risk a narrative dominated by those who portray AI technology as Terminator-style killing machines.

Autonomy. Our early tactical adoption of AI and autonomy is likely to be in the form of Human-Machine Teams (HMT). How do we assure each other that actions undertaken by your HMT are compatible and valid with those taken by mine if we are supporting the same mission? How do we ensure that capabilities are sufficiently interoperable? These are challenging technical questions, but if we can address them quickly then our adoption of HMTs can be a true force-multiplier and a potentially decisive capability. AI, autonomous systems, and HMT provide opportunities for, and threats to, the RAF. Encouraging innovation and accepting failure will assist in augmenting existing capabilities, but will not present us with the opportunity to leap ahead of competitors. With limited resources, how does the RAF work in parallel, augmenting existing capabilities while researching new game changers? How do we engage proactively in the public debate and counter the Terminator narrative, rather than be a spectator (as with the RPAS debate)?

Whole Force 'By Design' – A Risk? The UK has put its future delivery of military outputs in the hands of the Whole Force Approach (WFA), a blend of regulars, reserves, civil-servants and contractors. This approach is being developed through new conceptual work to introduce WFA 'by design'. But what are the risks? The recent Google situation where some of its employees effectively became conscientious objectors to their employer's involvement in supporting military analysis for fear of its algorithms being used in the targeting chain could be the start of a new, unpredictable, and worrying trend. I do not know what the best approach is to safeguard against this, but the current climate of fake news and misinformation, as well as the intentional use of information as a weapon, suggests there are inherent risks in a WFA. But I am sure that if we stick our heads in the sand and keep quiet, the potential for a contagion effect at the wrong time will increase. Notwithstanding the potential risks, the WFA is critical to maximising the advantages of fused air and space power and we need to start that journey now by looking at the wealth of knowledge and experience embedded in the aerospace industry and exploring what this can offer the Service now and into the future.

Manned-Unmanned Debates. By 2068 it is possible that there will be few, if any, manned combat platforms flown by what we label as tier-one air forces. Technically it will not be necessary – we're not far away now. But, more importantly, tactically it would be unnecessarily self-defeating. Unmanned platforms will be optimised for performance beyond human capacity to endure. The Air domain will be a risky place to operate given threat proliferation when in a contested situation. So how will air forces define themselves without the 'heroic' human in the cockpit? How will 'airmen' be perceived by the public? And what will we use our 'airmen' for instead of for flying aircraft in tactical engagements? Are there lessons to be learnt from the public controversy over RPAS and 'drones'?

Strategic Thinking. What do we want the RAF look like after the passing of its second century, and how do we get there? The origins of our first 100 years were the result of strategic thinking, rising to the emerging threats and providing alternative solutions to grand strategic problems. Conversely, the latter decades of our first century appear to be tactically-focused, inward looking, and narrowly technologically motivated.[18] While much of this could be attributed to the relatively narrow problem-set facing Defence we need to reinvigorate strategic thinking in the RAF and strategic planning as a core function. Our first step to realising this could be a better assessment as to how we anticipate the evolving threats and position ourselves to remain visible and relevant in the eyes of a public squeezed by austerity. How do we develop strategic leaders for such a rapidly changing political, economic and technological landscape?

Levels of Warfare. Does the compression of warfighting through technological advancement also result in the compression of the Levels of Warfare? Hitherto, air power has been viewed by many as a largely tactical endeavour, in support of and enabling joint

operations, but with an ability to deliver a strategic effect. Space power, conversely has been a very strategic endeavour with many of its products being utilised to maximise tactical effect – from imagery to communications. Now, and very much into the future, these domains will also be blurred from the viewpoint of the levels of warfare, with structures that are normally configured for the delivery of tactical C2 effect being used to deliver greater strategic C2 effect. Similarly, it is highly possible that platforms will be capable of stretching the meaning of multi-mission to new heights with platforms undertaking exo- and inner-atmospheric tasks within a single mission. So, as we go forward, air and space power will quite literally know no bounds.

