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NEWSLETTER

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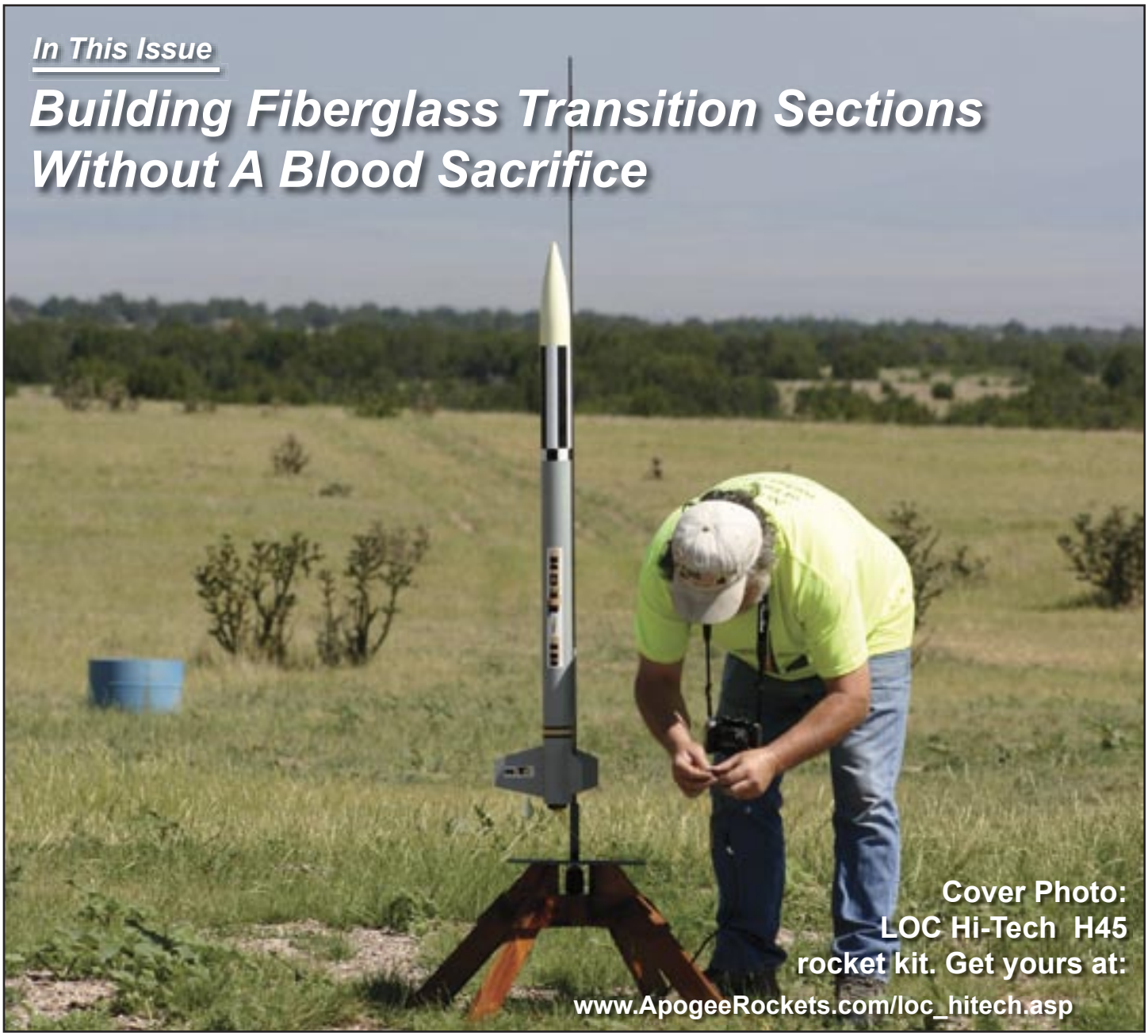
Building Fiberglass Transition Sections Without A Blood Sacrifice



Cover Photo: LOC Hi-Tech H45 rocket kit. Get yours at: www.ApogeeRockets.com/loc_hitech.asp

