SOUTH AUSTRALIAN AVIATION MUSEUM

SIGNIFICANT AVIATOR & AVIATION EVENTS PROFILES

AERIAL PHOTOGRAPHY
PART 2 – DEVELOPMENTS DURING THE FIRST WORLD WAR

Developments Leading up to World War I:

In his book, *'The First Great Air War'*, Richard Townshend Bickers described the airmen and aircraft of the First World War as "the first modern links in the chain of evolution from the inception of aerial mobility to its culmination in spaceflight." He goes on to say, "the modern fighter and bomber, supersonically fast, formidably armed, capable of climbing from Earth into the stratosphere in the time it takes a Wimbledon champion to win a love game, are the direct descendants of those sedately moving spheres that first drifted across the sky: lifted there by hot air or gas, driven only by the wind at the mercy of its whims, incapable of being steered. Their pilots and crews are the progeny of those who cheerfully took off suspended in baskets beneath the huge bags of air or gas, not knowing to which point of the compass they would travel, how many involuntary changes of direction they would make, or, most daunting of all to normally conventional beings, where they would come down."

The first British Army Balloon Unit was formed in 1878, as part of the Royal Engineers. By the following year, there were only a few trained officers and other ranks and five "reliable balloons." In Easter of 1879, the Army Balloon Unit's Commanding Officer, Captain H. Elsdale, along with Captain J.L.B. Templer, took a balloon to a Volunteer Review and manoeuvres in Sussex, where the first recorded "fly past" was conducted at 250 feet over the inspecting General, distracting attention away from the columns of cavalry, foot troops and artillery that were moving past the saluting base.

In 1884, the now Major Elsdale led a force, comprising one other officer and 15 rank-and-file sappers, who took three balloons in an expedition to Bechuanaland, but they saw no fighting. In 1885, the now Major Templer took a couple of balloons and nine men to the Sudan, where they provided a useful reconnaissance component. In 1894, the British Army commenced operations of His Majesty's Balloon Factory at Farnborough. The first Superintendent was the now Colonel Templer.

Between 1899 and 1902, The South African War provided an opportunity to demonstrate the tactical value of military balloonists, who demonstrated their effectiveness at the Battle of Lombard's Kop, where they reported the locations of the enemy and also directed artillery fire. At Magersfontein, they assisted ranging howitzers onto Boer cavalry who were concealed in a gully and unable to be seen by ground observers. At Paardeberg, they reported the positions of General Cronje's forces, enabling them to be attacked successfully. Despite the balloonists' success, most conventional field commanders remained prejudiced against and suspicious of what they saw as an experimental element being introduced into military operations and, more importantly, a threat to the way they had traditionally done things.

Colonel Templer was succeeded as Superintendent of the Farnborough Balloon Factory by Colonel Capper in 1906. Although described as a "prophetic protagonist of aeroplanes," Capper, while lecturing at the Royal United Service Institution, said, "In a few years we may expect to see men moving swiftly through the air... such machines will move very rapidly... up to a hundred miles per hour... they will be small and difficult to hit… their range will be very large."

Land-based and sea forces had obviously different reconnaissance requirements and the British Army and Navy went their separate ways to develop their aerial observation platforms further. The Army

relied on His Majesty's Balloon Factory at Farnborough, and in 1907, the British Army's first airship, measuring 120 feet long, made a three-and-a-half-hour flight from Farnborough to London, a distance of approximately 31 miles, circled London and returned to Farnborough.

The Royal Navy was far more ambitious: In July 1908, Captain Reginald Bacon, the then Royal Navy's Director of Naval Ordnance, recommended the acquisition of an airship to compete with the success of the early German rigid airships designed by Count Ferdinand von Zeppelin. The British Government agreed to allocate £35,000 (£3.7 million today) to the Admiralty to build a dirigible balloon. In May 1909, the contract was awarded to Vickers, Son and Maxim, who had previously designed and manufactured submarines.

His Majesty's Airship No.1 Hermione, better known as *The Mayfly,* was intended to be an aerial scout and similar in design to the contemporary Zeppelins of that time. However, at 512 feet in length and 46 feet in diameter, it was 66 feet longer than the most recent Zeppelin LZ 6 and had a 50% larger volume, which was expected to give a correspondingly greater lift. The LZ 6 had a useful load of around 4500 kg and could fly at 60 km/h. *The Mayfly* was intended to be moorable on water, carry wireless equipment, be capable of travelling 40 knots for 24-hours, have a ceiling of 1500 feet and carry a crew of 20 in comfort. A Royal Navy Admiral subsequently exclaimed, "It is the work of a lunatic" when sighting *HM Airship No. 1 Hermione*.

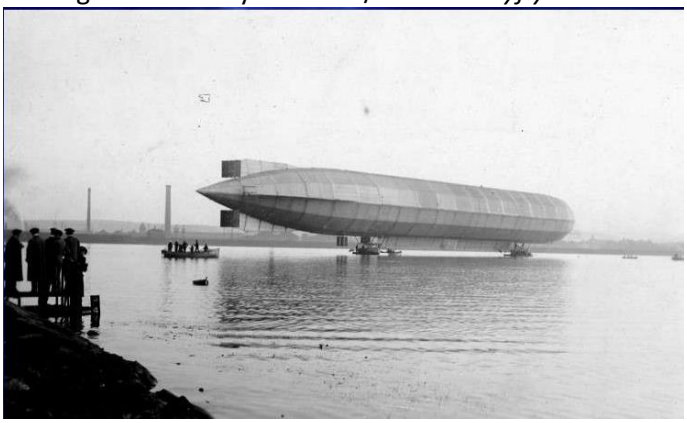


Figure 1: *24 September 1911: HM Airship No.1 'Mayfly", just after being removed from a floating shed at Vickers, Sons and Maxim Ltd, Barrow-In-Furness.*

The gigantic airship had been under construction for two years, but never flew beyond its mooring mast. It was first brought out of its floating shed in May 1911 and spent four days tethered to a mast to undergo mooring trials. During this period, it was found that its buoyancy did not exceed the airship's weight sufficiently to give the necessary lift to rise any further. The *Mayfly* was returned to its shed, for modifications, before emerging again in September 1911. Promptly breaking its back, the airship was deemed incapable of repair. So ended the Royal Navy's first attempt to provide the fleet with a vantage point higher than a crow's nest.

Figure 2: *HM Airship No.1 'Mayfly" broken in half after strong winds hit the side of the airship. It was also believed that one of the mooring lines had not been released and that the airship was literally pulled in half. Images from the collection of Vice Admiral Sir Cecil Ponsonby Talbot.*

Winston Churchill became the First Lord of the Admiralty on 24 October 1911. He was generally dismissive of airships and favoured the development of "heavier than air" aircraft. As a result, no attempt was made to repair *The Mayfly* and it was left to rot in its shed. Churchill made the following statement in the House of Commons on 26 March 1913: "Altogether, compared with other Navies, the British aeroplane service has started very well… I have a less satisfactory account to give of airships. Naval airship developments

were retarded by various causes. The mishap which destroyed the *May Fly*, or the *Won't Fly*, as it would be more accurate to call it, at Barrow, was a very serious set-back to the development of Admiralty policy in airships."

