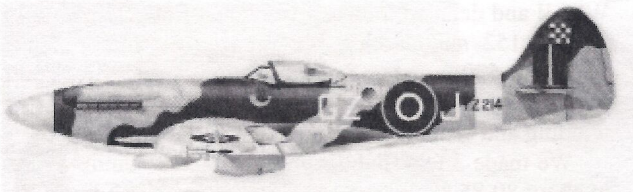

A model of the Spitfire Mk XIV

Bill Henn
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There are wetlands near my home where I have been testing my scale models for several years. People walking by often stop and watch, sometimes asking questions. None of them was ever able to identify my models until I began flying a Spitfire. It is amazing that almost six decades after the end of World War II that many people are familiar with an aircraft that was built in another country and served in distant parts of the world. Of course it is the illustrious history of the Spitfire that has made it so famous. Never before had a single machine been so instrumental in preserving a way of life. However, it is the distinctive configuration of the aircraft with its sleek fuselage, rounded tail surfaces and, in particular, the elliptical wings that have made it so recognizable.

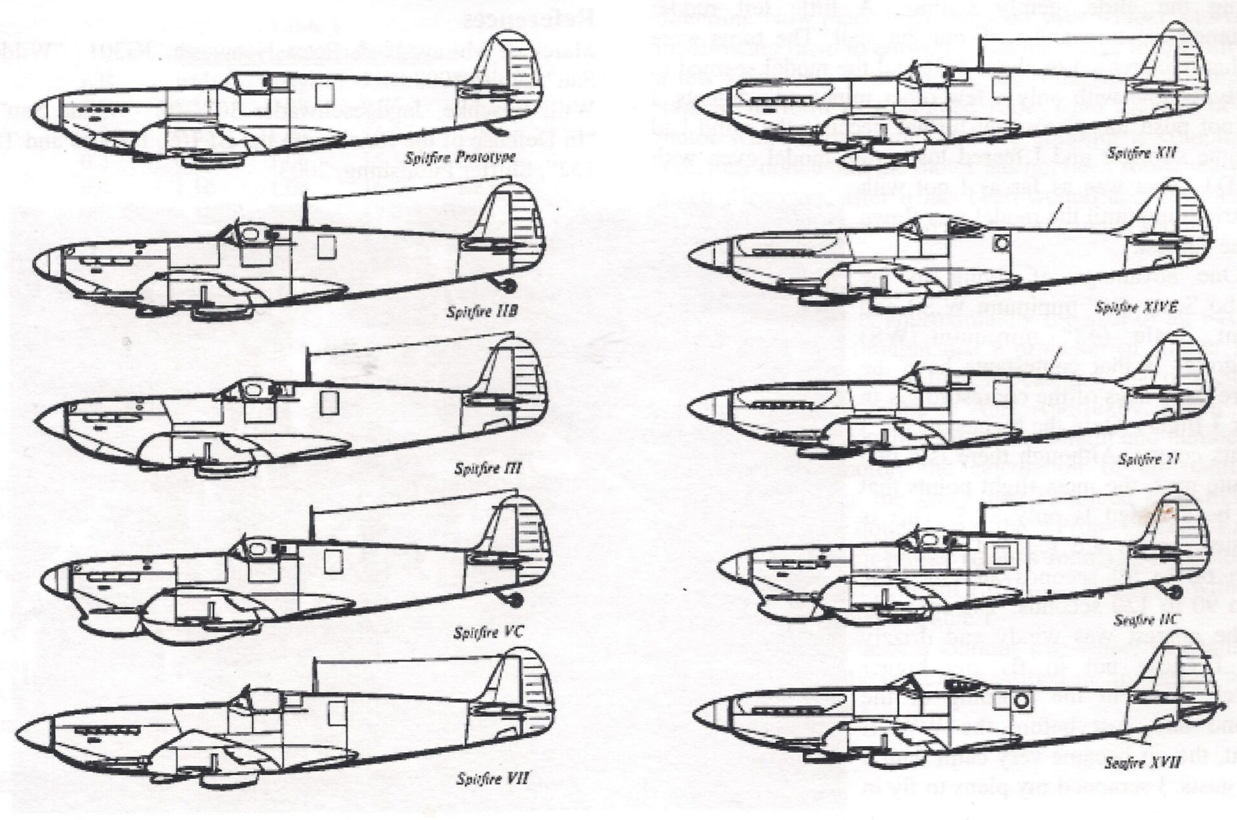
Although Supermarine enjoyed great success with its early efforts building racing seaplanes, the company's first attempt to build a fast monoplane fighter was a dismal failure. This was an aircraft built to Air Ministry specification F7/30, Type 224, No. 2890. It was a gull-winged monoplane with fixed landing gear powered by the Rolls Royce Kestral 'S' engine. After many modifications the 224 was only capable of 230 mph.

