# GLIDING HERITAGE CENTRE

| MANUEL HAWK | |
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| Author | Howard Torode |
| Description | Historical summary of the Hawk design by Bill Manuel |
| Date | Last updated 26 September 2013 |

The name of Bill Manuel is legendary in the history of UK gliding. The retired engineer from the General Aircraft, later Blackburn and General Aircraft Company had produced a variety of designs in the 1930's under the generic name of Wren (Willow Wren, Crested Wren etc). It nevertheless came as a considerable surprise to Ken Fripp of Southdown Aero Service when, in late summer 1969, he was visited by his old friend to be told that he had built a completely new sailplane in the years after his retirement. Manuel had gained access to the coordinate of the then modern Wortmann wing section FX61-184 and built a sailplane using it in accordance with the techniques he had use in the 1930's.

Many modern features that had been adopted were a cantilever wing, in three pieces, without struts or rigging wires, Schempp-Hirth airbrakes and enclosed cockpit with a semi buried landing wheel in a tail sitting configuration. The mid wing sat on an elliptical section monocoque fuselage with a fully faired cockpit and a T-tail. The cockpit transparencies were in three pieces the forward and over wing section of which were single curvature perspex sheets. The hinged cockpit canopy itself was laminated up from thin strips of perspex held in place by 7 aluminium cap-strips. These were a significant, but not disastrous, limitation to visibility but they did give the sailplane an 'old world' allure that was not wholly merited. A fully blown canopy would have been a great improvement but never made it up the priorities list. Other modern features lacking were a high aspect ratio, largely because of the small span chosen (42 feet), and there was no use of modern materials, even to retain the wing profiles shape. The basic wing section thickened towards the tip and at the extremity the thickness was well over 20%. As thickness improves low drag range rather than high life there appears to be no reason for this feature, which is most probably related to construction convenience rather than any high aerodynamic logic associated with tip stalling.

Finally, and most worryingly, no concession had been made to the established practice of design substantiation through any kind of calculation or structural test. Indeed the whole aircraft had been built entirely by the practiced eye of the creator to 1930 standards. Parts were largely approved AGS supply, with fittings from aircraft quality stainless steel purchased from the General Aircraft Company. Hemlock and Baltic Pine had been used in some structural members due to the failing availability of aircraft standard spruce.

Ken Fripp contacted Howard Torode, then working in flight test at College of Aeronautics Cranfield, to find out what could be done. A design survey was carried out against the most modest requirements then available British Civil Airworthiness Requirements Section E – Gliders using the non-aerobatic parameters – basically a 4G limit load airframe. With a Design Dive speed of Speed of 87 knots (Never exceed 79knots), probably an airspeed not even contemplated in the 1930. It appeared that the old engineer's eyeball had been pretty good when it came to basic bending, tensions and compressions, but was less reliable when considering strength and stability issues associate with monocoque shell structures. The only pure strength issue requiring attention was the lower fuselage longeron which needed substantial strengthening to accommodate winch launch loads. In fairness this was compounded by the forward position of the tow hook. Given the low allowable load factors only very limited car tows were performed during the test programme and certification for these was not sought.

Less straightforward was the torsional strength and stiffness of the wing which it derives from the D-box, from leading edge to main-spar. This had been laid down using thin (1/16 inch) plywood, in the most convenient manner not the most effective one, with the play grain of the laminates at 0 degrees and 90 degrees to the span direction. To maximise torsional strength and stiffness the better, but more challenging, practical approach is to lay the ply at plus and minus 45 degrees across the span line. It should be remembered that Manuel's pre-war designs had not used this 'stressed-skin' approach and had relied on wire bracing. This really was a major issue, as both strength and stiffness were inadequate. The solution was to re-skin the less curved underside with thicker (5/64 inch) V3 ply at +/-45%, and at the same time to insert inter-bay ribs to halve the unsupported panel area. In this way the upper skin could remain as its additional curvature gave better resistance to buckling.