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Building Fiberglass Transition Sections

By Steven B. Sands

As a child, I had always been into model rockets. I still have a box of Estes models I built as a boy. My son Daniel (now in Boy Scouts) and I have participated in a few rocketry campouts here in S. California, which has led me to become a 'Born Again Rocketeer' and this time, I decided to pursue some custom rocket designs. My first was a completely scratch built rocket made from Quaker Oats cartons, and included a top transition made from balsa and covered with monokote film. But along the way, I pictured in my mind a rocket with an hourglass shaped body section, surrounded by 3 longitudinal tubes equispaced around the rocket body. The rocket would use a 3" diameter main body tube, and be approximately 46" long. It would be powered by a 29/40-120 motor, although it will accommodate a 38 mm motor mount. The big question was how to fabricate the center piece of the body?

Figure 1 shows the basic scale drawing. Originally, I had planned the section to be a true hyperbola in cross section. While easy to draw, it was not obvious how to fabricate it. I don't have a lathe in my shop, although I did call around and speak with some local woodworkers who would have helped me turn a piece on a lathe. Eventually, I decided on creating the section out of fiberglass. I had not had any serious experience with glass previously, so I thought this would be a great way to learn how to use the material.

I researched and viewed many web pages on glass model making, and decided that I was not going to make a plug, which is used to make a mold; the mold is then used to cast the final pieces. Instead, I went to a direct system, where the piece was built on an existing form directly. I found a glass wine bottle which had a curved shape which was close enough to what I had in mind. I used this bottle as the 'mold'. Initially I was planning on sliding the glass piece off of the narrow end of the bottle, which necessitated cutting off the bottle top, where the diameter is larger for the cap/cork. But in the end, this was not necessary.

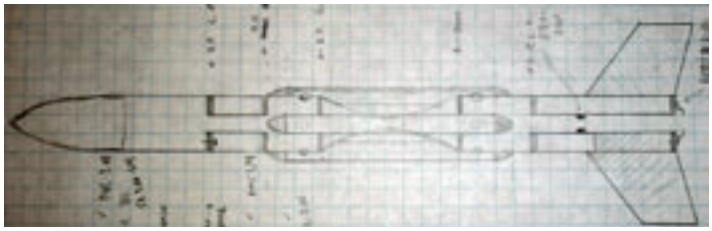

Figure 1: Scale drawing of fiberglass rocket

One important choice to make is the type of resin system to use. There are 2 choices: epoxy and polyester. I chose to use epoxy, mostly because it's stronger when cured, and the uncured resin is not malodorous and is much less hazardous. Uncured polyester smells very bad, and is not good for you. I used West System epoxy, and you can choose either the fast or slow hardener. I started off with the slow, but it's REAL slow. The epoxy will take 24 hrs to completely set. Ultimately I switched to the fast hardener, which sets up in about 30 min, and is dry to touch in about 3 hrs.

When applying the glass to the 'mold' (the bottle), just follow standard mold release directions: coat the glass first with 2 or 3 coats of liquid automobile wax (carnauba). Allow the wax to dry, then gently polish, and wipe off the excess, then reapply. Following the wax, apply mold release (again, can be purchased from West Marine). This can be brushed or sprayed on. This is the second layer of material which prevents the epoxy from sticking to your mold, and also is water soluble, which will help release the fiberglass later. You only need one coat of mold release, but make sure you cover the entire surface, and add a little extra on the ends.

When the mold release is dry, you are ready to glass. I used lightweight, 0.5 oz cloth (Sig Aircraft) for the initial fabrication. Make sure you have all of the pieces of glass precut and ready to apply. For a 750 ml wine bottle, you need to cut 7-8 rectangular pieces of fiberglass, and they will be applied to the bottle at an angle, to get the glass to lay down nicely over the complex curve of the bottle neck.

Use a roller blade (available at craft or fabric stores) to cut the glass cloth on a cutting mat. If you try to use scissors, you will most likely shear the fabric and cause a great deal of fraying at the cut edge, which just makes a mess. Use wax paper to cover your work surface to catch drips of epoxy.

