BIOGRAPHICAL
MEMOIRS

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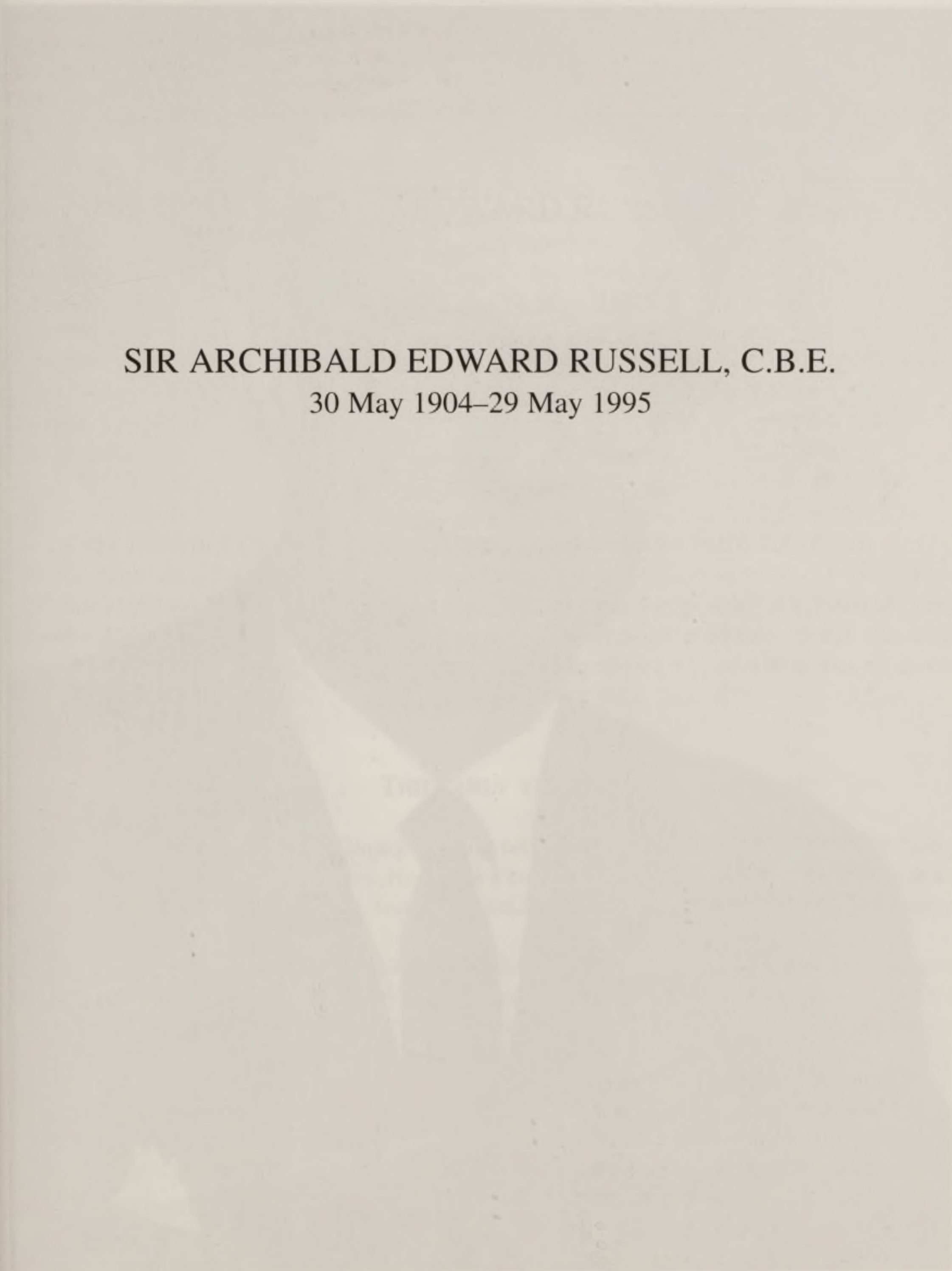

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Elected F.R.S. 1970

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Archibald Edward Russell was born on 30 May 1904 and was within a day of his 91st birthday when he died on 29 May 1995. He was a genuine pioneer of aviation who worked on the stick-and-string biplanes of the 1920s, but he is best remembered as the father figure of the supersonic Concorde.

