PEAK OF FLIGHT

NEWSLETTER

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How to Make Paper "Ogive" Nose Cones Pt 2

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PEAK OF FLIGHT

How to Make Paper "Ogive" Nose Cones: Pt 2

By David Stribling

This is Part 2 of an article in Peak of Flight Newsletter #409. Part 2 follows the construction of the designs made in Part 1.

Nose Cone Construction

OK, now that the math is out of the way, it is time to print off the templates, start cutting out parts, and build the nose cone.

(Figure 1): Cut out the support ribs. I am using Crescent board here, but thin balsa or plywood could be used.

Draw guide lines at the points where the segments connect to help align the intermediate support discs.

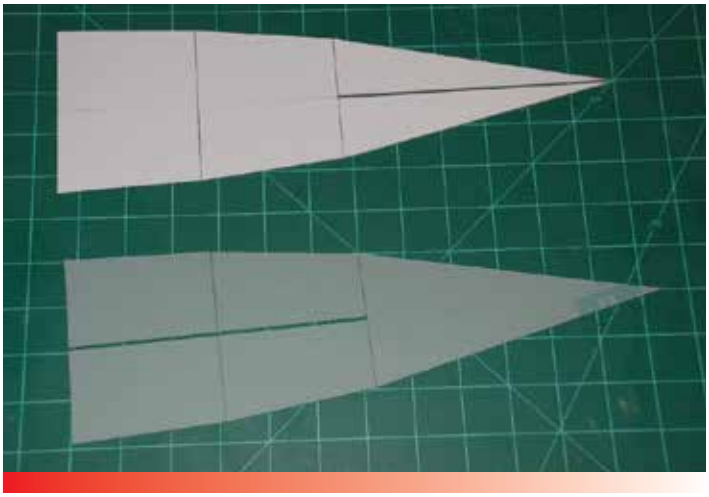

Figure 1

Figure 2

(Figure 2): Cut the support discs from cardboard or light wood. The intermediate discs will have to be sectioned to fit between the ribs.

Guide lines are drawn on the bottom disc to help align the ribs.

(Figure 3): A circle cutter is extremely handy for cutting the support discs. I am using an X-Acto circle cutter, but you can see an Olfa cutter on the work bench. I added a larger wooden handle (dowel rod) to the small plastic handle to aid in cutting from the mat board.

Figure 3

(Figure 4): Trim off the inner corner of the intermediate discs to provide clearance over the glue fillet when the support ribs are glued together.

Note the discs are marked so they won't get

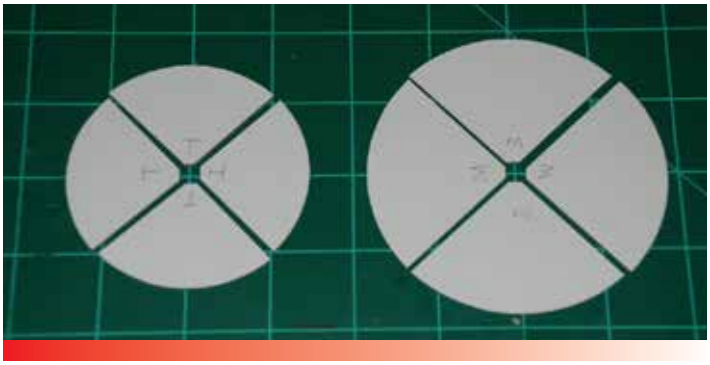

Figure 4

Continued on page 3

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Newsletter Staff

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Layout/CoverArtist: Chris Duran
Proofreader: Michelle Mason

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mixed up when it comes time to glue them to the rib structure.

(Figure 5): Apply a light bead of glue along the centerline of both support ribs, both sides. Slide the two parts together, making sure the bottom is flat.

A square is useful to make sure the ribs are perpendicular.

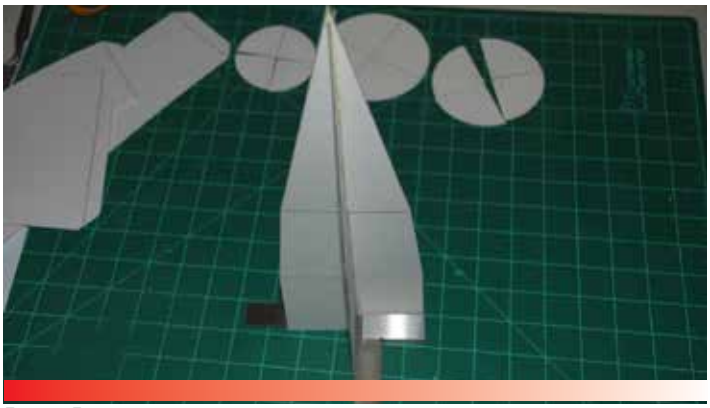

Figure 5

(Figure 6): Before the glue completely sets, glue the rib structure to the bottom disc, using the guide lines to make sure the ribs are still perpendicular.

