A full scale flying replica from Cornwall

Spitfire's Echo

Over the Xmas holiday I found time to revisit the Spitfire Society Founder's book " Spitfires Reborn". As is always the case on subsequent readings; I was surprised how much detail I had missed first time round. After his last operational sortie Gp. Capt. David Green walked away from his Spitfire feeling that his farewell was a mite too casual and possibly somewhat cavalier and uncaring after an intimate ten year association. He reflected that this was, of course, just sentimental nonsense but he couldn't help thinking of his aeroplane by her "name": Echo. And I think that is just as it should have been! This previously unnoticed and inconsequential detail struck me as a coincidence if not as an omen. My delight is in the book's title and the code letter of his last operational Spitfire. My aircraft also rejoices in the name: "Echo" and is a "Spitfire Reborn" – the echo of the real Spitfires – a Spitfire in spirit and soul.

I can't remember a time when the Spitfire was far from my thoughts. In the early sixties I saved my pennies and built free-flight balsa models of MkIs and IXs powered by small diesel engines and was distraught when they flew out to sea. As an air cadet I was thrilled to be accorded the privilege of manning a "stuffed" Spitfire at a RAF Benevolent Fund event. It was at that time that I first learned the folly of pretending expertise about this aircraft. I'm still learning! When I left the RAF in 1973 I attempted to buy one of the many gate guards, dozens of which were, at that time, in store and in many pieces. Having done a tour of duty at MoD I thought I knew which strings to pull but even with such access MoD policy was cast in iron. And a jolly good thing too! Had I succeeded I would have doubtless ended up sadder, wiser and certainly penniless. There they remained for better men in years ahead to do what I could never have achieved.

Time passes. Plans change. The idea of building a replica Spitfire began to take on a substantive form in the year 2000. It was then, on one bright spring morning when everything seemed possible that I announced to my wife that I was thinking of designing and building a full scale, flying replica Spitfire. We are still married.

And so, in the year 2000, began the design process, the turn of the century suggesting that the new aeroplane should be called the Spitfire 2000 or the Type 2K as it has been abbreviated. Of course the purist is quite right to say that a replica can never be a Spitfire in the true sense but what I have set out to achieve is as close as I shall get to satisfying a life-long lust. Surely every air-minded person has dreamed of flying a Spitfire? The Type 2K is a re-interpretation of the Spitfire using modern materials and a mixture of old and new techniques. Despite having slightly higher aspect ratio wings and an increased tail group volume; it is virtually indistinguishable from an early Mk IX - except of course to observant Society members. Its' intended role is purely as a recreational two place aircraft with good, safe handling, sweet and sparking aerobatic performance and short field capability. Unlike the genuine article: it has to be affordable to own, fly and maintain – or I risk penury again. These requirement necessitated a complete re-design; a new aircraft in fact; but of greatest importance: it still had to "*be*" a Spitfire.

The Type 2K is a two seat, dual control aircraft with the second cockpit disguised to give the aircraft the appearance of a single seater. It is designed to be a safe, strong aircraft that can be flown confidently by the average G.A. pilot. Its operational load factors are +6g –3g with ultimate load factors of 1.5. Ease and economy of maintenance and the ability to tow it home were also high priorities.

All design involves compromise. I recall the adage of Bill Stout of Ford Trimotor fame whose advice was that to build a good aeroplane you should *add as much lightness as possible*. The starting point had already been defined for me by the size and geometry of the Spitfire. So, in deference to Bill; the first task was to seek to reduce weight to a minimum. This is now settled at 2100lbs maximum take-off weight. Clearly this affects all other parameters. In particular I was concerned at the very low wing loading (ratio of wing area to all-up weight) which would have resulted in motor-glider type performance and would have severely limited the aircraft's effective operational speed and its manoeuvring characteristics. Clive du Cross' wonderful replica of K5054 was an inspiration but it had many points from which I could learn. In particular the lift provided by the wing was far too high; resulting in an excessively long landing run as the aeroplane floated in ground effect. The cruise speed was also limited by considerations of gust loading in all but very calm conditions. My solution has been to reduce the wing chord by 18% and to replace the inner portion of the flaps with a very effective, perforated ventral air brake extending the width of the fuselage. Once again, and perhaps surprisingly; these changes are scarcely discernible and don't detract visually. It's only you chaps who are likely to notice!

