Aviation Science & Development at Farnborough

History and Learning Briefings

4

A BRIEF HISTORY OF FARNBOROUGH AVIATION SITE
Part 4 : World War II 1939-1945

This is Part 4 of a much abbreviated history of the Farnborough Site and contains just a small range of the experimental research and development carried it out in its lifetime. In these brief notes, it has, unfortunately, not been possible to mention all of the many Departments' contributions or individual staff contributions. The tremendous width and depth of the research & development can be obtained from wider reading – just a few recommendations of which are made at the end of each section – most of which are available from FAST.

The Outbreak of War

With the onset of war, the RAE were employing some 553 officer grade scientists and technical staff; this had risen gradually from the 1934 figure of 214.

C F Caunter (Aero.2150A) descibes the situation at the Establishment in 1940 : *"Outward change was not easily perceptible but by then the war expansion and the extreme urgencies of the national and global situations had brought about the beginnings of a great increase in personnel and rapidly expanding Departmental work and policies as necessitated by the urgencies and vicissitudes of the progress of the war. Having reached this high pitch of concentration upon the immediate problem of winning the war, the Establishment maintained it until 1945, without however losing the ability to consider the future such as, for example, the initial schemes for the National Aeronautical Establishment which were begun in 1944…"*

RAE Under Fire

On August 16th 1940, soon after 5.30pm, eight German bombers approached the Establishment from the west at about 3000 ft and proceeded to bomb the RAE. About 20 bombs fell, of which about half fell on target, the remainder fell in Albert Road, Church Road East and Canterbury Road. In the RAE, three members of the LDV were killed. Work was partially disorganised for three days but was quickly resumed after some dispersal re-adjustments. Soon after this, a duty defence flight operated by the Experimental Flying Department was formed.

A considerable expansion of the Establishment buildings, aerodrome area and layout took place after the middle of 1940, the buildings eventually covered 56 acres, the long runway was 2400 yards in length, the perimeter track was 5 miles and the maximum number of personnel employed during WW2 was about 6000 (1943 – 45).

In the Aero Dept, low-speed wind tunnel tests were made on the first British jet-propelled aircraft the Gloster/Whittle E28/39 and the Gloster F9/40 – the Meteor. All subsequent jet types were similarly tested by the establishment and the experimental study of entry ducts entered into a new phase.

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.

Design for Change

In the Instrument & Photographic (I&P) Department, the development of the new RAE-designed innovative gyro gun-sight was started by a small team whose task was the design of a gun-sight, based on the principles which had already been tested in the air in 1939-40 with promising success. A major criterion was that it would be suitable for large scale manufacture for general use in combat aircraft. Details of the final design - the GGS Mk 1 – for quantity production were completed during the summer of 1940 and the first production order for 2000 sights followed soon after.

In June 1941, the operational trials showed that the average number of hits with the gyro gun-sight was 6.7%, against 3.0% with the fixed sight using tracer ammunition. So good was the design that the USA started immediate production for their own Army Air Force.

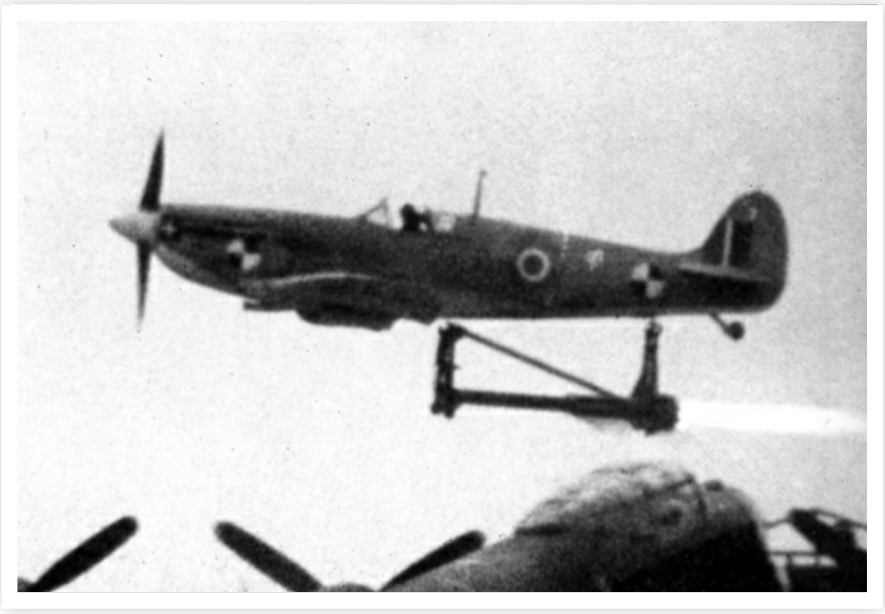
In December 1940 the basis for the design of the F2 axial flow jet engine, to give a thrust of 2300 lb, was completed and sent to Metropolitan Vickers Ltd for final design and manufacture. The first unit was completed in November 1941 and the initial runs made in the following month. The Gloster Meteor F9/40 was fitted with two F2 engines and flight trials started in November 1943.