Chief Supermarine designer, Reginald Mitchell, finally got it right with a subsequent design, Type 300, No. 5054. This was the prototype of the aircraft that was to be known later as the Spitfire. On the morning of 5 March 1936, test pilot Malcolm ('Mutt') Summer made the first flight. The plane was equipped with a Rolls Royce 'C' engine that produced 990 hp and a fixed pitch wooden prop designed to allow 3000 rpm at 18,000 feet. This meant the pitch was too high for take off at 1900 rpm. Therefore, the nose of the plane was pointed 35° across the wind to counter torque. Later in March, with an improved prop, the Spitfire reached 349 mph in level flight. While the prototype of the aircraft was still being tested, production began on the Mks I and II.

The development of the wing of the Type 300 was an interesting part of the Spitfire's history. It may be difficult to understand why Mitchell chose to adopt an elliptical shape as it posed many problems, the main one being difficulty of manufacture. What is clear is that Mitchell had used the shape before when he specified it for a six-engined flying boat in 1929. Another factor involved the requirement to house eight Browning 30 calibre machine guns in the wings.

Mitchell was also impressed with the Heinkel HE 70, a large single-engined mail plane with an elliptical wing. After the HE 70 was displayed at the Paris Air Salon in 1932, Mitchell wrote to Heinkel saying, "We found to our consternation that despite its vast dimensions, your plane is markedly faster than our fighters. Was the skin of the aircraft exhibited in Paris made of metal or plywood?" Rolls Royce was also interested in the HE 70 and had one built with a Kestrel engine which propelled it to over 260 mph. Mitchell was also impressed with the NACA 2200 series of airfoils developed in America and chose to use one on the Spitfire with a resulting low thickness:chord ratio.

Development of Spitfire from Mark I to Mark XVIII



The wing evolved into a very efficient design that could hold the landing gear, armament and still be able to withstand the strains of battle. The single main spar located at 25% chord together with a thick nose skin provided all the bending and torsional strength of the wing which had 6º dihedral, 2º incidence, 2.5º of washout and an area of 242 square feet. Development of the prototype wing was not without problems. Flutter developed at high diving speeds and some redesign was necessary. The spar web was moved from the front face of the spar boom to the rear. Also the leading edge covering material had to be increased in gauge from 16 or 14 and from 18 to 16 at the wing tips. The affect was an increase in torsional stiffness of about 40% with a weight penalty of only 20 pounds!

