

Air Warfare

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Summary

This article considers the use and evolution of air power during the First World War. By focusing on the principal air power roles – control of the air, tactical, strategic, and naval and maritime aviation – the article acknowledges the national, strategic, and operational contexts in which air power came to develop between 1914 and 1918; very often within and influenced by existing military and naval organisations. Although aviation was in an embryonic state during the conflict, war in and from the air became an increasingly visible and important aspect of the First World War.

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Introduction

The emergence of heavier-than-air flight in the decade before the outbreak of the First World War presaged the change in the character of [warfare](#) that appeared between 1914 and 1918. Yet, as John H. Morrow Jr. wrote:

Military aviation did not determine the outcome of World War I, but the airplane did establish its very real significance in support of the army on the battlefield.¹

This view raises a fundamental question about the evolution and effect air power had on the conduct of the First World War: did the First World War do more for air power than air power did for the conflict?² This question must fit into the broader historical discussion of whether armies in the First World War learned from their experiences. Indeed, if historians accept that the armies and navies of the First World War went through some form of a “learning curve”,

or process, then they had to cope with the changes forced on them by the emergence of air power and the impact that it had on the character of war. However, in many respects, aviation was an emerging technology, and all thinking on its application was, in 1914, experimental. Nevertheless, by the end of 1914, three of the four principal air power roles identifiable in modern doctrine can be recognised.³ These were control of the air, intelligence, [surveillance](#), and [reconnaissance](#) (ISR), and attack. The final role of air mobility in a nascent form would eventually appear by 1918. As such, this article examines the role of air power in the First World War covering the critical areas of control of the air, tactical air power, strategic bombing, and naval and maritime air power.

Tactical Air Power

The term tactical air power refers to the application of military aviation in support of ground forces through the provision of ISR – observation and reconnaissance – and offensive action against ground targets. The use of such a capability was applicable to both offensive and defensive operations during the First World War. Before 1914, it was recognised that air assets could provide a distinct advantage on the battlefield. The use of lighter-than-air platforms in the 19th century laid the foundation for the use of air power in the observation and reconnaissance roles, while the emergence of heavier-than-air flight added the further advantage of ever increasing speed. The pre-war militaries of Europe and even less powerful European countries did not ignore the potential benefits provided by air power. For example, air assets were used to limited effect during the [Italo-Turkish War of 1911](#) and the [Balkan Wars of 1912 and 1913](#). While there is some evidence that the pre-war officer classes of European militaries had reservations about the use of air power, the establishment of air arms by the major powers to support their armies illustrates that, in a limited sense, aviation was viewed as a valuable addition to existing capabilities.

While 1914 saw some limited strategic raiding by the French and Germans, it was on the battlefield that air power's impact was best illustrated, specifically, at the battles of [Mons](#), the [Marne](#), and [Tannenberg](#). In 1914, air power, with varying degrees of success, provided intelligence via reconnaissance and observation, which provided situational awareness to ground commanders. In the period leading up to Tannenberg, German [Zeppelins](#) were used for strategic reconnaissance while at Mons, the Royal Flying Corps (RFC), effectively the world's first expeditionary air force when it deployed to [France](#) in mid-August 1914, helped report on the German troop movements as well as the activities of the French Fifth Army. In the subsequent retreat that ended at the Battle of the Marne, the RFC continued to provide intelligence to Field Marshal Sir [John French's \(1852-1925\) British Expeditionary Force](#) (BEF) on enemy troop movements. While the effectiveness of these actions are debated, its

importance lies in French's first dispatch, published on 8 September 1914, in which he praised the RFC. This "buy-in" from senior leaders became increasingly crucial for all militaries as air power advocates sought to develop their respective arms.

At the Battle of the Marne, both French and German aviators provided prompt if uneven support. For example, General [Joseph Joffre \(1852-1931\)](#) praised French aerial observation on 10 September 1914 and was impressed enough to appoint Commandant [Joseph Edouard Barès \(1872-1954\)](#) as his head of aviation at the *Grand Quartier Général* (GQG). This was because Joffre recognised that he needed "someone with initiative to organize [the *Aeronautique Militaire*] at the front".⁴ Similarly, German aviators "detected Joffre's counteroffensive" at the Marne.⁵ While air power provided useful situational awareness that helped shape commanders' understanding of the battlespace, the application of this capability to the conduct of operations depended on the attitude of the end users. Some French and British officers were reluctant to use aeroplanes, while organisational issues caused challenges for the Germans.⁶ Nevertheless, as 1914 ended, ground commanders became increasingly supportive of the intelligence generated from the air. This was reinforced by developments in aerial [photography](#) that continued to evolve in 1915. Additionally, the use of offensive air power to support ground forces also began to appear around the time of the First Battle of Ypres.

As operations moved into 1915, air power became increasingly crucial to the planning and conduct of the land battles. In addition to aeroplanes, balloons were an important platform for observation by all sides because their static nature meant that observers became familiar with the terrain they surveyed and focused on the process of [artillery](#) support. They were, however, limited by the field of vision and became a prime target for fighters trying to restrict the situational awareness of the enemy. On the [Eastern Front](#), reconnaissance and observation were necessary, though the geographic scope of the theatre made it a challenging process. Nevertheless, [Russia](#) created the so-called *Eskadra Vosdushykh Korablei* (EVK or Squadron of Flying Ships) equipped with [Igor Sikorsky's \(1889-1972\) Il'ya Muromets](#) aeroplane. Although designed for transportation, the *Il'ya Muromets* was used as bombing and reconnaissance platforms. In the latter role, they were used to undertake long-range reconnaissance operations to track German troop movements.