The First Known Use of a Heavier Than Air Aircraft for British Military Reconnaissance:

Pioneer Scottish airman, Captain Bertram Dickson of the Royal Horse Artillery, was the first British serviceman to qualify as a pilot. At the beginning of 1910, he enrolled at the Farman Flying School at Mourmelon in France and gained Aero-Club de France Licence number 81, on 12 April 1910. Two months later, on 6 June 1910, Captain Dickson set a two-hour distance record for a flight in a Henry Farman biplane. Later that month, at the Great Aviation Week of Rouen, he took home 28,100 Francs in prize money. At a Bournemouth meet, he won £740, and at the Lanark Aviation Meeting, held between 6 and 13 August 1910, he won a further £900.

As a result of his rapidly gained financial success and fame, Dickson resigned from the British Army, and in September 1910, took up a position with the British & Colonial Aircraft Company (later known as the Bristol Aeroplane Company), to help promote its products, including the Bristol Biplane, or the "Boxkite" as it was better known. The Boxkite was a "pusher biplane" based on the successful Farman III.

Left -Figure 3: *Bristol Boxkite Replica, built at the RAAF Museum and successfully completed flight testing on 11 September 2013. Flown by Air Vice Marshal Mark Skidmore (RAAF retired), a former F-111 pilot and test pilot with the RAAF's ARDU at RAAF Base Edinburgh, the aircraft flew approximately 1000 metres and reached a top speed of about 42 mph. Photograph courtesy RAAF Museum*.

Leading up to WWI, the British Army held manoeuvres on Salisbury Plain every year. The British Colonial Aircraft Company had its flying school at Larkhill on Salisbury Plain. Seeing an opportunity to promote the Bristol Boxkite aircraft, Dickson volunteered his services to one of the teams named Red Force. On 21 September 1910, Dickson flew a Bristol Boxkite, to try and find the enemy Blue Force. Dickson located the Blue Force team and when landing to make a telephone call to his own team's commanders, to report the location of Blue Force, his aeroplane was captured by Corporal Arthur Edwards of the 4th Dragoon Guards, before being retaken by Red Force.

While waiting for the umpires to rule on the situation, Dickson met the then British Home Secretary, Winston Churchill, who was observing the manoeuvres. Churchill liked how the aeroplane had been used and how it could be utilised by the military.

DURING THE BRITISH ARMY MANŒUVRES.—Captain Dickson's aeroplane retaken by the "Reds."

Figure 4: *The retaking of Captain Dickson's Bristol Boxkite by Red Force. Photograph from* Grace's Guide to British Industrial History.

By the end of the day, Dickson flew twice more for Red Force, which was reported in the *Daily Telegraph* the following day. Having read the

article, and to even things out, actor and aviation enthusiast Robert Loraine, flew to Salisbury Plain and offered himself and his Bristol Boxkite to the Blue Force.

Although it was just manoeuvres, Dickson had flown the world's first ever military reconnaissance sortie by aeroplane. While taking part, Robert Loraine used a radio set, weighing approximately 40 lbs, to send Morse code reports, over a one-mile distance, to his Blue Force headquarters. Another first; this was the first aeroplane in the United Kingdom to send a message by radio.

Four Bristol Boxkites were ordered by the War Office in March 1911, for the planned Air Battalion Royal Engineers. An order for a further four was placed later that year, mainly to be used as trainers. Four more were purchased by the Royal Flying Corps following the outbreak of WWI, with the last of these being written off in February 1915.

In November 1910, two Boxkites were shipped to Australia, for a promotional tour. Observers from the Australian Army watched demonstrations, and some were taken on flights, but no aircraft were ordered. On 6 May 1911, a photographer from the Daily Telegraph was taken for a 25-minute flight over Sydney, during which the first aerial photographs were taken in Australia. A Boxkite was later ordered by the Central Flying School at Point Cook and the first official military flight in Australia took place on 1 March 1914. The same aircraft continued to serve until it was written off in 1917.

On 23 October 1911, the first use of an aeroplane in war was a reconnaissance flight, during the Italo-Turkish War in Tripolitania. The flight took place using a Blériot XI, piloted by Italian Carlo Maria Piazza, who took off to reconnoitre Turkish gun emplacements. Captain Piazza had difficulty recording all that he could see and flying the aircraft at the same time, so on 11 November 1911, he forwarded a request for a camera to mount on his aircraft. The camera was later mounted on the belly of his Blériot aircraft, with a lens pointing towards the ground. Recorded military aerial photography thus began in December 1911. The Italo-Turkish War afforded a limited beginning, but established the great potential offered by aerial photography.

In November 1911, British Prime Minister H.H. Asquith, asked the Technical Sub-Committee for Imperial Defence (TSID) to consider what part aeroplanes could play in future military operations. Captain Bertram Dickson provided the following opinion to the Sub-Committee: "In the case of a European war between two countries, both sides would be equipped with large corps of aeroplanes, each trying to obtain information of the other, and to hide its own movements. The efforts which each would exert in order to hinder or prevent the enemy from obtaining information would lead to the inevitable result of a war in the air, for the supremacy of the air, by armed aeroplanes against each other. This fight for the supremacy of the air in future wars will be of the first and greatest importance, and when it has been won the land and sea forces of the loser will be at such a disadvantage that the war will certainly have to terminate at a much smaller loss in men and money to both sides."

TSID's recommendations led directly to the formation of the Royal Flying Corps (RFC) on 13 April 1912. Although Dickson saw the formation of the RFC, he did not survive long enough to see his prophecy surrounding air supremacy during the Great War realised.

In another unfortunate first, on 3 October 1910, Dickson was involved in the first recorded mid-air collision, which took place near Milan in Italy. The collision involved a Farman biplane, flown by Dickson, and an Antoinette monoplane, piloted by Frenchman René Thomas. Although both survived, Dickson never fully recovered and his injuries were believed to have contributed to his early death, on 28 September 1913, at the age of 39.

Group Captain Frederick Charles Victor Laws and Stereoscopy:

Frederick Charles Victor Laws was an officer in the RAF, an aerial surveyor, and a founder and perhaps the most prominent pioneer of British aerial reconnaissance. He enlisted in the Coldstream Guards in February 1905 and was stationed in Egypt and Sudan until 1912. He supplemented his income by taking photographs with his Kodak Bullseye box camera and selling them to his fellow soldiers. He later applied for an assignment to the Signalling Section, mainly to obtain access to the unit's darkroom facilities. He also experimented with communication with aircraft by heliograph (a wireless telegraph that signals by flashes of sunlight reflected by a mirror. The flashes are produced by momentarily pivoting the mirror or by interrupting the beam with a shutter).

Following the formation of the Royal Flying Corps, during the early summer of 1912, the War Office called for volunteers to join the Military Wing of the RFC, as ground personnel. One area the RFC was particularly keen to improve on was in the adaptation of current balloon photographic techniques and methods for obtaining aerial photography in aeroplanes. Following his return to England, Laws presented himself for a trade test in December 1912. He passed and was graded as an Air Mechanic (Photography) First Class. At the time, Laws had a feeling that he knew more about the subject than his examiner. This later proved to be correct and within a few months of his posting to No.1 Airship Squadron at Farnborough, Laws was promoted to be Sergeant in Charge of the Photographic Section of his squadron.

In the spring of 1913, the Naval Wing of the RFC took control of all the British airships. Laws was more interested in aircraft than airships and asked to remain in the Military Wing. Laws and the whole of his photographic section were posted to the Experimental Flight at Farnborough. The unit at Farnborough carried out experimental work with wireless, bombing, photography and artillery cooperation. In the 12 months from the spring of 1913 to 1914, Laws and his team conducted many airborne experiments and learnt a great deal about photographic emulsions, the use of filters and the effects of shutter speeds.

