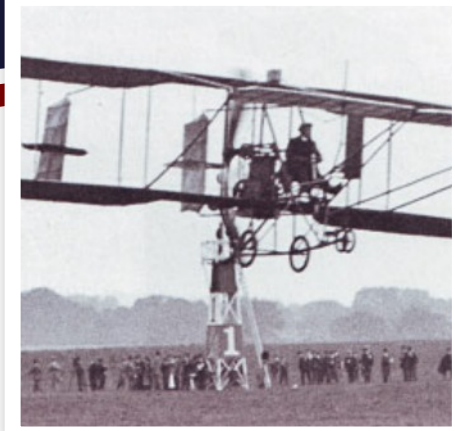


Aviation Science & Development at Farnborough
History and Learning Briefings

9

THE ROYAL AIRCRAFT FACTORY

The Continuing Story

Briefing No. 7 on the Royal Engineers Balloon Factory finished where the Balloon Factory was being moved to the Farnborough site after the winter of 1904/05.

This briefing looks at the development of the Balloon Factory, from its inception at Farnborough, into the Royal Aircraft Factory (see also History of Farnborough Aviation Site briefings).

Man-Lifting Kites

It took some time to complete the move to Farnborough, which occurred in August or September 1906. In the meantime, without the use of balloons, the factory's work continued as best as it could; and in mid 1904 work had been carried out to try and determine the effectiveness of man-lifting kites. The idea was not new; in mid 1894 a man-lifting-kite-section had been added to the Balloon School using equipment which had been designed by Captain B F S Baden-Powell, but the stability of these kites was not adequate enough in gusty conditions and the experiments were terminated.

The new type of kites were designed by Samuel Franklin Cody and were of bi-plane box form and used a number of these varying size kites flown on a common cable. They proved considerably superior to previously tried systems and observers were lifted to over 1000 ft on many occasions with high levels of stability. The primary advantage of the kite was that it could be used in wind conditions in which tethered balloons were un-useable; and this capability made it an attractive proposition for the Army. Cody worked hard with his kites and in April 1906 his diligence resulted in him being appointed the 'Chief Kite Instructor' to the Factory in full time employment.

During this next year or so, the Factory carried out a great amount of experimental and training work on spherical and elongated balloons, kites, aerial photography, signaling devices and balloon winches. In this way it extended its scope to include the accessories of aircraft as well as the aircraft themselves.

In 1906 J W Dunne had arrived at Farnborough to construct and test his tailless design aircraft – the D1 biplane. On completion it was taken to Blair Atholl in Scotland so that tests could be carried out in secrecy (see picture overleaf). Although it was originally fitted with two 12hp Buchet engines, it was tested both under power and as a glider. However, like many of its contemporaries, it was heavily damaged on landing and, having been repaired and fitted with its engines, crashed again. Not an unusual occurrence with these early attempts to fly.

FAST is developing a series of briefing on key aspects of Farnborough's Aviation Heritage.

These briefing notes are not intended to be a complete and comprehensive history of the subject of the title, but are intended to stimulate the imagination and encourage further reading. To that end, a 'further reading' list is included at the end of each briefing. By reading a number of different histories, written by varying authors over a range of timescales, a balance of the differences can be achieved – and the reader's own opinions formed. But we hope that these briefings will be an interesting summary.

It is a continuing process and a number of further briefings are planned.

BRIEFING SERIES

1-6 A Brief History of the Farnborough Aviation Site (1901 to 1991)

1. 1901-14 The Early Days
2. 1914-18 World War I
3. 1918-39 The Inter War Years
4. 1939-45 World War II
5. 1945-90 The Cold War Period
6. 1991 The Demise of RAE

7. Royal Engineers Balloon School
8. Royal Flying Corps
9. Royal Aircraft Factory
10. Edward Teshmaker Busk (Scientist)
11. Frank W Gooden (Test Pilot)
12. Samuel Franklin Cody
13. The Farnborough Wind Tunnels
14. Hermann Glauert (Aerodynamicist)

Please check www.airsciences.org.uk for the latest list of available titles.

