FLY RC PROJECT by Tom Hunt

Multiplex Twister

Aerodynamic Handling Improvements

Improving the Breed Part 2

The stock Multiplex Twister EDF model is a fine flying machine. It does, however, have a few quirks. Last month, in the first of this two-part series, I described how to make your Twister go faster without consuming more power. The simple changes implemented made a dramatic effect. The speed of the model increased nearly 10 mph (from 70 to 80 mph) with a very small weight gain.

THE FUNNIES

Maybe some of you have noticed the waggle that the Twister exhibits at low speeds or in a high speed dive with the power off. In this article I will describe to you the steps I took to find the cause and remove this unwanted motion. The motion can be described as "Dutch Roll" instability, and it happens when a model oscillates in both the roll and yaw axis at the same time. Typically, in jet-type models with long slender fuselages and smallish wings, this can be attributed to too little vertical tail area.

The other annoying trait happens when the model is put into a steep power-off dive and oscillates at a fairly high frequency. This oscillation is mostly in the yaw axis, but there is also some roll coupling. Though it still is a complete mystery, I suspect the problem is coming from nearly the 100% spillage of air around the inlet lip because of the windmilling fan with the power shut off. This spillage could be causing some very unsteady aerodynamics down the side of the fuselage. This is pretty easy to correct by leaving just a little throttle on during the dive and swallowing most of the air to send it down the tailpipe.

THE FIXES

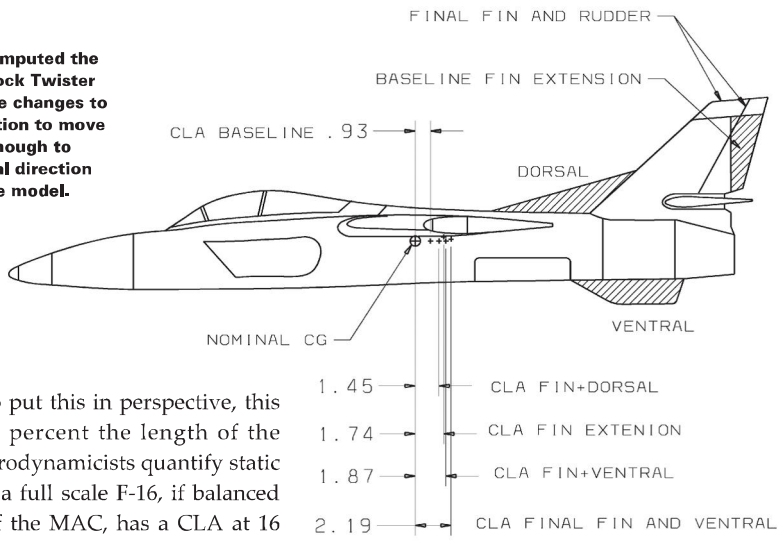
Multiplex was kind enough to put a scale side view of the Twister into their instruction manual. I scanned the image into my CAD program and using the specified CG location, I began to do some analysis.

I think many of us know why airplanes fly straight without pilot input; a sufficiently large vertical tail. Just as feathers on an arrow make it fly extremely straight and a weathervane points into wind, the Center of Lateral area (CLA) must be behind the CG of the model or arrow, or a weathervane pivot point. The CLA is nothing more than a calculation of the position of the point at which just as much area is ahead as is behind that point. For complex shapes (such as the side view of any aircraft) it is handy to have a computer. One other way to find the CLA of any object is to make a stiff cardboard cut-out of the side view and stick a pin in it to see where it balances. This cutout can be a reduced size as long as the shape is scaled accurately. If the CG of your model is significantly ahead of this point, then you probably have a stable model in at least the yaw axis. There are many other factors that contribute to the yaw stability of a model, but when you find any model where the CLA is pretty close to the CG, you can almost guarantee that the vertical tail is too small. In the case of the Twister, the CLA is behind the CG, but so little that this Dutch Roll tendency rears its ugly head at low speeds when the model angle of attack (AOA) is fairly high.

I have been involved with full scale and model aircraft design now for over 30 years, and it is surprising how many times the "TLAR" method (that looks about right) is used. Then when a problem shows up (usually through flight or wind tunnel testing) then "real" engineering is applied. When I first saw and flew the Twister, I had this feeling in my stomach that the vertical tail was just too small. Analysis and flight testing confirmed this feeling. Below is an assessment of the CLA of the Twister, and some changes I proposed to fly to see if they went in the right direction to cure the problem.

As you can see, the stock model CLA is less than one inch behind the specified CG which is approximately at the standard 25 percent

PHOTOS BY TOM HUNT



The author computed the CLA of the stock Twister and then made changes to the configuration to move the CLA aft enough to improve lateral direction stability of the model.

of the MAC. To put this in perspective, this is less than 10 percent the length of the MAC (a way aerodynamicists quantify static stability). Even a full scale F-16, if balanced at 25 percent of the MAC, has a CLA at 16 percent behind that CG. This was my first analytical clue that the vertical tail was smaller than ideal. I proposed to do some very simple changes to a stock Twister with simple foam and wood extensions before I committed to a permanent and final solution. Those changes include; enlarging the vertical tail in chord only, adding a dorsal fin and lastly a ventral fin.

Quick foam pieces were added to a stripped, but stock Twister to assess changes that might improve handling qualities of the model during landing and stall.