However, it was on the Western Front that crucial developments occurred. Developments in photography by both the French and British eventually led to the provision of image-based assessments that, through the production of photo mosaics, mapped artillery positions and allowed pre-planned registration of guns. Such techniques were put into effect during the planning and execution of the Battle of Neuve Chapelle; the "First Imagery-Planned Battle".⁷

These developments did not solve all problems but indicated the influence that air power could have on land battles. For the British, tactical support via observation was enhanced by the development of the clock code system of directing artillery fire, which mapped and corrected the fall of shot. As a critical element in the development of effective artillery fire support, air power contributed to an “indirect-fire revolution [that] required radical reorganization of the contending armies”. Air arms “reorganization” led to the emergence of “air defence” and “air combat” to stop the enemy from observing their operations. In due course, this, in part, led to the emergence of “separate air services”.⁸ The Germans also recognised the importance of observation, and by 1917, German doctrine reflected that in “positional warfare [...] aerial spotting takes on a decisive role within the whole context of the battle plan”.⁹

“Contact patrols” further enabled the provision of timely intelligence. In the RFC, contact patrols appeared as a response to the problem identified in 1915 of maintaining contact with forward troops, as communications could be easily cut due to artillery fire. Thus, it was necessary to find a means to allow rear headquarters to communicate with forward troops and vice versa; aeroplanes offered that capability. Derived from operational experience as well as learning from French experiences, contact patrols became the principal method of communication at the forward edge of the battlefield. However, contact patrols, as undertaken by “corps” squadrons, were not without challenges, namely communication between infantry and aeroplanes. German aviators highlighted similar issues, and one of the key problems was that ground forces were often reluctant to identify their positions to aeroplanes for fear that it would identify them to opposing artillery. Improvements emerged and as the war continued, specialised contact patrol methods were developed to work with cavalry and tanks. These developments also became codified in British army doctrine, notably SS135 – *The Division in the Attack – 1918*. The German army also codified its experience with contact patrols in its 1917 manual on *Der Infanteriefieger und der Infanterieballon (Infantry Airplane and Infantry Balloon)*.¹⁰

Beyond providing timely situational awareness to commanders and ground troops alike, air power became increasingly involved in providing kinetic support to the land battle. This included direct battlefield support, or close air support, and interdiction, or the use of air power to isolate or destroy forces at the operational level. In 1914, the air arms of the various combatant nations experimented in different ways concerning bombing military objectives, primarily enemy troops. French operations in 1914 highlight an interesting tension between the bombing of tactical and strategic targets. While the latter is discussed in further detail below, it is worth stressing that units involved in bombing, as opposed to ground attack, could, and did, attack both tactical and strategic targets. For example, French units coming

from the Belfort region in 1914 struck both German cities and airfields depending on conditions. Interdiction of [logistical](#) targets, such as railway stations, became necessary as bombing hindered the flow of reinforcements between sectors of the battlefield and the French increasingly viewed their bomber forces as “extra long-range artillery”.¹¹ However, interdiction operations were problematic, with Ground-based Air Defence (GBAD) used to disrupt attacks, as well as the growing aerial activity that was associated with the battle for control of the air. Indeed, as the air war took on a progressively strategic dimension, GBAD became ever more important in the battle for control of the air over the battlefield and home fronts.

Other challenges existed, however. In both the application of air power at the tactical and strategic levels, navigation also remained challenging, especially at night. However, wartime developments, such as the British development of signalling lighthouses, began to ease this issue as the war progressed. Concerning bombing, another difficulty was accuracy. The development of bombsights, such as the Michelin bombsight used by the French, increased accuracy. A final issue was the impact of bombing, and the British noted that towards the end of 1915 their activities on the Western Front did not produce the material effect desired. Nevertheless, bombing continued to form an essential element of operations by all sides throughout the war. At the tactical level during the [Battle of the Somme](#), the RFC, by this time commanded by Major-General [Hugh Trenchard \(1873-1956\)](#), dropped 13,000 bombs during the first four days of the battle, though post-war German analysis questioned the effectiveness of some of this effort. Similarly, on the Eastern Front bombing was recognised to be a useful adjunct to Russian operations and, for example, was used on the Southwestern Front; however, overall, air-ground cooperation remained difficult for the Russians.

A fundamental change emerged by 1917, when ground attack was added to the repertoire of the air arms. This development was based on experience gained during 1916 where aeroplanes had been used to strafe ground targets.¹² Eventually, ground attack operations came to encompass two methods: first, ground strafing on targets of opportunity, and second, the close support bombing of specific tactical objectives, such as artillery. Furthermore, for the British, as their contact patrols developed to include co-operation with tanks, offensive action against anti-tank guns became necessary. At a [technological](#) level, [Germany](#) developed a series of innovative aeroplanes that could be utilised at low levels. These so-called “infantry planes” provided close air support and the Junkers J1 was so well protected that it was described as a “furniture van”. Both the British and French principally relied on fighter designs, though by the end of the war the RAF had introduced a dedicated ground attack aeroplane, the Sopwith Salamander. While useful, the utilisation of air assets in direct support was often inefficient and led to a high rate of [attrition](#), though ultimately it was

accepted that direct support was needed in particular situations and provided a boost to ground troops' morale.

