Slingsby Sailplanes by Martin Simons: part 2

And now the first glider produced at Slingsby – the Type 1 Falcon (Falke) – and the development of gliding technique.

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Having achieved his A and B gliding certificates, Fred Slingsby was anxious to make progress. For early soaring attempts beginners needed a mild-mannered sailplane that would not respond too sharply to clumsy handling, yet had a sufficiently low rate of sink to allow sustained flight in slope lift. Günther Groenhoff, a young German pilot already establishing a high reputation, visited the Scarborough Gliding Club in the winter of 1930, and following Groenhoffs recommendation, Slingsby decided to build for himself, from plans obtainable through the Rhon-Rossitten Gesellschaft (RRG, the controlling body for gliding in Germany), a Falke. He was warned that it was not very easy to build, but he was confident that he could manage it.

The Falke had been designed by Alexander Lippisch in 1929, and it owed almost everything to the experimental tailless sailplanes which Lippisch had been developing since 1925. Flying models with wingspans of about 4m had been flown before the first full-scale Storch was tried in 1927 with limited success. It was followed by improved versions. The Storch 4 which Groenhoff tested in 1929 was entirely satisfactory. Stability was obtained with a back-swept wing having negatively twisted outer panels, or 'washout'. Tip winglets and rudders gave adequate control in yaw. The main improvement distinguishing the Storch 4 was the installation of lobate ailerons, or elevens, with their hinge line at 90° to the line of flight, rather than conforming to the wing sweep. The wing section at the root and for the inner panels was a modified version of the Gottingen 535, but the profile was progressively changed to a strongly reflexed shape at mid-elevon, and thence to a thin symmetrical tip. Lippisch’s experiments with tailless aircraft culminated in the Me 163 rocket powered fighter of the Second World War.

Lippisch, who was head of the technical section of the RRG, decided that if a sailplane with no tail could be made stable with a sweptback wing, then a glider with sweepback and an ordinary tail unit as well would be even more stable, and hence exactly what the beginner required. Moreover, with such a layout the pilot would be well protected, sitting under and somewhat behind the centre of the parasol wing. An adequate soaring performance could be ensured by keeping the wing loading down, which could be done by using a large wing area with strut and wire bracing, giving a strong yet light structure. Little attention need be paid to reducing drag. Sailplanes were launched directly into the slope upcurrent by rubber bungee, and there was no need to have a good glide ratio for cross country flights. The Falke was not expected to go anywhere except gently back and forth in front of a hill. It was considered an advantage for an intermediate sailplane that it should not gain much airspeed in a dive. In the inevitable accidents it would not strike the ground so hard.

When Groenhoff met Slingsby the Falke was in production in Germany. There was already one in England; it had been imported for publicity purposes by the J. Lyons tea company.

Gliders at this time were always built of wood. The timber normally used in Germany was pine. Spruce was more expensive and offered only slight advantages. Aircraft-quality birch plywood was readily available. Cold-water casein glues were approved for aircraft construction and, provided the joints were kept dry, were perfectly satisfactory but damp joints could be quickly destroyed by fungus. [This caused the decay of most of the Second World War de Havilland Mosquitoes] Accordingly, numerous drainage and ventilation holes were incorporated at all points in the structure where moisture might otherwise accumulate. Mild steel fittings and brackets were bolted to the timbers after painting with zinc chromate. Steel control cables were guided round pulleys and through fibre fairleads where required.

The Falke fuselage, of hexagonal cross-section, was a wooden framework of six curved longerons with cross-frames and diagonal braces, with plywood skinning in front and fabric covering aft of the cockpit. As usual where wooden members butted together substantial plywood 'biscuits' or solid corner blocks were used to cany the loads through the joint. The undercarriage comprised a rubber-sprung main skid of ash, and a tailskid. An open hook was fitted under the nose for bungee launching. The strut-braced tail unit was simple, but the wing was very complicated. The two spars, swept at 12.5°, were built-up box sections. The upper and lower pine flanges had large ‘bird-mouthed’ blocks filling in wherever fittings had to go, particularly at the root ends and the strut end points. Both sides of the spars were faced with plywood. The wings had a slight 'gull' kink, enough to complicate construction without having any measurable effect on stability or handling.

