AERIAL PHOTOGRAPHY

A Lecture given by Colonel J. T. C. Moore-Brabazon, M.C., M.P., President, before the Institution at the Annual Meeting on March 9th, 1923. Mr. F. R. Simms in the Chair.

COLONEL MOORE-BRABAZON said:

I am not going to give you a real lecture to-night, but just a talk on aerial photography and the work of the Photographic Section during the war.

When the Air Force arrived in the field there was no photography being done at all. Some had been done from Farnborough in 1913, but when the Flying Corps (as it then was) first arrived, nothing whatever was being done in the way of photography. It was not until General French was shown some photographs that had been taken by the French that a movement was started in the Flying Corps for a photographic section, and General Sykes formed the nucleus of what was then called the photographic section, consisting of Lieut. Campbell, Lieut. Moore-Brabazon (as he then was), and Major Laws (then Sergt. Laws).

We were stuffed into the back of a tender with two folding cameras, and sent to No. 1 Wing, under the command of Colonel Trenchard. We were about as welcome as the measles; everybody was very busy, and no one wanted to take photos. We went around the squadrons with a Pan Ross camera, and in the first month managed to get about eight satisfactory photos.

That first camera was about the most unsuitable type that could possibly be devised for the work. The bellows were flexible, and their shape when put into the slipstream of a hundred miles per hour can be imagined. However, I am not going to deal with apparatus at the moment. Later on we got better cameras and better photos.

I will tell you how the whole question of photography was received in the Army. It was very difficult to get the General Staff to take photos seriously; they thought them amusing but not useful. General Trenchard went about with a pocket full of photos, and used to call them his "luncheon card." Things went on like this, and we were very displeased at the use being made, because there was no such thing as a trench map: we had not reached that stage. There was no method of making a trench map until photography had developed. We got so fed up that in the Flying Corps days we started a

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Map Section. That was against the rules. However, in the 2nd Wing we produced 3,000 maps, done first by Wylie, son of the artist. We sent these broadcast through the 2nd Army, and the Army told us to keep to our business. It formed a crisis, but from that moment the care of making maps was taken up seriously by the Army Headquarters, and trench maps were produced. I do not think there were any better ones than those produced by our Army Headquarters later.

The next thing was that we were convinced there was a good deal more in photos than you could put on a map, so after a long struggle to get people to see the advantages to be derived from photos of enemy country, we got out a book on "Interpretation of Aerial Photographs," showing places for machine guns, barbed wire, hidden batteries, etc. Again acting against what we should have done, we sent the books round the Army, and again the poor Photo Section got it in the neck. But from that moment there was started an Intelligence Department whose duty it was to get aerial photos. The book they produced at the end of the war was the finest and most detailed work on the interpretation of aerial photographs that any army, allied or enemy, produced.

By this time photographs had become pretty plentiful; and I was in charge of photography in France from the start until the beginning of 1918, when I came home, and the thing was then getting so big that supply was one of the most difficult things to handle. Cameras, etc., were much harder to get than you would think. During the whole of the war, right to the very end, we were very, very handicapped through bad lenses, the lense position at the beginning of the war being in a strange state. There was a German firm called Schott that was started on almost a Communist basis by an old abbé. This particular firm made the glass known as Dense Barium Crown—a special glass that one must have in the making of an anastigmat. This glass had been sold to the world at practically cost price, and no glass manufacturer had taken the trouble to make it. When the war started not one firm outside Germany could produce any Dense Barium Crown except one small French firm. It was very difficult to make, so difficult, that although Para Mantois made a little of it sometimes, when they tried to do so in large quantities they failed, and it was so tricky that in one melting they failed and never got the thing again, because they were using coal other than Durham coal!

During that time, when we in England were trying things one against the other, we used to get 2 lbs. of Dense Barium Crown for 100 Lewis Machine Guns. It was essential that we got this better glass, and we eventually got Wood, of Derby, to succeed in making it. It was a great technical triumph, and we exported it to every country in the world.

As I said at the beginning, I want to repeat, before coming to the technical side, that during the first month—in the beginning of 1915—I think we took about eight successful photos. The last months of the war we were sending out to the units in France alone very nearly a million photos a month.

Now I come to the actual more or less pure photographic side of the question.

