THE conventional aircraft having a mainplane and tail-plane has not necessarily the ideal arrangement of aerofoils and it is the recognition of this fact which has prompted, from time to time, the construction of experimental unorthodox types. In the past such aircraft have been viewed as freaks and prejudice has invariably succeeded in both damping the ardour of the inventor and preventing the subscription of the funds required for development. This state of affairs still prevails, but it is now becoming apparent that scepticism will not in the future be so fashionable as in the past. At the present time, and in many countries, odd-shaped tailless aircraft are under construction or are already flying, and have, moreover, been sponsored and paid for by the several governments concerned.

The purpose of this article is to give the reason for the unconventional trend and also to compare the merits and defects of the various types, with particular reference to the Warren-Young design.

The discussion is concerned with the characteristics of aircraft designed to travel at moderate speeds, although the requirements for the high-speed machine and the tailless type, as such, are similar. For example, the requirements for the “supersonic” aircraft are a low thickness-chord ratio and sweepback, and these conditions are met by the delta wing, which is also a suitable plan-form for the tailless aircraft. The disc wing (“Flying Saucer”), or the delta wing of very low aspect ratio, each with its characteristic high lift developed at large angles of attack, also permits an exceptionally slow landing approach, so that the conditions for a low wave drag and high lift at low speeds derive from the same type of wing formation. The characteristics of the tailless aircraft at moderate and low speeds may have, therefore, an important bearing on the design of high-speed types.

The conventional monoplane, with a tapered, unswept and non-twisted wing develops, as compared with any tailless type, a higher lift per unit of wing area at all angles of attack; therefore, for a given speed, the angle of attack required for flight will be lower and the parasite drag will be less. The induced drag will also be a minimum for this type of wing, with the net result that the speed will be higher for a given horse-power. It should be observed, however, that the increase of profile and body drag with angle is very small and also that, at low angles of attack, the induced drag is a small proportion of the total drag. At low angles, therefore, these gains will not be substantial and the improvement in top speed will usually be negligible; moreover, the advantage in cruising speed is likely to be slight.

Against these slender advantages, the “efficient” aircraft is subject to the sudden stall, with which is associated the initially uncontrollable dive and tendency to spin, and this vice may be corrected only by a substantial sacrifice of the efficiencies already considered.

The tailless design which employs a swept-back wing having washed-out tips may next be considered. Most tailless aircraft have been, or are, of this type—for example, the Westland-Hiller Pterodactyl and the Northrop Flying Wing. For the true all-wing type the parasite drag is much less than that of the conventional aircraft, as the body drag is eliminated entirely. In fact, the minimum drag coefficient for the Northrop B-35 bomber is less than half the average figure for the comparable conventional aircraft. In addition, the elimination of the fuselage and tail surfaces results in a considerable saving of weight and resultant improvement of payload. For example, for a conventional aircraft of similar size to the B-35, the weight of the fuselage and tail would be of the order of seven tons. Tailless types other than the all-wing must justify their existence with other advantages, since their parasite drag may not be abnormally low or their structure be unusually light. The claims for such types have usually been for improved stability and innocuous stalling, but in fact most tailless designs have inherent defects which tend to nullify the advantages.

The disadvantages inherent in almost all tailless types are as follows. A large tip-washout is an essential condition for stable trim, since the no-lift moment of any type of aircraft must be positive (i.e., nose-up). At the zero lift angle, therefore, the negative lift at the swept-back tips must equal the positive lift at the inner parts of the span and thus, at all angles of attack, the lift coefficient of the outer parts of the wing will be less than that of the centre parts. The new C at a given angle of attack is then always below optimum and this, without exception, is a characteristic of tailless aircraft of all kinds. Furthermore, to achieve a high value of the maximum lift coefficient, which is essential for a low landing speed, flaps must be employed to raise the subnormal C.

This introduces a major problem. The downward deflection of a flap has the effect of moving the centre of pressure of a wing rearwards and creates a considerable nose-down pitching moment. In the conventional aircraft this moment is balanced...