The early years

His father was headmaster of a Gloucestershire school and was a mathematician specializing in the arithmetic of whole numbers. He wrote a book called *Rapid calculations*, in which he explained how he could perform feats of mental arithmetic with the aid of little known theorems.

His son inherited some of this talent. He gained a Merchant Venturers Scholarship and entered the School of Engineering in the University of Bristol. He graduated in 1924 with a B.Sc. in Automobile Engineering. He joined the Bristol Aeroplane Company design department as Assistant Stress Engineer at a salary of £2 10s 0d per week.

The development of the technical designer

The primary function of the Stress Office is to ensure structural integrity. In those far-off days, this only meant strength but the stress analyst had plenty of problems. He was required to predict stress distributions for anything from the whole airframe to the details of a small metal fitting. Computers were decades away. His tools were paper and pencil, the slide rule, and his own insight and ingenuity. The few available textbooks were aimed at civil engineering, with emphasis on beams and portal structures.

The first assignment for the inexperienced Russell was to predict the behaviour of a new type of landing gear. It was, he wrote, an unfriendly task to hand to a raw beginner, but it introduced him to the principle that a stress man should be ready to tackle any structural or mechanical problem, relying on the universal applicability of mathematics and the laws of physics.

The aeroplanes of the time were biplanes, and the primary structures were space frames using wooden struts and beams, with steel wire bracing. These structural elements were quite well understood and analysis of load distribution was becoming routine. New designs, often only minor variants, were proposed at frequent intervals and could be drawn and stressed in a few months.

In the mid-1920s a new form of structure was introduced. Wooden beams and struts were replaced by thin steel strip often only a few tenths of a millimetre thick. Stability was achieved by intricate corrugation. This brought Russell into a long and fruitful association with Henry Pollard. Pollard was developing draw-bench techniques for producing such components in high tensile steel, but joints and end-fittings were a difficulty. He and Russell worked together on these problems while Russell established design data for use in the Stress Office, of which he was now the head. The work bore fruit in the very succesful Bristol Bulldog fighter. Over 400 were built.

All this must have given the maturing Russell an insight into the mechanisms of buckling of thin metal under shear and compressive stress, as well as experience in planning test programmes to establish design data. A gift for combining theory and experiment was to become his hallmark.

The unsucessful Bristol Bagshot gave Russell an introduction to the new science of aero-elasticity. The Bagshot was a monoplane, rare in those days, and displayed a roll control problem. Russell flew as an observer, and his report of the alarming wing twisting provided Pugsley (later Sir Alfred Pugsley, F.R.S.) with a basis for his theory of aileron reversal, complete with a torsional stiffness criterion. There was no hope that the Bagshot could be modified to comply. Aluminium alloy sheet would provide an answer.

Aluminium alloys became available in industrial quantities in the early 1930s, most notably as extrusions and as Alclad sheet. Stiffened shells became the appropriate structural form, designed to buckle harmlessly under quite normal loading. Russell had experience in establishing design data for new structural forms. He organized a programme of tests, some on a model scale, of representative boxes and cylinders. In the absence of an adequate theoretical background, the problems of translation to real aircraft structures were formidable. Nonetheless, Russell and his team acquired an acknowledged competence in this new field.

The first important application was to the Bristol Type 142, better known as 'Britain First'. It was 50 mph faster than the latest R.A.F. fighters just entering service and its sponsor, Lord Rothermere, presented it to the nation in a blaze of publicity.

The military version, the Blenheim, flew a year later, and was rushed into production. By the start of World War II, a thousand had been delivered, initially as light bombers. Variants were demanded as long-range fighters, coastal reconnaisance and anti-submarine aircraft, and even float- and ski-planes.