(Figure 7): After the glue dries, apply fillets on all the joints for additional strength.

After the fillets dry, start gluing the support discs in place, centered on the guide lines drawn earlier.

You may want to double the number of intermediate discs, gluing them on either side of the

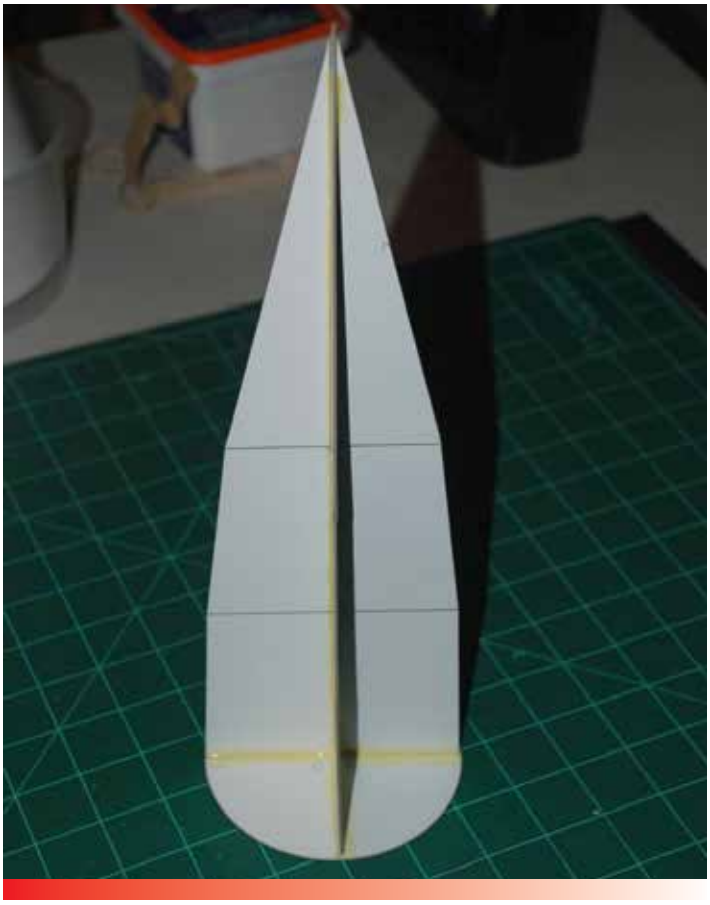

Figure 6

Figure 7

Continued on page 4

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guide line. This will give you more surface to align and glue the shrouds.

(Figure 8): Here is the finished support structure, without all the joint fillets completed.

(Figure 9): Even with careful cutting and assembly, some bumps and misalignment may occur. Sand the edges to remove any steps at the rib/disc intersections. A block sander can be used, but a benchtop belt sander makes quick work of this operation.

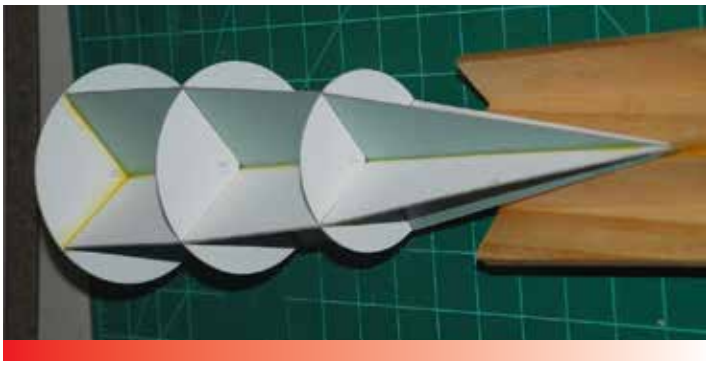

Figure 8

Figure 9

Beveling the edges of the discs will help the shroud slip over during assembly.

(Figure 10): While the support structure dries, print off the shroud templates on 110# cardstock.

I prefer to cut off the glue tab and use a backing tab so the joint is a butt glue joint rather than an overlap joint. This will make the seam easier to hide during the finishing process.

Figure 10

(Figure 11): I like to trace the glue tab onto bond (typing) paper, flip it over and trace the mirrored side to make a double width tab.