When everything is ready, mix your epoxy. I use dis-

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posable pipettes for removing appropriate quantities of resin and harderner (West systems is mixed 5 parts resin to 1 part hardener). You should NOT mix up a big batch...I once mixed up about 100 mls of epoxy; I only used a small portion of it, and large batches will heat up, enough to cause vapors to arise (the curing process is exothermic) and cure very rapidly (in your mixing dish)! For a small piece, you might need 10 - 20 mls of epoxy. You will quickly learn how much to mix up.

Use a disposable flux brush to paint a layer of epoxy onto the mold (the bottle). Then, working carefully, lay a piece of fiberglass onto the wet surface. It's best to try to touch the center of the fiberglass cloth to the wet epoxy, and then gently brush the glass down, from the center out to the edges. The lightweight cloth will wet quickly and conform to the shape of the mold. Do not pull or tug on the cloth...just gently brush it down. Its not hard to do, but you have to use a light touch.

Let the surface tension of the epoxy help pull the cloth down. You need to put 2 or 3 layers of lightweight cloth all around, and be sure to overlap the edges of the pieces. You do not need to worry about the circular edges at the top and bottom of the glass. After about 2 hours, while the glass is 'green' (i.e., set up, but not yet very hard) take a sharpie marker and draw a concentric circle around the bottom and top, and cut around the line (using a utility knife) to make a clean top and bottom. Then slice longitudinally through the piece; you can gently pry the glass off the mold while holding it under warm water. Use a small stir stick to get underneath the glass, and separate it from the mold. Don't worry about the little bumps; the glass will return to its original smooth state as it continues to cure. You need to make 2 pieces as shown in Fig. 2.

Now you have 2 pieces; you will note that they are lightweight, not too rigid, and are cut down the middle. So now we must glue the edges together and reinforce them. To do this, we will add layers of fiberglass to the inside of the piece. For this step I used 2 oz cloth (comes in a 2 inch wide strip, from West Marine), cut tapered (trapezoidal) gores which dry fit nicely inside the cones. Mix up epoxy, coat the inside, and gently lay in the gores. Since this is heavier cloth, you need to ensure that there is enough epoxy to wet out the cloth. As before, the wet cloth will almost take on a translucent character when wet. This step will also glue the cone back into one piece.

Figure 2: Two completed cones

Make sure you add enough gores to overlap all around on the inside. When dry, you can lightly

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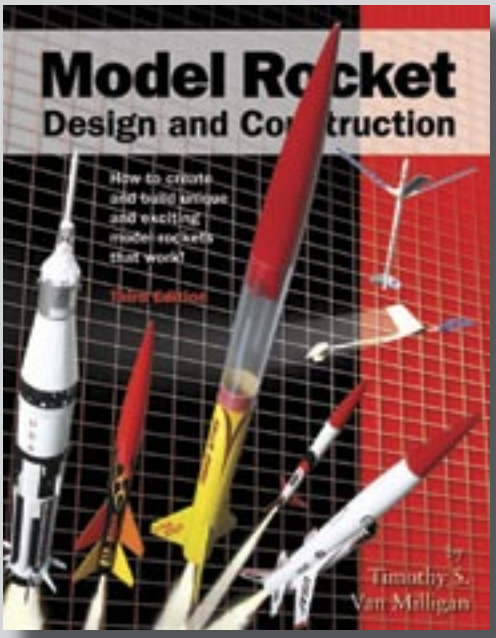

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Figure 3: Support for assembly cones.

cut/sand the edges of the piece. If the longitudinal cut did not completely fill in, don't worry...we will fill that in later.

Now the question is, how to assemble these pieces so that they are longitudinally and axially aligned. Well, it's not too hard. I used a bottle for a mold, and in general, the neck of most wine bottles is ~28 mm. So, what I did was cut balsa centering rings, and used a BT50 tube for support. It is important to note that the outer diameter of the CRs is exactly that of the coupler tube OD. The support tube is glued to the face of one centering ring, which ensures that the tube is perpendicular to the CR (Fig. 3). Again, the tube is glued to the face of the CR; there is no hole in the CR, to ensure that the tube is perpendicular to the CR (Fig. 4A).

