THE LIFTING STABILIZER MYTH

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Since at least the 1930s modelers have been led to believe that lifting stabilizer airfoils improve performance. But since winning models typically employ lifting stabs, most modelers tend to assume they are needed to maximize performance. Nothing could be further from the truth.

Should a thin, flat bottom stab be paired with a deeply undercambered, thick wing, there is normally no problem. The Comet Zipper had a pair of airfoils well suited to each other. But in the case of the Comet Sailplane, which employed undercamber in its stab airfoil, definite longitudinal instability resulted. Only rarely would a Sailplane pull out of a loop; almost all of them crashed in a 10 to 20 degree nose down attitude.

In contrast, with its symmetrical stab airfoil, the Shulman Zomby would actually gain altitude on a loop. So would the Comet Clipper.

Another manner in which the high-lift stabs exhibit longitudinal instability is in the pull-out from a stall. Here the typical recovery arc is quite large compared to the same design with the same CG. location, but with a symmetrical or semi-symmetrical stab.

One explanation for both of the above phenomena is that the model with its nose at a higher than normal angle of attack. (Visualize the just-stalled ship dropping through the air due to gravity while making only a little forward speed.) Under this condition the stab offers less relative vertical drag than the wing, and drops faster, thus raising the nose. In contrast the undercambered wing tends to "catch" the air like a parachute.

But you can convince yourself of the truth of our initial statement relative to the poorer performance of the lifting stab by trying a little experiment. Select a model for which you will have two stabs: one symmetrical or semi-symmetrical (2/3 over, 1/3 under, for instance), and one having a undercamber (but same area and shape). Trim the model out with either of the stabs. Do not change CG., but change only the incidence of the second stab in order to return the model as nearly as possible to the initial flight path. (In doing this you may notice some difference in longitudinal stability.)

Now, is it not true [that] the two stabs are lifting the same amount, since the CG. is still in the same place? Which of the stabs provides the greatest stability? If you started with the symmetrical, was it necessary to move the CG. forward to fly safely with the undercambered? Would this not indicate the "non-lifting" to be lifting more than the "lifting"?

When finished, compare the incidence difference between the two stabs. Did the undercambered not require the trailing edge to be lifted much higher than the symmetrical? How much lift can a high-lift stab provide when flying at a significant negative angle of attack?

Finally, make an estimate of the comparative drag of the two stabs, this at the approximate angle of attack at which each has been flying. Is it not true that the drag on the symmetrical is much lower? And if this is true, is it not obvious that the performance with the symmetrical is better because of reduced total drag?

More Observations on Lifting and Undercambered Stabs by Pete McQuade PhD.

One can show that if we make the stab produce positive lift- rather than a down-force, as in conventional, full-size airplane design—and do so without adding any additional drag, the model would enjoy a modest gain in gliding performance. This is because a lifting stab means the wing doesn't have to overcome both the airplane's weight and a tail down-force, and so can fly a bit slower—which increases the gliding endurance. Since we usually associate efficient lift production with undercambered airfoils, they ought to be a good choice for stabs, right? The answer is a surprising: "No." The explanation follows.

For a model to be stable, the CG. must be ahead of the airplane's "neutral point" —and usually ahead by a significant margin, to ensure good flying characteristics. Furthermore, for the model to be trimmed, the pitching moment about the CG must be zero; that is, the force on the tail acting over the stab's moment arm, must balance the wing's pitching moment. To achieve this balance with a lifting stab, we must move the CG backward from where it would normally be for a fullsize airplane. But to maintain our stability margin, we must also move the neutral point backward, and we do this by increasing the tail volume coefficient (i.e. by increasing the stab size and/or its moment arm). For the mathematics of how to do this, see John Anderson's Introduction to Flight (McGraw-HilI, 1999) This is why high-performance Free Flight models have such long tail moment arms. If we aren't careful to keep the tail boom and the stab light, this long moment arm can mean a slow response to pitch upsets, such as stalls, as well as an increase in overall model weight, both of which hurt glide performance. So there is a practical limit to how long we make the tail boom.

And what about the undercambered stab? For practical tail volume coefficients, and to avoid stalling the stab, the stab lift coefficient will be fairly small, so the stab will be at a small angle of attack. Undercambered stabs have significantly more drag at those angles than do thin, symmetrical stabs. (See, for example, *Profilpolaren fur den Modelflug*, by Althaus.) And this diminishes the performance gain we sought by using a lifting stab in the first place. Furthermore, if one uses an undercambered stab on an older model with more modest tail volume coefficient, trimming the model may actually require a down-force on the stab, which would put the stab at a negative angle of attack, with even more drag.

So, for our purposes, we would be better off to use a thin, symmetrical stab. But building and mounting an accurate, untwisted symmetrical stab is more difficult than for a flat-bottomed stab. Also, a flat-bottomed airfoil of the same thickness gives better leverage for dethermalizing. So it becomes an interesting design trade-off. Another possible answer is to use a thin, flat plate for a stab. I have tried this, with some satisfaction, but the stab was easily broken. So a good compromise solution to all these practical issues is to use a flat-bottomed, moderately-cambered airfoil, just thick enough to be strong. And that is how most Free Flight stabs are built.