At that time, most early aerial photographs were taken as "obliques", i.e. the camera axis is directed at a slanting angle to the ground. The resulting photograph gives a side view, like a view obtained from a hilltop or a high tower. In aerial photography, oblique images are classified as "low angle" and "high angle." In high angle obliques, the camera points only slightly downwards and the view will normally include the horizon. With low angle obliques, the camera points steeply downwards and the horizon does not appear in the photograph. In 1913, Laws identified a need for aerial images to be taken as "vertical", i.e. the camera axis directed toward the ground as vertically as possible. The resulting image provides a plan view of the ground and is therefore easy to compare with a previously existing map, and photo interpreters can identify changes since the map was made, along with apparent recent activity.

Approximately 75 years earlier, in June 1838, British scientist Sir Charles Wheatstone had published a paper describing a curious illusion he had discovered: If two pictures were drawn of something, e.g. a cube or a tree, from two slightly different perspectives, and then each picture was viewed through a different eye, the brain would assemble them into a three-dimensional view. The term used to describe this principle was "stereoscopy."

In basic terms, "stereoscopy" is the production of the illusion of depth in a two-dimensional image by the presentation of a slightly different image to each eye. The two images are then combined in the brain to give the perception of depth. The easiest way to enhance depth perception in the brain is to provide the eyes of the viewer with two different images, representing two perspectives of the same

object, with a minor deviation equal or nearly equal to the perspectives that both eyes naturally receive in binocular vision. The resulting stereoscopic image is called a "stereogram."

While most people can, with practice and effort, view stereoscopic image pairs in 3D without the aid of a stereoscope, the physiological depth cues resulting from the required unnatural combination of eye convergence and focus are unlike those experienced when actually viewing the scene in reality, tending to cause eyestrain and fatigue. It is therefore much easier and more comfortable to use some form of "stereoscope."

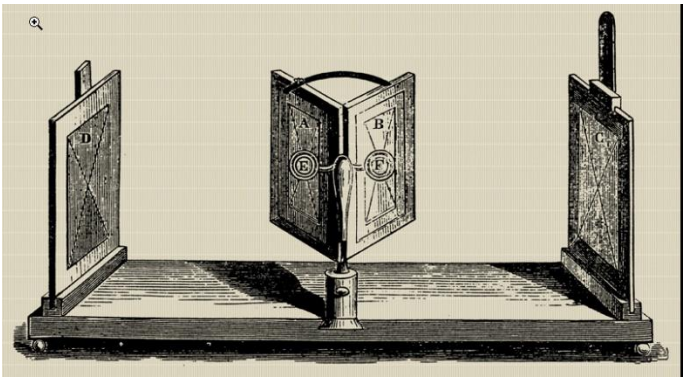


Figure 5: *Wheatstone mirror stereoscope.*

The earliest known stereoscope, with reflecting mirrors and refracting prisms, was invented by Sir Charles Wheatstone in 1832. It used a pair of mirrors at 45° angles to the user's eyes, each mirror reflecting a picture located off to the sides. Wheatstone's stereoscope was actually introduced about 12 months before the first practical photographic processes became available, so initially drawings were used.

David Brewster invented the lens-based Brewster Stereoscope in 1849, which allowed a reduction in size from the Wheatstone version and allowed the creation to become a handheld device. Because photography had still not yet become widespread, the early Brewster stereoscopes used hand drawn landscape transparencies.

Brewster was unable to find an instrument maker capable of working with his design in Britain, so he took it to France where the stereoscope was improved by Jules Duboscq, who made stereoscopes and stereoscopic daguerreotypes. Much admired by Queen Victoria when demonstrated at the Great Exhibition of 1851, an industry soon developed and 250,000 stereoscopes were produced, along with a great demand for stereograph viewing material. Photographers were sent throughout the world to capture views for the new medium and feed the demand for 3D images. In 1856, the London Stereoscopic Company offered 10,000 views in its catalogue. Within six years, views offered had grown to 1 million.

Figure 6: *Brewster-type Stereoscope circa 1870*

In 1861 Oliver Wendell Holmes created a much simpler and more economical viewer than had previously been available. He never patented the design. This stereoscope consisted of two prismatic lenses and a wooden stand to hold the stereo card. This type of stereoscope remained in production for a century and there are still companies making them, albeit in limited production, to this day.

In his experiments, Frederick Laws incorporated the already known principles of stereoscopy into aerial photography, after discovering that consecutive vertical photographs, taken with 60% overlap,

could be used to create a “stereoscopic” effect when viewed in a “stereoscope”, thereby creating a perception of depth that could aid in cartography and intelligence derived from the aerial images.

Figure 7: Economic Stereoscope created by Oliver Wendell Holmes, circa 1861.

The development of stereoscopes for aerial photograph interpretation and the use of stereoscopic models for precise photogrammetric measurement and mapping is discussed in a later Part.

Laws determined that to obtain stereoscopic coverage of a required area, an aerial camera would need to be able to take successive vertical photographs that ensured continuity of cover and overlap. During early 1913, Laws was the camera operator involved in an airship flight that captured an overlapping series of aerial images along the UK Basingstoke Canal. The camera used was the first specially designed and fixed Watson Air Camera that produced 4 x 5-inch glass plate negatives that had to be manually changed between exposures. This series of photographs proved to be a milestone in the application of aerial photography for mapping.

Later in 1913, Laws used the Watson Air Camera in a Farman F.20 biplane. The camera was seriously damaged the following year, after a heavy aircraft landing, when “the aeroplane crumpled into an unrecognisable heap of wood, wire and fabric” and the camera never returned to service.

In parallel with the experimental photographic work being carried out by Laws and his colleagues at Farnborough, members of No.3 Squadron RFC, realising the potential value of aerial photography to military reconnaissance work, purchased their own cameras and adapted them for use in the air. The handheld press-type cameras generally used, equipped with a six-inch lens, became the camera type used most frequently by the RFC

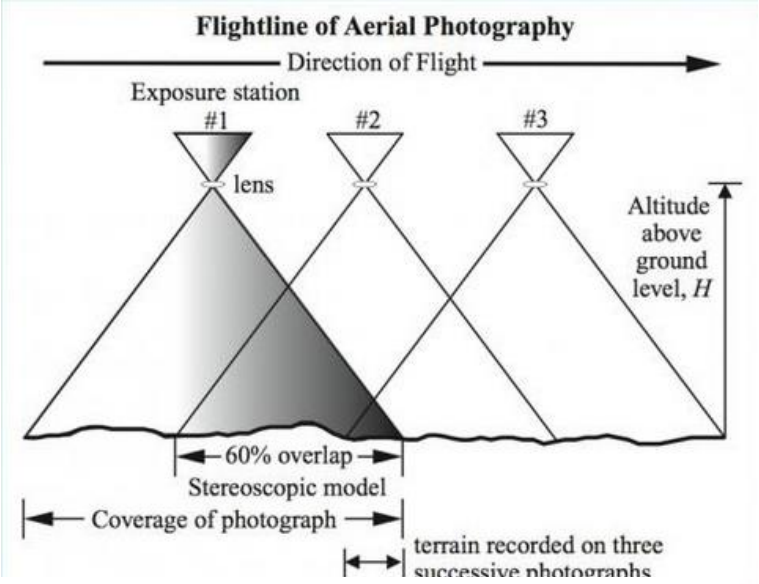


Figure 8: *Flight line of Aerial Photography, showing how 60% overlap can be achieved, the amount of terrain that will appear in a stereoscopic model (stereogram) and the small area of terrain that will be recorded on three successive photographs. The pattern is then repeated along the flight line for additional successive photographs as the exposure/ camera position moves.*