By 1918, despite challenges, air power was being widely employed to support land campaigns and regularly provided efficient situational awareness to ground forces as well as bombing and ground attack operations. It should also be noted that, despite the separate thematic treatment of the control of the air and tactical air power, the two were synonymous and Allied success in applying tactical air power to the land battle in 1918 cannot be separated from the fight for control of the air. Without achieving a degree of air superiority, the Allies could not have applied the full weight of their air resources in such battles as [Amiens](#) and Saint-Mihiel. Air power, from the strategic through to the tactical, was and remains an inter-connected domain, where a change in one area can influence the other.

Control of the Air

While representations of combat in the air have been shaped by the rhetoric related to the so-called “knights of the air”, the challenge of achieving control of the air saw the emergence of codified tactics and formation flying that allowed aviators to work together. Nevertheless, the thinking and language used to describe control of the air can be traced to various sources, including science-fiction literature and naval thinking.¹³ As on land, warfare in the air acquired a brutal, attritional character during the First World War. Moreover, thinking about control of the air was influenced by the wider strategic, operational, tactical, and cultural priorities of the parent organisations to which the air arms belonged. In [Great Britain](#), Royal Naval Air Service (RNAS) thinking mirrored that of the more strategically minded Royal Navy, as illustrated by the RNAS' attack on the German Imperial Navy's Zeppelin sheds in late 1914. Simply put, it was not enough to defend airspace against incoming attacks; you had to go out and achieve control of the air by offensively attacking the enemy's air assets, broadly defined, at the source. In turn, the RFC's focus, the provision of tactical support, was shaped within the overarching ethos of the British army; an ethos that stressed the importance of moral superiority and offensive action.¹⁴ Similarly, as the conflict progressed, German air power developed a flexible and defensive approach to control of the air, which mirrored the strategy of the German army in the West. By 1917, German doctrine recognised that “Command of the Air [was] the precondition” for the efficient use of air power and was not solely dependent on numbers.¹⁵

The early months of the First World War illustrated the importance of control of the air as it became apparent that it could deliver tactical and operational benefits to commanders. Control of the air created freedom of action for tactical assets employed in reconnaissance

and artillery spotting. As air arms moved into 1915, the importance of controlling the air crystallised. By June 1915, the RFC was issuing regular operational orders relating to the need to contest airspace. Nevertheless, in what became an increasingly complex battle of “challenge and response” between combatants, 1915 also saw the development of effective fighting aircraft, which, in turn, saw the creation of dedicated fighting squadrons. Technology was important in the development of ideas and practices relating to the control of the air. The appearance in 1915 of the Fokker *Eindecker*, a fighting aeroplane with a synchronised machine gun capable of firing through the propeller arc, saw a significant increase in losses for the British and a corresponding impact on RFC morale. The French, in response to the so-called “Fokker Scourge”, developed the Nieuport 11. This aeroplane was credited with ending German air ascendancy in this period of the war. Furthermore, concentrating air assets into specialised units allowed for better command and control at the decisive point. Additionally, as air arms increased in size, there was a need to create the necessary higher organisations with the essential support structures such as logistics networks. For example, by 1916, the RFC had introduced “Army” wings to control fighter units and “Corps” wings for close air support and reconnaissance that were brigaded together for better effect. At the operational level, in 1918 the French introduced the *Division Aérienne* (Aerial Division) that was comprised of both bombers and fighters and allowed for the flexible use of air power, as it was not linked to a specific field army and could be redeployed to any point of the front to support operations.

As the war moved into 1916 and the battle for control of the air swung back and forth, it was clear that achieving and maintaining this state was based on superior tactical, technological or doctrinal innovation. 1916 was also the year in which the first serious air campaigns were conducted. Both the battles of [Verdun](#) and the Somme saw the large-scale use of air power in support of the land battle, but more importantly, the massing of fighter units to achieve control of the air. At Verdun, German aviators had hoped to control the air by amassing 168 fighters to allow their observation aeroplanes freedom of movement; however, the French responded with a concentration of fighter units that no longer operated in close quarters with their observation counterparts. Instead, they were tasked to operate in combat air patrols searching out German aeroplanes. Slowly, the French wrested control back from the Germans due to organisational improvements as well as the latter’s failure to improve on the *Eindecker’s* performance. Via the coalition context, the British readily learnt from the French experience at Verdun, which shaped their conduct of the air campaign over the Somme. During this campaign, the RFC took to the offensive, and while the British possessed technically superior fighters, it was the way such aeroplanes were used that helped the British dominate the airspace over and around the battlefield.

1917 continued the pattern set in 1916, whereby it was recognised that control of the air was

the prerequisite for the effective employment of air power, although the use of aviation continued to be governed by wider strategic and operational priorities and capabilities. The offensive strategy of the RFC was linked to that of the BEF, and while there has been significant criticism of the British approach to controlling the air via the now infamous policy of “attacking [...] and [...] continuing to attack”, it is worth noting that strong direction from senior commanders in the British army and RFC did not remove the ability for more junior commanders to innovate and develop practices at the operational and tactical levels.¹⁶ Conversely, the German *Luftstreitkräfte*’s flexible defensive attitude in 1917 derived from that of the German army’s in the same period. Thus, during 1917 and 1918, German aviation came to concentrate air assets at time-specific and geographically important locations to contest the control of the air, a situation compounded by the industrial superiority of the Allies. In turn, German air policy and practice came to rely on quality over quantity in the battle for the control of the air, illustrated by the introduction of the Fokker DVII.