Subject to flight testing the standard day maximum continuous cruise speed is calculated as 253 mph and flapped stall speed is just over 46 mph. Several departures from the original design have been required by the certifying authority the most significant of which is that the tail group has to be enlarged by approximately 10% to increase the stability. The crispness of the handling will be slightly impaired but if you haven't flown the real beast you will probably never be conscious of it. The power loading is marginally less than the Mk I Spitfire on a maximum continuous power of 360 bhp so the initial climb performance will be almost as good. The maximum speed in level flight will, of course, be much lower since speed is governed by the relationship of the power and the drag. *Echo's* power is about a third of the Mk I's but the drag is almost the same – so she will be over 100 mph slower. This is of no concern to me at all since the aircraft will usually be operated at its cruising speed of around 200mph and at manoeuvring speed for aerobatics at around 180mph. The safe, low landing speed and short landing roll is a particular asset. I'm sometimes asked why I haven't specified a Merlin or an Allison and a thousand-plus horse power. The answer lies in the engineering maths: The design achieves everything that is required unless, of course, *Echo* is asked to chase FW 190s! The household maths gratefully accedes to the engineering assessment.

At this point its probably worth noting that in this context the process of design-optimisation is partly science and partly black art. R J famously reassured Jeffery Quill that if anyone ever told him something about an aeroplane *which is so damn complicated that you can't understand it; it's all balls*. Well, since I could never disagree with anything that RJ Michel said about aeroplanes and since I've always boxed above my weight (I confess: not always wisely or satisfactorily) I took the view that designing and building a replica was probably not "rocket science" - at least; not at the flying speeds that I have in mind. With a modest technical background in applied physics I reckoned that I could cope with ninety eight percent of the design. I strongly suspect, however, that it's that last two percent that requires ninety eight percent of the expertise to make an aircraft that flies – fly well! Fortunately I have just the right sort of friends. The LAA (Light Aircraft Association) must get a mention here. They will be the arbiters who will issue the permit to fly and prior to that they will have inspected and advised on every stage of the process.

The construction of the aircraft owes everything to established practice. At first I had hoped to build entirely out of modern composites since these are the materials with which I am most familiar. However, additional safety factors are required for laminates - thirty percent higher than the usual safety factors applied to more commonly used materials. This would make the structures far heavier than can be achieved by other means. The primary structures are therefore conventional, mainly welded steel trusses which are light, extremely strong and easy to build. The wing main and secondary spars are built traditionally using aluminium tubes and webs. The ribs and the skins of the flying surfaces are S-glass/polyester/foam laminates. Composite shells and skins give the fuselage its outward appearance and character but carry no applied loads. I had initially planned to have a completely smooth aircraft with no ersatz rivets and bumps but I'm now persuaded that it's appropriate to include "authentic" detail for the fuselage. Yes, I'm sorry: It is cheating a bit! But who of us are as we seem?

The wings fold to enable road transportation on a trailer behind a typical 4x4. Best of all: the Type 2K will pass through the average farm gate – but that's another story. The other "major" design change (that I challenge you to notice) is that I have been able to increase the undercarriage track by one foot. Although this is noticeable only if the Type 2K is parked alongside an original Spitfire, the effect on ground handling is dramatic: it is a Hurricane-width track and landings will be very much more straight-forward particularly cross-wind. The tyres are thinner than the originals in order to retract neatly into the wings but the original diameter is maintained. The aircraft is intended for grass strip operation.

The engine is quite an important part of any aeroplane I'm told. Unhappily there is no suitable liquid cooled aero-engine currently available and, unhappily, no British engine that I am aware of that could be adapted. The American automotive giant General Motors have some wonderful V8s which have been adapted for use in light aircraft. They have many thousands of hours airborne behind well designed propellers and propeller speed reduction units. It is essential that these three units be designed to work together largely on account of torsional vibrations which pose particular problems to piston engines driving airscrews. I recall the following words of wisdom, but I have forgotten their author:

It is alright to fly an experimental airframe, it is alright to fly an experimental engine and it is also alright to fly an experimental propeller. But you shouldn't ever fly an experimental airframe with an experimental engine and an experimental propeller!

I decided to abandon my plan to build the PSRU and propeller and to go for a well tested "firewall-forward" package based on a sophisticated 7 ltr GM, V8 swinging a 9 ft diameter, three bladed propeller. Operating at a maximum of 4500 rpm the engine develops its maximum torque and just happens to sound like a V12 at 3000 rpm!

The physical building of my Spitfire "*Echo*" began at exactly 11.02 hrs on the eleventh of November 2006. It seemed the right time to start. Now, three years on, the fuselage plug from which the multi-part moulds will be built is almost complete. I've more or less finished the "sculptural stage". Next comes the aeronautical engineering!

The work and the effort involved persuaded me that the Type 2K ought to be more than a "one off" and so at an early stage I decided that the moulds and jigs should be prepared with this in mind in the hope that scores will be built and that ever more of us will engage with the Spitfire.

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