Glue this tab to the back of the shroud and let it dry. I used Aleene's Tacky Glue to glue the shrouds. It shrinks less than yellow glue, plus it grabs quickly so you don't have to hold the

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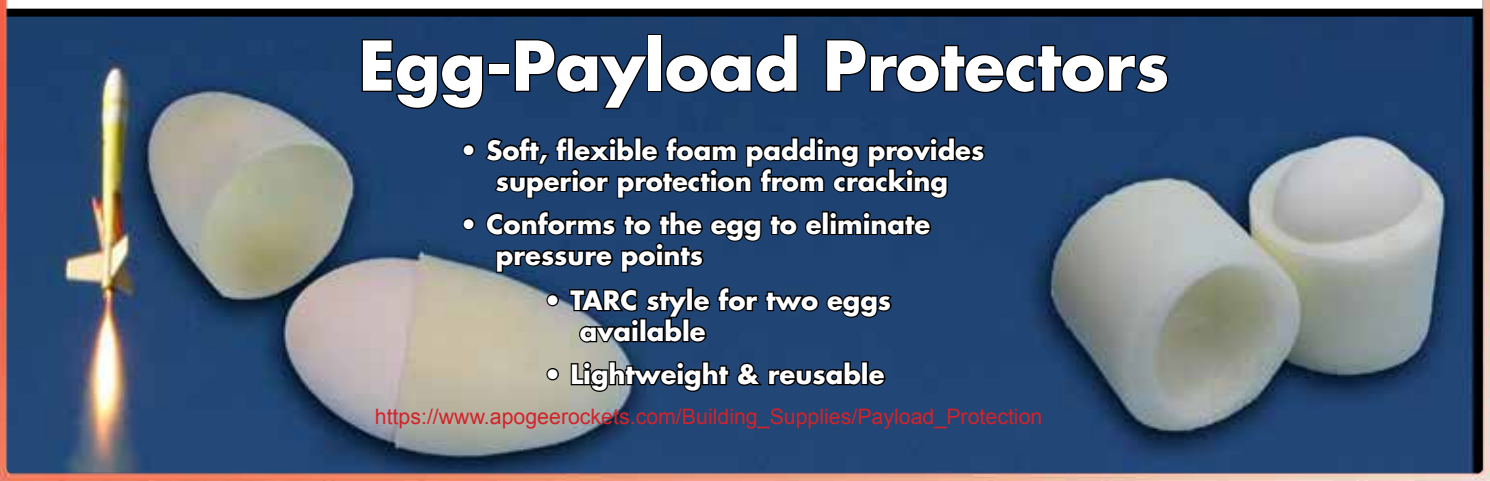

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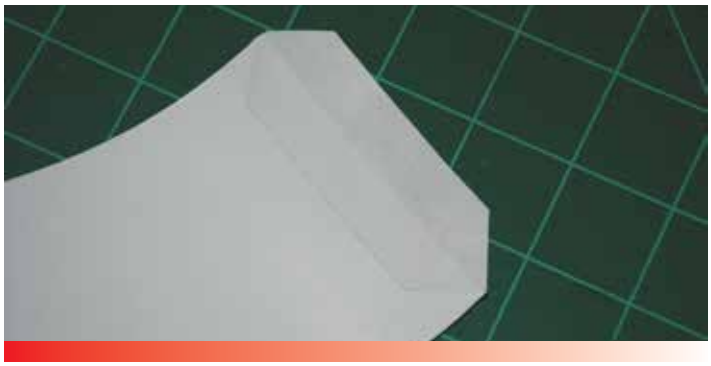

Figure 11

shroud very long during assembly.

(Figure 12): The glue tab for the top cone will require some additional trimming so it will tuck under the point as the cone is formed. A pencil or bamboo skewer helps form the point.

(Figure 13): Roll the shrouds and glue the ends of each together. Drawing the shroud

Figure 12

across the edge of a table will help form it. Pointed dowels help with the forming operation.

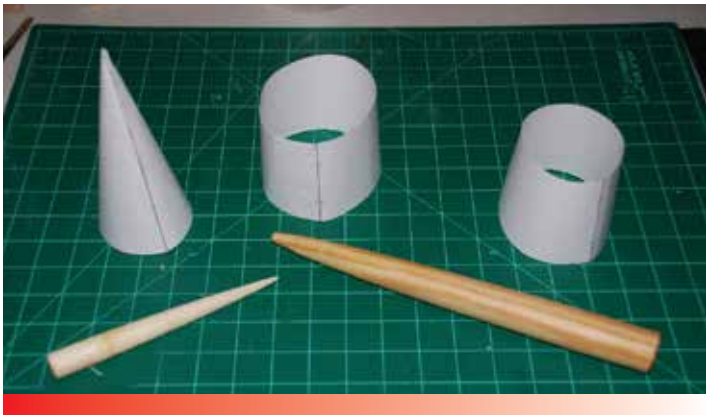

Figure 13

Other shroud tips are found in the Peak of Flight #136 article.

(Figure 14): There are several ways to attach a shock cord to this cone. For this example, a loop of Kevlar will be used. It will be easier to loop the cord before gluing the shrouds in place.