Whilst ground-based radar had been in use for a short time, the responsible team from Bawdsey were transferred to Farnborough to develop and engineer equipment suitable for use by the RAF. The RAE Radio Department had a wide experience in the mass production of radio equipment and it was considered that this vital experience would smooth the way for the design, prototype approval and flight trials of airborne radars.

In June 1940, the Experimental Flying Department received its first captured Messerschmitt Me109 for extensive flying and handling trials.

In the meantime, the designs department was not idle and during 1938-39 a track and trolley had been designed and built for the purpose of enabling large multi-engined aircraft to be launched without expensive runways. The first successful flight was with a Heyford (12000 lb) and in July 1941 a Manchester aircraft (38000 lb) was launched with great success.

Rocket Launch Tests



Above : Rocket launching trials at Farnborough for use on merchant ships 1941/2

In a similar vein, the launching of fighter aircraft from merchant ships by the use of a rocket propelled catapult was studied and a design produced in three weeks. The build was completed by the middle of January 1941 and successful trials carried out before the Admiralty and Air Ministry – just 25 days after the project had been undertaken.

The first ship to be equipped was *HMS Ariguani* which was ready for the Battle of the Atlantic by April 1941.

In 1939, Aero Dept had been involved with the calculations on the application of auxiliary rockets to reduce the take off run of overloaded bombers; and mid-1941 saw the initiation of flight tests with cordite rockets; in these cases it was in support of Fleet Air Arm aircraft.

Aerial Photography

Aerial photography was increasing in importance and aircraft altitudes needed to increase, particularly to cover bomb damage assessment; so a new camera was required. To meet this, the Air Photography Department, in the form of Harry Stringer and his team, designed the type F52 aerial camera. Film magazines of 250 and 500 exposures of 8 1/2 x 7 inch picture size and detachable lenses of 10 inch to 50 inch focal length were provided.

New Bombsight

In support of Bomber Command, in another part of I&P Department, the MkXIV automatically set bombsight was designed by Professor Blackett and Dr Braddick. The main feature of the design was that it permitted maximum tactical freedom and reduced to a minimum the computation and other operations to be performed by the bomb aimer. From 1941 to 1947, seven different sights of the Mk XIV type were produced. The T-1 series of sights, manufactured in the USA, were identical in principle with the XIV series, although some redesign was necessary to suit US engineering methods. This type of sight became the standard equipment for Bomber Command.

Tilly Shilling

In August 1941, in the Engine Experimental Department, Miss Beatrice Shilling and E Glaister found the rapid solution that was to solve the problems of engines cutting momentarily during negative 'g' manoeuvres. This consisted essentially in the inclusion of a simple restrictor union which could be easily applied to units without interfering with the production process – an essential requirement for the time. The Establishment made an initial quantity that were supplied directly to Fighter Command *(see Further Reading for a history of Miss Shilling and get the book from the FAST shop).*

In 1947 Miss 'Tilly' Shilling was awarded the OBE for this work. Nowadays in Farnborough, she also has a pub named after her!

Right : Beatrice 'Tilly' Shilling OBE PhD MSc CEng (1909–1990)

High Speeds and Wind Tunnels

Above : A model of the Typhoon in the High Speed wind-tunnel

The increase in operational ceilings (up to 40,000 ft by 1941) necessitated the adoption of pressurised cockpits. As a prototype, the Structural & Mechanical Engineering Department modified a standard Mk 1 Spitfire (Merlin 47) so that the cabin could be inflated to 2 psi differential pressure and the differential pressure controlled to give a cabin altitude of 25,000 ft. Its first flight was in August 1941.