To make each wing rib, an outline of 5mm square strip wood was laid in a jig, being steamed where necessary to conform without strain to the aerofoil section outline. Uprights and diagonals were fitted inside this form, and 1mm plywood biscuits and webs were then glued over all the joints, after which a duplicate 5mm square strip outline was laid into the jig with matching uprights and diagonals, and glued. This split-rib structure, which persisted for many years in German sailplane construction, prevented sideways distortions of the ribs when they were under the tension of doped fabric covering. The wing chord was constant over the inner panels, which allowed some saving in work, but for the tapered and reflexed outer wing panels every rib differed from the next.

In the Falke and other training gliders, the plywood covering the front of the wing was little more than an unstressed fairing. Each rib was made in one piece from leading edge to trailing edge and slid into place over the completed spars before gluing. Because the plywood was glued only to the ribs, not to the spar flanges, it added little st rength to the wing as a whole. For torsional rigidity a two-spar structure with internal diagonal cross-struts was used. Every third rib was a compression member requiring its own jigging. The wing spars met on the aircraft centreline with simple pin joints, the rear pin also connecting with the pylon behind the cockpit. The front spars had separate connections to the braced vertical cabane struts on either side. The V struts restrained the wings from folding up or down under load, and provided additional bracing against torsion. A detachable plywood fairing covered the gap in the wings at the centre. The aileron control cables ran externally up the side of the fuselage, entering the wing just behind the forward cabane strut. The elevator cables also were external for part of their length. There was a steel bracing cable from the nose to the struts near their outer ends.

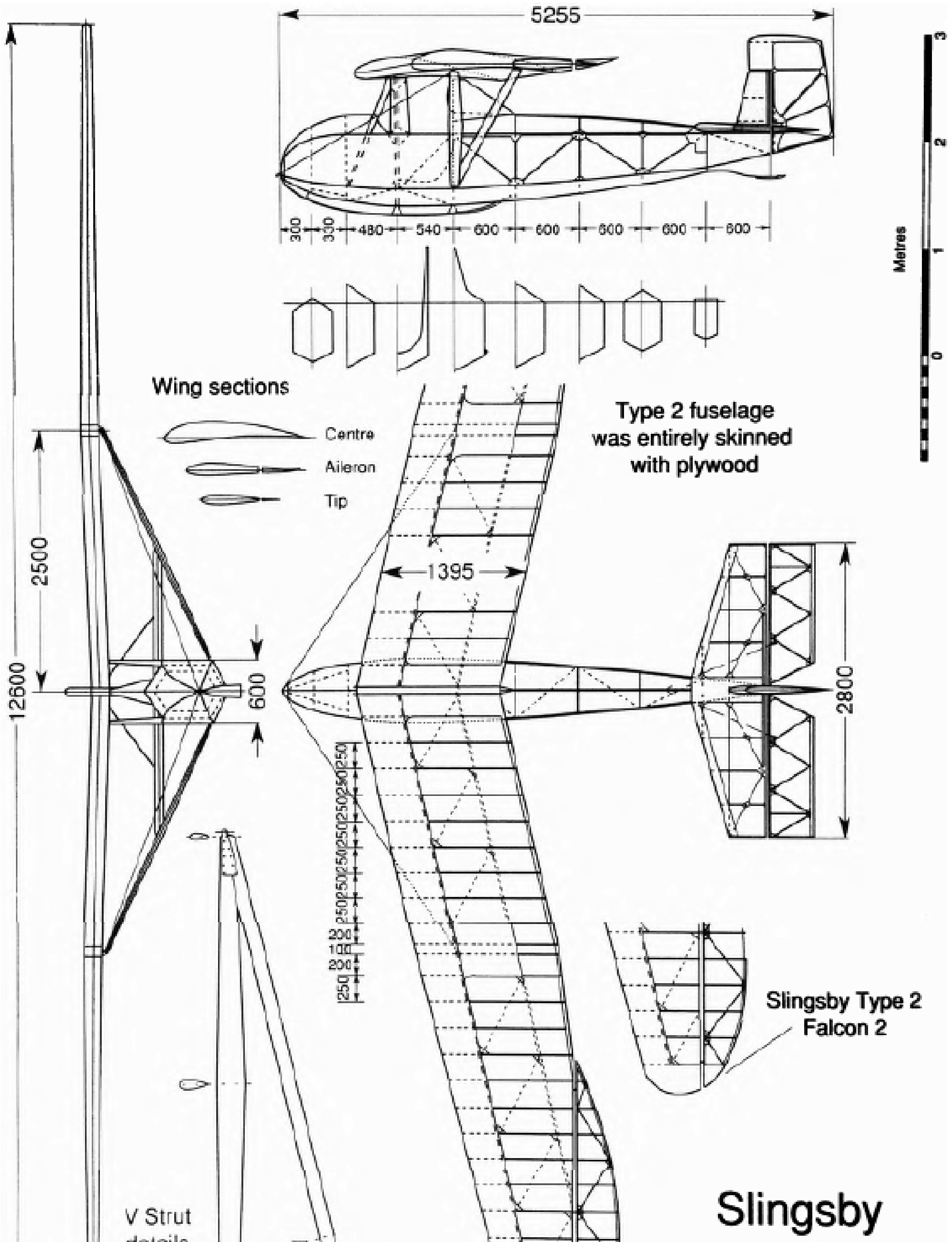
Slingsby completed his Falke in the spring of 1931. He stated that roughly 800 man-hours were required. Probably furniture production in his factory was much reduced for the preceding months. On completion the sailplane, in clear-doped finish and glossy varnish, was christened British Falcon. Slingsby made his first brief flight at Levisham Moors after a bungee launch powered by schoolchildren. Another pilot crashed the Falcon badly on its second flight. After repairs, Slingsby toured the country in search of good soaring sites, gaining his C soaring badge in September at Ingleby Greenhow and competing very successfully in the 1932 National Championships at Ireleth, near Askam-in-Furness, Lancashire. There were seven competing aircraft. The Falcon logged nearly 7hr total flying time during the five day meeting. Mungo Buxton borrowed it to break the British distance record with a 20km slope-soaring flight to Lake Coniston. To put this into perspective, in the German championships that year there were 60 sailplanes. Cross-country flights of 150km (93 miles) were made, but Groenhoff, Slingsby's adviser of 1930, was killed in one of two fatal accidents.

