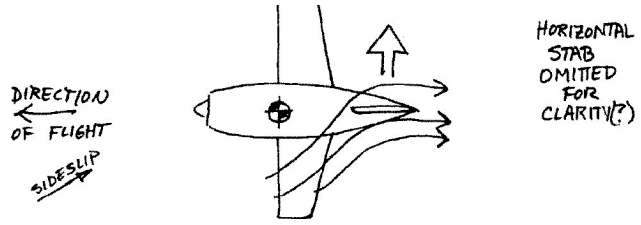
FORWARD FINS IN THE FAST LANE

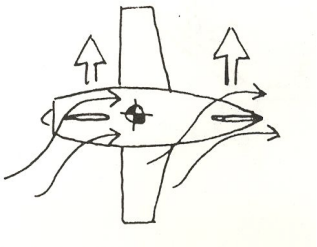
Dangerous Musings by the Tom Arnold

An Article by Tom Arnold published in the March 1991 issue of Scale Staffel.
Although this seems to be about scale models, there are some lessons here for all types (ed.)

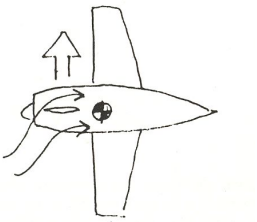
We who build free flight scale look with great envy at all the excess stability that the sport flyers and competition types flaunt. Life is so cruel - we work five times longer on a Sopwith Camel than some sport flyer with a 1930's gargoyle. Then we watch our Camel spin and pirouette to certain destruction while the old timer floats sedately through every gust around. If we bend up the wings on the Camel, it looks so ridiculous that small children point and laugh. Luckily, free flight scalers are devious and cunning and we have a bag of tricks that allow us to cheat nature to various degrees. When it comes to dihedral and tail size, there's an interrelation that we can play with to squeeze a bit of stability out of. First, let's look at why a large vertical tail makes a model want to spiral dive in. See in the illustration below how the side slip causes lift on the "wrong" side of the vertical tail. The side slip causes the nose to swing towards the ground if a model starts to fall off on one wing. If the aircraft is in a flat skid, it's good as it causes the aircraft to "weather-vane" out of the skid. How often does that occur in a model? Hardly ever!



Obviously, if we got rid of the vertical tail we'd get rid of this problem. The only problem is now the tail is free to swing wildly back and forth with no damping - not much better. The answer is to have a tail big enough to just stop the Dutch Roll but no more. The tail will still try to cause a roll off, but now we bring in dihedral to stop this small roll off force. The bigger the vertical tail, the more dihedral we will need. Before we leave the vertical tail to ponder the mysteries of dihedral, let's look at what a forward fin would do.

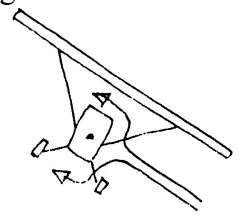


See how the forward fin tends to counteract the aft vertical surface? I know, I know the next question is, "If that forward fin works so great, why don't we have it only?" Take a look at what would happen if the aft tail was removed - the airplane would swap ends.

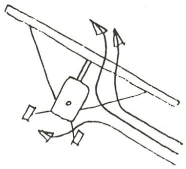


So what's all this leading to? Well, for years we have naturally "cranked in gobs of dihedral as a cure for spiral instability, but for some reason we never touch the size of the vertical tail. What's so sacred about the tail? We cheerfully enlarge the horizontal stabilizer and don't give it a second thought. In fact, a small stab looks funny to us now. Yet we can cut down on the dihedral by just shrinking the tail. Dave Kemp had a heck of a time with his Westland Wyvern which has a huge vertical surface, but it tamed right down with a 1/5 shrinkage of the scale outline. No one would have noticed had Dave not brought it to the attention of the observers either. Another way to cut down the size of the tail is to make the rudder "free to flop." In this way, it folds back away from the side slip and effectively eliminates itself from the vertical area. Make sure it really is free and floppy though, if it hangs up you'll have a wild ride before ground contact! Yet another trick, if the tail size is truly sacred to you, is to install a clear plastic fin forward of the CG. The area of the forward fin essentially subtracts a lesser amount from the vertical tail. Pat Dailey at the last FAC NATS had a beautiful Hawker Hurricane of about 24-26" span that was electric powered and just a gem. Flying was another matter as it rolled and dived in no matter how Pat trimmed thrust,wing tabs, or rudder. It acted like it needed more dihedral but that's a bit difficult to gin up on the flying field on a finished scale model. Pat's solution was to install a clear plastic forward fin right in front of the canopy and the result was 1st place in Power Scale with beautiful long smooth flights. What was surprising was that the Hurricane's tail is not big to begin with! It was a great cure and you could not see the fin in the air, and in fact is hard to pick out in the close-up photos.

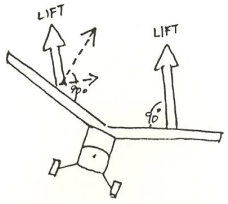
Parasols have never been too spirally stable and it's always a surprise to the modeler who expected his parasol to act like a high wing cabin job. You can see why now because the air flows right over the top of the fuselage and never touches the wing.



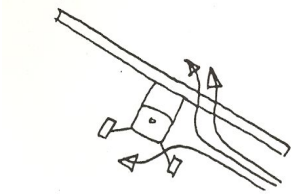
However, look what happens if you put a clear plastic forward fin between the wing and the fuselage. The upward sliding air is forced up against the low wing and you get roll out instead of roll off!!



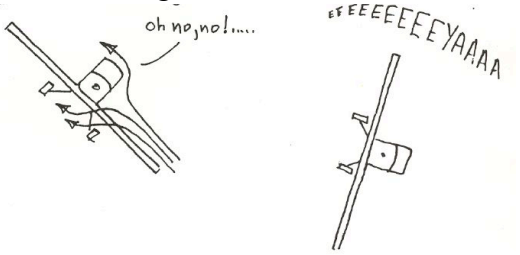
Dihedral works in 2 ways. One is the low wing has more vertically directed lift than the high wing.



But that's only a small part. The biggest is that air flowing against the side of the nose in the sideslip flows up the fuselage to strike the low wing. The wing "feels" this as an increased angle of attack (the air flow is hitting the airfoil on the chin instead of the nose) and consequently produces more lift than its mate.



Now you can see why low wings are so spirally unstable. The airflow slides down the fuselage to hit the wing at a downward angle. The wing "feels" this as a lesser angle of attack and produces less lift than its mate and over she goes!



Now comes a bit of armchair theorizing. Remember what a dog a Fokker Triplane is to fly? Come on, you've all built one and it is a DOG. Dihedral looks ridiculous on It, but what If you put a clear plastic fin between the fuselage and top wing? Would that work? If Dutch roll occurs, it means the vertical tail is too small to handle the plastic fin, so enlarge the tail a bit then. That's less offensive to the eye than 3 wings of dihedral, for sure. If anyone has a DR and they haven't stamped in frustration (I did), please dust it off and give it a try. Let us know your luck.

A final note on forward fins. If you put a big enough one right over the CG, you don't need any dihedral. Walt Mooney (who else) had a little profile sports job powered by an .049 that had wings as flat as an Ironing board and a huge cut out of a cartoon pilot. It was the most stable

thing you've ever seen and buzzed cheerfully around the sky all morning.