Diva, Part 4

As mentioned in last month's column, construction of the Diva airframe has been completed for some time. As we receive so many questions about how to achieve a smooth aerodynamic fuselage from basic sheet and block construction, this month's column is primarily devoted to explaining how we accomplish that task. We've also included some photos of the completed framework just prior to painting and covering.

Fuselage structure

As previously explained, the fuselage consists of eighth inch plywood front sides, eighth inch balsa rear sides, and eighth inch top and bottom sheeting. The fuselage sides change from plywood to balsa in the area of the main spar. The initial rectangular cross-section is held together with triangle stock at the box corners. The plywood sides were cut to follow the eventual cross-section, the triangle stock was added, and then the top and bottom sheeting was glued on. See Photo 1.

The root of the wing does not meet the fuselage itself, but rather is butted against a fully sheeted root fillet. Creating this fillet was a task which involved a lot of 3-D visualization. The outer rib of course matches the wing root. The rib against the fuselage side is five inches longer (19") but retains the same contour dimensions as the wing root from the leading edge to the area of the section high point. The upper rear surface of this root rib is formed by a straight line from the high point of the profile to a new trailing edge point which is half way between the datum line and the airfoil high point. The lower surface is formed by a straight line from the new trailing edge point and tangent to the section lower surface. Figure 1 shows this construction process in graphical form. Photos 2 and 3 portray the completed fillet fairly well.

Fuselage shaping

The eventual fuselage cross-section from the nose to the maximum thickness point of the wing has a circular top and bottom. The nose is perfectly circular; in the area of the receiver and servos the cross-section has transitioned to flat sides and circular upper canopy and lower belly.

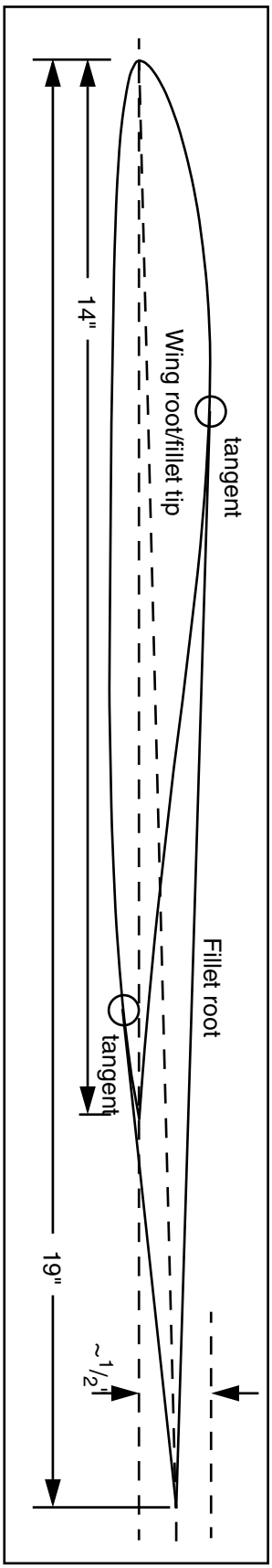


Figure 1. Diva wing fillet construction

Transforming a rough rectangular structure into a shape with smooth rounded flowing lines is not at all difficult, just somewhat time consuming. We spent about six hours getting this fuselage into shape and ready to 'glass.

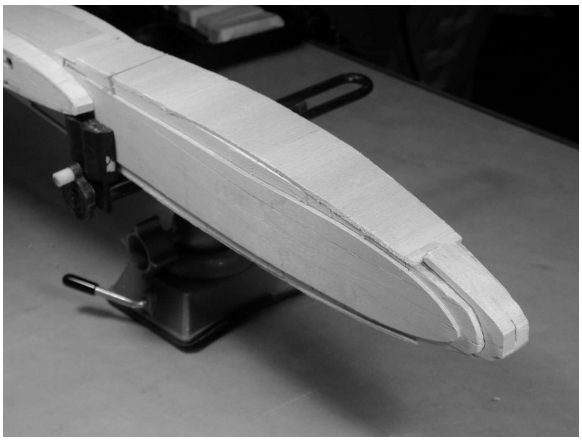
Our tools included a large X-Acto carving blade, #11 blade and a circular hollowing blade, a Stanley low angle plane, and coarse and fine PermaGrit attached to aluminum sanding bars with double sided carpet tape. The latter creates a lot of dust, so frequent use of our new Emerson Electric Stinger miniature shop vac was a necessity and worked extremely well. The Stinger also easily picked up the shavings created by the knives and Stanley plane.

