

# NOTES ON SYMMETRIC AIRFOILS

By Clarence Mather

*Published in the July 2008 issue of the WHAM Newsletter*

*Ed. Note: The late Clarence Mather was a prolific designer and builder of scale models*

Tom Arnold's Flightline Musings, July 2004 (Scale Staffel) issue, brought back memories of that occasion. We were at a Cactus Squadron's contest some years ago and rain began to fall. Three of us dived into my mini camper. A couple of my models were out and Tom looked them over closely and asked a lot of questions. We were parked on a dirt road used by farm equipment, a half mile from the hard road. Time flew by and finally Tim reminded us that water changes dirt into mud! Yikes! I fired up the Nissan's mighty four cylinders and we slithered our way to the hard road. There was an incline up to it and the truck spun its wheels and stopped. Lucky for me some of the saner fliers saw us dallying out there and waited for us. It took the muscle power of several to get that clunker up to solid ground! True friends!

The models that Tom inspected were a Folkerts SK-3 and a Topsy Junior. Tom has an excellent memory but the models were about 22" in span and so not Jumbos as reported. The airfoils had bottom recures about two thirds that of the top. So they were semi-symmetrical. I'm not trained in engineering so my comments will be mainly uneducated guesses from eye ball engineering. Somewhere I read that symmetrical airfoils have a fixed center of pressure rather than one that moves forward with the angle of attack. This effect was nicely explained and illustrated by Tom. Most of my scale models are of low wing design and have their pitch stability strongly affected by that motion. We have to add nose weight or move the rear peg forward farther than a mid or high wing design. Some full size aircraft have symmetrical airfoils including the B-17, the Hughes Racer and the Taylorcraft lightplane. I wondered how a model would perform with them. The bottom of the wing of an old low-wing was remodeled by adding recures to the ribs and recovering.

The top was not changed. No precise measurements were made, but the model flew well with good stability. It seemed as good or better than before.

There are other features of recurved airfoils. Many of the aircraft that we model have some recurve. Models that include it are more realistic. They have less drag than other foils and so the models fly faster thus producing more momentum. They will penetrate rough air better. With the recurve, the rib is deeper. If surface spars are used the wing can be made lighter. I find surface spars much better than the single deep spar often used. Air forces acting on the wing tend to bend the spars. One side is compressed and the other stretched. The wood in the middle holds the edges apart. This is a leverage action throughout the wing where the forces are inversely proportional to the spacing. If the recurve rib holds the two spars fifty percent farther apart, the forces on the spars are reduced by one third! So the spars can be considerably lighter. On the models that Tom studied, the wing panels were about 11" long. Two spars were on top and two on the bottom directly below.

I use very hard balsa for spars and edges as it is less likely to be brittle. I strip all spars and edges with a razor blade, metal straight edge, and eye ball micrometer. So the dimensions are approximate. The spars were about  $1/16" \times 1/32"$  at the centers and tapered towards the tips as the forces are usually less there. I have built two jumbo sized models with these airfoils. Those spars are about  $1/16" \times 3/32"$  at the centers. If a frame seems too flexible, small pieces of balsa can be placed between the spars halfway between the ribs. That step will stiffen it considerably. I place ribs quite close together and so haven't used the spacers much. The ribs are made of softer balsa and sometimes lightening holes are cut in the wider areas. Do not remove wood from between the spars though, as it is needed to hold the spars apart.

Building the recurved wing is more work than other types. I measure how deep the recurve is and then cut small balsa blocks to that thickness. The blocks are pinned to the building board and the edges of the wing are pinned to them. Making the block higher can produce washin or washout, if desired. Tapered wings require blocks of different sizes at three or four stations.

I have built ten or so wings of this type. They are strong and perform well.