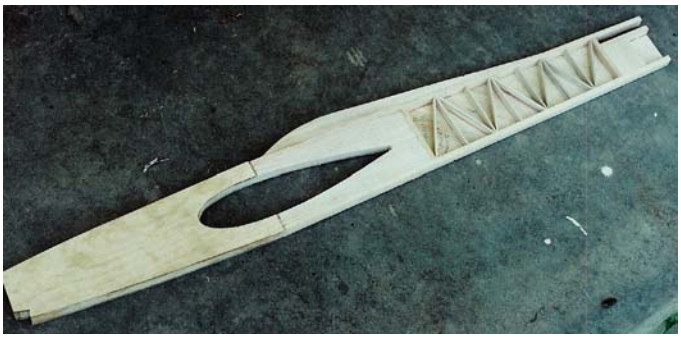
Constructing Profile Fuselages for Strength

by Larry Cunningham

Some of the construction techniques which benefit full fuselages are applicable to profile fuselages as well. However, the physical shape of a profile fuselage is a serious limiting factor. For this reason, choice of materials can be especially important.

Recently I updated the Mo'Best profile fuselage construction, based partly on some feedback by **Tom Morris** (November/December 1999 ***Stunt News***). Tom has been mass producing profile *Cavaliers*, using a fuselage construction similar to the Mo'Best t, with a framed and planked aft section.



Mo'Best V profile fuselage construction

The published Mo'Best plans show 1/16" balsa sheet planking at a bias of 45 degrees over the frame, which uses a Warren truss former structure. Tom indicated that he had experienced twist problems when the aft fuselage was doped. One might expect that with parallel grain direction of the biased planking on both sides, warping problems would be minimal. But as one reader noted, balsa can do "funny things" when dope is applied. Contracting more on one side than the other produces a twist.

Tom mentioned **Tom Farmer's** method of planking over 1/2" foam with 1/64" plywood, and the incredible stiffness it provided. I decided to try the 1/64" plywood planking over the balsa frame and was completely amazed at the results.

Actually, I built two test fuselages. The first was similar to the original Mo'Best fuselage, with the following "twists" (forgive the pun): 1) unidirectional .007" carbon fiber was applied to the interior edges of the 1/2" x 1/4" balsa perimeter frame, 2) aft former sides were curved, with .1" of convex curvature, and 3) 1/64" plywood sheet planked the entire structure aft of the nose doublers AutoCAD was used to accurately draw the curved former sides, taking into account the required heights of each for the Warren truss structure.

The convex curvature idea was inspired by a very favorable experience with my Special Effects' [full] fuselage. I expected it to improve strength and perhaps appearance as well. In practice, however, I concluded that the effort was simply not worthwhile. It was not unsuccessful, just not optimum!

As **Tom Morris** noted, the 1/64" plywood planking weighs about an ounce more than 1/16" balsa sheet. But the strength improvement is incredible! This is due to the tremendous tensile strength of 1/64" plywood. To bend or twist, it is necessary to stretch the plywood, which is virtually impossible.
Something to note here was the pre-finished weight of this profile fuselage, complete with the balsa tripler on the inboard nose: just under 9 ounces. While this is not overly heavy for a Mo'Best fuselage, the full fuselage for my Special Effects ship weighed only 7.65 ounces. It all comes down to the amount of material in a stressed skin shell structure versus a solid sheet and framed one, with heavier plywood nose doublers.

I decided to see what might be done to reduce weight, while taking advantage of the incredible strength of the 1/64" plywood planking. The second test fuselage applied changes: 1) 1/8" SIG aircraft birch plywood nose doublers were reduced to 3/32", 2) the 1/2" balsa sheet fore section was reduced to 3/8", 3) 1/2" x 3/8" hard maple engine mounts were turned 90 degrees to conform with the 3/8" nose sheet, 4) the aft perimeter was framed in 3/8" x 1/4" sticks, again with .007 carbon fiber on the interior edges, 5) vertical formers in the aft section were removed, retaining the angled "geodesic" portion, and 6) no convex curvature was used on the aft section formers.

The result was a weight savings of about one ounce over the 1/2" sheet fuselage with no significant loss of strength. I'm convinced! THIS is the fuselage for my latest Mo'Best profile, Omega.

I used medium thick CA to attach the 1/64" plywood skins and was nearly asphyxiated by the fumes! This can't be healthful. In the future, I will use a fast epoxy here.

