Engineers Walk

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Sir Archibald Russell (1904-1995) Aircraft Engineer

Designer of Concorde

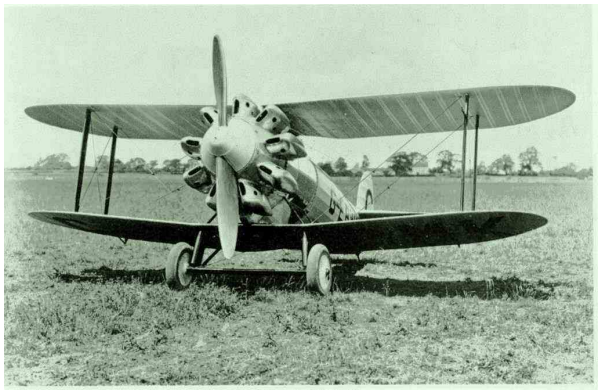
Sir Archibald Russell started to work at Filton for the Bristol Aeroplane Company as an assistant stress calculator in 1925 in the era of biplanes and retired as Chairman, Filton Division, British Aircraft Corporation in 1969 in the era of the supersonic airliner.

Russell was raised in the Forest of Dean and attended the school where his father was headmaster. When he was fifteen the family moved to Bristol and his education continued at Fairfield Grammar School, and then the Engineering faculty of Bristol University where he gained a BSc in automotive engineering. His first job was maintaining buses for the Bristol Tramways and Carriage Company (one of Sir George White's companies).

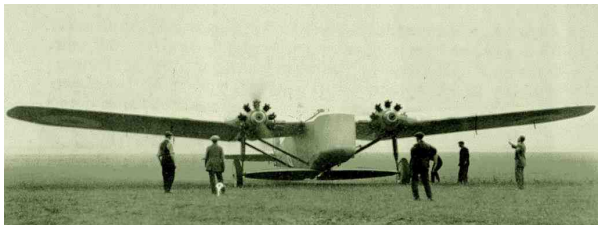
Another of Sir George White's companies was The Bristol Aeroplane Company founded in 1910. Bristol made their name with the *Bristol Fighter* biplane making over 5,500 during the Great War. They were making the last of another 600 when Russell joined the company. He met Miss Lorna Mansfield, a secretary at the company, and they were happily married for over 50 years.

Biplanes to Monoplanes

The years following the Great War were lean times for warplane manufacturers. Of 56 distinct Bristol designs only 18 reached flying prototypes and only 2 entered production. One unsuccessful plane was the *Badminton*, for which Russell did the wing stress calculations, and specially designed for the 1926 King's Cup air race, He was gravely concerned when the plane crashed a month before the race killing the pilot. It turned out that the uprated engine had seized solid.



adminton Type 99, King's Cup Racer, 170mph (1925–6).



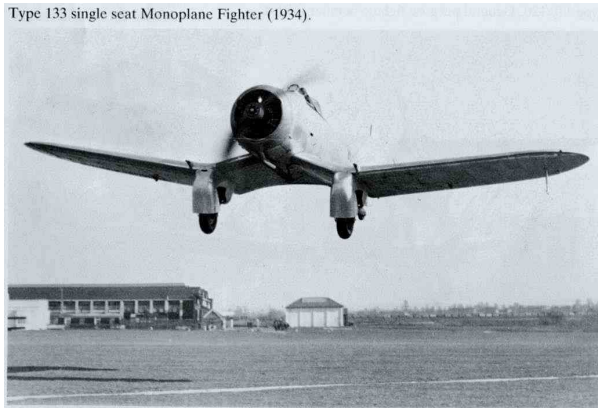
The *Bagshot* of 1925 was an attempt at a monoplane fighter but it did not perform well. Russell was sent up with the test pilot and he observed quite alarming twisting of the wings.(The two wings of biplanes could be strutted and stayed to form a rigid 'box' with high torsional stiffness)

After inconclusive consultations with various academics Russell realised that the bending and torsional stresses could be calculated independently. He was later granted a patent on a single spar wing design using these principles.

There was to be another successful biplane fighter from Bristol in the *Bulldog* (1928). Russell did the stress calculations for the wings and was an interested observer of the loading tests that proved the validity of the calculations. A near complete plane was suspended upside down and the wings were progressively loaded with 1600 bags of lead shot each weighing 16 lbs. In total 440 *Bulldogs* were built including exports to many countries including Japan.


Type 105 Bulldog single seat fighter, 3500lb (1926).

