A Possible Solution to Adverse Yaw in Plank Planforms

In a previous column (August 1992) we discussed the possible effects of differential on the performance of tailless planforms. Since that column, we have been involved in effective solutions for two types of control problems, one involving a plank, which we'll discus this month, the other involving a swept wing. Both difficulties are related to aileron differential.

The first case centered on our favorite design, Dave Jones' "Blackbird 2M." The "Blackbird 2M" is essentially a plank type planform which can use either the CJ 3309 airfoil (3% camber at 30% chord, 9% thick) or the CJ $25^{2}09$ (2.5% camber at 25% chord, 9% thick). Both of these are reflexed sections with strong positive pitching moments.

The original elevon design for the "Blackbird 2M" was of the "Frise" type. The Frise aileron utilizes a rearward hinge line such that when the aileron is deflected upward the leading edge protrudes into the airflow along the wing bottom surface. (See Figure 1) This produces some amount of drag, and effectively counteracts adverse yaw.

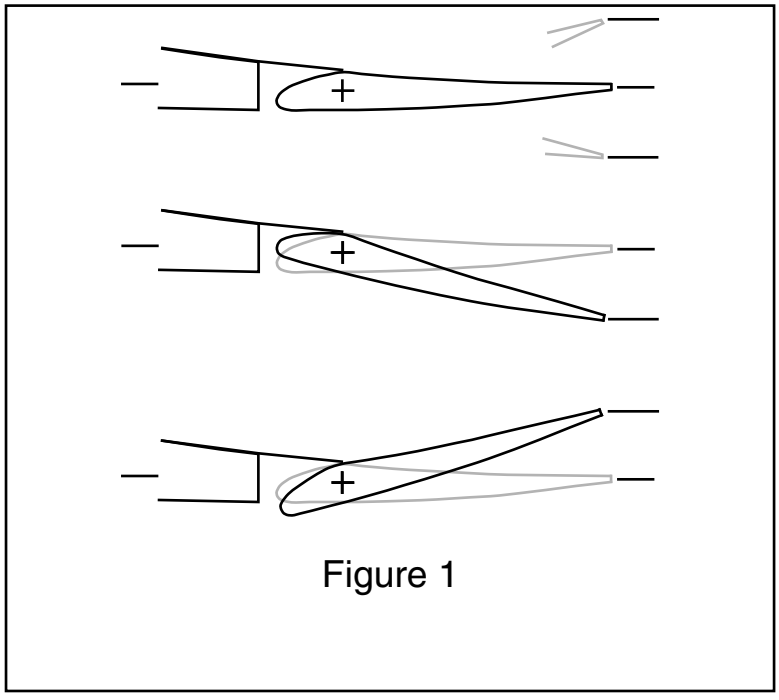

Figure 1

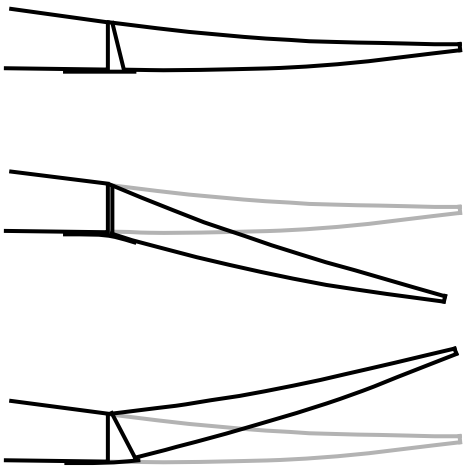

Figure 2

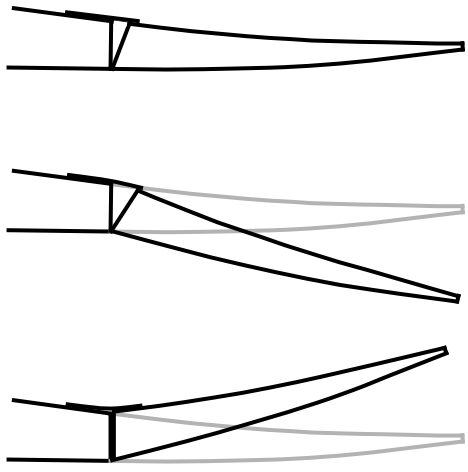

Figure 3

After building several Blackbirds of various sizes, we noted they all shared a common fault. When flying in a straight line, alternating left and right aileron input did not produce rolling motion. Rather, the wing would simply oscillate around the yaw axis.

Our initial attempt at inhibiting this tendency was to hinge the elevon from the top surface, thus eliminating the Frise type action. (See Figure 2) The "Blackbird 2M" which we took to Australia in 1993 utilizes this hinging method. The yawing motion resulting from the alternating input described above is reduced but not eliminated. On the other hand, up elevator is no longer accompanied by the increased drag of the control surface leading edge protruding into the airflow.

When constructing a foam core version of the Blackbird, we decided to hinge the elevons from the bottom surface. (See Figure 3) Hinging from the bottom was no more difficult than hinging from the top, but the elevon area is actually reduced as it is deflected upward. Bottom hinging thus gives reverse differential action. Yaw response to alternating aileron input has been nearly entirely eliminated, roll control is very precise, and beautiful coordinated turns can be easily made. This is the smoothest flying Blackbird of all, including our XC version, which is significantly larger.

Next time we'll describe an effective solution to a tip stall problem in a swept 'wing.

Tails! You lose!