CONCLUDING REMARKS

So What? The Air and Space domains are distinct, but this essay has shown that there are many potential advantages to thinking of them as a single entity or at least as a continuum of each other. Emerging technology and changes in how we fight will provide opportunities to achieve this. It is, therefore, clear to me that opportunities await those who can embrace the blurring of air and space power. Changing national demographics, Defence governance structures, and strong organic air and space sectors provide opportunities to realise an affordable Air and Space capability that will undoubtedly serve as an efficient and effective force multiplier for Defence. But, to do so we need to improve our understanding of the risks and articulate a clear strategy to realise the potential on offer. My observations of several national space 'startups', who are already exploiting what has been labelled 'new space', is that they present an open door for cooperation and exploitation of the blurred Air and Space domains. But we need to strike now – Carbonite II is a great a first step – but we need to transition from the step, to the jog (maybe with HAPS), to the run (undoubtedly with hypersonics), and where needed the sprint, very quickly if we are to capitalise upon and further develop our sovereign capabilities and maximise Defence capability. But to do so requires resources and commitment – from within the MOD, across Whitehall, and nationally – towards a clear strategy and accompanying narrative on 'what we are for in the air and in space'. This brief, very personal perspective, was written with the intent to stimulate. We are on the launchpad of a very exciting journey to exploit the blurring of Air and Space to the maximum effect possible. Because of the nature of what has been discussed, it is impossible to be precise or predictive – there is no crystal ball! There is deliberately much in this paper that is open to challenge – and I would welcome that challenge. Because to challenge requires thought, and that thought will lead to further informed debate, which can only lead to a position of better understanding. From understanding the opportunities and challenges we will be able to exploit the advantages of the blurred Air and Space domains to the greatest effect possible. The RAF represents the best national means through which the military potential of a combined Air and Space effort can be realised. So, take this paper to be a conceptual nudge, and help those whose business is the Conceptual Component to codify, realise, and challenge some of its assertions!

NOTES

[1] Joint Doctrine Publication (JDP) 0-30 'UK Air and Space Power' (Development, Concepts and Doctrine Centre (DCDC): Shrivenham, 2017) Page iii.
[2] Joint Concept Note (JCN) 1/17 'Future Force Concept' (DCDC: Shrivenham, 2017).
[3] Lucy Rogers 'Its only Rocket Science' (Springer: New York, 2008) Page 2.
[4] Joint Concept Note (JCN) 1/17 'Future Force Concept' (DCDC: Shrivenham, 2017) Part 3.
[5] The themes of multi-domain and multi-dimensional operations are being explored in the re-write of JDP 01 'UK Defence Capstone Doctrine'. No formal definitions are offered here as each of the compound terms, derived from the Concise Oxford English Dictionary', are suitably descriptive.
[6] Implied in 'Conduct of Maritime Operations' (MWC: Fareham, 2015) Section 1.1, Page 13 and JDP 0-20 'UK Land Power' (DCDC: Shrivenham, 2017) Chapter 1 Page 3-10.
[7] JDP 0-30 Pages 25, 91 and 92.
[8] Ibid.
[9] See **www.reactionengines.co.uk**.
[10] See **https://s3.amazonaws.com/files.cnas.org/documents/CNASReport-Quantum-Tech_FINAL.pdf?mtime=20180912133406** accessed 11 Oct 18.
[11] See **https://www.bbc.co.uk/news/technology-45194333** accessed 11 Oct 18.
[12] See **https://www.forbes.com/sites/bernardmarr/2017/10/19/why-space-data-is-the-new-big-data/#4a08755f69a1** accessed 11 Oct 18.
[13] Where the need for conceptual innovation is based upon agenda, bias or opinion rather than on empirical evidence of need.
[14] The following paragraphs on 'insights' were compiled from several discussions and email exchanges between the author and Group Captain Paul Wilkins RAF, Assistant Head Strategic Analysis in the DCDC.
[15] JCN 1/17 page 19.
[16] JDP 3 Campaign Execution (DCDC: Shrivenham, 2009) Chapter 3.
[17] See JCN 2/18 'Information Advantage' (DCDC: Shrivenham, 2018).
[18] To the support and enablement of relatively geographically fixed Counter Insurgency and Counter Terrorist operations.