By late 1942, the newly completed high speed wind tunnel was opened and in the same month (November) the tunnel was in use.

The operational need for auto-pilot units was now so great that the Mk 8 Autopilot, which utilised the many components of the Mk 4, was developed from basic work dating back to 1937 and manufactured in great quantity to become the standard auto-pilot of the RAF.

In 1942 the station constructed for the research on gas turbines – Pyestock – started work, under Hayne Constant, as a separate Turbine Division of the Engine Experimental Department. In 1944, Pyestock was taken over by Power Jets Ltd. The Radio Department had been in the process of developing mobile radars for overseas use and when these were given a higher priority, the result was the mobile Ground Controlled Interception (GCI) sets. These proved to be the best and most versatile ground radar produced by MAP and the Department was almost completely responsible for their design and engineering.

By 1943 the High Speed Tunnel research was in full flow and models of the Meteor, Tempest V, Welkin and the Gloster E.5/42 were tested in the first year of use. Several model tests of the Hawker Typhoon and its tail unit were also carried out, in order to obtain data relevant to the large number of break-ups that had been experienced in flight. Farnborough was also involved in the investigation and analysis of these accidents.

During 1943 there was a rapid increase in the pace of flight research at high Mach number. The necessary data could only be obtained by diving the aircraft steeply until the required speeds had been reached. Compressibility effects on drag, stability, control and other characteristics were investigated in this way on several aircraft. Eventually, in April 1944, a Spitfire of Experimental Flying, flown by Sqn Ldr AF Martindale reached a true figure of M=0.9 and this Mach Number was not reached by any other aircraft until the American transonic flights in 1948.

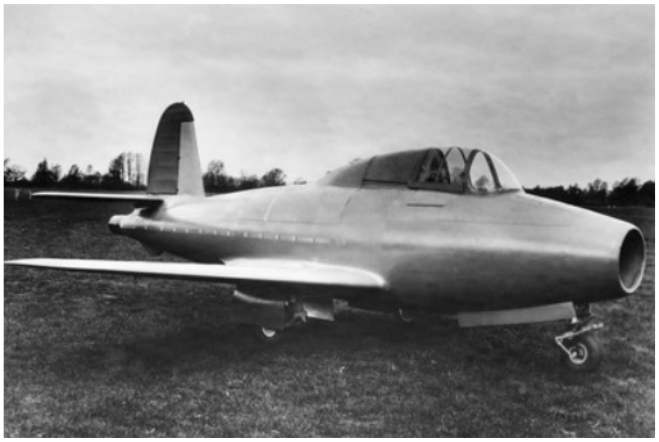
Churchill's Pressure Compartment

Meanwhile, the Structural & Mechanical Engineering Department was given the responsibility for the design of a special pressure compartment to enable Winston Churchill to fly at any altitude, in his personal Avro York aircraft, without having to use an oxygen mask. A compartment was designed by the Establishment and manufactured by AV Roe and the RAE. It had an apparent altitude of 8000 ft at an aircraft altitude of 25000 ft. The compartment was most successful in tests but was not installed for various non-technical reasons.

Experimental Flights and a New Establishment

On May 3rd 1943, the experimental Gloster E28/39 (W4046) fitted with the Whittle W2B engine of 800 lb thrust made the first jet propelled flight at the Establishment. The flight tests – 21 hours were accomplished in May – were to investigate engine performance throughout the flight envelope, the result of which the complete performance of a turbine engine was obtained for the first time. High speed dives were made on a full scale experimental basis to supplement the work on the high-speed wind-tunnel.

During the early flight tests with jet engines, Fl Lt Davie had to abandon the aircraft at 36000 ft and survived the subsequent free fall and parachute descent. Sadly he lost his life on January 4th 1944 when the Meteor (Gloster F9/40) he was flying (DG204) had one of its F2 engines disintegrate in flight and both pilot and aircraft were lost.