The Blenheim was the first of a dynasty of Bristol types exploiting more and more powerful engines with increasing refinement but little innovation. The special competence in structural design of Bristols, and of Russell in particular, was recognized by his appointment

to the prestigious Stressed Skin Commitee of 1939. The outcome, the highly regarded data sheets of the R.Ae.S., was advanced for the time, allowing the optimization of stiffened shell structures in the post-buckled mode.

By this time, Russell was Technical Designer, an unusual title reflecting his specialist reputation. He was much in demand to chair technical commitees.

In the early 1940s, advanced structural design concepts began to change. Bigger aircraft and higher speeds meant more severe loading actions. Design was moving into a field in which structures with thick skins designed not to buckle in normal use would be efficient. They were also more amenable to theoretical analysis and optimization, and they opened the way to the long-life fail-safe structures of today.

Russell was quick to see the potential. He formed a small hand-picked team to develop the new concepts and expanded it into a core team of scientifically oriented engineers ready to tackle any technical problem in any field of aerospace.

The competence in structural design of the team he had built up was demonstrated in the 1950s. The well known Comet disasters were due to structural fatigue and led to a mandatory 'tank test'. The nearly contemporary Bristol Britannia demonstrated that such problems were avoidable. It was, in fact, one of the first truly fatigue-designed aircraft in the world.

By this time Dr Russell, as he now was, was becoming a world figure in aviation. The Wright Brothers Memorial Lecture in 1949, a world lecture tour in 1951 and the Wilbur Wright Memorial Lecture in 1954 heightened his visibility. At home, as Chief Designer (1943), Chief Engineer (1944) and company director (1951), he was increasingly involved with government agencies and airlines around the world. The political and admistrative workload drew him away from the technical challenges he loved, but he always returned to them whenever other demands permitted

Concorde

Concorde is the aeroplane with which Russell is most generally associated, and his contribution was very great. This is no place for yet another version of the Concorde story. It is the place to assess how it presented itself to Russell.

The years of gestation were good years. He loved the technical challenge of mastering new disciplines in metallurgy, aerodynamics and a whole range of subjects from power-plant integration to tank sealants and lubricants. Even structural design, his long-term stronghold, was transformed. Thermal stresses and creep of metals, and their interactions with more familiar topics like fatigue and crack propagation, were new fields.

He had developed a technique for joining in the design process despite his other commitments. He would challenge technical decisions, often quite late in the day, and skilfully contrive fierce debate far into the night. These challenges were sometimes bizarre, but they often led to new insights into difficult topics. Always a fighter, he relished the competition within the UK, culminating in the success of Bristol against the whole Hawker-Siddeley Group.

The joint enterprise with France was formalized by the agreement of 1962. For Russell it brought frustration. Pierre Satre was made Technical Director of the joint enterprise, with Russell as his deputy. Satre believed that technical directors should not be involved in the day-

to-day design process, and should confine themselves to policy, a view ardently supported by his team in Toulouse. Russell's attempts at intervention were strongly resisted.

Many aspects of the joint organization were frustrating to Russell and, indeed, to all engineers. Then, too, he could see with total clarity that the French were using Concorde to build a commanding position in European aerospace and the British government did not seem to care.

In 1967 he became joint Chief Executive of the Anglo-French Concorde organization. The next year he became Chairman of what was now the Filton Division of the British Aircraft Corporation. He was now commited to management, but still took an informed interest in technical matters. He saw Concorde fly before he retired.

In conclusion

Honours had come his way: the R.Ae.S. Gold Medal (1951), Honorary D.Sc. Bristol (1951), Honorary F.R.Ae.S. (1967), F.R.S. (1970), a knighthood (1972), F.Eng. (1976) and the David Guggenheim Medal (1971).

His first wife, Lorna, supported him throughout his long career. A charming hostess, she was immensely popular with his colleagues. They are survived by a son and a daughter, and they celebrated their Golden Wedding in 1980. His second wife, Judy, survives him.

Acknowledgements

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Bibliography

A bibliography appears on the accompanying microfiche. A photocopy is available from the Royal Society Library at cost.