Firstly, an aeroplane is not a very good form of tripod, because you are moving very fast, are in a very great draught, and the vibration is bad. You would naturally suppose that the right way to take a photo would be to hold the camera in the hand. That has advantages if you can keep it out of the draught and take it through the hole in the bottom of the machine; but remember first of all that we were not using between lens shutters; we were using focal plane shutters, which are better for this work, because in various forms of lens you have to adapt it to each lens. The curious part of a focal plane shutter is that it is not taking the whole of the photo at the same time. It consists of a blind with a slit in it, and that slit is moving across the plate. One end is taken at a different time from the other end. It was not until we had taken many photos by hand that mapping experts came to us and said that they were upset because the photos were not the same every time. We found that although you damped out by holding the camera in your hand, small vibrations often put in a big sweep of the whole camera. If you sweep the camera while taking the photo, in view of the fact that the photo is spread from one side of the plate to the other you can keep piling up the image on one side and spreading out the image on the other. The thing was simply ridiculous, because after having got the photo to scale, a house would be shown in three different positions.

That introduced great trouble, and we concluded that in spite of the undesirability of having a camera rigid to the machine, we must do that. So we (unlike the French and others) were the first people to take a camera and put it rigidly to the machine. Although we got very much vibration we did not get a big angular movement of the camera.

I start with this photograph, to give you an idea of what we suffered from in this respect. You will see how clearly it is shown that the photograph is not all taken at the same time. The top part of the screen is sharp, showing that the camera was at rest when it was taken. The centre part shows vibration, getting less towards the bottom.

Now I come to cameras.

The first type of bellows camera was very soon displaced by a rigid type. At that time we had them made of hard boxwood, and we had the Mackenzie Wishart type of slide, where every plate is contained in an envelope. It is rather a difficult business when the camera is strapped outside in the wind, but some of the pilots were very good at it. It was a very primitive and bad method. About this time it was getting essential to have more and more photos, and you will see that it was necessary to get as many photos out of one flight as possible. This was a device I got out to put on the " A " camera whereby you got a type of magazine. You had a plate running across from side to side, a simple box containing 24 plates, and another box quite empty. As you pushed the handle the plate was taken from the focal plane, deposited in this box, and the shutter wound. All you had to do was to take hold of the handle, push it back again, change the plate, and wind the shutter. With that method a change of photo took about a second. Here is the completed camera; here is the box containing the plates, and here is the magazine into which the plates are going to be pushed. This is the handle which the operator took hold

of. This was a great development in aerial photography, because from taking about a dozen photos a pilot using that camera has taken about a hundred and sixty in one flight. It also gave us a very great power—the power to get stereoscopic photographs from the air.

When you deal with stereoscopic photography you get the relief through the separation of one photo from the other. When you are trying to get relief in a trench about 6,000 feet away you want wide separation. From the moment that we could change plates quickly we were able to get quite excellent stereoscopic photographs right along the front line. The relief varied according to the separation, but it was very, very useful.

Another point I want to talk about is the method of suspending a camera in an aeroplane in order to avoid vibration, which will, of course, give a bad photo.

A camera, like all other things, is free to move in six separate ways—sideways, up and down, to and fro; about a horizontal axis in one direction and about a horizontal axis in another, and about a vertical axis. It is necessary in considering this question to get into one's head just which of these particular movements matter, and which do not. If you focus a camera on an object, say 6,000 feet away, and then move your camera one foot and take a photo exactly the same about 6,000 feet away, those two photos will be practically identical. If they are nearly identical, then vibration between those two positions will have no effect on the sharpness of the photo. Similarly, if the photo is taken one foot further back than where it was before, the photo will change only in scale, and not in any other way. Thus we have three movements of the camera that do not matter from the point of view of a perfectly distinct photo, always bearing in mind the distance of 6,000 feet.

There are two movements which are important—the movements about the two horizontal axes. The movements about a vertical axis of the camera will give a slight blurring at the edges, but the two vibrations about a horizontal axis are the ones that matter. It was due to those two that bad photos came, and we tried to devise a suitable mounting to eliminate the trouble, for it was essential that it should be eliminated.

One experiment that helped us to do so was this: having got the camera on to the machine, to start the engine and to put on the side of the camera a mirror. We projected a thin beam of light upon the mirror and received it on board. After the engine was started we got a graph of the actual vibrations of the mirror. This was in the trunnion type of attachment. After altering the position of the attachment we got a fairly satisfactory method of mounting the camera rigidly. It was not so good as later methods, whereby we turned vibrations into lateral and not angular ones.

Another interesting experiment which Williamson thought of was to fly with a camera at night with the lens open over a winking light. That gave interesting results, because across the plate there was a definite line which gave an absolutely clear rendering of every vibration taking place in the camera. It was our ideal to get the line to go across the plate perfectly straight. It was not until this method was inaugurated that camera mountings became

so perfect as they did later. No other photographic department mounted their cameras in the end so perfectly as we did.