It was remarked that the Falcon flew itself, but handled easily when it was required to manoeuvre and was capable of soaring well. It was a great builder of confidence for nervous pilots. Rigging was rather a struggle, and it suffered from lack of upward view when turning. This became important as the soaring ridges grew more crowded, but for its purpose it had few rivals. Slingsby announced later in the year that he would build a Falcon for anyone for £95.

The second Falcon, which Slingsby later counted as his Type 2, was built to the order of Espin Hardwick, a stockbroker who played an important role in the development of British gliding. Falcon 2 was flying by October 1933, Hardwick obtaining his C soaring badge at a Sutton Bank meeting in that month. The *Type* 2 had rounded wingtips which improved its performance slightly, and its fuselage was entirely skinned with plywood. Hardwick suffered from a spinal deformity, so most ordinary sailplane cockpits must have been extremely uncomfortable for him. His Falcon had extensive padding and movable elbow rests, and it also possessed instruments, which very few other sailplanes in Britain did in 1933.

Slingsby soon decided that there was a future in glider manufacture, and he began to advertise under the heading, 'Slingsby Sailplanes, Scarborough'. The decision to abandon furniture manufacture altogether came in 1934 with a temporary shift to the disused Scarborough Corporation tram sheds, where there was more space for glider assembly. Eight more Falcons were built during the next few years after the move to Kirbymoorside, making a total of ten including the Falcon 2. One, of which nothing more is known, went to Canada. Three, including Slingsby's original, were written off at various gliding sites before the outbreak of the Second World War. The rest probably survived to be impressed for use by the Air Training Corps (ATC). One of these, piloted by a cadet, met its end in collision with a sheep at Camphill in Derbyshire about 1944. Others doubtless perished at other ATC schools. One was rebuilt with a flying-boat hull for the ATC to fly from Lake Windermere in 1943, and survives at the Windermere Steamboat Museum. Espin Hardwick's Falcon *2* was ceremonially burned at the Long Mynd following his death in 1955. (In Germany, one Falke survives. It was rescued from a Swiss Alpine mountain railway shed by Klaus Heyn and restored to museum standard by him.)