A cardboard "doubler" is glued to the top of the bottom disc and two holes are drilled through both pieces of cardboard. Note the shape isn't

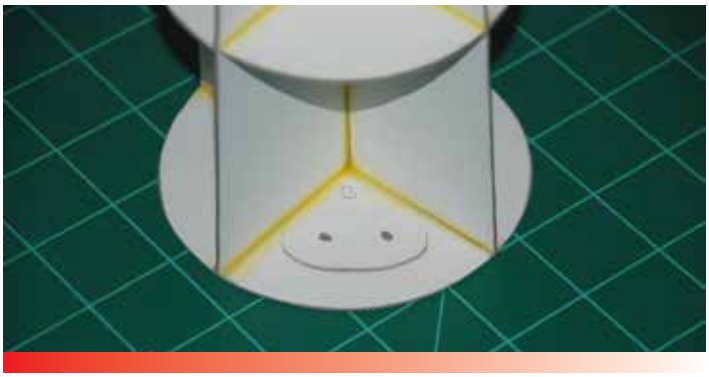

Figure 14

Continued on page 6

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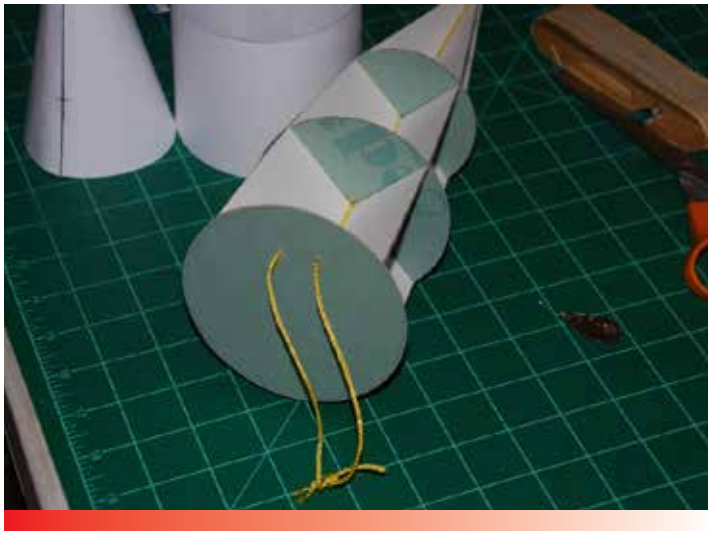

Figure 15

important, I just cut out an elliptical piece. Be sure it doesn't extend past the edge of the ring where it would interfere with the shroud.

(Figure 15): The cord is looped through the holes and temporarily tied. (The cord in the photos is actually nylon which will be replaced with Kevlar after the cone is completed)

Tape the loop flat to the bottom of the structure to keep it out the way during the rest of the assembly.

(Figure 16): A thin, flexible blade will help work the shrouds over the support discs during assembly. This blade was made from a piece of thin plastic, similar to a credit card. I traced it from the palette knife, which I originally tried but found it too flexible to work the shroud over the disc.

(Figure 17): Dry fit the shrouds first. Slide the shroud over the rib structure and use the tool to

Figure 16

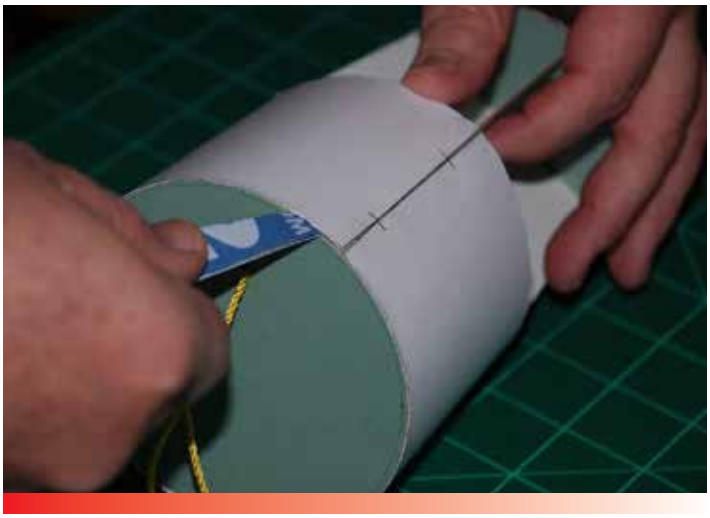

Figure 17

help work the shroud over the disc.

Take your time to work the shroud down over the ribs. It should be flush with the bottom disc, and about half of the upper disc should be exposed when the shroud is in place.

Remove the shroud, apply a light coat of glue to the edges that will be contacted by the first (bottom) shroud, and carefully refit the shroud.

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Some rubber bands will help keep the shroud in contact with the ribs while the glue dries.

(Figure 18:) Repeat for the next shroud. You may get some wrinkles or gaps -- but don't panic, filler will cover these later.

(Figure 19): If your model requires nose weight, this would be a good time to put it in. Epoxy clay mixed with metal shot can be pushed into the spaces between the ribs. Regular modeling clay with an oil base might stain the paper shroud but if coated with some glue might work.