Above : The Dunne D1 on the moors at Blair Atholl testing as a glider

Nulli Secundus

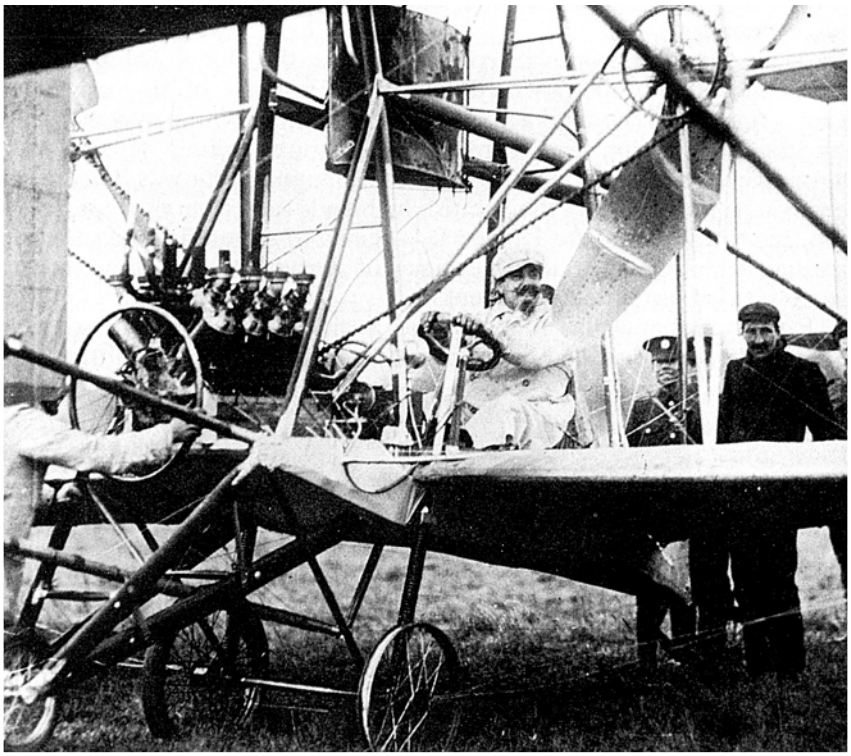
In September 1907 much of the experimental work of the Factory culminated in 'Nulli Secundus' (Latin meaning 'second to none') - the first British Army Dirigible. Nulli Secundus became Britain's first military aircraft when she flew on 10 September 1907. She was built at the balloon factory at RAE Farnborough, and powered by a 50 hp (37 kW) Antoinette engine. On 5th October - piloted by Col. Capper, Lt Waterlow and Cody - she flew some 35 miles from Farnborough to London, averaging 16 mph. She completed a tour over the city and, after circling St Paul's Cathedral, attempted to return to Farnborough, but 18 mph (29 km/h) headwinds forced her to land at the Crystal Palace. Taking off at 11:00pm, the flight lasted for 3 hours and 25 minutes and covered 50 miles (80 km) overland.

On 10 October, still moored at Crystal Palace to avoid damage in high winds, she was buffeted so severely that some of the guy ropes tore free. Hydrogen was released through escape valves and a slit was made in the envelope to speed up the process. Deflated and partially dismantled, the remains were taken back to Farnborough where they were used in the manufacture of Nulli Secundus II.

Back at the Factory, Cody was urging Capper to allow him to convert one of his kites to a power-driven machine. The War Office would not allow this approach, but consented for him to design the power train for 'Nulli Secundus' - its similarity in design concept being seen in his first aeroplane. In 1907, Cody modified one of his kites to be driven by the 12 hp Buchet engine and this was flown on a long wire suspended between two 100 ft poles. Later it was flown unmanned on Cove Common which was generally recognised as the first powered flight at Farnborough (see Briefing No 12).

Above : Nulli Secundus over Farnborough Common

British Army Aeroplane No. 1



Above : Cody sitting for a press call in his British Army Aeroplane No 1, Sept or Oct 1908

Using the 50hp Antoinette engine from the recently abandoned Nulli Secundus dirigible programme, Cody built his first manned, powered aeroplane - Army Aeroplane No. 1 - in the Factory in the existing No.3 Building.

After many hops and experiments, Cody made the first official manned, powered and controlled flight on the 16th October 1908 at Farnborough. The flight took 27 seconds and covered some 496 yards.

