The Role Of The Sailplane In Aerodynamic Research

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If we can call the development of the airplane, "research," then we can say the sailplane's role in scientific research began with the first glider. The Wrights solved the vexing problem of lateral control with their glider. In fact the complete problem of stability and control was solved first on the glider and then propulsion was added. Still deeper in history are the researches of Lilienthal whose glider disproved a fallacy held by the eminent physicist, Kirchoff. Kirchoff's theory claimed dynamic lift to behave in such a way that much smaller lifts would be obtained than computed by our modern theory of lift generation. If Kirchoff's influence had not been attacked by Lilienthal, the advent of mechanical flight might have been delayed for years. When Lilienthal's measurements on a whirling arm were not sufficient to dethrone Kirchoff, Lilienthal built his glider and showed that it would develop lift of a magnitude predicted by him.

If a critical study of the many contributions of the sailplane were made, it would be found that without these contributions our airplanes would not fly. An excellent enumeration of these many contributions will be found in Dr. W. B. Klemperer's article, "Contributions of Gliding and Soaring to Aviation," in SOARING, March-April 1945.

If we were to look for an example showing a systematic use of this tool in aeronautical development, we could find none better than that of Dr. A. M. Lippisch's work in the development of the delta wing for high speed flight. It appears rather odd that the slow sailplane operating at Mach numbers below one tenth should contribute to the knowledge of flight at speeds close to the speed of sound. However, it was essentially Dr. Lippisch's technique to study flight at very low speed by means of free flight models, then progress to man-carrying gliders from which he would gain so complete a knowledge of the dynamics of the particular configuration that he felt confident enough to apply power to the configuration and thus achieve the high speed flight. This method of aeronautical research of using a glider as the test vehicle intrigued A. R. Weyl * to commenting about Dr. Lippisch's work, "This development clearly demonstrated how quickly, safely and inexpensively complex problems of aerodynamical design may be investigated by means of gliders and sailplanes. It is worthwhile noting that during all these years of experimenting not a single accident occurred and not one of the gliders suffered damage to such an extent that it became a complete loss."

So much for the history of the sailplane in the early development of aviation. We must now consider what has been done in modern aeronautics with the sailplane as a tool for gathering new information about the physical processes of airflows.

The first step in using a sailplane for research is to develop the techniques and instruments for making the required measurements. If we are to study the aerodynamic properties of lift and drag generation we must find a way to measure the lift and drag of the whole sailplane or a component while in free flight in still air. Fortunately it is possible to measure the lift in steady flight quite simply by weighing the craft and its load on the ground. The drag can be measured by determining first the ratio of drag to lift and then, since the lift is known, so also is the drag. The simplest way to determine the drag to lift ratio or its reciprocal L/D is to measure the sinking speed for each forward indicated airspeed. By means of this simple procedure it is possible to determine the behavior of drag in relation to lift for the complete sailplane. It is also possible by means of a wake measurement to separate the drag of the airfoil, profile drag, from the total drag*, so that one can determine exactly how the induced drag of the aircraft is affected by such variations as wing twist, sweep, outline, boundary layer control etc. The data so collected is similar to that obtained in a full scale tunnel but without the errors which result from stream turbulence or wall interference.

The sailplane is not restricted to providing aerodynamic data in symmetrical flight only. It can and has from its earliest conception been used as a tool for the study of control and stability. By means of simple tests it is possible to determine the static and dynamic stabilities on each axis. A beautiful example of a study of longitudinal stability is that of Dr. Werner Spilger, "Investigation of the Flight Path Oscillations on a Motorless Aircraft" (Jahrbuch 1942 der deutschen Luftfahrtforschung I 298.) In this research Dr. Spilger changed the center of gravity of a Habicht sailplane while in flight and investigated the damping in relation to center of gravity position. He also reported in this paper a most novel method for determining the lift and drag at negative lift condition. He made performance measurements while flying on his back!

Recently as a result of flight tests on several sailplanes a rather odd behavior of ailerons was discovered.** It was found that by disconnecting the inboard aileron on a sailplane having divided ailerons the time to turn at 20% above stall speed from a bank of 45° in one direction to 45° in the other with full aileron deflection was reduced by 15% over that for the complete aileron operative. In other words half the aileron area does not yield only half the rolling velocity. The importance of this knowledge to airplane design cannot be foretold, but its importance to sailplane design can be gleaned from the following advantages:

a. Less susceptibility to wing torsion-aileron flutter.

b. Less drag due to a shorter aileron gap.

c. Smaller vertical tail surface required, perhaps small enough to attain spiral stability for the craft.

d. Smaller control forces.

e. Reduction of adverse yaw.

*Tailess Aircraft and Flying Wings. Aircraft Engineering, Dec. 1944, p. 348.

*Raspet, A., Influence of Systematic Variations on the Drag Polar of the Sailplane RJ-5. Paper given at IAS Meeting, Univ. of Florida, April 13, 1951.

**Obarr, F., An Investigation of Anomalous Aileron Behavior. ISA Meeting, Univ. of Florida, 1951.