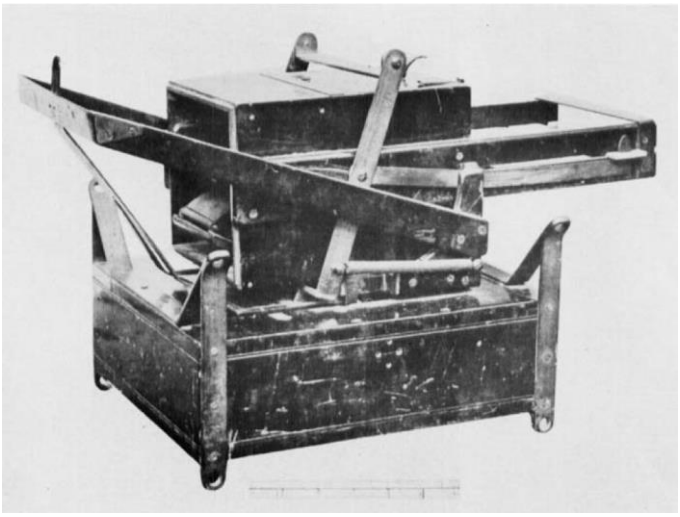


Figure 9: *The Watson Air Camera 1913.*

until 1915. Members of No.3 Squadron devised systems for developing negatives in the air, and after reconnaissance would land with the negatives ready to print. In early 1914, on one day, members of the Squadron, at altitudes of 5000 feet and over, took a complete series of photographs of the defences of the Isle of Wight and the Solent.

Later in 1914, Frederick Laws went to France with No.3 Squadron RFC and organised the air reconnaissance sections. In February 1915, he was posted to the Experimental Photographic Section, 1st Wing, and qualified as an observer and pilot.

Commencement of World War I:

Setting the stage for aerial reconnaissance during WWI, British and French reconnaissance and scouting had traditionally been the role of cavalry, more recently supplemented by observations from tethered balloons and airships. During the 1910 Salisbury Plain manoeuvres, senior British cavalry officers objected to the involvement of Captain Bertram Dickson and his Bristol Boxkite, on the grounds: it would "usurp their function, and moreover, frighten their horses." During similar manoeuvres in 1912, in which RFC's No.2 and No.3 Squadrons took part, the defending force of two Divisions was commanded by General Grierson. On the first afternoon of the exercise, the Cavalry Commander told General Grierson, that on account of the distance separating the opposing forces, he would be unable to supply information about the enemy until two days later. General Grierson referred this to Captain H.R.M. Brooke-Popham, who was in command of No.3 Squadron. Aircraft took off at 6 AM the following morning and returned three hours later with the detailed information that the Force Commander needed. From then on, General Grierson planned his tactics entirely on aerial reconnaissance.

Compared to the British, the French showed considerably more professionalism in developing a military aerial reconnaissance component. By 1911, the French had identified reconnaissance and the observation and direction of artillery fire as the most important use of the air. At that time, they had 200 military aeroplanes, some of which were already equipped with cameras. Training was thorough and the air force frequently practiced cooperation with French artillery, cavalry, and infantry. Special gridded maps were used, from which pilots or observers could notify the fall of shells, and battery commanders could record the same. Infantry commanders were taught to make the best use of air cooperation, and aerial photography was initiated.

In January 1912 Britain had only 11 Army pilots and 8 Royal Navy pilots. France had 263.

Germany declared war on France on 4 August 1914. To support the French, the British Expeditionary Force immediately prepared to cross the English Channel and embarked six days later. The Royal Flying Corps (RFC) made ready to send all four of its Squadrons, together with the Headquarters Unit, and an Aircraft Park that held spare aeroplanes and parts. On 13 August 1914, RFC No. 2, No. 3 and No. 4 Squadrons departed from Dover for the British Expeditionary Force in France and No. 5 Squadron took off on 15 August 1914.

The RFC started WWI with 63 aeroplanes, comprising rear-engined Henry Farman F 20s with a pusher propeller, front-engined Bleriot XIs, BE2s, Avro 504s and BE8s with a tractor airscrew. It was not until 22 August that all aircraft caught up with their Squadrons. According to Richard Townshend Bickers, in his book *'The First Great Air War',* "They appeared out of the summer sky, engines clattering and stinking of castor oil: flimsy structures of wood, canvas and bracing wires; many of them primitive looking contraptions with a naked fuselage of ribs and spars. They landed at varying intervals, according to how well the engines had functioned, how much the wind had affected them, how many forced landings they had made and how accurate their pilots' navigation. One aircraft had crashed in England and killed its pilot and his mechanic prior to reaching the Channel." Another pilot, whose aircraft had no markings, was captured after an emergency landing in France and locked up in the nearby town.

The Royal Flying Corps was also responsible for the crewing and operation of observation balloons on the Western front. However, when the British Expeditionary Force (BEF) arrived in France, in August 1914, the RFC had no observation balloons, which had all been transferred to the RFC's Naval Wing in 1913. It was not until April 1915 that the first RFC balloon company was on strength, using balloons loaned to them by the French Aérostiers.

The first British balloon unit arrived on 8 May 1915 and commenced operations during the Battle of Aubers Ridge. Balloon operations continued thereafter throughout the war. Operations proved to be highly hazardous and balloons were only expected to last a fortnight before damage or destruction. Results were also highly dependent on the expertise of the observer and weather conditions. To keep the balloons out of the range of artillery fire, it was necessary to locate them some distance behind the front line or area of operations. Balloon crews were the first to use parachutes.

Figure 10: *A French Caquot kite balloon. It used wind pressure to inflate one or more stabilising ballonets at the rear, which acted as tail fins. A yoke or harness connected the balloon to the tether and was arranged to aid stability.*

One advantage of balloon reconnaissance operations at the time was that the stable platform offered by a kite balloon made it more suitable for the relatively long exposures required for cameras of the day, as opposed to using cameras in a moving and vibrating aircraft.

France had 25 "escadrilles" ("squads" or small "squadrons") based at aerodromes across the country, equipped with a total of 142 aircraft. These were rear-engined two-seater Farman Longhorns, Voisins, Caudrons and Farman F20s; front-engined, single seater Blériot's and Morane-Sauniers. Twenty two of the two-seater equipped escadrilles, each comprising of six machines, were for general army cooperation. The four single-seater escadrilles, each comprising of four machines, operated with the cavalry.

Germany sent 33 Field Flying Units, each consisting of six tractor types, totalling 198 aircraft. The Taube and Fokker were single-seater monoplanes. The majority, albatross, LVG, Aviatik, AEG, were two-seater biplanes.

RFC Western Front Aerial Reconnaissance in WWI:

From the first days of WWI, the aeroplane demonstrated its ability to serve as the "eyes of the army." On 19 August 1914, six days after arriving in France, the RFC undertook its first action of the war, with two of its aircraft performing aerial reconnaissance. Taking off in poor weather and to save weight, instead of the usual pilot and observer, each aircraft carried a pilot only. Both pilots lost their way and only one was able to complete his task.

On 22 August 1914, RFC Captain L.E.O. Charlton and Lieutenant V.H.N. Wadham reported that, contrary to all other available intelligence, German General Alexander von Kluck's army appeared to be preparing to surround the British Expeditionary Force. The British High Command listened to the pilots' report and commenced a retreat towards Mons, thereby possibly saving the lives of 100,000 troops.