Right : The full scale replica in the Cody Pavilion at the FAST Museum

Change and Perseverance

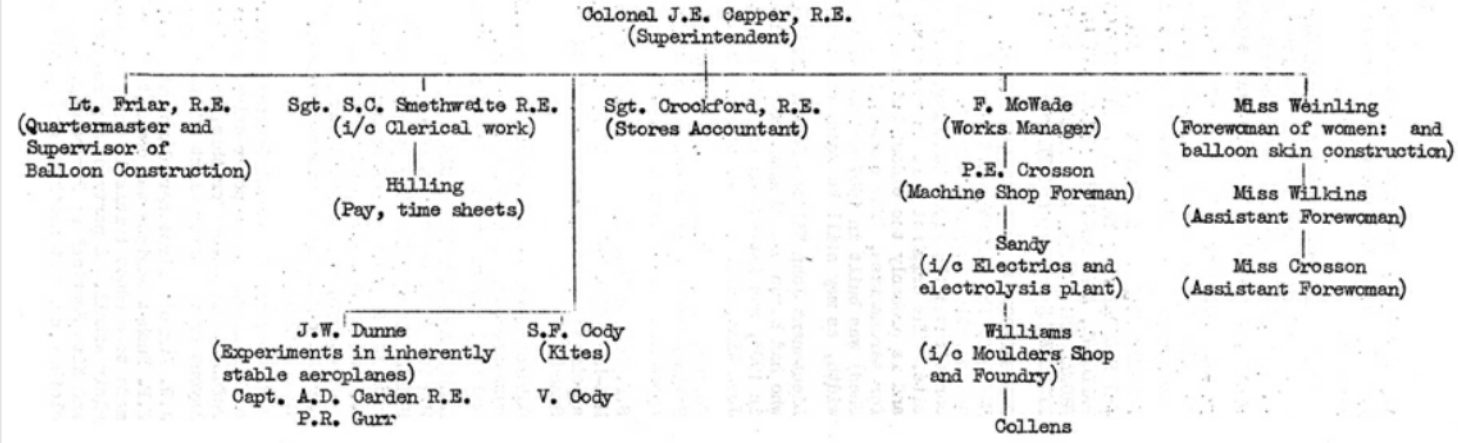
In spite of these triumphs, dark clouds were ahead and in the spring of 1909, the War Office decided that the costs of this type of flight - they had already funded all the aeroplane experiments to the tune of £2,500 - was excessive for the results obtained. Both Cody and Dunne were dismissed. Subsequently Dunne formed a company at Eastchurch and Cody moved to the other end of Farnborough/Cove Common - South West of the Factory - to Laffans Plain. With much perseverance and courage Cody built a number of aircraft (see Briefing No 12) winning many awards and competitions, but was killed in an aircraft accident in 1913.

In the same spring of 1909 that had dispersed Dunne and Cody, the Secretary of State for War, R B Haldane, took two important steps by forming the Advisory Committee for Aeronautics and making preparation for re-organisation of the Balloon Factory - which was chiefly meant for the production of Army dirigibles. Thus, in December of that year, this process caused the separation of the Balloon Factory and the Balloon Section R.E. into manufacturers and users. Capper was appointed in command of the Balloon Section and Mervyn O'Gorman became the Superintendent of HM Balloon Factory.