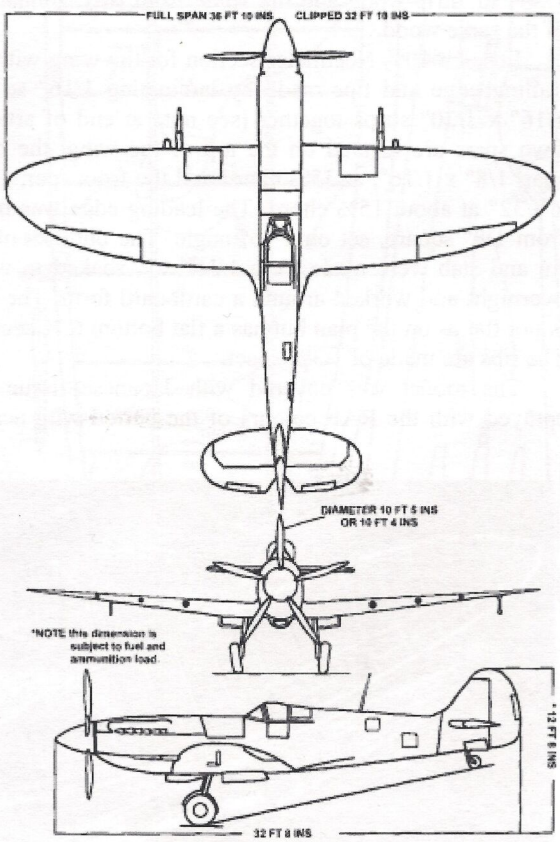
Initial attempts to produce an efficient variable pitch three-bladed propeller to replace the fixed pitch two-bladed prop were not successful. The early De Havilland three-blade type had two settings, fine for take off and coarse for top performance. It worked adequately until the pilot forgot to select the fine pitch during take-off and, of course, the Spitfire was unable to get airborne as the propeller was moving the aircraft forward too slowly. The cockpit control for the pitch was a simple mechanism but it did require the pilot's cooperation

By the time the Battle of Britain started the RAF was equipped with only 128 Spitfires and 458 Hurricanes. Nevertheless, these few fighters were able to destroy the myth of the Luftwaffe's invulnerability.

The Mks I and II that were used in the Battle of Britain were followed by the Mk V, which was powered by a more powerful Merlin engine. 6478 Mk V's were produced. The limitations of this variant were realized after the appearance of the FW190 on the Channel coast

"The rejuvenated Spitfire Mk F.XIV with the Rolls Royce Griffon 65 engine, disclosing its superb control in roll as demonstrated by Supermarine chief test pilot Jeffrey Quill. The picture was taken by Supermarine photographer F.H. Burr from the open doorway of a Dragon Rapide." (Frontispiece photo and caption, CF Andrews and EB Morgan, *Supermarine Aircraft since 1914*, Putnam Aeronautical Books, UK, 1987)

late in 1941. The FW190 was faster than the Mk V at all altitudes and could climb, dive and accelerate faster. The manoeuvrability of the FW was also superior except in turning circles. However, when the FW190 was in a turn and was attacked by a Spitfire its faster roll rate enabled it to flick into a diving turn in the opposite direction and escape. Later in the same year the Mk IX Spitfire became operational. It was equipped with the more powerful Merlin Series 60 that made it faster than the FW190, closing the gap between the two fighters.



Supermarine Spitfire Mark FXIV
Photo Reconnaisance variant

While not appearing to change externally, the Spitfire was massively developed during the course of the War. The basic outline of the wing remained the same but some variants had the tips clipped to increase roll rate and speed at low altitudes. Others were equipped with pointed wing tips to improve high altitude performance.

The airframes were strengthened to enable the aircraft to withstand the stresses involved with more powerful engines. The Rolls Royce Merlin was continually upgraded but without increasing the displacement with the power reaching 2000 hp, twice the output of the engine used in the prototype. R-R developed the larger V-12 Griffon engine used in the late Mks as they did with the Merlin and, with the 60 series, introduced a two-stage supercharger and intercooler to give much greater power at all levels and almost double at high altitudes. Spitfires powered with initial versions of the Merlin were at a disadvantage compared with the German fighters as they had a carburetor supplying mixture to the supercharger assembly, a system that did not permit the sudden manoeuvres that the fuel injected Daimler-Benz engines would allow, but later in the development of the R-R engines this deficiency was corrected.

The most formidable of all the Spitfires used in the War was the Mk XIV. This was a Mk VIII or a late Mk XII with the Griffon 65, resulting in an even longer nose than the Mk XII and needing a five-bladed propeller to absorb well over 2000 hp. To counter the destabilizing effect of the long nose, the fin and rudder were increased in chord. In all, 957 of the Mk XIV's were built; some with clipped wings and others with teardrop canopies and cut down rear fuselages. The final variant of the Spitfire, the Mk XXIV, was more than 100 mph faster than the Mk I in level flight. It had an 80% faster rate of climb despite an all up weight of thousands of pounds more, and five times the firepower. Notwithstanding the early origin of the design and major theoretical criticism, the performance of the wing close to the speed of sound was not bettered until well into the jet age.