This major refurbishment was effected over the winter of 1971, and further demanded a complete recover of the centre-section. At this time these were in clear fabric alongside the clear varnished woodwork. Minor structures, such as the alloy nose cone, were in light blue. Further, improvements were introduced, such as 'D' noses filling the gaps between control surface and main panels on all controls, to improve their effectiveness. All controls were cable operated, with the exception of the slightly offset elevator tube from the cockpit area to the rear bulkhead and a drive rod up the fin. This gave a simple modern pin connection for the elevator, but the ailerons always required cable connections through turnbuckles and careful adjustment. The cockpit also needed fitting out with a floor, adjustable pedals, a panel and instruments and some revision to the controls. For example, in fitting modern Schempp-Hirth type airbrakes, Manuel had reasoned, in isolation, that the logic would be to 'push forward to go down', not illogical, but in complete reverse to all other known gliders!

The revised torsion box was re-tested and demonstrated adequate torsional stiffness and stability for the modest flight envelope during summer 1972. The Hawk finally made its first flights on the weekend of 25/26 November 1972, at Cranfield, watched by Manuel himself. The flight test programme proved uneventful, the only changes being measures to improve rudder effectiveness including a 4 inch extension to the rudder trailing edge. Stall was docile and spinning was only possible at aft CG. In all cases care has to be taken to keep within the low Never Exceed speed. The control authority was acceptable and handling was good except for the ailerons which could have benefited from a larger differential movement.

Some measures were taken to improve performance but this was always essentially limited by the low aspect ratio. The airbrake boxes were sealed following the removal of the lower paddles. While flight speeds were quite low down to the stall about 34 knots, the glider was not particularly light for its size with 407 lb empty weight. Nevertheless it thermalled, well and was quite capable of modest cross country flight by the standard of the time. It was also circulated and flown by a wide variety of pilots with differing experience levels without mishap. Comparison flights showed approximately the same performance as the Olympia/Meise albeit that the differences in size and configuration were significant. In July 1973 it was demonstrated at the PFA rally at Sywell and secured first place in the 'best home-build' competition; as far as anyone is aware the only time that this accolade has been laid upon a glider.

The Hawk continued to be flown in the Bedford area during the late 1970's, It continued to benefit from ongoing improvements such as a virtually full recovering with the centre section in white and the tips and control surfaces in red. The general standard of engineering preparation was raised. It flew several hundred hours in all before it was placed in storage in the early 1980's by its then owners. It was perhaps an unremarkable sailplane which

suffered from the only partial application of modern technologies to an interesting variation from the conventional configuration. Further steps to reduce drag through improve surface finish, or the aerodynamic sophistication of the lifting surfaces would have undoubtedly led to unacceptable weight increases, even had they been possible within the light construction and limited flight envelope. Maybe today it would be possible to improve the wing tip flows by the addition of a well designed winglet which improve the span effectiveness of the low aspect ratio wing.

The lasting sadness of the Hawk experience is that it did not spur Bill Manuel to grasp further modern technologies. Whether this was borne of his frustration of long delays between construction and first flight, or a dis-illusionment that the design was not recognised by the gliding community only Manuel could have told. He subsequently regressed to produce replica style designs (eg. Condor, Gnat, Wren replica) without any further attempts to embrace the massive developments that has taken place since his heyday's in the 1930's. There can be few individuals who have designed, built and had flown four separate sailplane designs subsequent to their retirement!

MANUEL HAWK (1973)

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| Wing Span | 42 ft (12.8m) |
| Wing Area | 149ft2 |
| Aspect Ratio | 11.8 |
| Root chord | 4ft |
| Tip chord | 2ft |
| Wing section | FX61-184 |
| Thickness chord ratio | 18.4% rising to 22% at tip |
| Main spar line is straight and perpendicular to fuselage (38% wing chord) | |
| Spanwise location of transport joint (3 piece wing) 11.5 ft | |
| Dihedral | 3degs on outer panels only |
| Centre-hinged circular nosed aileron on tip sections only. Constant chord 0.625ft | |
| Deflections 30degs up 22 degs down | |

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| Fuselage length | 22ft 6ins (inc. rudder extension) |
| Fin height | 4.37 feet |
| CG range | 31.0 – 40.0% SMC |
| Tare weight | 407lb 184 kg |
| Design AUW | 640lb 290kg |

Date last updated 26/09/2013