On a recent model I used a slurry of 30 min-

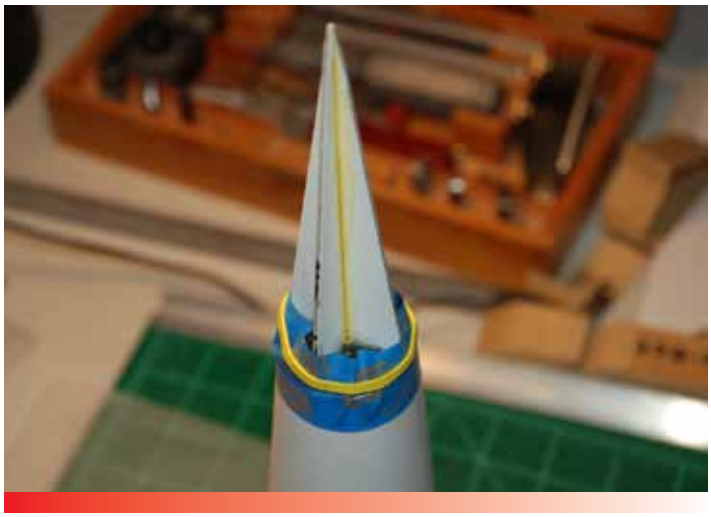

Figure 19

Figure 18

Continued on page 8

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Continued from page 8

ute epoxy and lead shot poured in even batches on top of the middle disc. I built a dam around the nose with masking tape to keep the epoxy in place. Some light sanding was required to clean up some of the edges.

(Figure 20): The final shroud can be glued in place. Now it looks like a nose cone!

Figure 20

(Figure 21): Applying a coat of water-thin Cyanoacrylate (CyA) glue really strengthens the nose. When it soaks in and hardens, the paper feels like plastic and can be sanded to a smooth finish.

Make sure you do this in a well ventilated area as CyA fumes will burn your eyes. I set a

Figure 21

fan up behind and off to the side of me so the fumes will blow away from my face. Wear rubber gloves to prevent gluing your fingers together or to any object you touch.

When dry, the paper takes on a semi-translucent appearance. After sanding with 320 grit sandpaper, filler can be applied to fill joints, cover any wrinkles, or low spots.

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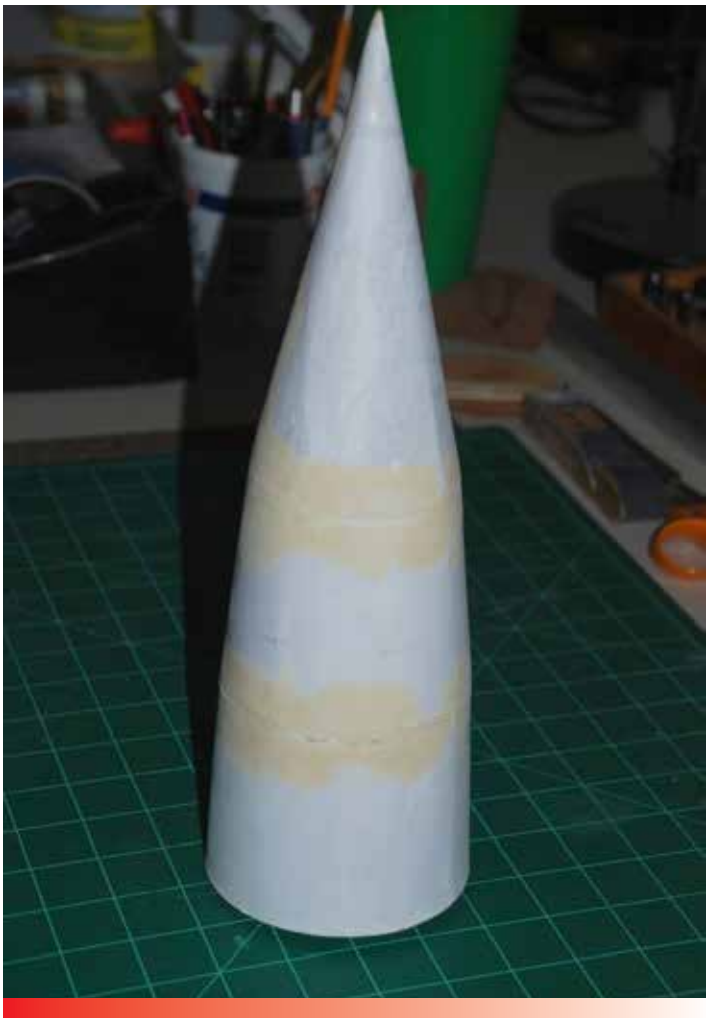

Figure 22

Figure 23

(Figure 22): Here is the cone after some filling and sanding. As you can see, I got some wrinkles, so more filling and sanding will be required.