After the War the two-stage blower equipped machines remained in service for s few years and it was a Mk XXI that made the RAF's last Spitfire sortie, in Malaysia on 1 April 1954. Some 22,500 Spitfires of all Mks were built but now only a few dozen are kept in flying condition. They are the stars of today's air shows.

It appears that some of the Merlin and Griffon engines that powered these magnificent aircraft will live on indefinitely, used in the highly modified Mustangs and custom built aircraft flown in the National Air Races in Reno, Nevada, USA. These engines have been modified so as to produce nearly 4000 hp, driving these aircraft more than 500 mph. A modified Mustang P-51D ('Dago Red') established a speed record of 517 mph for a piston-engined aircraft in 1981 with a highly tuned Merlin engine. Other Mustang Griffon-engined racers have been unofficially timed at speeds as high as 530 mph.

Since childhood I have been enamoured with the elegance of the Spitfire and I built a solid model of one in 1941 at age 10, mounting it on top of a deactivated, .50 calibre. machine gun bullet. I have observed that many FF rubber scale modellers are wary of the Spitfire and believe it to be inherently unstable. Models of the Spitfire rarely appear in the winner's circle at major contests here in the USA. After achieving success with my Reggiane 2005 (*FFQ* No. 5) I decided to build a late-Mk Spitfire because they had a similar configuration.

The Italian fighter also had an elliptical wing and the area of the tail surfaces was almost the same. The Spitfire has a shorter nose and longer tail, which I believed, would make it even more stable.

I chose for my subject the Mk XIV, JEJ MV268, which is the aircraft that Spitfire Ace Johnnie Johnson flew in the final months of the War. Johnson flew all variants of the Spitfire, starting with a Mk I in December 1940. He ended up with a total of 34 victories, 27 of them while flying a Mk IX, but none with the Mk XIV.

The Griffon Spitfire model

There is a scarcity of Griffon powered Spitfire rubber scale plans here in the USA and I did not want to spend the time drawing one myself. Fortunately I succeeded in acquiring an excellent 23" WS, Mk XIV plan from Mike Woodhouse in the UK, drawn by Lubomir Koutny. Mike has great variety of wonderful Czech scale model plans by Koutny and Pavel Stranik on his website: http://www.freeflightsupplies.co.uk/.

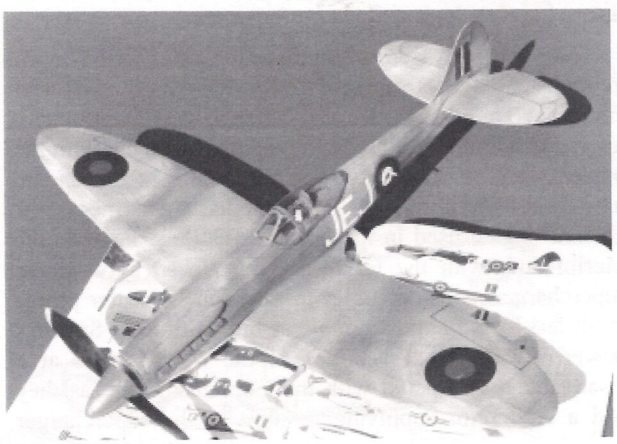
Those plans that I have purchased in the past were very accurate, the outlines and especially the fuselage cross-sections being true to scale. They tend to be rather heavily built but that is easy to correct by reducing wood sizes and eliminating parts of the structures that I feel are not necessary.