A week later, French aerial reconnaissance units began reporting that the Germans were moving towards the east of Paris. Although the intelligence officer refused to listen, General Joseph-Simon Gallieni, the military commander of Paris and a supporter of aviation, did listen and issued orders sending French troops towards the exposed German flank. The resulting first Battle of the Marne was a victory for the French because it forced the Germans away from Paris. Meanwhile, on the Eastern front in Poland, German aerial reconnaissance reports on the movements of the Russian Army helped the Germans and Austrians stop an advance at the Battle of Tannenberg. The result of these two battles was to push the armies fighting on both fronts into defensive positions in the trenches; creating a stalemate that would last almost until the end of the war.

By September 1914, artillery observation became as equally important as reconnaissance missions. RFC pilots reported where enemy batteries were, then controlled the counter fire of their own gunners. Two officers of No.3 Squadron were reported as being "outstandingly effective" at this work. A wireless telegraphy unit, commanded by Major H. Musgrave, worked with Lieutenants D.S. Lewis and B. T. James, who flew alone in BE2s, carrying a wireless set to report and correct the fall of shells, usually under heavy fire themselves. In signals, senior ground troop commanders expressed their "great admiration" for the splendid work the Royal Flying Corps was doing, on a day by day basis, "showing such heroic and efficient work." It had only needed six weeks at the Front for the RFC to overcome the prejudice, which only a couple of years earlier, had dismissed the RFC machines as "useless and alarming to horses."

RFC Photographic Reconnaissance:

RFC's photographic reconnaissance began on 15 September 1914, when Lieutenant G.F. Pretyman of No. 3 Squadron took five pictures of German trenches on the Aisne, using a handheld camera.

From the March 1915 Battle of Neuve Chapelle, vertical aerial photographs were put together in "mosaics", to form photographic maps. An example appears over the page.

For the remainder of the war, photo maps of the German trenches were always produced before an attack. Photo interpreters became skilled in identifying where barbed wire was thickest, where machine guns were positioned and where the enemy's artillery was located behind the lines.

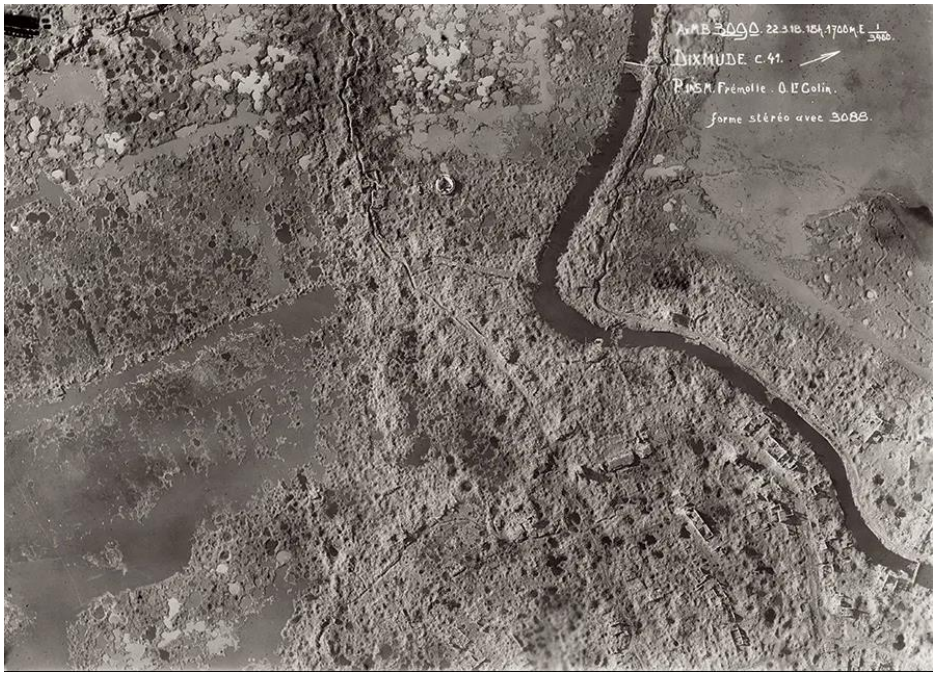
During periods of intense activity in 1918, French aerial units were developing negatives and printing as many as 10,000 photographic prints each night. During the Meuse-Argonne offensive, 56,000 aerial prints were made and delivered to the American Expeditionary Forces over a period of four days.

By the end of the war, the Germans and the British were photographing the entire Western front at least twice a day, enabling both countries up-to-date records of their enemy's trench construction. The most active day for RFC pilots was reported as 3 May 1918, when 4090 photographs were taken. The British estimated their reconnaissance planes took approximately half a million photographs during the war.

Germany calculated that if all its aerial photographs were laid side-by-side, they would cover the country six times.
While only a few hundred aerial photographs were taken during the opening six months of the war, by 1918, well over 5 million photographic prints were produced in the nine months between January and September 1918. Below are examples of the types of image obtained.

Figure 11: *1917 Mosaic of aerial photographs of WWI trenches.*

Left - Figure 12: *Shows German front line and support trenches at Thiepval village, while under bombardment by British artillery. Image from Imperial War Museum.*



Left - Figure 13: *The town of Dikmunde, almost destroyed in1918, due to the intensity of the bombardments. German bunkers which had been concealed in ruined houses are now visible. Image from Imperial War Museum.*

British Aerial Camera Development:

While vertical camera installations were used from the beginning of WWI, the cameras were too heavy and bulky for light aeroplanes. As a result, most early reconnaissance from aeroplanes consisted of visual observations and written reports. The French had incorporated cameras into aeroplanes from the beginning. In stark contrast with the French, early British aerial photography from aeroplanes was essentially conducted on an amateur basis, lacking in official backing. Handheld cameras were widely used by the British, but with generally disappointing results, because good photographs required both skilled flying and an operator who could devote time to handle the camera and the heavy glass plates required. The exposures had to be set manually, and after every shot the glass negative had to be replaced and the exposed negative stored away. Meanwhile, the observer/photographer also needed to comb the skies for enemy planes looking for observation planes to shoot down.

By the end of 1914, reasonably clear photographs were being taken by the RFC, but French results were better. Major W. G. H. Salmond, on the staff of Colonel Sykes at RFC HQ, was impressed by a French map on which German trenches had been plotted from air photos. His investigation of the French unit responsible found it highly centralised and with many skilled photographers. As a result, he advocated concentrating RFC photographers into RFC Wing sections. An experimental section was formed in January 1915 and was sent to Trenchard's First Wing. Members of this experimental section included then Flight Sgt

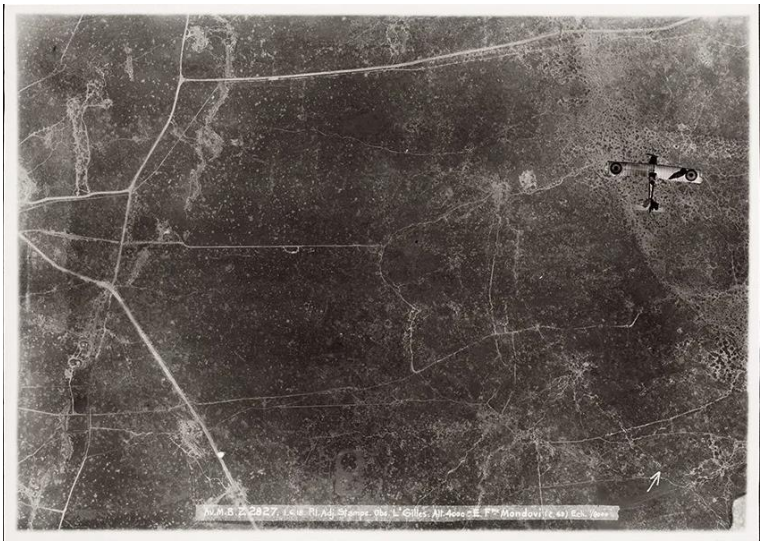


Figure 14: *Image taken on 1 June 1918, altitude 4000 feet, over Kortekeer, capturing a Belgian Breguet 14.*

Frederick Charles Victor Laws and Lieutenants Moore-Brabazon and Campbell.

