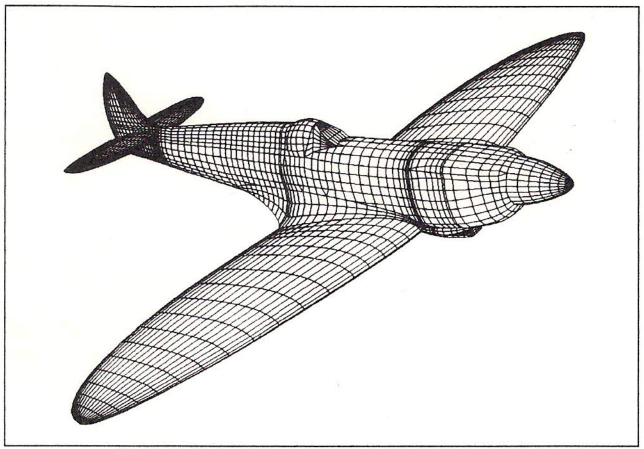

Figure 3. VSAERO panel model of the Spitfire.

model to represent a Spitfire IX, which could be fully defined from the drawings (Fig. 3). Coordinates were present on the drawings, but preparation of the fuselage proved to be difficult as a global coordinate system was not used. For instance, bulkheads could only be located by accumulating distances from a known reference. The Fw190 drawings were actually a recently redrawn set, based upon the original factory drawings. Initially, a radial engined Fw190A-8 (Fig. 4) was modelled, but this was later modified to represent an inline engined Fw190D-9 (Fig. 5), in this case using actual Focke Wulf drawings. Despite sparse fuselage cross section information, this model was constructed with relative ease.

WING GEOMETRY

In a sense, these three aircraft types represent three stages within a single generation of fighter development. This can be most easily seen in the wing aerofoils used on the aircraft. The Spitfire, designed in the mid 1930s, used the NACA 2200 series of aerofoils, which was new at the time. The wing root aerofoil is a NACA 2213, transitioning to a NACA 2209.4 at the tip rib.

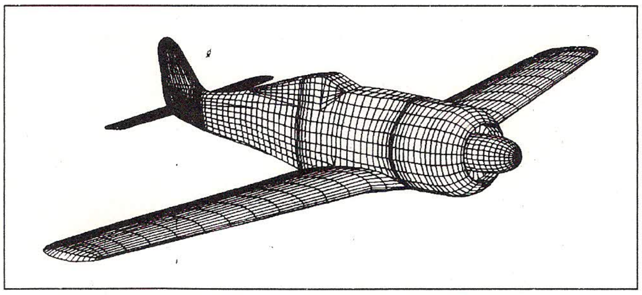

Figure 4. VSAERO panel model of the Fw190A-8.

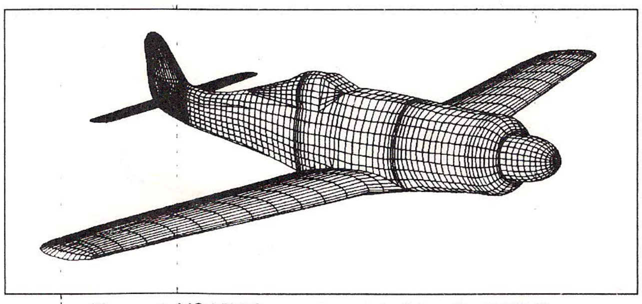

Figure 5. VSAERO panel model of the Fw190D-9.

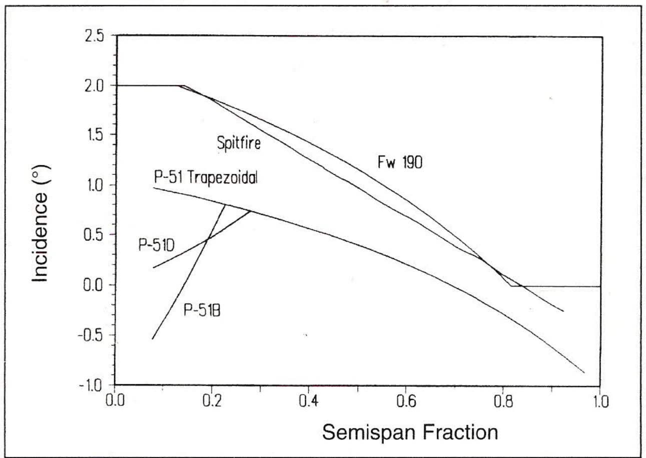

Figure 6. Wing twist distribution comparison.

The Fw190, which was designed at the end of the 1930s, used the NACA 23000 series of aerofoils. The wing root aerofoil is a NACA 23015.3 and the tip aerofoil a NACA 23009. The P-51's wing, designed in the early 1940s, uses an early laminar flow aerofoil which is a NACA/NAA hybrid called the 45-100. The wing root aerofoil (of the basic trapezoidal wing, excluding the inboard leading edge extension) is 16% thick, while the aerofoil at the tip rib is 11·4% thick. With the inboard leading edge extension, the wing root aerofoil on the P-51B is 15·2% thick and on the P-51D 13·8% thick. The later model P-51H used a NACA 66,2-(1·8)15·5 a = 0·6 at the wing root and a NACA 66,2-(1·8)12 a = 0·6 at the tip and has no inboard leading edge extension.

It is interesting to note that approximately 2° of washout was used on all three aircraft. However, the distribution of twist varied for each aircraft. The Spitfire wing has a constant incidence (2°) to the dihedral break, where the twist starts. This aircraft actually has 2·25° of washout, distributed linearly (Fig. 6). The Fw190 wing is unusual in that 2° of washout exists between the root and a point at 81·5% semispan. Outboard of this location there is no more washout, the incidence holding fixed at 0°. This will be discussed in more detail later. The basic trapezoidal wing of the P-51B and P-51D has 2° of washout, with the tip rib at –0·8478° of incidence. However, addition of the drooped inboard leading edge extension modifies the appearance of the twist distribution. Lift distributions for the three aircraft show the results of these twist distributions (Fig. 7). These lift distributions were calculated, using VSAERO, with the aircraft trimmed at 360 kt and 15 000 ft altitude to representative and gross weights and CG locations (Table 1).

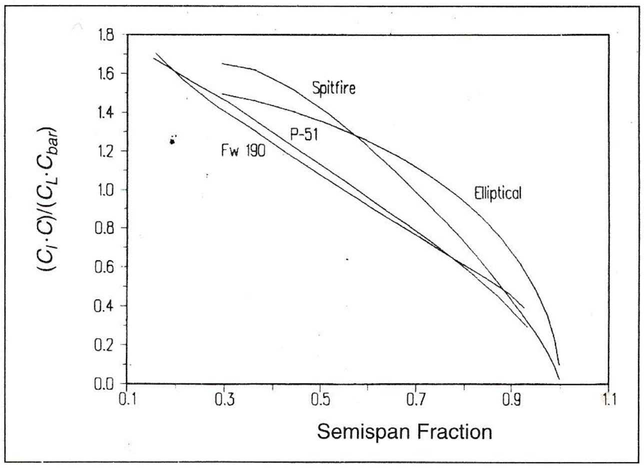

Figure 7. 1g flight wing loading comparison.