THE Belly-Slider GLIDER

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Aerodynamics

Is today's streamlining of aircraft perfect? Is there, perhaps, a body which moves through the air with less drag than a modern streamlined shape? Were these questions answered, aeronautical engineers could increase the speed of aircraft by reducing drag rather than by adding horsepower. Such questions appear contradictory to most of us because we feel that a streamlined body has no drag. As a matter of fact, even the best shapes have considerable drag. It is the purpose of this discussion to show how the drag of aircraft can be reduced and how present sailplane designs can be modified accordingly to yield better performance.

In the early days of aeronautics, it was thought that a streamlined shape should have a sharp leading edge. A knife-edge was supposed to cut through the air with least drag. At that time little was known about the effect upon drag of the trailing-edge shape. Now that we think we know all about streamlining, we must not forget the importance of these early-bird ideas in the development of aerodynamics.

We all know how a streamlined shape appears in the light of modern theory. Aircraft fuselages, tail surfaces, struts, navigation lights, aerial bombs and even luxury liners employ streamline curves as a basis for reducing parasitic resistance. So commonplace a concept is streamlining that it has become not only a criterion of aerodynamic efficiency but also a standard of beauty. At any airport you can hear young fellows exclaim about a modern plane, "Isn't she a clean job? Boy, what a beauty!" It is the smooth-flowing curves which add so materially to the appearance of any craft and it is those same smooth-flowing lines controlling the air flow past the craft which subtract so much from the drag.

Now that we have looked broadly at streamlining, let's get up close to the subject and study more critically the factors affecting parasitic resistance. In so doing we shall perhaps find an answer to our introductory question—how may we reduce drag? We can calculate the drag of a body by using the formula $D=C_DAv^2$. The drag, D, is the number of pounds of pull necessary to move a fuselage of cross section A square feet through the air with a speed of v miles per hour. C_D is called the co-efficient of drag. It is the numerical value of C_D which tells us how well a form is streamlined. Large C_D means poor streamlining. It is in sailplane design that we observe true perfection in streamlining. C_D for the smooth clean fuselages of high-performance soarers is as low as 0.00016. By going to a great deal of expense and spending a lot of effort on refinement, it might be possible to reduce the C_D of a sailplane to 0.00015, a gain of 6% over the previous case. When we balance the ledger and discover that in the above case several hundred dollars of fairing and smoothing has resulted in only 6% drag reduction, we are forced to return to our drag formula for a better answer to our problem. On looking at the formula, we see that reduction in either v or A would diminish the drag.

Since we wish to make distance flights with our sailplane, it would be wise not to reduce the speed v. Also, a reduction in the speed would cut our lift proportionately to the drag. As a result of this fact, no net gain is made in slowing the glider. After eliminating the factors C and v as possibilities in drag reduction, we are finally left with the one remaining factor, the cross section A. We must now answer the question, "Can we reduce the cross section enough to yield a substantial reduction of drag?" If it were not necessary to provide a space for a pilot, only wings and a tail supported on a boom would be needed for a high-performance glider. Since, however, we wish to ride in this sailplane, it will be necessary to have some form of fuselage. A fuselage of *16* square feet in cross section is necessary to comfortably contain a pilot conventionally seated in an upright position. If we were to make the fuselage so small that the pilot would have to be shoehorned into the cockpit, we would still not have made much of a gain. Now, suppose the pilot flies in the prone position with his body along the line of flight. In this position the pilot requires a cross section of only *4* square feet. By thus diminishing the cross section of the fuselage to 25% of that of present sailplanes, we have diminished the drag to 25% of its former value. There are, of course, considerations of pilot comfort and of visibility in the prone flying position; but at the moment let us concern ourselves only with the aerodynamics of this radical design. In Figure I are shown the fuselage sections corresponding to the sitting and prone flying positions. You can immediately see the large reduction in cross section and also note the resulting drag reduction accomplished by laying the pilot in the fuselage along the line of flight.

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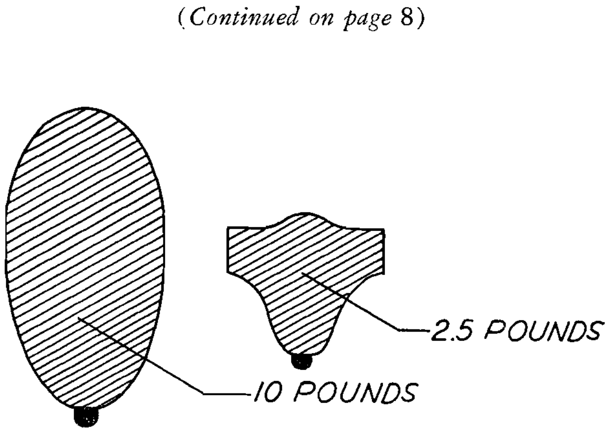

Comparative cross sections and corresponding drags at 60 mph of conventional and Belly-Slider fuselages.