In February 1915, the first successful British air camera was produced by Thornton-Pickard Ltd, to Moore-Brabazon's and Campbell's design. Known as the Model 'A' camera, the handheld camera was of wooden construction with reinforced strapping to withstand all climate conditions. Fitted with a Zeiss-Tessar 9 7/8-inch lens, the camera had a 8 ½- inch focal length and accommodated a 5 x 4-inch plate. It was fitted with a specially designed focal plane shutter with an adjustable aperture and spring tension. The shutter had a patented device which made it impossible to accidentally expose the sensitive plate. The back of the camera was fitted with a MacKenzie Wishart slide.

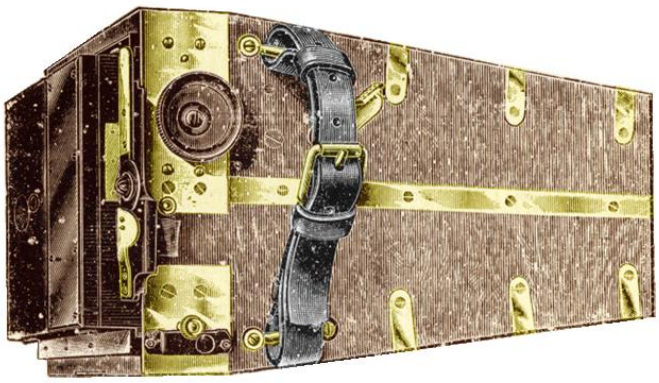


Figure 15: *Thornton-Pickard Model "A" aeronautical camera.*

First used over German trenches on 2 March 1915, the camera produced excellent results and the aerial photography produced helped First Army Intelligence to create new 1:50,000 trench maps for the Neuve Chapelle battle.

The Model 'B' camera was developed and introduced in mid-1916. Production was delayed due to the shortage of optical quality glass. It was manufactured solely at the RFC repair depots in France and was developed to satisfy the requirement for high resolution oblique photography.

The camera was an enlarged version of the Type 'A', using 8.5 x 6.5-inch plates and longer lenses, of up to 20 and 40 inches, could be fitted by using a metal tubular extension to the main body of the camera. Most of the first Type "B" cameras were constructed using captured German lenses.

By the summer of 1915, the Thornton-Pickard Model 'C' vertical camera, with semi-automatic plate-changing, began service. The Model C' camera, fitted with a 10-inch lens and using three magazines, with two magazines containing 18 plates each, weighed about 26 lbs. Fitted on a wooden frame and mounted on the side of the aircraft, it became the standard RFC issued camera until the spring of 1917.

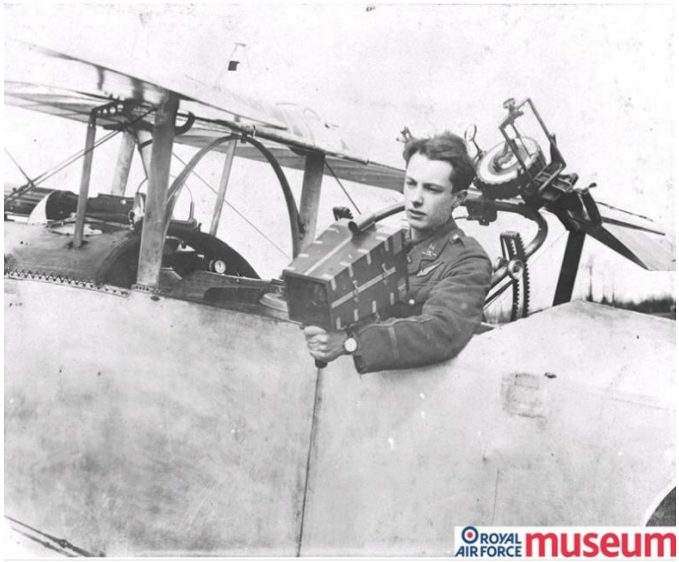


Figure 16: *Lieutenant S C Thynne demonstrating the use of a Thornton-Pickard Model 'A' handheld camera from the back seat of a Nieuport aircraft.*

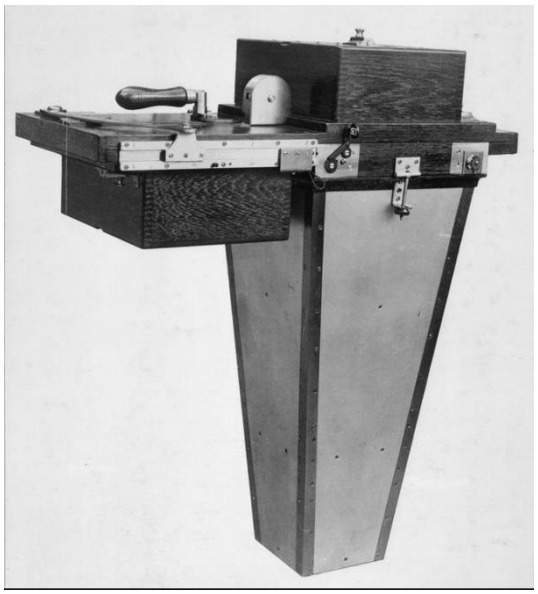


Figure 17 *A Type 'B' camera. The one illustrated has been fitted with a semi-automated plate changing mechanism.*

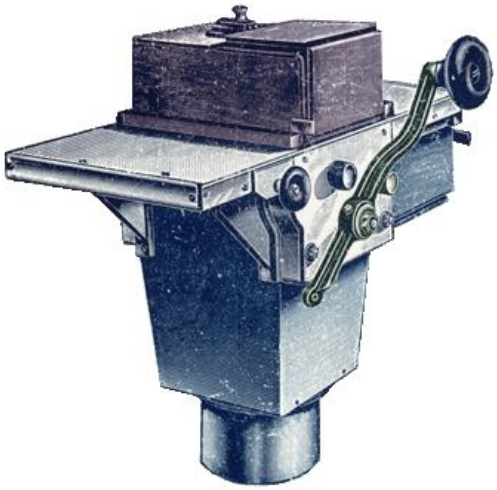


Figure 18: *Thornton-Pickard Model "C" aeronautical camera. Constructed of wood, with brass hardware, it was fitted with a top mounted magazine plate changer capable of holding 18 plates housed in metal sheaths. After exposure, the plate was transferred to another magazine, similar to the one on top of the camera, with the slide operated by moving the handle on the side of the camera. The plate changing action automatically reset the shutter for the next exposure.*

Aerial cameras grew more sophisticated as the war progressed. Cameras were developed that could be triggered by a remote control, operated by the pilot or observer. Later cameras had a propeller driven mechanism to set the interval between exposures.