(Figure 23): To make the nose cone fit on your body tube, use a tube coupler. This coupler was 6 inches long, so I cut it in half to make the nose shoulder.

(Figure 24): Before gluing the coupler to the cone, cut a disc from Crescent board (or thin wood) so it will fit inside the coupler.

Figure 24

(Figure 25 - Next Page): Place a spacer on your work surface on top of a piece of wax paper. The spacer could be another piece of Crescent board or thin wood.

Apply glue to the inside of one end of the coupler, set it on the work surface.

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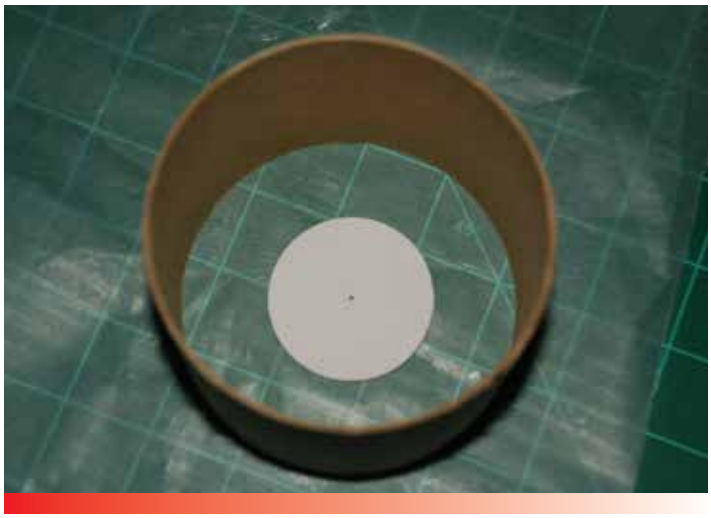

Figure 25

Figure 26

Figure 27

Figure 28

(Figure 26): Slide the disc down inside the coupler so it rests on the spacer. Allow the glue to dry.

I placed a rubber band around the coupler since it was slightly egg-shaped to help make sure the disc and coupler were in contact.

(Figure 27): After the glue is dry, apply a fillet to the inside joint.

(Figure 28): When the inside fillet is dry, turn the coupler assembly over. The disc should be offset from the end of the coupler to allow a nice fillet to be applied.

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Making Paper Nose Cones: Pt 2

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(Figure 29): If you decided to attach your shock cord loop to the bottom disc (in the coupler) only, you may want to glue a doubler inside and then punch or drill holes for the loop.

Run your loop through and tie a good knot. You can hide the knot inside the coupler.

Since I chose to attach my shock cord loop to the upper disc next the shrouds, I had to thread the cord through the bottom disc before gluing the coupler onto the nose cone.

(Figure 30): Apply a thin coat of glue to the bottom of the nose cone, and to the top of the coupler. Let this coat dry. Apply a second coat of glue then press the parts together, making sure the coupler is centered with the nose cone.

Figure 29

Figure 30

Figure 31

This is called a double glue joint and works well on fins too.

(Figure 31): This is the finished cone with a coat of primer, ready for finish sanding and coat of paint.

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Making Paper Nose Cones: Pt 2

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(Figure 32): Another option for shock cord attachment is to glue a length of body tube to the top disc, and cut a hole in the bottom disc to fit over the body tube.

Glue a standard balsa bulkhead into the body tube and use a standard screw eye to attach your shock cord.

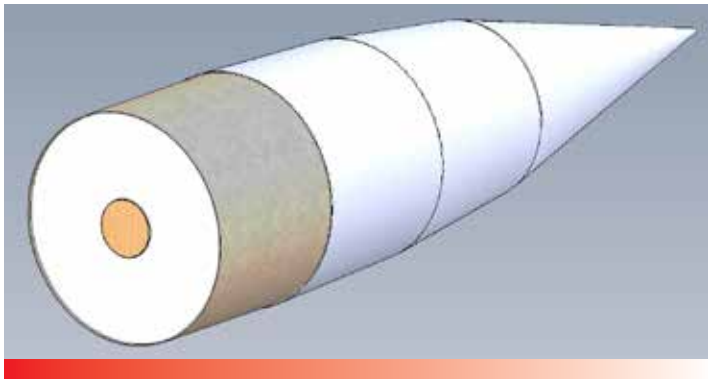

Figure 32

(Figure 33): Yet another option for the base is to glue a balsa plug inside the coupler for the screw eye.

This particular cone was designed for a core from a roll of plotter paper, so I had to turn a custom plug on a lathe. When I cut off the dowel and sand the surface flat, the screw eye will screw into the hard dowel material for a secure attachment point.