Above : A Gloster-Whittle E28/39 in 1945

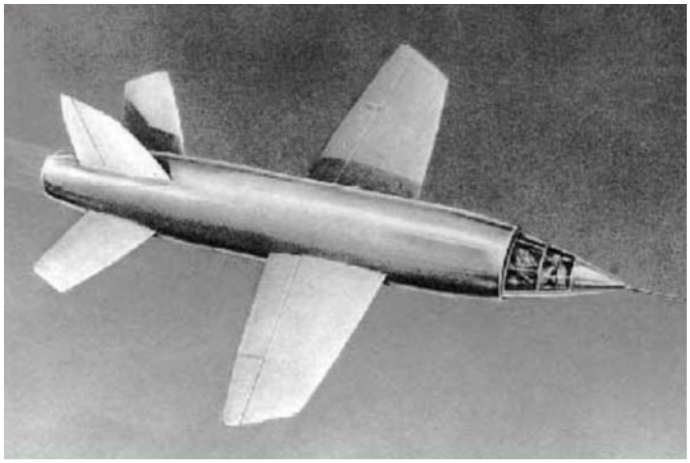
In 1944, plans for research still needed a forward looking view, in spite of the immediate needs of the war; and on March 23rd an ARC Report (No7500) recommended that there should be a National Experimental Establishment for research & development work into aerodynamic and structural aspects of aircraft design and on aircraft engines. In the detail a five mile runway was considered essential and Bedford was chosen as the appropriate site.

Dealing with German Bombs

Also in 1944, on July 21st twelve large packing cases were landed at RAE by a Halifax containing about 2 tons of the pieces of a German Guided Missile which had disintegrated in the air over Sweden. This was the first A4 rocket (V2) to arrive; and Farnborough's job was to reconstruct, analyse and determine its design and performance. In the same month the remains of a V1 flying bomb were bought to the Establishment. The impulse motor was copied and within three weeks a replica was running.

Supersonic Flight

In the tunnels, the first low-speed tests were made on the Miles E24/43 (the Miles M52) and in the following year high-speed tunnel tests were made. This was designed to be the first 1000 mph aircraft, but was abandoned towards the end of the war.



Right : The Miles M52 - Britain's first entry in the race for supersonic flight

Highlights at the End of the War

The Experimental Flying Department was working long hours to complete the necessary flight programmes on many research topics over a wide range of aircraft; and by the end of 1944 the year's total flying carried out by the test pilots amounted to the record figure of 8593 hours (23.5 flying hours per day, 365 days per year!!)

At the end of the war, the test pilots of Experimental Flying Department collected many new types of enemy aircraft, including unknown jet types, and flew them to the Establishment for trials.

In May, the Radio Department staged a very successful four day exhibition of its work in P161 & 160 buildings.

In May 1945, the Physiological Department (PL), which had been working on oxygen systems and much physiologically related work from its inception, moved from its temporary quarters in the Establishment by Beta shed to a permanent building in the adjacent Royal Air Force Station and renamed the RAF Institute of Aviation Medicine.

The termination of the war brought about a considerable reduction in commitments, particularly the urgent day-to-day kinds that characterised the war period. Also the change over to new policies, such as turbine aero engines and rocket aircraft and guided weapons, led to a period of policy reorientation.

The peak total wartime personnel of about 6000 was reduced to about half that number in the interests of economy and the redirecting of a proportion back to civilian industries.

FURTHER READING

The brief notes for this period above do not include all the research going on in many other Departments. Further details can be gained from the following titles, most of which are available from the FAST shop.

Richard Dennis	Royal Aircraft Establishment at War	ISBN 09523157-1-7
Richard Dennis	Farnborough's Jets	ISBN 0-9527363-4-9
Richard Dennis	Farnborough Caterpillars	ISBN 0-9515738-8-8
Geoffrey Cooper (2008)	Farnborough and the Fleet Air Arm	ISBN 978 1 85780 306 8
Roy Conyers Nesbit (1996)	Eyes of the RAF	ISBN 1-85833-389-X
Negative Gravity A Life of Beatrice Shilling		ISBN 0-9546165-0-2
Peter J Cooper	Farnborough: A 100 years of British Aviation	ISBN 0-85780-234-X
Ian McKenzie	Pyestock From RAE to QinetiQ	ISBN 141208681-7
Cpt Eric 'Winkle' Brown	Wings on my Sleeve	ISBN 0-297-84565-9
Gibson & Harrison	Into Thin Air - A History of Aviation Medicine in the RAF	ISBN 0-7090-1290-X

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