Shaping the Diva fuselage is accomplished in a few simple steps. Maintaining the appropriate top and side views is a primary consideration. In the case of Diva, the plywood sides and attached triangle stock are used to get the balsa upper and lower sheeting to conform to the side view outline while the internal bulkhead and servo tray hold the structure to the top view outline.

The first step in shaping the fuselage is to cut down the sharp corners at a 45 degree angle until the flattened crest is slightly higher than the eventual contour. See Photo 4. Progress can be judged by referring to the plans and watching the size and shape of the exposed triangle stock and seams.

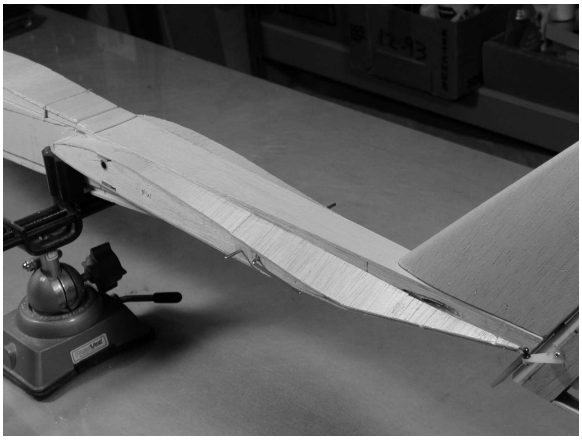
The next step involves holding a rough sanding block at the appropriate angle and taking down the eight angles formed by the initial rough carving. Watching the shape of the shaded plywood layers and the exposure of the interior laminations is used to assist in getting the final smoothing just right. See Photo 5.

Templates can now be used to check



1. Diva's basic rectangular fuselage, ready for shaping.

2. The wing-fuselage fillet viewed from the rear.



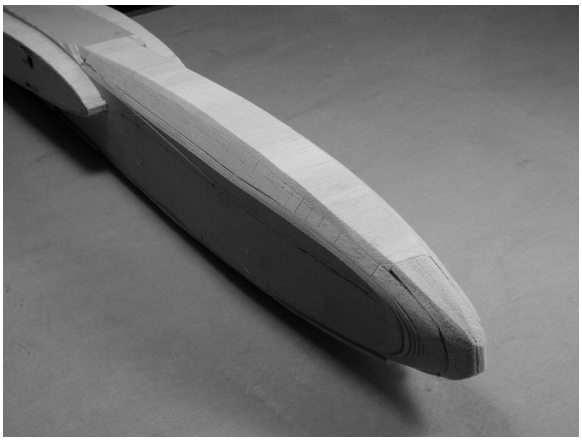
3. Another view of the wing-fuselage fillet. The rudder pushrod exits the fuselage just above the fillet.

progress. Our semicircle templates are made from plastic cards using brand new Forstner bits and are in eighth inch increments. Photo 6 shows several of these cards in position along the fuselage nose. In the cited Photo, the rear portion of the canopy near the wing is finished but, as can be seen by the sliver of light between the template and the fuselage, the front end still needs more work. A bare light bulb accentuates such differences, and creates shadows which assist in finding ridges and high spots.

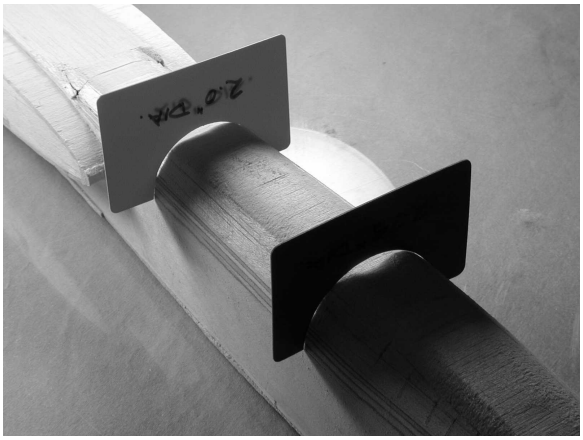
The circular portions can be shaped to final contour with strips of sandpaper pulled over the surface, much as you would use a rag to polish the toe of a shoe.