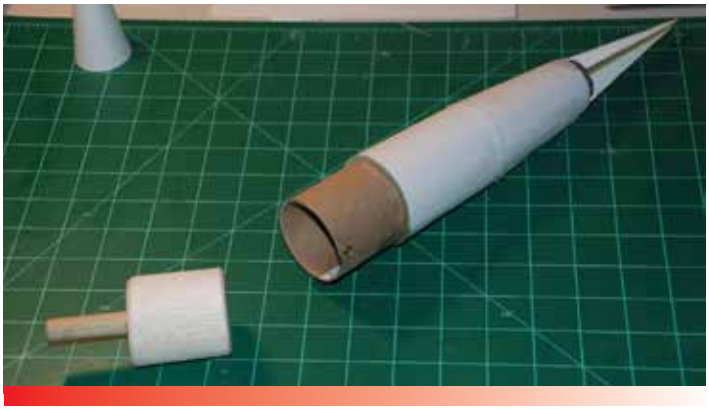

Figure 33

Tail Cone (Boattail) Construction

Construction steps and details are similar to those of the nose cone. You will need to mark the motor tube for the rib locations, just like marking a body tube for fins. Marking guide lines on the ribs to help align the support discs will help make sure they are in proper position.

If the inner tube is going to be the engine mount, and you plan to use an engine hook, go ahead and install the hook between two ribs, off-center so you will clear the fins when they are installed.

(Figure 34): Glue the tube to the bottom centering ring. Next glue the support ribs to the tube, using the guide marks to make sure the ribs are running straight and perpendicular to each other.

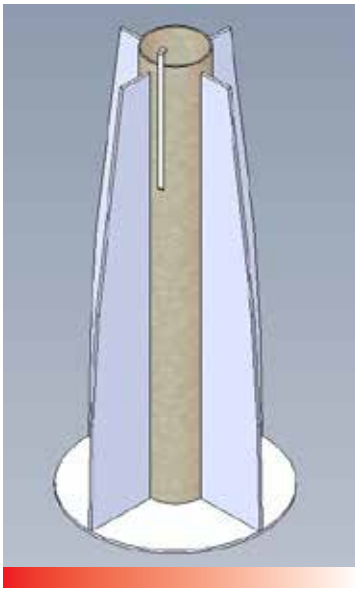

Figure 34

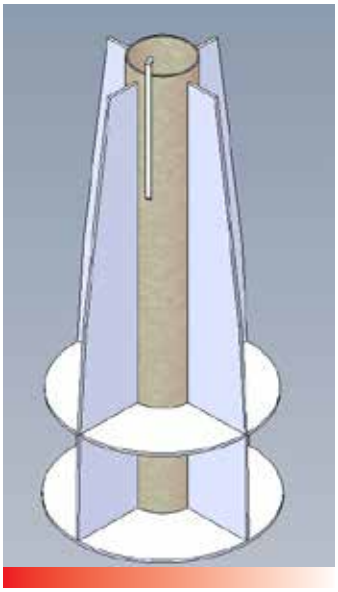

Figure 35

(Figure 35): The intermediate centering rings will need to be cut to fit between the support ribs, similar to the nose cone support structure.

(Figure 36) (Next Page): Continue gluing the support discs (centering rings).

(Figure 37) (Next Page): The last centering ring needs to be slotted for the engine hook (if one is used) and glued in place.

Light glue fillets can be applied to all of the joints. Try to minimize the size to keep weight down, else you will need more nose weight (you

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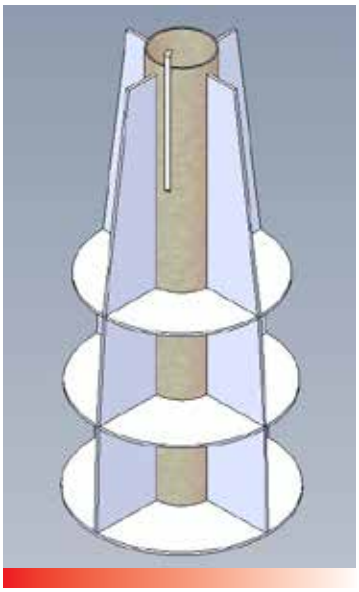