For each flight only one modification was employed. However, before I made any changes I made nearly a dozen flights with the stock Twister to fully understand the handling qualities at high speed, low speed and stalls. The first modification I tried was the simple addition of a trailing edge extension to the fin. It seemed like I was certainly going in the right direction, but at very high AOA, the model still did not handle well. The nose would slice off to the right or left and then drop a wing, just as it did in the stock condition. The Dutch Roll prior to the stall was a bit reduced, however.

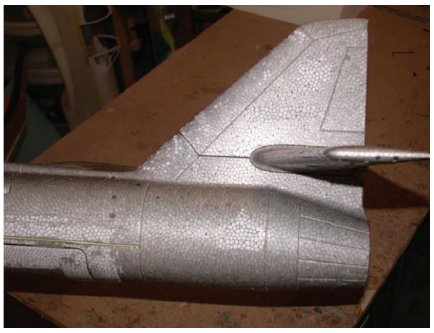
The next mod, though I had little confidence it would do any good, was to add a fairly large dorsal fin on top of the fuselage. Again, it showed some improvement but failed to improve the handling near and through stall. The dorsal fin becomes masked by separated flow over the top of the wing/fuselage at high AOA. The dorsal was then combined with the trailing edge fin extension, with still no remarkable improvement. The dorsal was abandoned and a ventral fin added. This is a particularly common fix to many 1960 and 70's jet fighters of both the US and Russian armed flying services. The Russian dorsals got so big on some aircraft they had to be folded out of the way for landing! The ventral fin cured the nose slice problem through stall and the model now stalls straight ahead every time. The Dutch Roll tendency was also reduced substantially.

Now, if I was going to accommodate a permanent change to the model, the ventral fin would have to be made from 1/8 (3mm) light ply and the fin extension, to look right and provide me with the rudder control I longed for, would need to be extended up and aft. Work on the model progressed quickly.

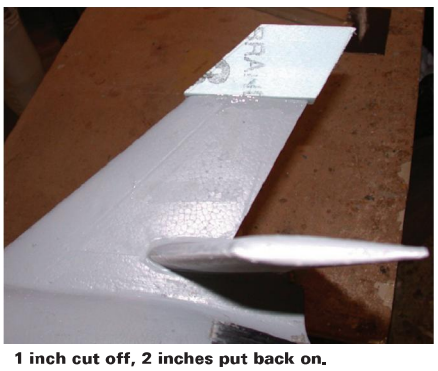
The stock vertical tail was cut off about an inch from the top to provide a better gluing surface for the two-inch foam extension. I cut off the trailing edge at a steep angle to create a hinge line for the new balsa rudder. Then, I glued a piece of Dow blue foam to the top of the old fin and shaped it to an airfoil. A piece of 1/8 sheet balsa glued to the aft face provides some stiffness to the assembly and a good anchor for hinging the rudder.

After the assembly was dry and sanded into shape a solid balsa rudder was shaped and covered with gray MonoKote and hinged to the new fin with live hinges.

I installed a Hitec HS-55 servo in the left hand side of the fin just ahead of the stabilizer leading edge to complete the new modifications. The added servo, pushrod and associated wire moved the CG aft a bit. Fortunately the stock model requires the modeler to install two steel ball bearings in the aft fuselage. I just dug them out with an X-Acto knife and filled the holes with spack-

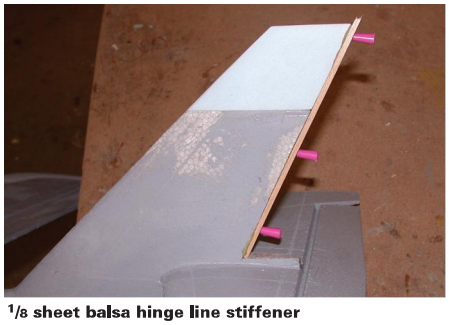


Stock tail



1 inch cut off, 2 inches put back on.

Stock tail



1/8 sheet balsa hinge line stiffener

Completed mod with solid balsa rudder installed

Rudder servo installed in LHS of fin.

le. If you are doing this modification from a brand new Twister, you can simply leave them out. If you are not interested in a movable rudder, just put one ball in. As a final touch, a coat of Latex house paint (1960/70's US Navy gray) was applied over the entire model and some appropriate decals added.

FLYING

I could not be happier with the way my Twister flies now. The increase in speed (from Part 1, last month) and now superior handling qualities during low speed and/or high AOA flight, including aerobatics, makes this one of my favorite models to bring out to the field. The Dutch Roll is all but gone, the model stalls straight ahead and will only spin (more like spiral) when I ask it to with rudder. The rudder is a great bonus. Not only does it add to the repertoire of the models aerobatic capability, the model can actually be flown rudder/elevator only! Yes, that is right. I intentionally made an entire flight with the ailerons disabled and the rudder hooked into the aileron channel. I certainly do not recommend this for normal flying, but it is a lot of fun to watch; an 80-mph rudder-elevator jet! I never did fully correct the tendency of the model to shudder in a high speed power-off dive, but the motion was substantially reduced by these mods. The full solution as mentioned earlier is to leave the power on slightly while diving.

CONCLUSION

Just a little analysis and some simple modeling steps have made an already great model into something really special. I hope you attempt this mod to either a new or old Twister. It breathes new life into a great model. Also, if you have another model with similar traits, consider some experimenting on your own. You may well find success with a much more predictable and enjoyable flying model.

Links

Hitec USA, www.hitecrcd.com, (858) 748-6948

Multiplex, www.multiplexusa.com, (858) 748-6948

For more information, please see our source guide on page 121.