The defining characteristic of aerial combat during this period was its complex, attritional and industrial character. By 1918, meaningful opportunities for individual sorties across the lines were gone. The changing character of air warfare also had an impact on logistics and training. Though aspects of this had begun in late 1916, the experience of “Bloody April” during the Battle of Arras in 1917 led to a rethinking in British training policy, in part because of the large numbers of operational casualties suffered during air operations over the battlefield. Conversely, German forces operating over Arras illustrated that “thorough and systematic” training could be a counterweight to superior numbers.¹⁷ German developments in training stood in contrast to the sometimes haphazard British system that sought (and at times struggled) to manage the massive expansion of its air arm. All belligerents experienced such expansion during the First World War, with the RFC, for example, growing from some 1,244 personnel in August 1914 to 291,748 in October 1918 as the newly formed RAF.

While control of the air could never be absolute, by 1918 air power had become a fully integrated component of most belligerents’ approaches to war. However, it was not without its challenges, and the ability to gain and maintain control of the air was inherently linked to tactical, strategic, doctrinal, and industrial developments, as developments on the [Italian front](#) illustrated. From the [Battle of Piave](#) in June 1918 through to the [Battle of Vittorio Veneto](#) in October and November 1918, the Italians, with British and French support, achieved control of the air through the combined means of offensive-counter air operations (OCA) on Austro-Hungarian airfields while also contesting for air superiority. In this, Italy was aided by the Allies’ better industrial organisation when compared to [Austria-Hungary](#), which struggled throughout the war to effectively mobilise its industry. Importantly, rather than being a partner, Germany dominated Austria-Hungary. This relationship was further compounded by

the “general military disarray” that characterised the Austria-Hungary’s war effort.¹⁸ The Austria-Hungary example highlights the argument that a first-class aviation industry must support a first-class air force. Lacking in this regard, Austria-Hungary could not compete for control of the air.

Strategic Bombing

The term “strategic bombing”, viewed via the lens of the Second World War, conjures up images of fleets of bombers and devastated cities, raising serious ethical questions that continue to vex scholars. While debates about bombing during the First World War generally avoid such controversies, the impact of such operations between 1914 and 1918 was three-fold: first, their political impact, especially in Britain, as the public, press and political reactions to German raiding were a driving factor in the creation of the RAF and contributed to the ongoing debates over independent air power; second, by compelling belligerents’ air arms to consider and develop localised air defence systems; and third, the legacy of strategic bombing in shaping air power theory, doctrine and practice in the post-war period.

The origins of strategic bombing were found in the pre-1914 period, and the development and proliferation in Germany of rigid airships did much to focus military and non-military theorists on the potential for air power to achieve a strategic effect. This included striking at industrial and military targets to create a material effect and civilian- and infrastructure-related targets to produce a “moral” effect. The Royal Navy became greatly concerned by the potential for German airships to strike warships and naval installations, and there are suggestions that Germany saw strategic air power as a potential force multiplier and a way to help negate Britain’s overwhelming naval dominance.

On entering the conflict, the Royal Navy looked to neutralise German air assets capable of striking Britain by launching an OCA campaign against airship sheds at the end of 1914. Demonstrating the link between strategic air power and control of the air, these operations sought to limit the potential for strategic raids against Britain. These efforts, an outgrowth of the Royal Navy’s offensive culture, while successful in the short-term, were not sustainable. Nevertheless, the Royal Navy continued to use bombing to limit German naval operations by attacking their capability at its source. These operations illustrate the threat and counter-threat character of air operations. By 1918 RNAS/RAF activities had, for example, limited the “fighting ability” of the *Marine Korps Flandern* in [Belgium](#) and led Germans to combat this risk with increased GBAD, fighter defence, and their own OCA campaign to battle for control of the air.¹⁹ The [United States](#) mirrored these British air operations with the creation of the US Navy’s Northern Bombing Group. Furthermore, bombing by Royal Navy air assets went beyond just those with direct military objectives. The formation of No. 3 Wing, RNAS, at

Luxeuil-Les-Bains to attack targets in the Saar region in 1916 highlights the extension of bombing to broader strategic goals. However, these objectives were deemed legitimate as they linked to naval production, thus extending the concept that attacking at the source was more efficient than seeking direct battle.

Both France and [Italy](#) conducted bombing operations, and in the case of the former, they were the first nation to create a dedicated bombing unit (*Groupe de Bombardement 1*). It has been suggested that French operations illustrated a degree of restraint, though this was more for pragmatic and geographical reasons than for any significant moral or ethical objections. The French experience highlights the changeable meaning of strategic bombing concerning the nature of the targets attacked and the effect created. While there was a preference for the use of attack in direct support of the French army, “targets away from the battlefield” were attacked, such as “heavy industry and railway stations”.²⁰ The French also showed a preference for reprisal raids for geographic reasons, but by 1917 there were calls for restrictions to be lifted. When Italy joined the war in 1915, it did so as the only country with an aeroplane specifically designed for bombing, the Caproni Ca1. However, geography and technological limitations precluded a long-range campaign against the hinterland of Austria-Hungary. Geography and technology also affected the RAF’s Independent Force and Germany’s so-called “*England Geschwader*”, which were stationed as close to their targets as possible. As in other areas of the air war, theory often outpaced the technological realities of the period. Despite these challenges, by late 1918 the French, Italians, and Americans joined with the British to form the Inter-Allied Independent Air Force. Established to conduct “strategic” bombing, the force was formed just before the end of the war and took time to emerge due to the development of unified command on the Western Front, Marshal [Ferdinand Foch’s \(1851-1929\)](#) desire to control all forces in this theatre, and competing national requirements.