Once the fuselage met our template criteria, two layers of 'glass were glued to the fuselage bottom using thin CA. The first layer was relatively narrow, the second was wrapped up and onto the flat plywood sides. A single layer of 'glass was then glued to the fuselage top and wrapped down onto the flat sides. Light 'glass was applied to the bare wood sides and across the edge of the previously applied 'glass using clear butyrate dope. We usually use polyester resin for this task, but we found the dope to be a much more forgiving medium which held the gossamer weight 'glass to the balsa and plywood just fine. The thinned dope went right through the CA'd 'glass and bonded well to the underlying plywood and balsa. Because dope shrinks as it dries, it's important that any concave surfaces be CA'd so the fiberglass does not get pulled away from the substrate.

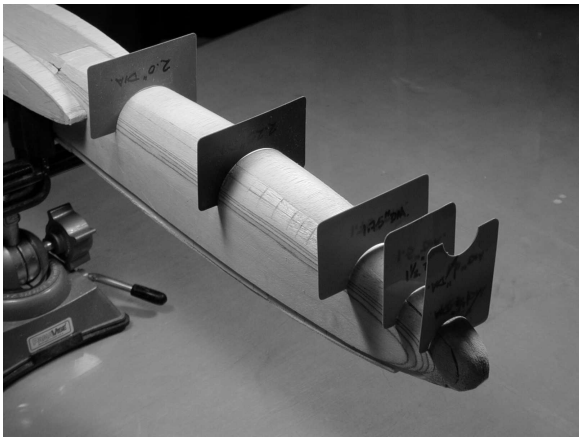
How durable the doped 'glass will be as it slams across freshly cut grass is yet to be determined, but the dried dope is certainly lighter and easier to sand than polyester resin!



4. Preliminary carving at 45 degree angle.



5. The initial template check following blunting of corners. A bare light bulb shows the gaps and creates shadows along the ridges.



6. Another contour check using the plastic templates. There's still some work to do near the nose.

Now it's time to cut the access canopy free from the fuselage. We use the point of a single edge razor blade to penetrate a spot along the seam, then work the blade from one end of the seam to the other. In areas where the blade cannot make progress, we use a thin X-Acto razor saw which has ben removed from its spine. It's important to work slowly with this tool, as it's easy to get off the seam.

Finally, we used the X-Acto circular hollowing tool to carve out the excess balsa from the inside of the canopy, leaving a shell about an eighth of an inch thick. This interior hollowing provides clearance for the servo arms and room for additional protective foam around the receiver.

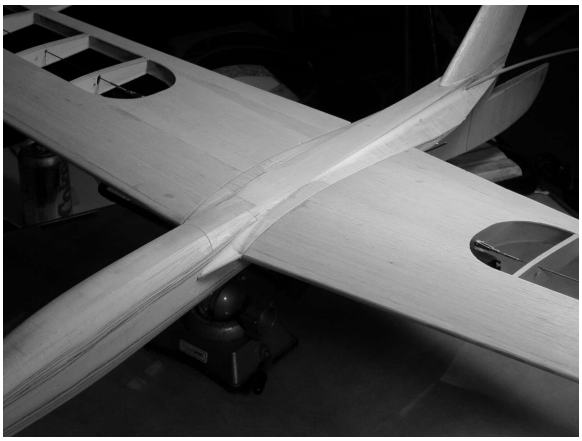
Details of the completed fuselage can be seen in Photos 7, 8 and 9.

Ready for painting and covering!

The wing root panels are very strong and rigid. This is not surprising considering the 14 inch chord, nine percent thickness, and the box spar system. The outer panels, on the other hand, are a bit more flexible than we had anticipated, but this is due to the relatively small chord - it tapers from seven to five inches - and will no doubt improve with covering. The entire aircraft can be easily supported by the two wing tips, and we're not planning to impose heavy flight loads.

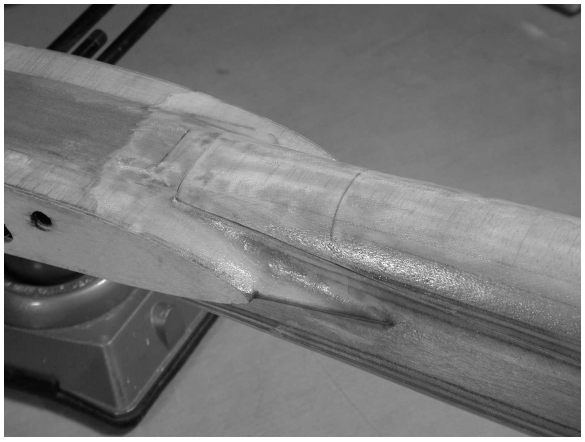
The vertical fin and rudder are just as we had envisioned; the BTP8 airfoil worked out wonderfully well for this application. The rudder looks especially good, and is both light and rigid.