The early suspension of that type of camera was a brain wave. It introduced the employment of rubber sponges.

The size of our plates was 4 inches by 5. If we started again we should use a square plate. We found that plates were better than films, because films did not keep. We found that a plate of the micro type was the best for us at the beginning of the war, and that, with a K.2 screen and an F. 4.5 lens, was about the standard practice at that time. The plates stood very strong developing and brought out great contrasts, which the General Staff very much wanted at first.

Here is a camera which is a development of the kind which Major Laws was responsible for designing. Here is a camera very much of the same type, with box-full of plates, empty plates, etc. It was known as the " L." It had this very great advantage—an automatic changing device, with a long cable and a fan put into the slipstream. Directly you took the photo you engaged a gear which this fan drove, and changed the plates. This was a great advance in the technical side.

This is an example of the rubber sponge mounting.

Here you see a bigger type of camera put into the fuselage, mounted in a well with a rubber sponge underneath it. It was in the early days before changing boxes, and the poor observer had to change his plates as best he could. To get a photo in this way was a triumph. All the time he was at the mercy of enemy aircraft.

Here is a development of the same type of camera, with a fan driving the changing box to one of the magazines to take the vacant plates. The cones were standardised, and you could put on any cone according to what lens you wanted to use. In some cases we used a lens as short as six inches : it took in an enormous area. On the same camera, by changing the cone, you could use five different lenses. The standard was a 20-inch lens.

Here, again, is Laws' type. We had nearly 2,000 of these; they were very useful. The advantage of this type, once we got the fan, was that you could put it on the back of the fuselage and hide it as much as possible, and nobody need attend to it except to change one magazine against the other after 18 photos had been taken.

The pilot was always responsible for taking the photo. It was obvious that the man to take the photo should be the one who could fly to the spot, so the pilots took the best photos. It was due to the automatic type of camera that this was possible. The plates were changed in about three seconds.

Here is one of the early " L " cameras. That was a type of mounting which we used for a long time. The end floated on rubber sponge pads, and was held by the nose with rubber sponges.

Here are the various cones for whatever lenses you wish to put in. You simply change the cone. Everything was dead up to infinity, and it was quite a triumph to get these things always right. The Germans got to 1 metre 30 in size of camera. They always used a curious type of Erniman changing box.

They had some good photos, but taken in the old-fashioned way, with the camera held by the observer. If the observer does the work you get some excellent photos of something you do not want.

Here is a layer of rubber sponge which takes off the primary vibrations. It is essential that you should grip the camera at the c.g., so that when transmitting any vibration it should move laterally and not about an axis, so as to avoid angular vibration. It was a system of bell cranks which eliminated angular vibration. It was by vibrating in the way that did not matter that they were saved from vibrating in the way that did matter. Although it seemed impossible to take photos with the vibration that went on, yet they were simply vibrations that did not matter.

Here is a type of camera for taking obliques. These were very much wanted, especially for tanks. We designed all kinds of cameras for taking obliques. We had some of the most magnificent workpeople I have ever seen in my life at our aircraft depots. They would turn out a perfect camera from an old packing case in half an hour. They were really wonderful. We built a camera with two silver-surfaced mirrors that reflected the light twice, using a lens of nearly seven-foot focus. We took one or two photos on a fine day, and they were marvellous. It was a pity we could not get long focal length cameras mounted out of the nose of the machine.

Here is a photograph of a lorry camouflaged in a wood.

The organisation of photography started by being a Wing affair, but it grew to such a size that it changed from Wing organisation to Squadron organisation, and every Corps Squadron had its own photographic section.

This is another type of camera I must show you, as it came a great deal into Flying Corps work. This is a method whereby aerial gunnery was improved very much. The camera was built by Thornton-Pickard and designed by Laws and Campbell. It looked to us a replica of a Lewis gun, but you knew, when you came to develop the photo, whether you had made a good or a bad shot. They were of great value in training.

Here is a photo of a flight.

There was another department of photography which occurred to us at the end of the war, which would have been more successful if the war had continued, that is, training by cinematography. In such cases as instruction in a machine gun the instructor can only talk to about seven people, but if you could get his demonstration and his lecture on one paper, and the other on a film, anybody can read out his lecture and show his pictures to thousands. The training of people in the Flying Corps at the end of the war was very important, and cinematography speeded up that training very much indeed. Some of the photos were very ingenious. When you had seen the operation once on a film it was worth about ten lectures by word of mouth. One of the biggest films was "The Construction of the Fuselage of an Aeroplane." The lecture went on for hours, but it was too dull. I heard, however, that some people got through it without going to sleep. With things like machine guns it was very good, but I do think that the making of the fuselage of an aeroplane was taking the thing rather too far.