Germany undertook strategic operations against Britain, firstly with airships such as the Zeppelins, and later with specialist aeroplanes such as the Gotha, a twin-engine bomber with a relatively large payload and additional crew whose role was to utilise dedicated defensive armament mounted on the aeroplane. While there was an initial outcry about airship raiding against Britain, especially in the [Northcliffe Press](#) (*The Times* and *Daily Mail* among the most influential publications), the spasmodic nature of such operations limited their political impact. However, after the Gotha raids in the summer of 1917, the political, press and public reactions were nothing short of sensational. It was the powerlessness experienced by the British, juxtaposed against the island’s historic geographic security and command of the sea, which did much to set the tone for the reaction. As the *Daily Mail* declared, German bombers made “serene progress” across the London skies while the efforts of the British defenders

were described as “disgraceful” and “humiliating”.²¹ Rather than a response based upon fear, the reaction was one of anger, and a key driver in the subsequent creation of the RAF was the desire to develop a dedicated strategic bombing force able to strike directly at Germany.²²

As a direct result of German raiding, the [British government](#) asked General [Jan Smuts \(1870-1950\)](#) to investigate the management and use of air power. His second report recommended the creation of the RAF and suggested that at some point in the future, independent strategic air operations might become the key operation in war. Such conclusions were apparently extrapolated from a very limited basis of experience and evidence, but they set the tone for the legacy of strategic bombing in the post-war era. Of course, another important consequence of the Smuts Report was the development of an organised air defence system in Britain. This was part of wider efforts to control the air, demonstrating the holistic qualities of this endeavour. In Britain, an ad-hoc system of defence, divided and ineffectually managed by both the British army and Royal Navy, evolved throughout the conflict into a sophisticated network, supported by an advanced command and control system, which was capable of defeating strategic bombing aeroplanes during day or night.²³ Similarly, in 1916, in response to British and French operations, Germany created a home air defence command, thus improving the coordination of vital elements of the country’s air defence system. If anything, evidence from the war indicated that the bomber would *not* always get through and that localised air defences could be made to be effective. However, the implications of developing such a system resulted in a drain of resources from offensive operations on the Western Front, a process resisted by senior commanders in the British army and RFC.²⁴

While the Smuts Report and the anger generated by German raids led to the creation of the RAF, in the longer term this process was influenced by the “maladministration” associated with developments in air warfare notable in the industry and supply. This issue in general affected most countries, though the French aviation industry enjoyed a distinct advantage in the production of engines as well as aeroplanes. The eventual solution in Britain was the establishment of an Air Ministry with the same standing as the War Office and the Admiralty, and the RAF. This bureaucratic and organisational change during a global war remains remarkable and in stark contrast to the experience in other nations. For example, in 1916, Germany reflected on the potential of air power and created the position of *Kommandierender General der Luftstreitkräfte (Kogenluft)* in October 1916; yet it did not create the necessary higher political framework to manage a genuinely independent service. Indeed, one argument from the German Imperial Navy was that a war was being fought and that it was not the time for such considerations. As such, while the *Luftstreitkräfte* allowed for

a more efficient means of deploying German army air power, it was not an independent service, though it did benefit from the improved status in Germany's industrial planning during the latter part of the war. Similar organisational challenges existed for other air arms such as in France and Italy.

Returning to bombing, the ability to achieve a material or moral effect via aerial bombardment depended primarily on aeroplanes capable of lifting ordnance of sufficient weight over a long distance to strike at strategically significant targets. Thus, strategic bombing during the First World War was severely limited by technology, problems of navigation, the ability to drop bombs accurately and the lack of a systematic approach to targeting. This was clear in both British and German approaches to bombing. Despite useful theoretical and scientific work conducted by the Royal Navy, the practice of bombing was defined in mostly moral terms, with spasmodic strikes against a range of civilian and military targets. Such an approach defined the use of the RAF's Independent Force during the second half of 1918, which has led to debates about the overall effectiveness of strategic bombing during the conflict. The importance of strategic bombing during the First World War, outside of it birthing the practice, was its legacy on subsequent air power theory, doctrine, and practice. While significant emphasis was placed on the "moral" effects of bombing, the post-war analysis of strategic raiding, especially in Britain, saw theory and doctrine working for political ends, with the RAF using strategic bombing to justify its continued existence in the face of post-war parsimony. Moreover, the experience of the First World War would lead to emergence of key air power thinkers including [Giulio Douhet \(1869-1930\)](#) and [William Mitchell \(1879-1936\)](#). In 1921, Douhet published one of the cornerstone works on air power theory, *Il dominio dell'aria (The Command of the Air)*.²⁵