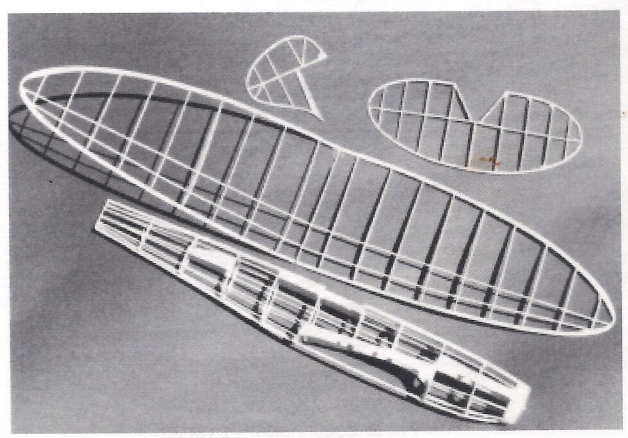
The Spitfire plan was for the version with the conventional fuselage so I cut down the rear formers so as to form the teardrop canopy configuration. I increased the area of the stabilizer about 10% over that shown on the plan.

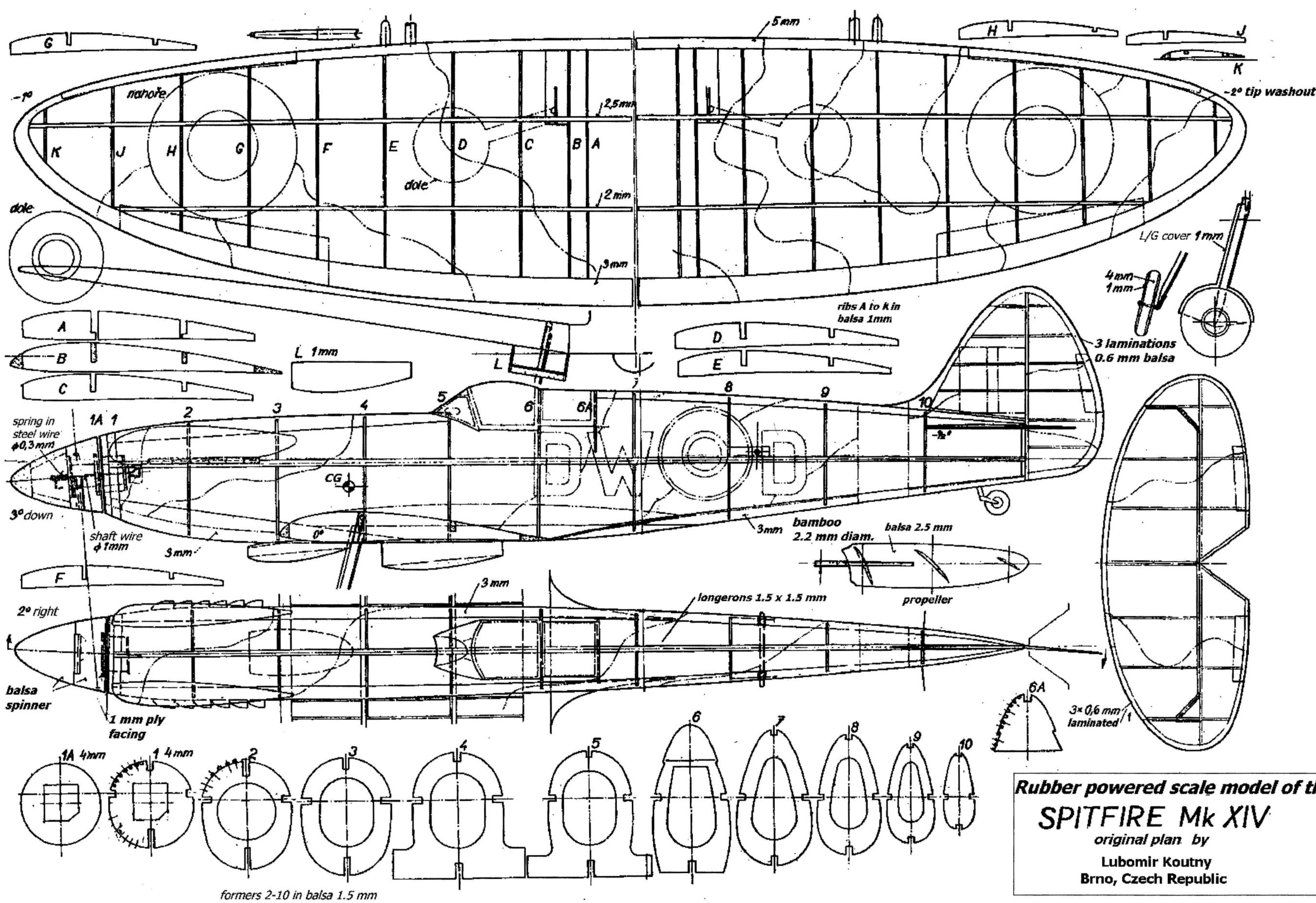
The only firm wood used in the construction of this model was for the wing spars with all the rest being 4-6 lbs. balsa. The wing ribs and fuselage formers were made of 1/20" sheet. The fuselage is constructed using the half shell procedure and I found that a nice rounded contour could be achieved by using only 12 stringers, including the upper and lower spine. The stringers are made from 1/20" sq. strip-wood and the spine from two laminations of the same wood.