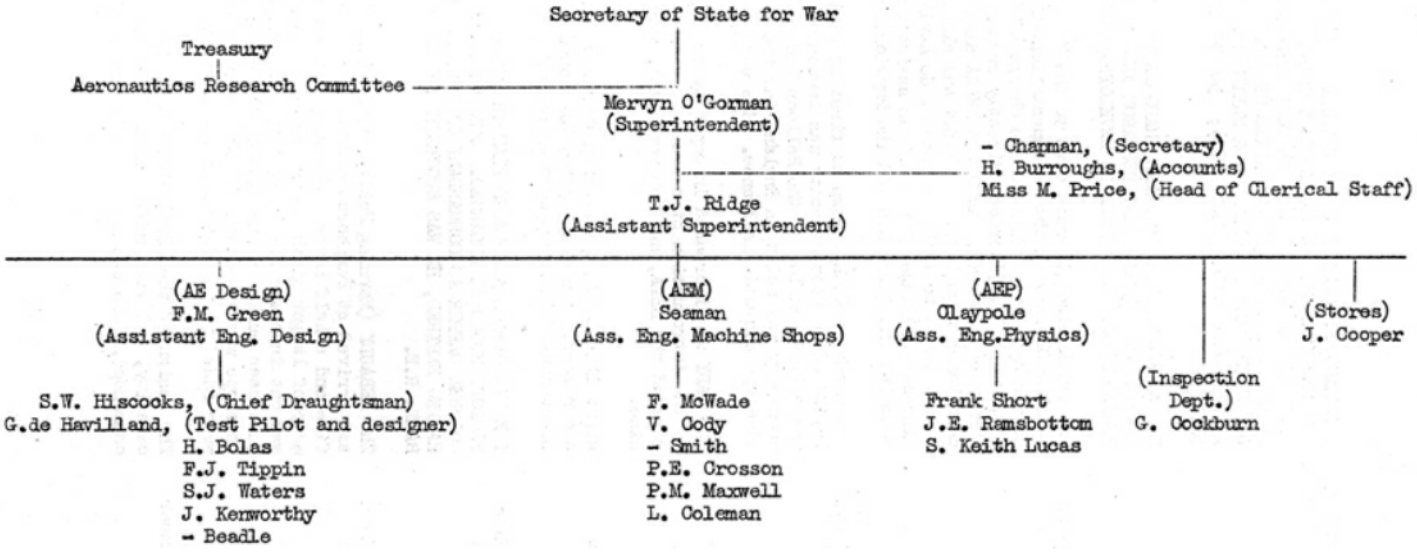
Staffing and Specialisms

Upon O'Gormans appointment at the end of 1909, the Balloon factory consisted of one large shed (the existing No. 3 building that had been originally erected on the Aldershot site in about 1900) for making balloons, one airship shed, one small machines shop and the adjoining Farnborough Common for use as an aerodrome. The total staff complement was fifty men and fifty women who were employed in those functions required to run the site - a drawing office (DO), workshop and administrative functions. Under the new management of O'Gorman, the DO and the workshop were re-organised and specialised to meet the new technical and scientific specialisms of departments such as Chemistry, Physics, Engine, Metallurgy and Wireless. This was the start of bringing a rational and scientific approach to the design, construction and ground and flight testing of aerial machines.

ORGANISATION OF BALLOON FACTORY, FARNBOROUGH: 1907



Organisation of the Army Aircraft Factory, Farnborough, 1910 - 1911



Above : Organisation Charts showing the change from 1907 to 1910-11

The Ascent of the Aeroplane

Work on dirigibles continued, testing on the BETA and GAMMA dirigibles went on, construction of DELTA was started in 1910 and completed in 1912. Experiments in airborne wireless communications were also continued by Lefroy; BETA and GAMMA were brought up to date; ETA was constructed and flown; and EPSILON designed but not built. Then in January 1914, the Admiralty took over all airships and this ended the airship phase at Farnborough.

However, during course of this airship phase - from 1907 to 1914 - the Factory became focused soon after 1910 on the aeroplane with its more practical and economical approach to reliable flight. In 1910 an aeroplane was purchased from its designer and pilot, Geoffrey de Havilland, and he joined the Factory as test pilot and airframe designer. This altered approach to aeroplanes led to the name of the Factory being changed to the Army Aircraft Factory in April 1911.

Right : The great pilot and aircraft designer Sir Geoffrey de Havilland

The Factory had been discouraged by the War Office from the design and build of new designs of aeroplanes but had been authorised to carry out re-construction. The first of these had been the reconstruction of a Bleriot monoplane into the Factory SE.1. The only vestige of the original Bleriot was the ENV engine and this innovative approach by the Factory was continued in April 1911. A Voisin biplane was sent to the factory for repair and after a short while re-appeared as a tractor biplane designated as a B.E series, only the Wolseley 60 hp engine, its radiator and a few metal fittings being retained in this new aircraft.

Right : Royal Aircraft Factory experimental aircraft SE1

From this design, the similar BE2 was developed using a 60hp Renault V-8 air-cooled engine. This made its maiden flight on 1 February 1912 with de Havilland at the controls, and was to become one of the signature military aeroplanes of the First World War. It was in this type of aeroplane that Edward Teshmaker Busk, a brilliant young Cambridge physicist, carried out all his pioneering work at Farnborough on aeroplane stability (a serious problem on early aircraft) leading to the first truly inherently-stable aeroplane - the BE2c. He died, like many of the early pioneers, in an aircraft accident in November 1914, when piloting an experimental aircraft in the cause of this early research on the evolution of this aeroplane and aerodynamic stability in particular. (See Briefing No. 10).

As well as this growing effort in aerodynamics, one of the more serious problems facing adequate and reliable flight was the poor quality of aero engines in general; and British engines in particular. The power output was poor, engine mass too high and reliability unspectacular. Competitions (with cash prizes) in 1909, 1911 and 1912 for acceptable British engines were held, the latter being hosted by Farnborough. Results were somewhat unsatisfactory and, as a result, the Factory put forward a request that they should design and build an engine.

Above : The BE2a 23 August 1913
Left : The legendary BE2c - the first really stable aircraft

A first refusal was later rescinded resulting in 1913 in the production of the 90hp RAF (Royal Aircraft Factory) 1a engine. A vigorous engine research programme was initiated which not only embraced the design and prototype production of more ambitious engines, such as the RAF2 (nine cylinder static radial), the RAF3 (200hp 12-cylinder water-cooled Vee) and the RAF4 (an air-cooled 140 hp V-12), but included investigating rotary and sleeve valves and other accessories.