Maritime and Naval Air Power

While the bulk of [casualties](#) incurred during the war occurred in the land campaigns, and the search for a decisive battle at sea ultimately proved futile, the naval war played a pivotal role in the outcome of the conflict. While debates remain over the significance of the [naval war](#) to the outcome of the First World War, Britain, nevertheless, led the way in the application of air power in this domain. This was because Britain and France relied on their sea lines of communication for supplies; defending these routes was a key focus of the war at sea. In 1913, a year after the creation of the joint RFC, the British Admiralty reiterated the importance of both airships and aeroplanes at sea – until 1914, when the RNAS emerged, the RFC consisted of an army and naval wing and joint Central Flying School.²⁶ Similarly, in late 1910 and early 1911, [Eugene Ely \(1886-1911\)](#), a civilian aviation pioneer, undertook trial deck flights off US Navy cruisers, while in 1912, Austria-Hungary established a seaplane base

at Pola. However, a major obstacle facing the effective use of aviation in a naval context related to the organisational ownership and logistical support of such assets. For example, “German naval aviation was [...] subordinate to military aviation”; a situation also witnessed in other countries during the conflict.²⁷

Control of the air was as necessary at sea as it was on land, and the need to battle for control of the air mirrored the same principles as those found on the Western Front: enabling friendly aviation activity while denying operational freedom to an opponent. This included aerial observation, spotting for naval guns, and the direct attack of ships and critical infrastructure. The result, a seesaw battle of concepts and technology, became notable in both the North and Adriatic Seas. In the latter, the Austro-Hungarian Imperial Navy fought with the RNAS and the Italians for control of the air. In this, they were partly successful as they defended Adriatic ports from attacks by Italian bombers; yet by 1918, problems of supplies and logistics meant that they were not able to contest airspace efficiently. This left the Adriatic dominated by Allied air power, including American naval aviation assets. In the North Sea, in 1917 the Germans sought to contest British control using floatplane fighters such as the Hansa-Brandenburg W.12. This contest emerged because of RNAS activity around the Flanders coast, with Dunkirk emerging as a significant centre of naval air power activity.

In the maritime sphere, the development of trade defence was most important for air assets. Using a mix of heavier- and lighter-than-air platforms, aviation offered the advantage of height and reach, and in the case of balloons, persistence, that allowed for situational awareness and, on occasion, attacks. It was also recognised that aviation assets could provide eyes for the fleet as a supplement to cruiser forces. During the First World War, the navies of Britain, France, Germany, and Russia fielded seaplane carriers as adjuncts to their fleets. However, the use of air assets was often limited by technical challenges, such as communications and the time taken to prepare and offload seaplanes from their tenders or carriers. This was most notably illustrated at the [Battle of Jutland](#) where a seaplane from the seaplane carrier HMS *Engadine* detected the turn to the south but the message failed to reach the Royal Navy’s Battlecruiser Fleet. The challenge of launching and recovering seaplanes led to the development of aircraft carriers. Another driver in the development of aircraft carriers, which was led by the Royal Navy, was the need to control the air and to deliver aerial support for navies. Again, a case of threat and counter-threat drove development. The Royal Navy recognised that aeroplanes launched from decks could attack Zeppelins, thus maintaining control of the air and providing freedom of movement to the fleet from observation, which was deemed a major impediment. While seaplane carriers were seen as useful for reconnaissance, the commander-in-chief of the Grand Fleet, Admiral Sir [John Jellicoe \(1859-1935\)](#), recognised their technical limitations.²⁸ As such, in late 1915, a

Bristol Scout fighter was launched off a deck on HMS *Vindex*, which marked a turning point in the Admiralty's thinking about aeroplanes at sea. As well as being used for air defence, the development of carriers also led to thinking about how to use them offensively. The introduction of the Sopwith T1 Cuckoo carrier-based torpedo bomber led several officers to develop schemes for its use that would have seen the Royal Navy attack the High Seas Fleet at harbour in much the same way as the Taranto raid and the Japanese attack on Pearl Harbor during the Second World War. As such, by 1918, the use of air power at sea had become an essential feature of naval warfare.

Returning to trade defence, the development of anti-[submarine](#) and anti-[mine](#) methods by the British marked the major evolution in the use of air power at [sea](#). At the end of 1916, the Royal Navy created an Anti-Submarine Division (ASD) that brought together different constituencies involved in anti-submarine work. The critical development that emerged in April 1917 was the Spider Web Patrol. This method, centring on the innovative use of signals intelligence linked to a command and control network, enabled RNAS flying boats to patrol a large area of sea effectively and to combat and detect German submarines. However, operational hazards existed, such as navigational difficulties and German seaplane fighters that sought to control the air. Nevertheless, the patrols also benefitted from the introduction of the large Felixstowe F.2 flying boat that had long range, a good bomb load, and defensive armament. Patrols were not limited to flying boats but also extended to airships and balloons, which increasingly operated in conjunction with surface vessels in providing intelligence via wireless for actions against submarines. While the British were the most successful, they were not the only ones attempting to combat submarines. For example, the Austro-Hungarians managed to sink the British submarine B10 in a port at Venice in August 1916. The most significant contribution of air power to trade defence came in support of convoys. While there had been some convoys before 1917, the German decision to resume unrestricted submarine warfare led Britain to adopt convoys for overseas trade. In this sphere, air assets – airships, kite balloons and seaplanes – were used to provide situational awareness to convoy escorts through the advantages of height and endurance. However, this capability was limited by the inherent lack of reach of air assets to range further out into the Atlantic. The process of integrating air power in conjunction with other naval assets highlighted the need to analyse capabilities and link them with technology. Furthermore, the development of air power during the war involved not only the development of doctrine and ideas but also the emergence of the appropriate technology to support those ideas.