I used a 10% Neelmeier section for the wing with the trailing edge and tips made by laminating 1/16" sq and 1/16" x 1/20" strips together (see note at end of article). Two spars are located on the top of the wing, the main spar, 1/8" x 1/16", at 35% chord and the front spar, 1/16" x 3/32" at about 15% chord. The leading edge was made from 1/8" square, set on a 45° angle. The outlines of the fin and stab were made from 1/16" sq., soaked in water overnight and worked around a cardboard form. The stab is not flat as on the plan but has a flat bottom 6 % section. The ribs are made of 1/32" sheet.

The model was covered with Japanese tissue and sprayed with the RAF colours of the period with acrylic







Rubber powered scale model of the

SPITFIRE Mk XIV

original plan by

Lubomir Koutny
Brno, Czech Republic

paint: dark green overlain on medium sea grey in a disruptive pattern with the undersides a lighter shade of grey. Even with the lightly built tail it was apparent that the model was going to require nose ballast. Therefore I departed from my usual practice of carving the prop and decided to use a 9.5" Peck plastic prop, the same type that are used on P-30s. Since this prop would be too large and heavy for the Spitfire, I cut it down to 8.25" and scraped the blades with a sharp knife until I got the weight down to about 3.25 gr. It has a pitch of about 9", and with this prop installed, there was no need to add ballast. Because of the light wing and stab structure I pre-shrunk the tissue used on these components to prevent warping. The points on the fuselage where the model is held for winding and launching were reinforced.

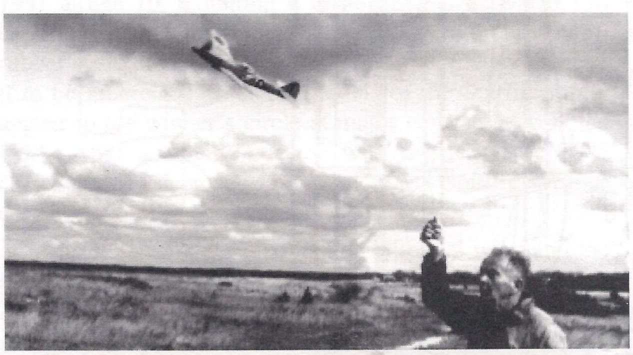
The completed weight of the model without rubber was 27g considerably heavier than my 23", 19g Reggiane Re 2005, but still light enough to be competitive.

Trimming and flying

This model did not fly off-the-board like my other recent low wing fighters. Initial settings were 3° right and down thrust, 3° positive on the wing, 0° on the stab, and neutral rudder. The right wing tip was slightly washed out and the left wing tip a little more.

The glide was carefully adjusted, with the prop removed and nose ballasted to achieve a CG at 35% chord, for a straight, flat glide path. With these settings it would be expected that the model would turn right under power but it just wallowed around, yawing back and forth as if the fin was too small. Adding right rudder or more thrust caused the model to go into a sharp, banked right turn. There did not seem to be any 'in between'.