In case you missed my Mo'Best construction article [March/April 1996 Stunt News], I strongly advocate a very robust profile nose construction. The engine mounts should be hard maple, a full 9" long, extending to the leading edge of the wing. Although 1/2" x 3/8" maple is adequately strong, I am not sure that 3/8" x 3/8" would be. My trick here was simply to orient the mounts so that the 1/2" dimension is vertical. And added advantage was the ability to slightly widen the fuselage bolt pattern for the New Mexico Universal Engine Mounting Plate.

Nose doublers should use aircraft quality BIRCH plywood - never Lite Ply. The particular plywood I used had three layers for both the 1/8" and 3/32" material. Consequently the 3/32" plywood weight was a bit more than 75% of the 1/8" plywood. But such a weight savings is significant, and the 3/32" plywood is adequately strong. As before, the plywood doublers extend slightly aft of the high point of the wing airfoil, which ties the critical nose structure to the wing.

The narrower 3/8" fuselage sheet and 3/32" nose doublers resulted in the bottom of the engine case contacting the inboard doubler. To solve the problem, I considered a thicker aluminum engine mounting plate as well as relieving the inboard doubler surface with a 3/4" Dremel sanding drum. My final solution was to add a 1/32" laminate (made up of "cross grained" 1/64" plywood sheets) to the outboard fuselage surface under the engine mounting area.

Also, to match up properly with a 2" spinner, the 1/4" balsa sheet tripler on the inboard was increased to 5/32".

The latest Mo'Best t fuselage retains the recessed fuel tank feature. Horizontal edges of the tank cutout hole in the outboard doubler and fuselage sheet align with the interior edges of the engine mounts, spaced 1.25" apart. (In theory) 1/8" Lite Ply shims can be installed above and/or below a standard 1" tall metal tank. Typically, both shims are placed below the tank to raise it 1/8". In application, however, 1/8" was sometimes not quite enough adjustment - for this reason, the engine mount directly above the tank is relieved an additional 1/8" to allow more.

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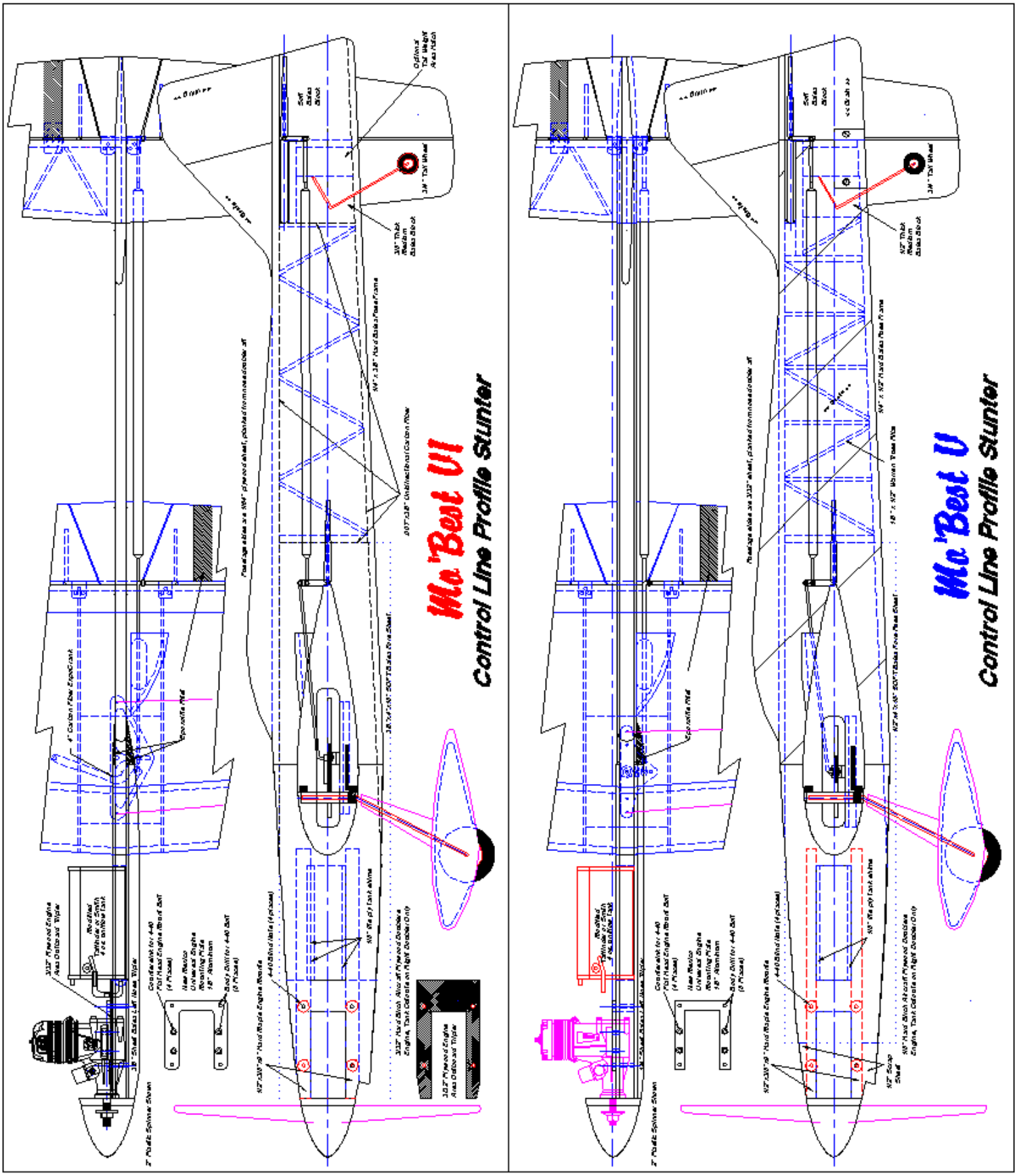