Here is a photo which Laws lent me, showing two photos joined up roughly to start with. This was in the early days.

Here is a very early photo of the trenches from an oblique aspect. They were not of great value, but at the beginning of the war there was no possible way of seeing what the enemy trenches were, without photography. Trench warfare without aerial photography was an absolue deadlock. Tanks might have crashed through, certainly, but they wanted to have some idea where they were going. Without photography the war would have been an absolute deadlock.

Here is an ordinary standard aerial photograph worth looking at. It is very dull to those who understand it, but to those who do not know it is interesting. Here you see a road, and here are the trenches. Here is a battery. You will see that this curious line is very big barbed wire. It was very interesting in some of those photos to trace out possible Headquarters, because these photos always gave the thing away. Some of the camouflage was wonderful, but it took so long to construct that everybody knew exactly where the battery was.

This particular department of aerial photography, that is, the study of camouflage, is a department entirely by itself.

Here you see Arras Cathedral in the snow.

It was very strange how used you got to the front line, and knowing what everything was. At one time of the war you could show me any photograph of trenches, and I could tell you exactly where it was. I knew every trench by heart.

Here is a typical piece of front line, looking as if it was made in peace time. The barbed wire looks almost ghostly.

Here is a very much mined country, very near the Hohenzollern Redoubt: nothing but lines. This is a very complicated piece of country.

Here is a picture of what I was telling you about. It is a picture of the most marvellous camouflaged battery that was ever made. It was perfectly obvious to us. By the time it was finished it was covered with turf and you could not see a sign of it.

The chalky country is extremely difficult to photograph, except by great contrasts. It was at one time very popular with the General Staff, but after a time they wanted something flatter. It was a very common trick to make a mock battery have a real one behind it.

Here is a semi-oblique photograph of Ypres.

Here is a photo which I got from Laws to show the improvement in sharpening. It was taken pretty low, which always means that the movement is enhanced, because the travel of the object is faster than when taken from a greater height.

Here is a picture of a modern film-camera. I do not know much about what apparatus is being used since the war, but here you get what height it was taken at, etc., but these things are never really true in an aeroplane. I certainly wished we could have used films during the war, but they were very difficult to get. The films do not last very long.

Here is St. Paul's from a height. You can even see the pigeons on the steps.

I must say that I think aerial photography ought to be used more in peace time from the point of view of technical photographs and generally to exploit places, because it gives a very graphic view. It should certainly be exploited commercially.

This is the last photograph, which I thought a picturesque one, of a Bristol Fighter flying along, and I thought it best to come back to show you the actual pilot, because the photographs which were taken during the war were at great personal risk. The loss of life was very, very high, and the work was done for the sake of the man in the trenches. That was the primary work of photography in the Flying Corps—to help the poor man sitting in discomfort in the trenches. I am sure that is why all those pilots went out with a willing heart, some of them never to return.

DISCUSSION.

CHAIRMAN.—I have listened with very great interest to the excellent lecture given by our President. He has given us the early history of aerial photography, and he has told us in graphic language the evolution of the modern aerial camera, very modestly referring to his own genius.

I will not detain you further, because the time is getting on, but I will remark that we have all enjoyed the lecture immensely. It has taken me into quite new fields. The evening is getting on, and I therefore now invite you to commence the discussion.

MR. H. B. MOLESWORTH.—This is a subject of which I know nothing. I have been extremely interested, but it is not a subject on which I can start any discussion whatever.

MR. HOWARD-FLANDERS.—The only thing I wish to ask is whether most of the photographs were taken at sunrise or sunset.

THE LECTURER.—They were only taken when the light was best: midday if possible. Many were taken in the early morning, but at that time, and later on at night, the light becomes yellow. Although we had faster lenses at the end of the war, some were not so quick as we should have liked, and we therefore had to take most of the photographs at midday.

COLONEL BELAIEW.—As one of the many people who had the honour of standing some few months in the trenches, I should like to say that from our point of view such photographs as we have seen are, of course, of the greatest use and benefit. The part I spent in the trenches (1914 and 1915) was, of course, at a time when we were without the pleasure and privilege of having these photographs. As the O.i/c of an Artillery Battery I understand perfectly well what immense personal risks and what immense difficulties we