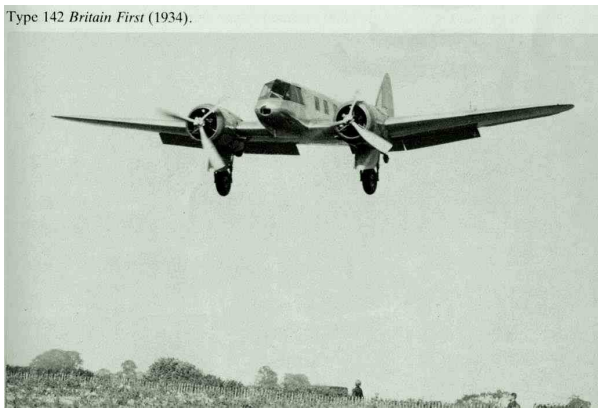
In the early 1930s a new sheet material became available. This was Alclad, a sandwich of thin layers of aluminium (for corrosion resistance) over a layer of duralumin (for strength). Covering a wing frame with this material gave a smooth surface and also increased the torsional stiffness.


Type 133 single seat Monoplane Fighter (1934).

Now the company built the handsome Type 133 monoplane fighter of 1934. This plane could fly at 250 mph and was 25 mph faster than any serving fighter or prototype around. With all tests satisfactorily completed the plane looked like a winner, but the day before official trials it was destroyed in a bizarre accident due to pilot error. Contracts were placed for its slow rival the Gloster *Gladiator* - another biplane. The future looked bleak for Bristol.

Planes for World War II

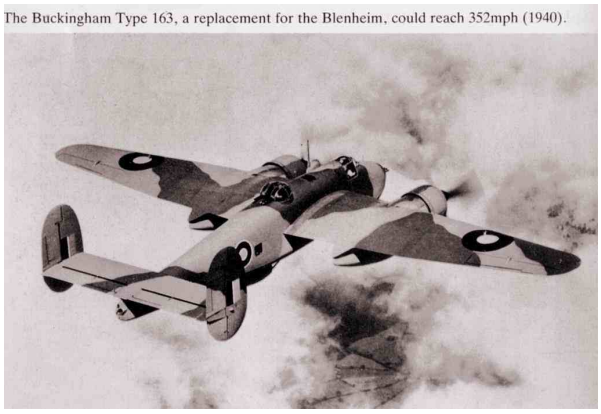
Lord Rothermere ordered an aeroplane with the highest possible speed, a crew of two, and cabin space for six passengers. Earlier plans for a small airliner were dusted off, and soon Lord Rothermere had a twin engine monoplane Type 142 (1934) that could fly at more than 300 mph. He named it *Britain First* and used his newspapers to boast that his new plane could fly 50 mph faster than the very latest RAF fighters.


Type 142 *Britain First* (1934).

With a minimum of effort and a great deal of foresight the Type 142 was transformed into a bomber the Type 142m *Blenheim* (1936). The wings were raised from the low position to mid fuselage to make room for a bomb cell with 1000 lb bomb capacity. The Air Ministry placed orders for 718. Russell was made head of the Technical Office responsible for stressing, structures development and tests, aerodynamics and weight estimation. Derivatives from the *Blenheim* using higher wing loadings, increased engine power, higher payloads, gun turrets, radar etc. included,

- *Bolingbroke* (1937) – Coastal reconnaissance for the Royal Canadian Air Force
- *Beaufort* (1938) – Tactical reconnaissance and torpedo carrier

- *Beaufighter* (1939) – Multi-role fighter/bomber
- *Buckingham* (1940) – Bomber
- *Brigand* (1944) – Torpedo carrier


The Buckingham Type 163, a replacement for the Blenheim, could reach 352mph (1940).

Blenheims were made in Canada, *Beauforts* in Australia, and large numbers of *Beaufighters* were rolled out at Bristol and various shadow factories. The *Buckingham* was the fastest fully armed day bomber (330mph) of its time, but when the Americans entered the war they took over day bombing, and *Buckingham* production tailed off. In the midst of hostilities Bristol was left without any new design work.

The best that came the company's way was a Design Study Contract for a bomber capable of carrying an 80,000 lb. bomb load to Berlin at as high a cruising speed as possible. For ten years the company had been designing medium sized twin-engine monoplanes. Russell learnt all he could about streamlining and aerodynamics, so that drag could be minimised in the big bomber. To provide sufficient power eight 2,500 HP Centaurus engines were required. Arranged in pairs driving contra-rotating propellers they could all be housed within a wing, with a span of 230 feet and area of 5,000 square feet, again minimising surface drag. Russell became Chief Designer and soon the opportunity came to redesign the bomber as an airliner.

Post War Planes

The Brabazon

The Government had set up a committee under the chairmanship of Lord Brabazon to determine post war policy for civil airliners. In February 1944 a contract was placed with Bristol for detailed design of a luxury airliner for British Overseas Airways Corporation (BOAC). Russell was appointed Chief Engineer and assumed full responsibility for the *Brabazon*. Original development work was required on vibration testing, ac electrics, hydraulically powered flying controls etc. The prototype, with Centaurus engines, flew in 1949

Unfortunately another new technology was overtaking the project – jet engines. De Havilands were developing the *Comet* with pure turbine engines, and Vickers were developing the *Viscount* with turbo prop engines. BOAC wanted Bristol Proteus turbo prop engines in the next prototype *Brabazon*.. By 1950 it was obvious that the Proteus was not sufficiently developed to do the job and the *Brabazon* project faded into history.