After spending several hours trying all kinds of thrust, rudder, and wing wash settings the model still refused to fly in a consistent manner. Several times I thought I had it right but on the next flight the Spitfire would do something different. I even increased the size of the fin with tabs of various sizes to no avail.



Finally I gave up and did what most experienced scale flyers would have done in the first place, set the model up to fly to the left under power. After reducing the right thrust to about 2°, adding left rudder and reversing the afore-mentioned wing washes, I was pleasantly surprised to see the model climb out in a stable manner in flat, wide circles, transitioning into a nice flat left glide. As I worked up to maximum winds, the turn tightened up slightly but the model did not bank to any significant degree. With a short motor of 4 strands of 0.110" thick Tan ll weighing less than 5g the model was putting in flights of about 70 seconds and reaching the limits of my small test field. The next day I returned to the field for another testing session. The wind had risen up but the model still grooved as if on rails. I believe that with a larger 10g motor of 4 x 0.125" (braided), flights over two minutes could be achieved.

Although the model flies to the left it seems to reach an equivalent altitude as my right flying subjects. As I watch it climbing steeply I have to remind myself that it is turning left instead of right. My experiences with the Spitfire and other low wing fighters lead me to believe that low wing subjects can be just as stable as high wingers if one adheres to the proven construction techniques and the trimming procedures that are used on endurance models. However the question remains as to why the Spitfire was so resistant to my efforts to make it turn right unlike other models with similar configurations that are adjusted in the same manner. Although the Spitfire has yet to be used in competition, its performance appears to be at least equal to the best of the models being flown in local FAC World War II events.

Note on balsa lamination techniques

Recently I developed a painless method of bending balsa around sharp curves, a variation of an old woodworker's trick. Make a form of the desired outline from thick card-board and wax the edges. The ends of the form should be slightly longer than the desired outline. Procure a flat nylon shoelace that has a width of about 1/8" when stretched. Pin and tape the end of the shoelace to the end of the form so that it dangles in the direction that the wood must be bent.

Soak the wood in water for at least 12 hours. Forget the often-repeated suggestions about using ammonia because it does nothing useful. Slip the end of the thoroughly moistened strip of balsa (or laminated strips) between the form and the shoelace at the point it is attached to the form and tape it securely. Carefully work the balsa around the form while keeping the shoelace under tension on top of the strip, taping every inch or so (closer on sharp bends) as you progress until finished. The constant, uniform, downward pressure exerted on the balsa will keep it from buckling. Let it dry overnight before removing tape.

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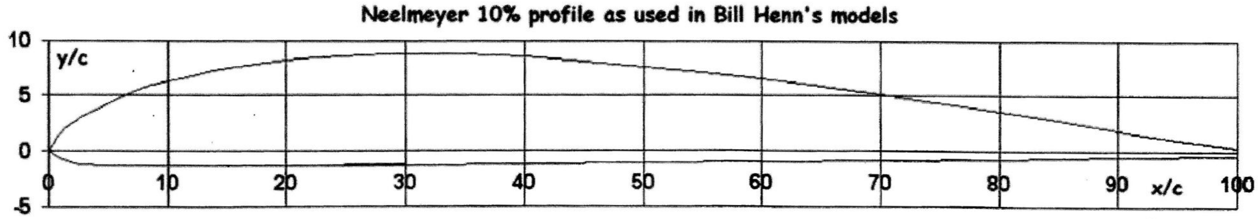
Neelmeyer 10% profile as used in Bill Henn's models



Profile coordinates

X%	**0.0**	**0.625**	**1.250**	**2.50**	**5.0**	**7.5**	**10**	**15**	**20**
Upper Y	0.0	1.200	1.812	2.939	4.378	5.458	6.313	7.515	8.268
Lower Y	0.000	-0.520	-0.800	-1.244	-1.388	-1.381	-1.375	-1.359	-1.341
X%	**25**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Upper Y	8.629	8.769	8.612	7.689	6.563	5.126	3.619	1.834	0.17
Lower Y	-1.319	-1.293	-1.223	-1.129	-1.011	-0.870	-0.711	-0.538	-0.17