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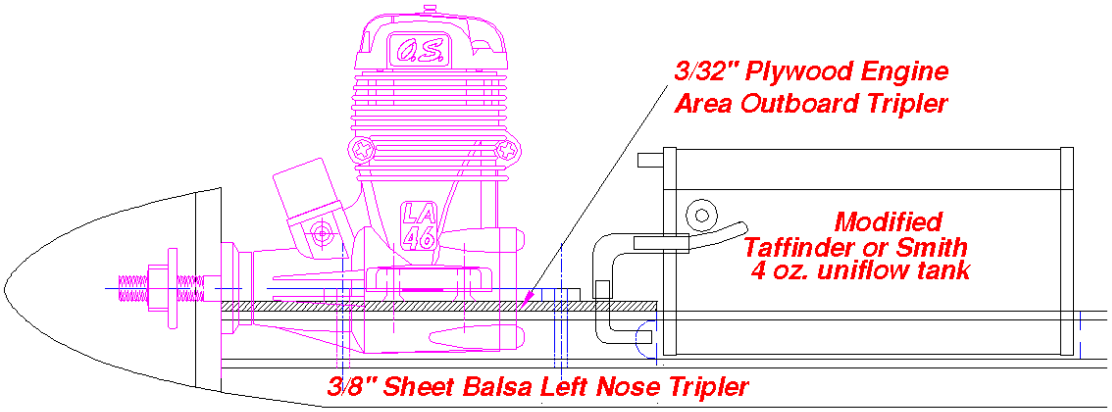

Mo'Best VI Fuse Tank Vent Detail

Another fuel tank "twist" I'm trying on *Omega* is to shield the uniflow vent from direct airflow. In the past, I've always pointed the uniflow vent forward, for a "ram" air effect. Clearly this works, but it has an undesirable side effect: increased air pressure on the upwind side of the circle tends to richen the mixture and slow the engine - just opposite of what might be desired. A short section of brass tubing "vent" is neatly installed permanently inside the fuselage. After fueling, this vent is connected to the tank's uniflow vent, which then "sees" a constant pressure of one atmosphere, instead of ram air effects.

Some notes about .007" unidirectional carbon fiber. This is an incredibly strong material, but can be fairly difficult to use. If it needs to be cut to width, a balsa stripper works about as well as anything, but the process is far from simple. You don't easily cut this material with a razor blade or fine saw. A blade often wants to follow its "grain", which complicates stripping.

Before gluing to a balsa surface, the carbon fiber surface should be prepared with #220 sandpaper. I used medium thick CA to bond it. Once in place, edges can be dressed with a long sanding block. Be VERY CAREFUL when handling any carbon fiber material! Edges can be very brittle and sharp and a splinter of this material can be very dangerous. That warned, I truly believe carbon fiber is well worth the effort.

The .007" carbon fiber material is available as precut strips in standard widths, which are far more convenient, and recommended. And fast epoxy is an alternative to CA for bonding it to balsa.

So, there it is. Thank you **Tom Farmer** and **Tom Morris** for making me aware of the great benefits of 1/64" plywood planking for profiles!

-Larry Cunningham

Three previous *Mo'Best* V profile ships