THE SAILPLANE IN AERODYNAMIC RESEARCH

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The application of the sailplane to research distinguishes it from its more romantic use in sport where the quality of the craft and the skill of the pilot are used to gain energy from the discontinuities in the atmosphere. The aim in soaring is to fly long distances or to gain high altitudes. In research flying with the sailplane the pilot strives to fly when the atmosphere is perfectly homogeneous. During a measurement he makes an effort to maintain as accurately as possible a constant airspeed and a constant angle of attack with the skid angle kept zero. Under these conditions the exact counterpart of the windtunnel test is attained.

One classical use for the sailplane is that of a prototype for determining the performance, control and stability of a larger powered version. The slow speed of the sailplane prototype permits the researcher to make "cheap and dirty" changes in outside geometry by means of putty, balsa or cardboard and scotch tape.

Aerodynamic Measurements on the Complete Sailplane

Since the principal theme in sport soaring is that of maximizing cross-country distances the sailplane must be designed with a view toward most efficiently extracting the available energy in the atmosphere anomolies, storing this energy as altitude. When the rate of energy extraction begins falling off the pilot converts his excess potential energy to distance by means of a long high speed glide. In view of this functional program the sailplane designers strive to achieve minimum induced drag for the energy extraction phase and a very low drag so that during the glide a high speed may be flown without excessive altitude loss. This emphasis on high speed glide is dictated by the necessity of making the distance flight in the fixed number of hours during which upcurrents are present in the atmosphere.

In view of the penalty paid for high profile drag many sailplane designers have recently adopted the laminar airfoil. In using these airfoils on the currently outstanding American Sailplane RJ-5, the importance of a wave-free contour was established. Previous applications of these airfoils to sailplanes had been disappointing for the very reason that the criterion for contour accuracy had not been established.

The technique for aerodynamic measurements with sailplanes consists in towing to altitude by means of an airplane and then during the glide the rate of altitude loss is determined for various forward speeds of the sailplane. From this data and the weight of the craft the drag coefficient and the corresponding lift coefficient may be computed. Analysis of the behavior of drag and lift coefficients permit the induced drag and parasite drag to be separated. From this information the aerodynamicist is able to predict what change in external geometry should be made to improve the performance of the sailplane. On the RJ-5 sailplane a series of systematic changes made

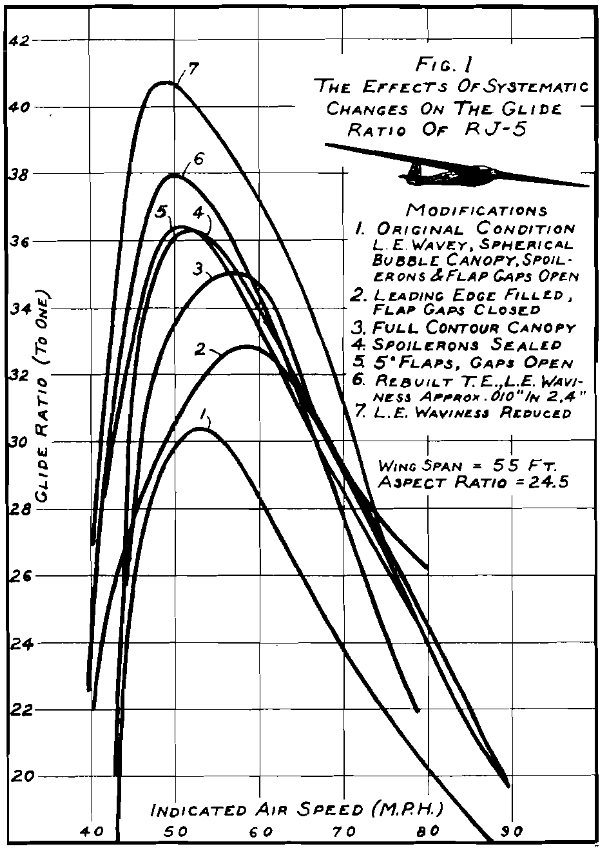

Fig. 1 The Effects Of Systematic Changes On The Glide Ratio Of RJ-5

in this manner permitted the maximum glide ratio to be raised from 30 to 1 to 40.5 to 1. Fig. 1. A similar gain on a transport airplane would raise its cruising range 30%.

To the field of control and stability the motorless aircraft has contributed much since the early days of aeronautics. Before engines were available the early aeronautical engineers sought a solution to the little understood problem of control and stability by flying gliders. If we look into the reports of Lilienthal, of the Wright Brothers, of Langley, or of Cayley or of any number of early experimenters we will find that each solved his problem first without an engine in place. Perhaps this is fortunate for aviation today for if the weight and inertia as well as the effect of thrust and slipstream had been included in the first designs, the problem would have been confused by a multiplicity of variables. Such a confusion would have resulted in a delay in the achievement of stable controlled flight. It would no doubt have also resulted in numerous mistakes and fatal accidents to the researchers. In this connection a quotation from A. R. Weyl remarking about motorless prototypes of Lippisch in Aircraft Engineering (1944-1945) is most illuminating:

"It is worthwhile noting that during all these years of experimenting not a single accident occurred