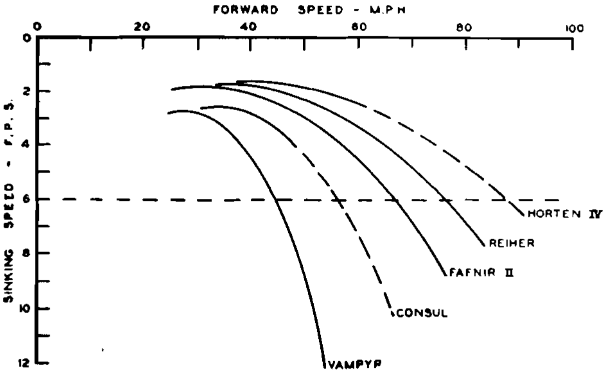

Figure 32. Speed Polars of Representative Sailplanes.

Prior to 1924 this ratio increased rapidly with increasing span, but at that time several wing failures due to lack of stiffness led designers to be more cautious, and for the next ten years the cantilever ratio decreased slightly. Since 1934 there has been a demand for higher cruising speeds, and as new structural techniques permitted the adoption of thinner wings, the cantilever ratio has again increased very rapidly.

Some of the more popular sailplane wing sections have been drawn on Figure 31 which also shows how changing requirements have affected the type of section favored by designers. Camber was decreased at first, and then increased steadily until 1930, as attempts were made to increase C_L^3/C_D^2 by increasing $C_{L\,max}$. Since 1930 emphasis has been placed on high values of L/D, and camber has been reduced from 9% to about 2%. The present tendency is to choose sections for low drag. A section thickness of 16 to 17% of the chord was popular until 1935. Since then thinner sections have been favored, and many modern types use sections as thin as 10% of the chord.

The over-all improvement in performance is shown by the speed polars of representative types plotted on Figure 32. Particularly significant is the increase of "cruising speed" (arbitrarily defined as the forward speed at which the sinking speed is 6 f.p.s.) from 42 m.p.h. for the Vampyr in 1921 to nearly 90 m.p.h. for the Horten IV in 1941.

The Present State of Design

So much for performance. What of the other design factors that contribute to successful flights?

To provide safety for aerobatics and flights in turbulent cloud, the strength factor of modern sailplanes in the positive high angle of attack case is usually about 10—much higher for normal civil airplanes, and about the same as for modern fighters. Adoption of these high factors has been dictated by experience, and has been principally responsible for the marked increase in sailplane weight, for about 60% of the structural weight of a sailplane is in the wing.

The maneuverability of sailplanes is now very good, and they handle very much like a good power plane. This maneuverability, combined with adequate stability in straight and circling flight, has been attained by the general adoption of a rather long tail arm, at least four times the mean wing chord, and a well tapered wing with slight dihedral. The usual wing taper of about 2.5:1 requires considerable washout to avoid tip stalling during tight spirals, but is structurally efficient and also reduces the moment of inertia about the roll axis.

The very flat gliding angle of sailplanes would make it difficult to land in small fields if some means of spoiling the glide and increasing the sinking speed were not employed. This usually takes the form of extendable lift spoilers or drag brakes mounted on the wings, which also serve to reduce the terminal velocity to a safe value if the pilot gets into difficulties in clouds.

Extensive use of the strong up-currents within clouds for soaring flight has made it necessary to equip performance sailplanes with a full set of blind flying instruments. In addition a barograph must be carried on record attempts, and many sailplanes are equipped with a supply of oxygen.

Recent attempts to increase the over-all lift/drag ratio of sailplanes by reducing the drag has led inevitably to the adoption of wing sections of rather low maximum lift coefficient. The resultant increase in landing speed has not been serious, but the increased speed corresponding to minimum sinking speed has been a nuisance, as it has meant that the minimum radius of turns has increased in proportion, making it more difficult to spiral in small thermals. The usual solution has been to adopt some form of high lift device—split flaps, slotted flaps, or Fowler flaps—for use in thermals, but the difficulties of fitting an efficient flap to a light wing of small chord are considerable, and flaps have not proved very popular on sailplanes.

Increased speed range has led to the general adoption of elevator trimming tabs operable by the pilot, and these have also proven very useful on long aerotowed flights, when the rather high speed would otherwise be very tiring. Lack of an engine makes a rudder tab unnecessary, but sailplane ailerons are sometimes equipped with small trimming tabs adjustable only on the ground.

With the increasing complexity of sailplanes in recent years the development of a craft capable of breaking the present world records has become very expensive, only to be undertaken by subsidized institutions; an increase of gliding angle beyond 1:30 with a simultaneous reduction of sinking speed below 2 f.p.s. can only be achieved by costly construction, and one may wonder if such an outlay is justified.

It is well known that under the conditions that at present obtain in soaring competitions the expenditure that goes with high performance brings only a slight

(Continued on Page 16)

Table 1
Principle Characteristics of Record Breaking Sailplanes

Year	Type	Span	Wing Area	Wt.	Glide Ratio	Sinking Speed	Wing Section
1920	Schwarzer Teufel	30.0	160	304	7	5.0	
1921	Vampyr	41.3	171	450	16	2.7	Gö 482
1923	Consul	61.0	232	485	21	2.6	Gö 535
1924	Roemryke Berge	52.0	188	485	20	2.5	Gö 426
1927	Darmstadt I	52.5	184	470	23.5	2.3	Gö 535
1928	Kakadu	63.0	190	525	24	2.0	Gö 652
1929	Wien	62.8	194	500	25	2.0	Gö 649
1930	Fafnir I	62.0	189	840	26	2.1	Gö 652/535
1932	Condor I	57.0	213	607	26	2.0	
1933	Milan Mü 10	58.5	237	772	27	2.0	
1934	Fafnir II	62.3	205	750	28	1.8	Gö 535
1935	Minimoa	55.8	204	660	26	2.1	Gö 681
1936	Atalante Mü 13	52.5	178	518	24	1.9	
1937	Reiher	62.4	208	705	33	1.7	Gö 549/676
1938	Cirrus D 30	66.0	129	606	36	1.7	NACA 23012
1941	Horten IV	66.0	206	770	37	1.6	