Next, glue one cone onto the assembly. You need to add epoxy to the tube, and to the edge of the cone (Fig. 4B). Note the wide opening of the cone should not come down completely flush over the lower centering ring. If the glass cone is of the correct diameter, the CR should fit snug, and the small remaining gap will be filled with epoxy/balloons when you assemble the section to the main body tubes.

When dry, you can add the second cone (Fig. 4C & D). Here, you slide the narrow end of the cone over the tube, and when in place, use a small applicator to add epoxy down in the tip. Then, using the second centering ring, which has a 25 mm hole in the center (0.976", the diameter of the BT50 tube), glue this into the top of the cone. The two CR and the tube will maintain appropriate alignment of the cones.

The gap (however big) in between the 2 cones can be filled with epoxy/microballoons, and covered with a couple of layers of 0.5 oz cloth. Microballoons are hazardous for your lungs, and are 'dusty'. They will fly out of the container due to static, so I never open the jar inside the house.

Mix the microballoons and epoxy outside, or if you have a vacuum cabinet, use that as long as the exhaust is filtered. I use 50/50 vol. epoxy/microballoons, and apply the paste. When dry, the entire assembly can receive a light coat of epoxy, to fill in the small gaps in the cloth, or use epoxy and microballoons (it sands much easier with the microballoons). The assembly should now look like figure Fig. 4D.

The final piece of the assembly requires the addition of the coupler tubes, and again, we want to attach these while maintaining axial alignment. The bottom coupler can simply be glued to the CR. Since the diameter of the CR is that of the coupler, this should match precisely.

To attach the second (top) coupler, I purchased a 6 ft piece of aluminum angle at the hardware store. I inserted both couplers about halfway into their respective body tubes, and then while the whole body is aligned on the rail, glued the second (top) coupler onto the top centering ring.

Use rubber bands to hold the various pieces onto the aluminum angle so they don't move, and as shown, use blue painters tape to hold the body tube an inch or so up, so that it does not get accidentally glued together to the

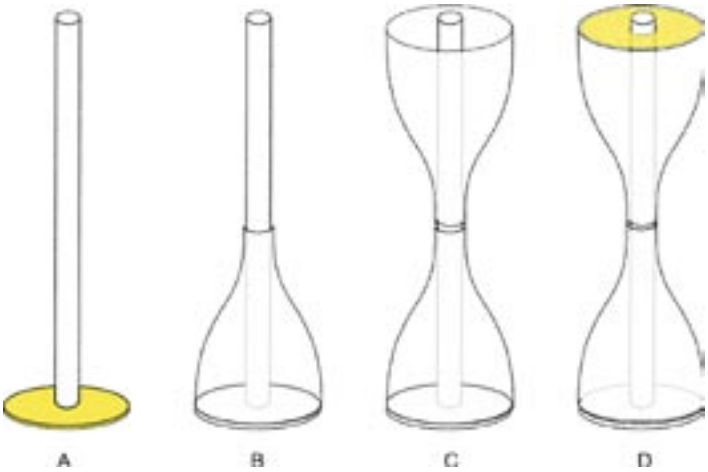

Figure 4: Assembly of the body structure

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Figure 5: Gluing the top coupler (brown tube) to the center section. Note the blue painters tape, which elevates the body tube away from the glue joint (indicated by arrow).

coupler (Fig. 5).

When this step is finished, you will have completed construction of the custom center section, which is ready to be assembled into the rocket!

The final portion of the rocket to complete is preparation of the 3 outrigger longitudinal tubes. These are made from BT20 tubes and balsa nose cones. As you can see in Fig. 1, these tubes need to be cut so that they contact the surface of the fiberglass section as well as the main body tubes on both ends.

The tubes are cut in half longitudinally for the portion that lies along the main body tube, and then have to match the curve of the fiber- glass section. In this design, because the center section is not a through section (i.e., there is no passage for the ejection charge gasses to pass through), I used the outrigger tubes for this. The reason for doing this (besides the fact that I thought it sounded interesting) is that it adds a natural baffle, and I think will eliminate the need for ejection wadding in parachute compartment.