There were other more successful ventures at this time. The Directors instructed Russell to produce a modest 'aerial truck' and the result was the twin-engine high wing *Bristol Freighter* that first flew in December 1945. The plane and its passenger version Wayfarer sold in reasonable numbers to small operators all over the world. They are well remembered for their car ferry operations.

As Chief Engineer Russell was also responsible for a recently acquired helicopter company, that manufactured single and twin rotor machines, and for another engineering group within the company that manufactured guided missiles, with ram jet engines. The Bristol Ferranti Bloodhound was used by the Royal Navy, the RAF and was also adopted in Sweden and Australia.

The Britannia

In 1947 Bristol won a design competition for 'An airliner to required to carry thirty six passengers on routes to South Africa, Australia and the Far East.' The number of passengers (36) had been

set by the capacity of the standard BOAC airport bus! Russell redesigned the plane for sixty eight passengers. Two years on BOAC wanted Proteus turbo prop engines in this plane as well. The wing area and span of the *Britannia* was increased, for greater altitude and speed and seating was raised to 96 without altering the fuselage.

The first prototype flew in August 1952 using the substandard Proteus engines. Little more was achieved until December 1953 when the second prototype flew with the much improved Proteus III engines designed by Stanley Hooker. Unfortunately an engine exploded on a demonstration flight in February 1954 and with fire risk in mind, the pilot ditched the plane in the mud of the Severn. The fault was failure of the reduction gearing of the engine, and the solution was to change from straight to helical toothed gears.

Worse was to follow for the *Britannia* project, and for the British aircraft industry in general. The De Haviland *Comet* was the first jet engine airliner in the world but it was grounded after three crashes in quick succession, the last in April 1954, all due to metal fatigue. A water tank fatigue test became mandatory for all British airliners and the *Britannia* was probably the most thoroughly tested plane ever at the time. There was further delay when icing problems in the engines nacelles were encountered in of all places the Tropics! A solution to BOAC's satisfaction took another year.

Britannia finally entered service in 1957 – 3 years late. It was a fine aeroplane, but bigger pure jet airliners were now just around the corner and the plane became a stopgap for major airlines. Ninety Britannias were built in Bristol including twenty for RAF Transport Command and some exports. A long range version of the plane could carry 96 passengers, non stop from London to New York, fulfilling the dream of the original *Brabazon*. Another 87 variants of the plane were built under licence in Canada for military and civil use.

Last years of Bristol Aeroplane Company

The *Brabazon* and *Britannia* stories illustrate a weakness of the civil aviation industry in the United Kingdom in the post war years. Russell pointed out that the National carriers BOAC and BEA 'had unwisely been granted the privilege of bespoke tailoring their aircraft requirements, heedless of international sales potential.' None of the manufacturers were reaping the benefits of long production runs.

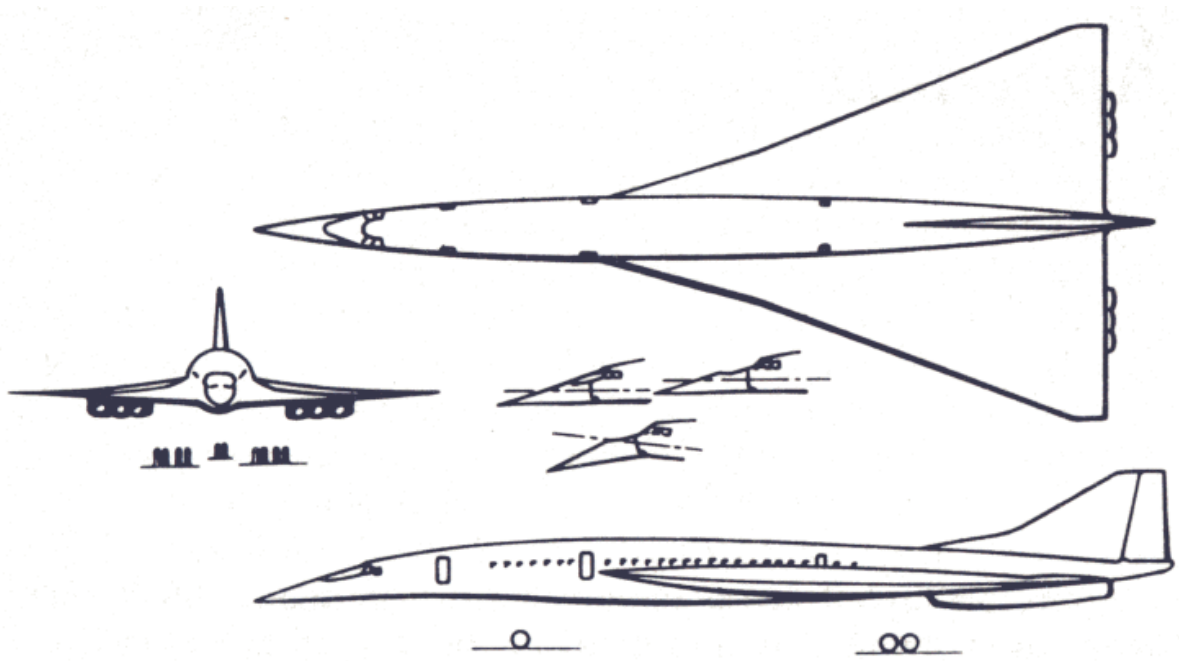
Research fighter Type 188 ready for flight (1961).