We're extremely pleased with the overall shape of the fuselage, particularly the fillet which provides the wing-fuselage junction.



7. The preliminary wing-fuselage fit.

8. The completed fin and sub-fin framework.



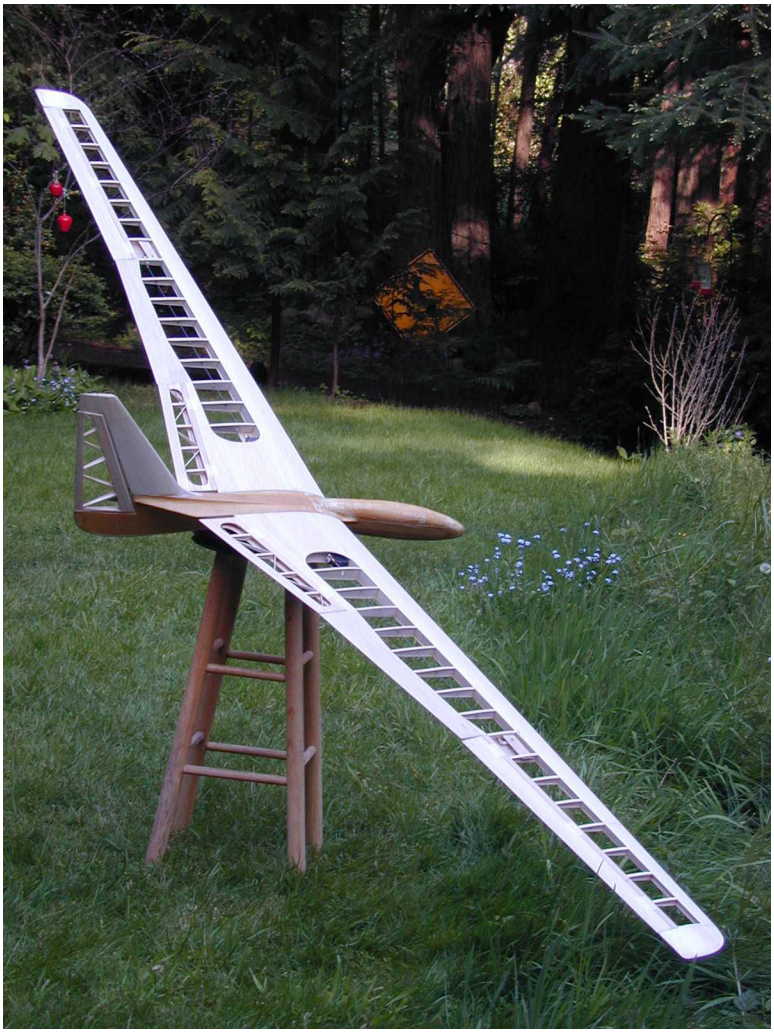
9. The eighth inch plywood chines.

The small plywood chines at the leading edge provide quite an accent.

The fiberglassing with 0.6 ounce cloth went smoothly, due in no small part to the use of dope rather than resin to attach the cloth to the structure. There was no wrinkling of this light 'glass. The single layer of 1.5 ounce 'glass cloth made the removable canopy surprisingly rigid.

10. The shaped fuselage ready for 'glassing.

The last two photos, numbers 10 and 11, show the completed Diva framework with fuselage 'glass applied and just prior to painting and covering. For those interested, the weight of the airframe at this point, with all radio gear installed, was 50 ounces. We were aiming to have this be the ready to fly weight, so Diva is going to end up to be a bit heavier than we anticipated. But with 1,000 square inches of wing area the loading is going to be right around eight ounces per square foot.



11. The completed Diva airframe, ready for final painting and covering.

Next time

The next installment in this series will cover painting and covering and initial test flying. Alyssa's already chosen the color scheme after looking at an automobile graphics pictorial in *Hot Rod* magazine, so finishing this sailplane is certain to be an interesting experience. The color photos she was perusing were sure impressive!

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