Mike Russell provided the initial inspiration for the construction during 1984-85 of an entirely new fully airworthy Falcon 1 by Ken Fripp's Southdown Aero Services at Lasham, using the original drawings rescued from Slingsby's loft. There were substantial contributions of work and financial support from John Sproule. The first flight was made in August 1986, with Derek Piggott at the controls. This Falcon, the only extant airworthy example, appears occasionally at vintage glider meetings in its clear-doped and varnished finish like the original Slingsby Type 1.



Type 2 fuselage was entirely skinned with plywood

Slingsby Type 2 Falcon 2

Slingsby Type 1 British Falcon

Drawn by Martin Simons 1994 ©

Fred Slingsby in a Falcon

Sixty years on, the modern replica of Slingsby's Falcon, built from the original drawings, is seen here at Dunstable in the UK in 1991. (P. *Warren.)*

The development of soaring technique

In 1930, knowledge of soaring in Britain was almost nil. Gaining height in the upcurrent on the windward side of a hill proved fairly easy. Anyone with a B certificate and a certain confidence could do this. After being bungee launched from the crest the glider was flown steadily along the hill to the end, performing a gentle turn there to come back and fly to the other end of the beat to turn again. Every turn was made away from the slope. As long as the wind blew sufficiently up the gradient a moderately efficient glider, flown well, could soar, possibly rising several hundred feet above the launching point. An extended soaring flight of 5min earned the C certificate. It was quickly learned that to turn or drift behind the hill was to be forced down to a premature landing.

The next important development came more slowly, hampered for the first few years in Britain by the total lack of any instruments in the gliders. To exploit thermal upcurrents to make cross-country flights over level ground seemed almost miraculous at first, and veiy few understood how it was done. The slope soaring pilot could judge his rises and falls fairly well by observing the level of the hill, but as soon as a sailplane was more than a few hundred feet up, the lack of a visual reference made it impossible to tell if height was being gained or lost. Turbulence felt in the air might indicate either lift or sink. Airspeed was measured by the force of the airflow on the face and by the humming of the flying wires. Altimeters were not used. The main requirement was a sensitive rate of climb indicator, or variometer. German pilots began using these in 1928.

In 1931 Kronfeld again came to Britain, gliding across the English Channel from a high aero-tow. Ha made a cross-country flight in thermals over London from Hanworth, south of Richmond, to Chatham, on the Thames estuary. On the following day he returned, passing directly over Croydon on the way to land back at Hanwoith. This was one of the first successful goal distance flights. He was observed to circle repeatedly in the narrow cores of the thermals to gain thousands of feet before gliding off in the direction he chose to go. Despite such demonstrations, and subsequent lectures and publications, it was not until 8 January 1933 that a British pilot, Eric Collins, dared to perform a complete 360° turn in a sailplane. In August of that year the first thermal soaring cross-country flights were attempted in Britain, Collins setting a British distance record of just under 50 km. By this time, flights of over 270 km had been made in Germany.

When good variometers, sensitive altimeters and airspeed indicators became available, British pilots soon learned to use them. The technique was to circle and climb in each thermal and then glide on to find the next one, climb in it to the top and move on again. By 1936 sailplanes were sometimes also fitted with gyro instruments to enable them to fly blind, taking advantage of the strong lift inside cumulus and cumulo-nimbus clouds. Airbrakes, or at least lift spoilers, became essential to allow safe landings in small spaces. The Silver C certificate, requiring a cross country of 50 km, a 1,000 m gain of height and a duration of 5 hr, was instituted internationally in 1931. Collins was the first Briton to achieve this, in 1934. By the end of 1939, 56 British pilots had so qualified.

Before the outbreak of the Second World War, flights over 200 km and one over 300 km had been achieved in England, the last, together with a height climb in cloud to over 14,000 ft, earning the International Gold C badge for Philip Wills. The English Channel was crossed in soaring flight from Dunstable by Geoffrey Stephenson in April 1939, flying a Slingsby sailplane, the Kirby Gull. The Second World War then intervened, bringing a general ban on soaring until 1946.