Figure 19: *To ensure vertical images, cameras began being mounted on the sides of aircraft. This shows a Type 'C' mounted on a B.E.2c, for operation by the pilot.*

Originally, aerial photography was flown between 2,500 feet and 6,000 feet and the optimum was 4,000 feet. Obviously, flying straight and level at these sorts of altitudes for long periods of time, necessary for consistent scale and overlap, was extremely hazardous for the crews involved. The development of longer focal length lenses and development of faster climbing aircraft allowed images to be taken at much higher altitudes. By 1918, lenses of up to 20-inch focal length were capable of recording good and readable images from 20,000 feet.

The Williamson 'LB' Type vertical aerial camera was designed by Frederick Charles Victor Laws and John Theodore Cuthbert Moore-Brabazon. Connected to the camera body was a propeller and flexible drive shaft for automatic operation. A remote shutter release was attached by a Bowden cable. The slit in the roller blind shutter could be varied, giving speeds from 1/100th to 1/600th of a second. The most significant improvement over previous models

included a system of easily detachable, interchangeable lens mounts, allowing the use of any focus lens from 4 to 20-inch focal length. Other improvements included an exterior lever for adjusting the shutter slit, and an instantaneous method for converting from manual to automatic operation. A movable guide was fitted which enabled the quick removal of the top magazine in the event of a jam.

Figure 20: *Shows a variety of cameras used by the US First Army's 14th Photo Section ("The Balloonatic Section") circa 1918.*

An excellent video of an RAF training film, circa 1918, showing how to ready a Type 'L' camera before flight, appears on the Imperial War Museum website. Below is a link to the video.
https://www.iwm.org.uk/collections/item/object/1060023301

The Williamson 'BM' Type, introduced in 1918, included all the refinements of the 'LB' type. The development of this camera was triggered by the need for higher resolution images from aircraft that were now flying higher. This was the largest camera used by the RFC and was made entirely of metal. Focal lengths of the interchangeable lenses varied from 7 inches to 20 inches. It was an extremely heavy camera and it was not easy to change the magazines, which, when loaded with plates, were also heavy and awkward to handle. When ready for flight, with the 20-inch lens cone and three magazines, the camera and equipment weighed 82 lbs.

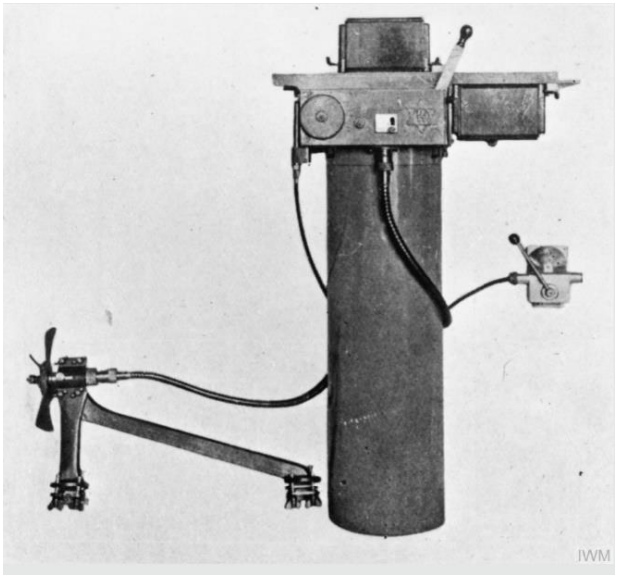


Figure 21: *Williamson Type 'BM' aerial camera.*

Bagley Tri-Lens Mapping Aerial Camera:

Although not widely used, the innovative Bagley Tri-Lens Mapping Aerial Camera is worthy of inclusion. Patented in 1903, by Topographic Engineer James Warren Bagley, in 1917 the camera was taken to France by then Captain Bagley. The camera had three lenses, through which three simultaneous exposures were made on a single roll of film. The centre lens was parallel to the plane of the horizon (i.e. produced a vertical image), while the other two lenses were inclined towards the plane of the horizon (i.e. produced oblique images). The inclined negatives were required to be transformed or projected to the plane of the horizon before being used. This was done in a laboratory, using a transforming camera.

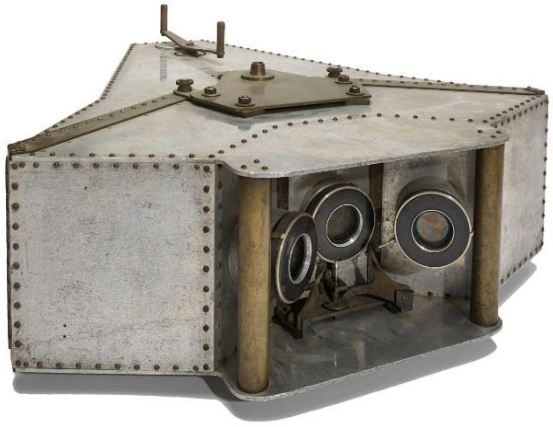


Figure 22: *Bagley Tri-Lens Mapping Aerial Camera.*

Figure 23: *Type 'LB' camera being handed to an observer in a DH4 – Image Imperial War Museum (IWM FLM 3582).*

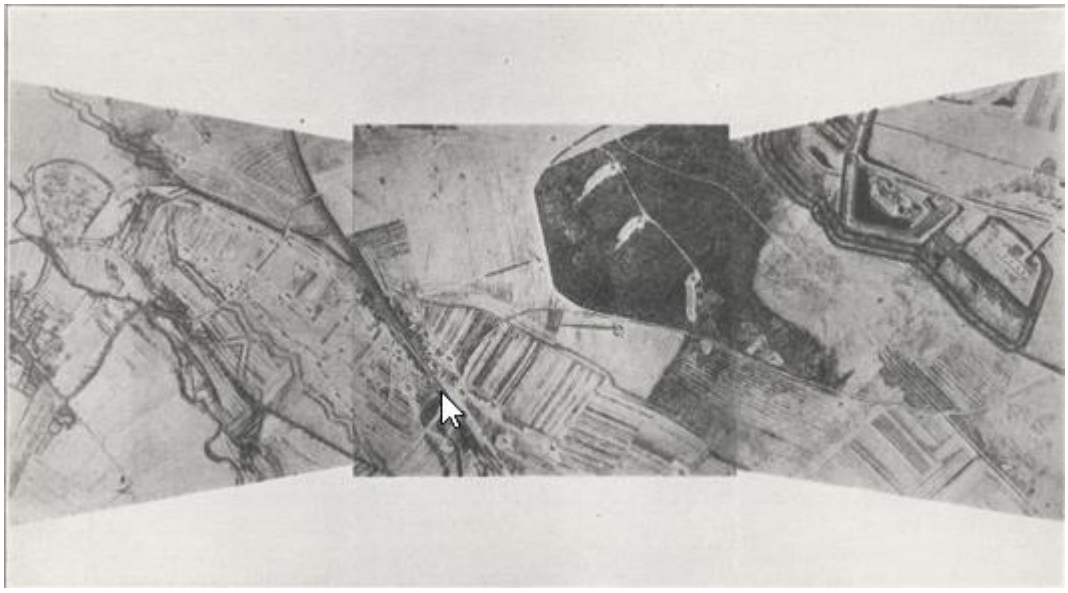


Figure 24: *Transformed Tri-Lens Photograph, Showing Hindenberg Line and outer forts of Mètz.*

Australian Aerial Photography Operations in Palestine:

No. 1 Australian Squadron of the RFC left for the Middle East in March 1916. Although renamed 67th Squadron RFC in September 1916, and retaining this designation until February 1918, records kept by the Squadron retained their Australian designation of No.1 Australian Squadron. Other British Squadrons, including No.14, No. 17, No. 111, No. 144 and No. 145, were deployed in the Middle East, forming the Palestine Brigade.