To cut the profile onto the tubes is not difficult, and here is a neat way to do it. Dry assemble the 3 main rocket sections: top main body tube, our custom center section, and the lower main body tube, and lay this down over a long piece of paper. Take a pencil, and while holding it perpendicular to the paper, trace along the body of the rocket, so that the profile of the rocket is transferred to the paper.

Now, cut the paper along the profile. You will have 2 pieces, we will call them positive (which matches the rocket profile) and the negative profile. Take the positive profile, and trace it onto a piece of 1/4 inch thick foam board (foam core poster board, or equivalent) and cut this profile out. Cut 2 additional rectangular pieces of foam board (they should be as long the BT20 tubes, and 3/4 of the tube diameter wide), and using glue or double sided tape, attach these long rectangles 1/2 of a tube diameter below the top and bottom of the profile (see Fig. 6).

Now, use a pencil to carefully trace the profile onto each side of the tube. You need both shelves to trace the profile on both sides of the tube, and use these lines to guide the tube cutting. The portion that lies opposite to the fiberglass does not have to be perfect, because any gaps

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can get filled with epoxy/microballoons. Once the tubes are cut, I reinforced them with one layer of 1⁄2 oz. fiberglass just to stiffen them up, especially since they are outboard and may hit something when the rocket lands.

Glassing these tubes is straightforward. Sand the tubes lightly to get better adhesion through the glassine covering layer; use a dowel of some type to support the tube in a horizontal position while you cover it with epoxy/glass. I cut balsa nose cones in half, sanded them on the body tube to get the shape to match the tubes, and then glued these into the ends of the outboard tubes. I cut 1" long, 1⁄2" wide rectangular holes through the body tube and coupler on both the top and bottom portions of the rocket, to permit the ejection gasses to communicate with the parachute chamber in the top half of the rocket.

The remainder of the rocket is standard. Fins are Baltic birch ply, glued through the fuselage to the motor mount. Use a centering ring with a hole (I used a 3" diameter ring with a 29 mm motor mount hole) in the upper body tube to attach the shock cord. First flight is scheduled for the fall, once it begins to cool off at our launch site (Plaster City)

About the Author:

Steve Sands is a pharmaceutical scientist who enjoys rocketry with his son and the Boy Scouts, cycling, and pretending to be a rock guitarist.

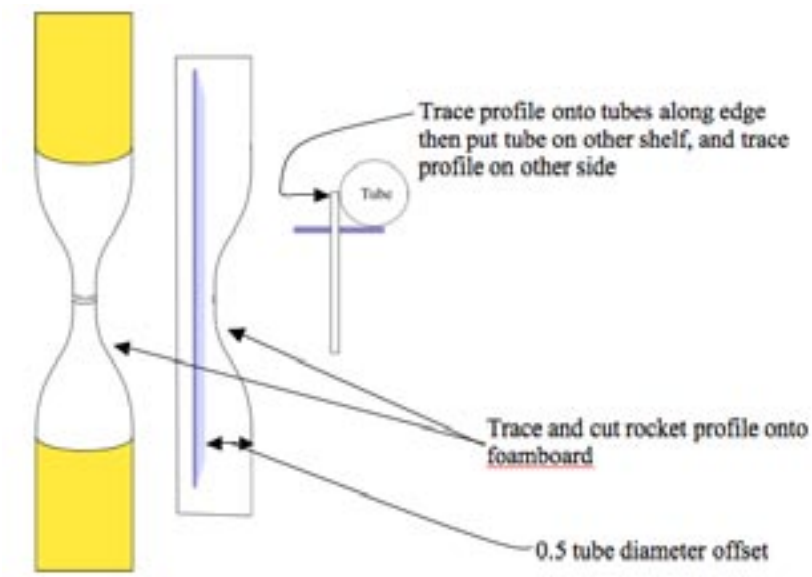

Figure 6: Creating the profile using foamboard.

Figure 7: The finished product!