Wireless and Other Innovations

In January 1912 the wireless experiments of Lefroy were now applied to the aeroplane. A wireless set was installed in the first BE1 and with this equipment made successful artillery spotting reconnaissance reports for the first time in history with an aeroplane.

Other areas of research and development were tackled particularly in the areas of measurement and instrumentation - the ability to bring scientific processes to the development of aeroplanes required the ability to accurately measure the parameters under test. Due to his leading of this approach to bring science and technology into the design and testing of a wide range of aeroplanes, Mervyn O'Gorman was awarded a CB in June 1913.

In April 1912 the official name of the Establishment was changed from the Army Aircraft Factory to the Royal Aircraft Factory, and we can see the extent of its operations at this time in the photograph below.

Above : H M Aircraft Factory in early 1912.

War and Expansion

In August 1914, war was declared and this event finally dissipated the resistance of the War Office to the inclusion of aeronautics into the military sphere. They released the necessary Treasury funds for adequate development and supply. However, Britain, due to the neglect in the previous years by the authorities, was ill-equipped and prepared, from an aeronautical point of view, to enter such a war.

The Factory had produced a number of prototypes and experimental aircraft of the FE, SE, BE and RE types and, at this time, the Factory aircraft were essentially the only types suitable for immediate production. So the FE2b bomber and the BE2c general purpose machines were produced in large numbers together with the 100hp RAF1b engine and later the 140hp RAF4a engine with which to equip them. About 2000 BE2c aeroplanes were subsequently built by outside firms.

This relaxing of the Treasury coffers meant that the Factory, no longer restricted by meager grants, began to expand in personnel, equipment and buildings. By the middle of 1915, it had run night and day for the best part of a year under the urgencies of war; and the number of personnel engaged in this process had risen to around 4000 from the 1910 figure of 100. To supplement the work on aerodynamics, a seven foot wind-tunnel was installed in 1917 to provide for the growing performance of aeroplanes and the growing complexity of their development. A second tunnel was added a year later to allow the closer investigation of aerofoils and aeroplane scale models which became necessary at that time.

This growing complexity of design and development led to the increased volume of effort needed on auxiliaries and ancillaries of all types. Caunter notes in his historical summary of the Factory development, *"…this work included such items as the preparation of non-actinic fabric dope for both airships and aeroplanes; the metallurgical problems of all-metal fuselage construction, the evolution of the first practical aeroplane compass; streamlined bracing wires (called RAF wires); variable camber wings and flaps and the initial investigations into the essentials of stability and control; air brakes; the development of aircraft stressing methods and the technique of testing to destruction; various instruments such as bomb sights, cockpit instruments, navigation instruments, special instruments for full scale and wind tunnel research work; variable pitch propellers; theoretical and full scale investigation into the phenomenon of spinning; the development of tool steel for exhaust valves; liquid cooling for valves; special light alloys for pistons, cylinder heads and cylinder barrels; the application of supercharging to aero engines; oleo undercarriages; automatic remote control of aircraft; AGS standards and the inauguration of inspection methods and services for aircraft and engines."*

The breadth, depth and speed of the research was a consequence of the energy and enthusiasm of Mervyn O'Gorman and his staff. The Factory had become, and was still developing into, a national centre of scientific aeronautical research and development which supplied the greater part of the knowledge that was required to produce efficient and effective aircraft. Late in 1916, a maximum total of personnel of 5000 was reached and the Factory in 1913-14 received a vote of £234,000 - some 46% of the Air Estimates for that year.

By 1916, O'Gorman had completed his seven years contract as Superintendent of the Factory and he was succeeded by H Fowler in September 1916. Many of his original senior staff were directed to industry on the score of national economy, although on this aspect of national economy Caunter notes, *" …the total salary of the Factory staff was about £6000 a year and, in private firms, they were soon receiving a total of £42,000 per year."*

A New Era - The RAE

With the creation of the Royal Air Force (RAF) in April 1918, the title of the Royal Aircraft Factory (RAF) was altered to the Royal Aircraft Establishment (RAE) to avoid confusion in the initials.

Thus ended one era and started the illustrious era, to last for another 74 years, of RAE Farnborough.

FURTHER READING

Early Aviation at Farnborough Vols 1 & 2, Percy Walker

A Historical Summary of the Royal Aircraft Establishment 1918-1948, C F Caunter, Aero Report 2150A November 1949

The Royal Aircraft Factory , Paul R Hare, 1990 Putnam Aeronautical Books, ISBN 0-85177-843-7

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