While similar technology, processes and practices were being used in the Middle East, to obtain aerial images, as described above for the Western front, forces on the Western front were aided somewhat by existing maps from the Napoleonic era, detailed maps of the Middle East were almost non-existent.

The British forces which were moving towards Palestine in 1917, had no town maps for some of the key towns in Palestine. Towns situated beyond the front line, such as Gaza, Beersheba and Ramleh were photographed by the Palestine Brigade Squadrons and maps of those towns were made. The first town map produced on 25 January 1917 was of Gaza. This is believed to have been the first ever town map made by using aerial photographs.

Figure 25: *Five unidentified members of the Photographic Section of the AFC, engaged in drying and trimming prints. Photo, circa 1917 from the Australian War Memorial.*

Below are some aerial cameras known to have been used by No. 1 Squadron, Australian Flying Corps (AFC) in the Middle East, and used to photograph many thousands of square kilometres, ultimately giving rise to the first detailed maps of much of the Middle East. How many can you pick out from your reading so far?

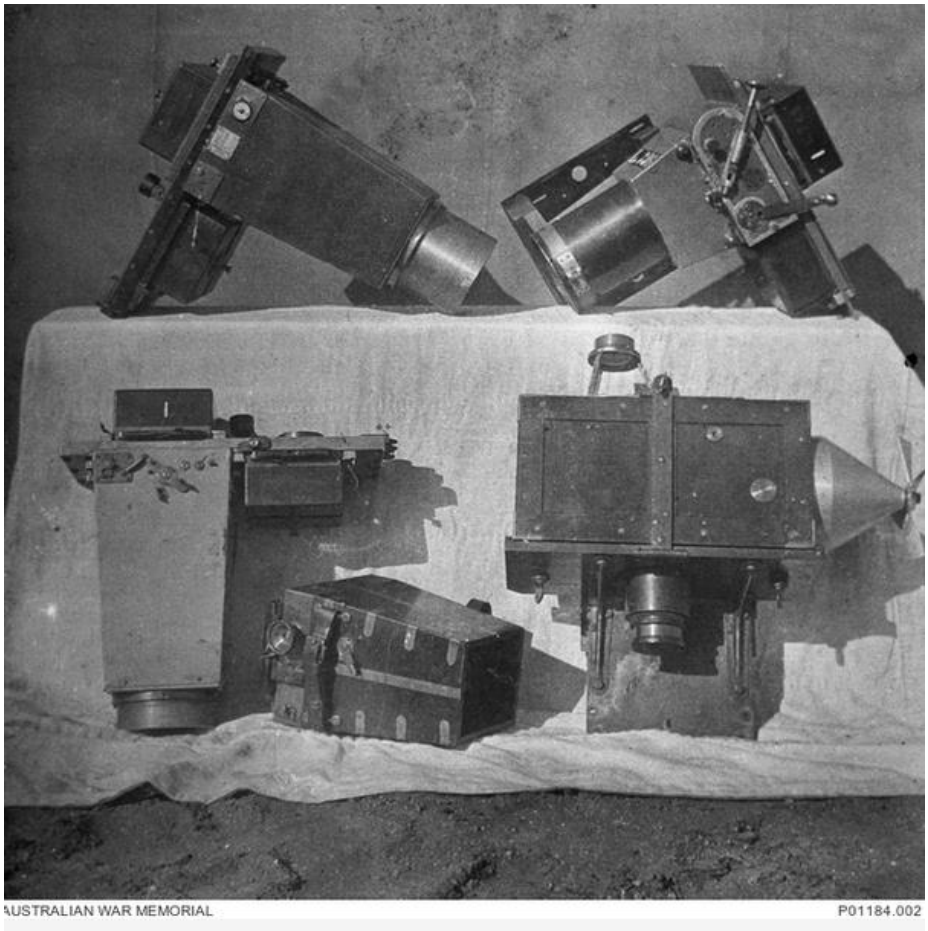


Figure 26: *Aerial cameras used by the AFC in the Middle East. Circa 1918. Photo from Australian War Memorial.*

In 39 patrols, over a 15-day period, in January 1918, No. 1 Squadron, Australian Flying Corps (AFC) completed an aerial survey in Palestine, photographing an area of about 624 square miles, covering a 32-mile-wide strip, back from the Turkish front line. Five aircraft (Martinsydes and B.E. 12As) flew in line at 12,000 feet. They flew 1000 yards apart, to obtain overlap for the exposures from each camera. 1616 plates were obtained during the operation.

South Australia's own Sir Ross MacPherson Smith, KBE, MC, DFC, AFC, qualified as an observer and later as a pilot. After volunteering for and transferring to the Australian Flying Corps on 4 August 1917, he served mainly with No. 1 Australian Squadron (No. 67 Squadron RFC). His operational duties included reconnaissance/photographic and bombing operations in Palestine.

Left - Figure 27: *Then Captain Ross Macpherson Smith left, and his observer, Lieutenant Ernest Andrew Mustard, DFC, of No. 1 Squadron, in a Bristol Fighter, in 1918. Photo from Australia War Memorial.*

Below is a photograph known to have been taken by Sir Ross Smith in the Middle East:

Figure 28: *Oblique aerial photograph of Dera Railway Yards, 16 September 1918, taken by Ross Smith from a Handley Page bomber, during a bombing raid. Photograph from E. A. Crome collection of photographs on aviation.*

Sir Ross MacPherson Smith was a recipient of the Military Cross and Bar, Distinguished Flying Cross and two Bars, the Air Force Cross and Knight Commander of the British Empire.

His first Military Cross was received while an observer and was Gazetted on 11 May 1917. The following year, he received a Bar to his Military Cross, Gazetted 24 August 1918, which recognised his aerial photography achievements. The Citation read:

"For conspicuous gallantry and devotion to duty. He was one of two pilots who carried out a remarkable series of photographs in one flight, completely covering an important area of 45 square miles. On a later occasion he successfully bombed an important bridge head from a low altitude, and his work throughout, as well as his photography, has been invaluable and characterised by the most consistent gallantry."

Figure 29: *Military Cross.*

Sources:

The First Great Air War by Richard Townshend Bickers. Wikipedia – HMA No.1. Wikipedia – Bertram Dickson. Wikipedia – Bristol BoxKite. Wikipedia – Frederick Charles Victor Laws. Wikipedia – The Royal Flying Corps. Wikipedia – Aerial Reconnaissance in World War 1. *British Aerial Photography and Photographic Interpretation on the Western Front* – Blog by Tim Slater. Grace's Guide to British Industrial History. *The Ultimate Way of Seeing Aerial Photography in WWI* – Centre for the Study of The Drone at Bard College. *Manual of Map Reading Air Photo Reading and Field Sketching, Part II, Air Photo Reading* – War Office 1958. *The War in the Air: Being the Story of the Part Played in the Great War by the Royal Air Force* by Sir Walter Alexander Raleigh. *The Great War Seen from the Air in Flanders Field, 1914-1918* - Yale University Press 2014. *Images of Conflict: Military Aerial Photography and Archaeology* - edited by Stichelbaut, Bourgeois and Saunders. *The Tri-Lens Camera in Aerial Photography and Photographic Mapping* by J. W. Bagley. SAAM Props and Mags – February 2020.

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