Conclusion

Assessing air power's overall contribution to the First World War remains problematic and our understanding of its development, impact, and experience in this period is still incomplete.

For example, further research into critical areas such as training and the social composition of air arms requires attention from scholars.²⁹ While Morrow suggested that air power did not determine the outcome of the First World War, it is clear that it played a part in changing the character of war during the conflict. As James Corum has suggested, the “use of airpower in World War 1 fundamentally transformed modern warfare”.³⁰ All aspects of modern air doctrine can find their origins in the First World War, even limited examples of air mobility by 1918, and the conflict “tested theory and became the anvil on which new aerial missions were forged”.³¹ Air power became a vital element of the emergence of the combined-arms doctrine in the British and French armies that led to victory in 1918. Without air power, this victory would have been more difficult, and the impact of air power on the character of war has posed fundamental questions for militaries since 1918.

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Notes

1. Morrow, John H. Jr.: The First World War. 1914-1918, in: Olsen, John Andreas (ed.): A History of Air Warfare, Dulles 2010, p. 24. ↑
2. Buckley, John: Air Power in the Age of Total War, London 1999, p. 69. ↑
3. For example, see: Ministry of Defence: Joint Doctrine Publication 0-30. UK Air and Space Power, Second Edition, Shrivenham 2017, p. 4. ↑
4. Morrow, John H. Jr.: The Great War in the Air. Military Aviation from 1909 to 1921, Tuscaloosa 2009, p. 63. ↑
5. Ibid., p. 69. ↑
6. For example, on shifting British attitudes see Jordan, David / Sheffield, Gary: Douglas Haig and Air Power, in: Gray, Peter / Cox, Sebastian (eds.): Air Power Leadership. Theory and Practice, London 2002, pp. 270-71. ↑
7. Finnegan, Terence: Shooting the Front. Allied Aerial Reconnaissance and Photographic Interpretation on the Western Front. World War I, Washington, DC 2006, p. 48. ↑
8. Bailey, Jonathan: The First World War and the Birth of Modern Warfare, in: Knox, MacGregor / Murray, Williamson (eds.): The Dynamics of Military Revolution. 1300-2050, Cambridge 2001, p. 150. ↑
9. Corum, James S. / Muller, Richard R.: Instructions on the Mission and Utilization of Flying Units within the Army, in: Corum, James S. / Muller, Richard R. (eds.): The Luftwaffe's Way of War. German Air Doctrine, 1911-1945, Baltimore 1998, p. 62. ↑

10. Corum, James S. / Muller, Richard R.: The Infantry Airplane and Infantry Balloon, in: Corum/Muller, Luftwaffe's Way of War 1998, p. 67. [↑](#)
11. Morrow, Great War 2009, pp. 94-5. [↑](#)
12. Hooton, E. R.: War Over the Trenches. Air Power and the Western Front Campaigns. 1916-1918, Hersham 2010, p. 66. [↑](#)
13. Hippler, Thomas: Bombing the People. Giulio Douhet and the Foundations of Air-Power Strategy. 1884-1939 Cambridge 2013, p. 40. [↑](#)
14. Pugh, James: The Royal Flying Corps, the Western Front and the Control of the Air. 1914-1918, Abingdon 2017, passim. [↑](#)
15. Corum/Muller, Instructions 1998, p. 55. [↑](#)
16. Molkentin, Michael: Australia and the War in the Air. The Centenary History of Australia and the Great War, volume 1, Melbourne 2014, pp. 118-19. [↑](#)
17. Corum, James S.: World War I Aviation. From Reconnaissance to the Modern Air Campaign, in: Strohn, Matthias (ed.): World War I Companion, Oxford 2013, p. 68. [↑](#)
18. Morrow, John H. Jr.: German Air Power in World War I, Lincoln 1982, p. 185. [↑](#)
19. Karau, Mark D.: "Wielding the Dagger". The MarineKorps Flandern and the German War Effort. 1914-1918, Westport 2003, pp. 220-2. [↑](#)
20. Barros, Andrew: Strategic Bombing and Restraint in "Total War". 1915-1918, in: The Historical Journal 52/2 (2009), p. 420. [↑](#)
21. Daily Mail, 7 and 8 July 1917. [↑](#)
22. On this subject more generally, see Biddle, Tami Davis: Rhetoric and Reality. The Evolution of British and American Ideas about Strategic Bombing. 1914-1945, Princeton 2002; Grayzel, Susan: At Home and Under Fire. Air Raids and Culture in Britain from the Great War to the Blitz, Cambridge 2012. [↑](#)
23. Ferris, John: Airbandit. C3I and Strategic Air Defence during the First Battle of Britain. 1915-18, in: Dockrill, Michael / French, David (eds.): Strategy and Intelligence. British Policy during the First World War, London 1996, pp. 23-66. [↑](#)
24. Pugh, Royal Flying Corps 2017, chapters five and six. [↑](#)
25. On Douhet, see; Hippler, Bombing the People 2013, passim. [↑](#)
26. Extracts from Report by the Admiralty on Aerial Navigation, dated June 1913 (CAB 37/115/35), in: Roskill, Stephen (ed.): Documents Relating to the Naval Air Service. Volume I - 1908-1918, London 1969, pp. 87-96. [↑](#)
27. Morrow, Great War 2009, pp. 74-5. [↑](#)
28. Letter from Jellicoe to Admiralty, 29 July 1915, in: Patterson, A. Temple (ed.): The Jellicoe Papers. Selections from the private and official correspondence of Admiral of the Fleet Earl Jellicoe of Scapa. Volume I - 1893-1916, London 1966, pp. 173-4. [↑](#)
29. Examples of important and innovative recent scholarship include: Hanna, Emma: "Say it with Music". Combat, Courage and Identity in the Songs of the RFC/RAF, 1914-1918, in:

British Journal of Military History 4/2 (2018), pp. 91–120; Cobden, Lynsey Shaw: The Nervous Flyer. Nerves, Flying and the First World War, in: British Journal of Military History 4/2 (2018), pp. 121–42. ↑

30. Corum, World War I 2013, p. 76. ↑

31. Biddle, Tami: Learning in Real Time. The Development and Implementation of Air Power in the First World War, in: Cox, Sebastian / Gray, Peter (eds.): Air Power History. Turning Points from Kitty Hawk to Kosovo, London 2002, p. 4. ↑

Selected Bibliography

- [Abbatiello, John J.: **Anti-submarine warfare in World War I. British naval aviation and the defeat of the U-Boats**, London, 2006: Routledge.](#)
- [Biddle, Tami: **Learning in real time. The development and implementation of air power in the First World War**, in: Cox, Sebastian / Gray, Peter W. \(eds.\): Air power history. Turning points from Kitty Hawk to Kosovo, London; Portland 2002 Frank Cass, pp. 3-20.](#)
- [Christienne, Charles / Lissarrague, Pierre: **A history of French military aviation**, Washington, D.C., 1986: Smithsonian Institution Press.](#)
- [Cobden, Lynsey Shaw: **The nervous flyer. Nerves, flying and the First World War**, in: British Journal for Military History 4/2, 2018, pp. 121-142.](#)
- [Cooper, Malcolm: **The birth of independent air power. British air policy in the First World War**, London; Boston, 1986: Allen & Unwin.](#)
- [Dye, Peter: **The bridge to airpower. Logistics support for Royal Flying Corps operations on the Western Front, 1914-18**, Annapolis, 2015: Naval Institute Press.](#)
- [Grayzel, Susan R.: **At home and under fire. Air raids and culture in Britain from the Great War to the Blitz**, New York, 2012: Cambridge University Press.](#)
- [Hanna, Emma: **'Say it with music'. Combat, courage and identity in the songs of the RFC/RAF, 1914-1918**, in: British Journal for Military History 4/2, 2018, pp. 91-120.](#)
- [Haslop, Dennis: **Early naval air power. British and German approaches**, Abingdon; New York, 2018: Routledge.](#)
- [Hippler, Thomas: **Bombing the people. Giulio Douhet and the foundations of air-**](#)

[**power strategy, 1884-1939**, Cambridge, 2013: Cambridge University Press.](#)

- [Johnson, Herbert Alan: **Wingless eagle. U. S. army aviation through World War I**, Chapel Hill, 2001: University of North Carolina Press.](#)
- [Molkentin, Michael: **Australia and the war in the air. The centenary history of Australia and the Great War**, vol. 1, South Melbourne, 2014: Oxford University Press.](#)
- [Morrow, John Howard: **German air power in World War I**, Lincoln, 1982: University of Nebraska Press.](#)
- [Morrow, Jr., John Howard: **The Great War in the air. Military aviation from 1909 to 1921**, Washington, D.C., 1993: Smithsonian Institution Press.](#)
- [Pugh, James: **The Royal Flying Corps, the Western Front and the control of the air, 1914-1918**, London; New York, 2017: Routledge.](#)
- [Renner, Stephen: **Broken wings. The Hungarian Air Force, 1918-45**, Bloomington, 2016: Indiana University Press.](#)
- [Rossano, Geoffrey Louis: **Stalking the U-boat. U. S. naval aviation in Europe during World War I**, Gainesville, 2010: University Press of Florida.](#)
- [Streckfuss, James: **Eyes all over the sky. Aerial reconnaissance in the First World War**, Oxford, 2016: Casemate.](#)
- [Ungari, Andrea: **The Italian air force from the eve of the Libyan conflict to the First World War**, in: War in History 17/4, 2010, pp. 403-434.](#)
- [Vitarbo, Gregory: **Army of the sky. Russian military aviation before the Great War, 1904-1914**, New York, 2012: Peter Lang.](#)
- [Westermann, Edward B.: **Fighting for the heavens from the ground. German ground-based air defenses in the Great War, 1914-1918**, in: The Journal of Military History 65/3, 2001, pp. 641-670.](#)

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- [Gettinger, Dan: The Ultimate Way of Seeing. Aerial Photography in WWI, 28 January 2014 \(Center for the Study of the Drone at Bard College\) \(Article\)](#)
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- [Hawkins, Clive: Britain's air forces in the First World War, 13 December 2013 \(The National Archives\) \(Audio\)](#)
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- [La storia dell'aeronautica militare \(Aeronautica Militare\) \(Online Exhibition\)](#)
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- [Wilkin, Bernard: Aerial warfare during World War One, 29 January 2014 \(British Library\) \(Article\)](#)

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