STABILIZER (& FIN) SIZE VS. STABILITY

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This is a very useful article that provides ideas for explaining the flight behavior of model airplanes. It was originally published in the Jan/Feb 2005 issue of the Flying Aces News.

Adequate longitudinal (fore and aft stability) in our models is readily achieved by most with a combination of forward CG and a larger horizontal stabilizer. The usual formula of a tail area equal to at least 25% of the wing area meets the test of reality, though 30-33% is even better. True scale tails, at about 15%, just don't do the trick.

Why aren't full scale tail surfaces made larger? Surely, pilots would appreciate the greater stability—approaching that of an autopilot—or would they? Here is the answer. Greater stability produces reduced maneuverability. At about the 25% point aircraft become reluctant to dive steeply no matter how much force the pilot applies to the controls. When a large horizontal stab was used in the BE2c, a WW I Royal Aircraft Factory design, complaints from air crews were fierce. Men died because they were unable to dive away from attacking German aircraft. Upon investigation, the BE2c was officially declared a "non-diver": The commotion has strongly influenced full scale design parameters ever since. Result: tails are small.

Model designers know this. With them, making the horizontal stab bigger is an important and necessary step. The problem is a tendency to make the vertical tail larger as well. Doing so maintains a sense of scale - if only the horizontal stab is enlarged, the vertical stab seems too small. The catch is that making the vertical stab larger will probably lead to spiral instability.

We struggle with two basic forms of lateral (side-to-side) instability: that sensed under power and that developed in the glide. These differ because the prop blast itself is a powerful factor in lateral stability; prop blast presence or absence has much to do with the result.

Prop blast doesn't go straight back; it spirals, reflecting the motion of the prop. The usual affect of a too large vertical tail, taken together with motor torque, is to force the model into a left bank. Unless corrective action is taken, the final result is usually a spiral dive into the ground. Fortunately, for most models the cure is simple: offsetting the prop a few degrees to the right, or adding right thrust.

When a model is gliding with torque and prop blast no longer significant, oversized vertical tails can produce a delayed spiral dive either to the left or right. Because the disturbing force is small, it sometimes takes many seconds for the instability to become clear. In some models, only a lengthy thermal flight will force the slight "divergence" to reveal itself.

We tend to write off such late flight oddities as flukes owing to sudden wind gusts. Sometimes, this is indeed the case, but sometimes not. If you see it on two or more separate flights, the chances are that the instability is real.

As to the cure, some believe in potent combinations of washin and washout. I don't. There will always be some gust/breeze/thermal combination that will negate those washin/washout settings to recreate the unwanted spiral dive again. Instead, I think the only genuine solution is to chop the vertical tail down in size to something acceptable. It should be less than scale in size. Unfortunately, the process is no fun. Removing the vertical tail is not easy, and reducing it in size is a nuisance, When all is done, it invariably seems too small.

Can this resizing be overdone? What happens if the vertical tail is made too small? A new form of instability then arises, called Dutch Roll, in which the model rolls slightly clockwise, then counterclockwise, etc. This happening is rare; I've only seen it a few times during the course of my modeling career. As a practical concern, I don't think we needn't worry about this one. With full scale vertical tails so large, most real airplanes are spirally unstable. Oddly enough, pilots don't complain. They like that feeling of being in control that's given by a large vertical tail.

Tailspin Editor's Note: Two airplanes, the WW II Vought F4U Corsair and the post war Grumman AF-2 Guardian, when done as rubber-powered stick and tissue models, often require reduction of their vertical tails to fly successful/y. There are others as well. In general, however, caution is advised when fooling around with the stab sizes of proven designs. Do not make any changes until you are absolutely sure that stab size is indeed the source of a model's flight problems. One thing you can be sure of however, is that a rubber scale model with true scale fin and stab sizes isn't likely to fly very well.