Penetration

In the post-war period, with mathematical studies pointing the way, the importance of speed was recognised. The length of a good soaring day is limited to a few hours. Some heating of the ground is needed to set off thermals, and this usually meant waiting until about 10 a.m. or later before starting a cross-country flight. The land cools in the evening, so to achieve a worthwhile distance the pilot needed to make a high average speed while the conditions lasted. The sailplane designer was now required to produce an aircraft with a low rate of sink when circling, but which on leaving the lift zone would glide at a high airspeed without losing too much height. Only the best part of each thermal should be used to improve the average rate of climb, then in the glides the airspeed must be increased, even at the expense of lost height. This improved the average cross-country speed, always supposing that another strong thermal could be found. If there was sinking air it was proved by calculation and experience that it was essential to fly through it fast, the height lost by putting the glider's nose down to gain airspeed being much less than that wasted by lingering too long in the bad air. The requirements are to a large extent incompatible. To achieve the lowest possible rate of sink at slow airspeed, a low wing loading and a very-high-aspect-ratio wing are necessary. To fly very fast with minimal loss of height in the glide requires a high wing loading, together with wing profile drag and the parasitic drag of tail and fuselage reduced to an absolute minimum.

Low-drag, so-called laminar flow wing profiles developed in the USA were found to be very useful, but required new approaches to glider construction and new materials. The aircraft became heavier with greater and greater spans. To remain safe at high speeds they had to be much stronger and stiffer than before. High-strength metal alloys began to find their way into the structures. To place a check on escalating costs, a simple 15 m span Standard Class specification was developed internationally, and proved successful, but the unrestricted 'open class' sailplanes continued to grow in complication and cost.

As aircraft and the pilots improved, gliding competitions changed from simple distance and goal flying to racing round prescribed courses. The need for *penetration,* the ability to glide fast at a shallow angle, became more and more urgent. Given a good glide angle at high airspeed, the racing pilot can sample a large mass of air in a short time, passing through the weaker thermals without circling in them. Only those that yield high rates of climb are selected. The need for low rates of sink in circling remains, still demanding high aspect ratios.

Further researches in aerodynamics produced better wing profiles, but these required even more accurate, wave-free wing surfaces. Careful attention to the form of fuselages and tails yielded worthwhile savings in drag. Traditional materials such as spruce, pine and plywood, even metal, were no longer good enough. Glassfibre, carbon and aramid fibre-reinforced moulded plastics were widely adopted.

With the new profiles and materials, even higher wing loadings were demanded. Some German sailplanes were fitted with water tanks as early as 1934, but carrying ballast did not become general until the 1970s. Given that the pilot will circle only in the strongest thermals, some loss of climbing ability owing to the extra weight is more than compensated for by the improved glide at high speeds. The water can be jettisoned if the thermals weaken. Some modern singleseat 'open class' sailplanes with spans of about 25 m (82 ft) may carry 200 to 250 kg (440-550 lb) of ballast on take-off.

The most recent development has been the widespread introduction of self-launching. A retractable motor with a propeller is built into the sailplane, dispensing with the need for launching apparatus or aerotowing, and with the business of retrieving sailplanes by road after out-landings. The weight of the propulsion unit becomes unimportant in a sailplane, which will normally be loaded with water ballast anyway. The long-term influence of this development on the traditional gliding club remains to be seen. There is nothing now to prevent a soaring pilot from keeping the sailplane at an ordinary aerodrome, taking off unaided and flying to the open country, where the engine will be shut off for several hours but started up again to fly home in the evening to join the regular landing pattern and taxi in.

The best glide ratio of a sailplane the measure of how far it can glide in still air from a given height is a useful indication of all-round aerodynamic efficiency. Slingsby's British Falcon in 1931 probably achieved about 16:1 and weighed about 230 kg (506 lb) in flight. By 1982 the best open class sailplanes had glide ratios close to 60:1 and weighed 750 kg (I,653 lb) fully ballasted. Corresponding figures for good 15 m sailplanes like the Vega were 42:1 and 508 kg (I,120 lb). Slingsby's Falcon was used for a 20 km (12.4 mile) flight soon after it was completed. In 1982 the world record distance flight for a sailplane stood at 1,460 km (907 miles) but, more importantly, the 1,250 km (750 mile) triangular flight speed record stood at 133.2 kph (82.76 mph). Slingsby sailplanes were produced during the half-century while these advances were taking place, and it was never easy to keep up.