After the very successful Vickers *Viscount*, BEA ordered a new turboprop plane the *Vanguard* at very high cost, instead of a modest modification of *Britannia*. Bristol had a three engine design (Type 200), the very first of this configuration, but BEA bought De Haviland *Tridents*, whilst the rest of the world bought *Boeing 727*. The *Boeing 707* was sold world wide, but BOAC bought the *Vickers VC10*. Bristol was losing out all round and reorganisation of the industry was inevitable.

Russell took the opportunity in these lean times to learn about supersonic flight. Bristol built two stainless steel research planes (Type188) designed for Mach 3, but limited in trials to Mach 1.8 by

underpowered engines. From the Royal Aircraft Establishment at Farnborough, Russell also learned of a 'breathtaking novelty' for supersonic flight – a narrow delta wing with a sharp leading edge. With immediate separation at the nose, the airflow rolls up into a strong vortex over the wing. Contrary to all existing streamline theory there was no aerodynamic penalty with this vortex. The configuration also reduced stall to such an extent that landing flaps were un-necessary.

American manufacturers were considering Mach 3 planes but Bristol settled on Mach 2.2. This was the maximum speed for which the surface temperature rise would not be excessive using the latest aluminium alloys. The Bristol design study of 1959 and the revision (Type 223) of 1960 for a transatlantic airliner had a narrow delta wing, a variable geometry cockpit and engines in nacelles under the wings. *Concorde* as built looks remarkably like these studies. But reorganisation came first.



Projet Long Courrier B.A.C.
(First Bristol design for a long range supersonic airliner)

In 1958 there were still 27 aircraft companies and 7 engine manufacturers in the United Kingdom. The Minister of Aviation forced the industry to organise itself into two aircraft groups. In 1960 Bristol aircraft merged with Vickers Armstrong, English Electric and Hunting as the British Aircraft Corporation. Russell was appointed Managing Director, Filton. The other group was Hawker Siddeley.

Concorde

The strongest player in French aviation was Sud Aviation based in Toulouse after their successful *Caravelle* jet airliners. Sud had been doing design studies for a smaller Mach 2 transcontinental airliner, assuming that America would produce a Mach 3 intercontinental airliner.

There was considerable politicking, not least Prime Minister Heath's desire to take the United Kingdom into the Common Market against French opposition. In 1962 the two Governments signed an agreement that British Aircraft Corporation, Sud Avation, Bristol Siddeley Engines and SNECMA the French engine company, should cooperate to design a single supersonic aircraft in two versions one long range and one short range. Bristol Siddeley already had a proven engine in the Olympus, and took the lead in engines. To balance this Sud Aviation took the lead in the aircraft. M. Pierre Satre, the acclaimed designer of the *Caravelle*, was appointed Technical Director and Russell was appointed Deputy.

The joint Anglo-French supersonic airliner Concorde on take-off.

Somehow the project survived political problems, national pride and jealousies, cost rises, environmental objections, duplicate production lines and technical problems. It was the French that proposed dropping the short range version. The first metal was cut in 1965, and the first prototype flew in March 1969. *Concorde* was a technical triumph but was not a commercial success. The only buyers were British Airways and Air France.

Russell was appointed Chairman, Filton Division of British Aircraft Corporation in 1968 and retired in 1969.

Postscript

Airbus Industrie was a product of commercial interests between Hawker Siddeley and German and French companies. Without government support Hawker took only a 20 % share of Airbus. In 1977 the government nationalised the aircraft industry merging British Aircraft Corporation and Hawker Siddeley, and the new British Aerospace inherited Hawker's stake in Airbus.

The very core of Sir Archibald Russell's many talents was designing wings and calculating stresses. Perhaps his greatest legacy is that the wings for all of the Airbuses have been designed at Filton in Bristol, and Airbus Industrie is now the largest manufacturer of airliners in the world.

John Coneybeare *August 2005*