Figure 36

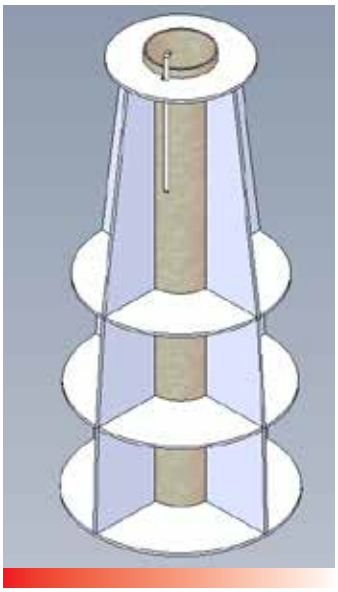

Figure 37

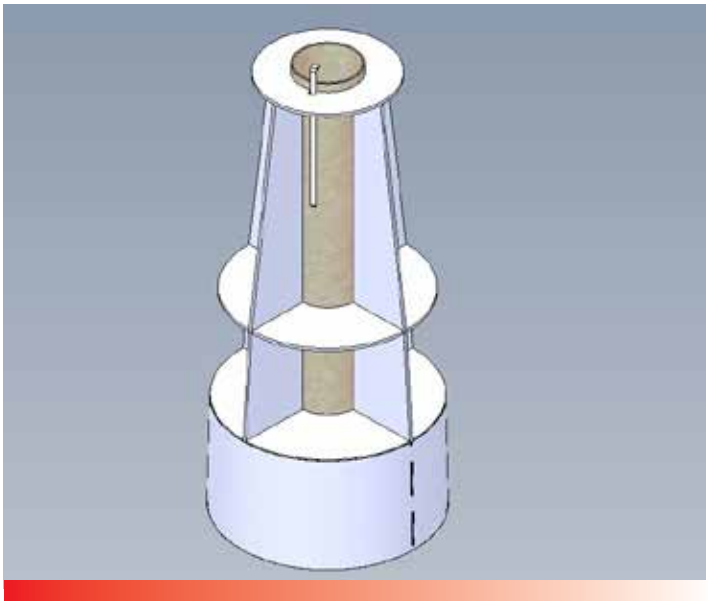

Figure 38

didn't glue that last nose shroud on yet did you?).

(Figure 38): Glue the shrouds together as shown earlier. When they are dry, install them on the structure, starting with the largest shroud.

(Figure 39): Here is a picture of my first tail cone. Note I have notched the ribs to clear the wrap of paper used to hold the engine hook in place.

Also note the ribs on this example were cut to the ogive curve rather than the straight-segments and see how the shroud does not fit quite right. I used a lot of filler to finish this part!

Figure 39

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(Figure 40): Once all the shrouds have been glued on and the glue has dried, apply a coat of CyA glue to stiffen the paper shrouds.

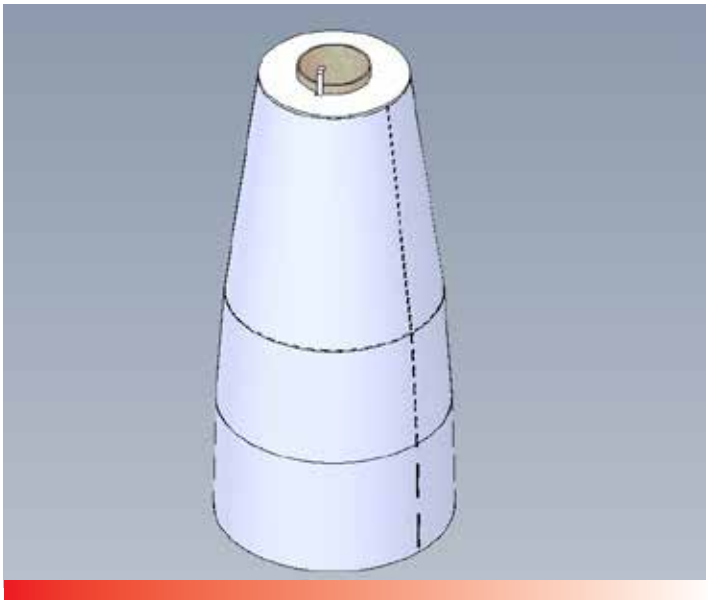

Figure 40

(Figure 41): Glue on the tube coupler, and the

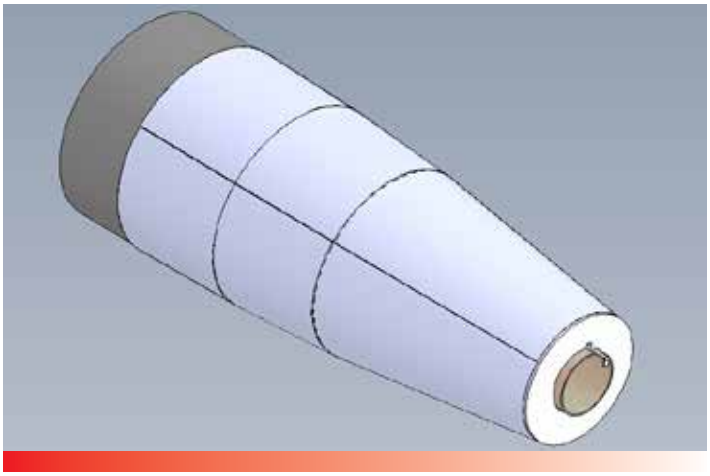

Figure 41

tail cone is complete!

(Figure 42): The best way to attach the fins is to use "through the wall" construction, by adding tabs to the root of the fin that will glue to the inner tube, and slot the shrouds for the fin tab.

A method for drawing guidelines for the fin slots is shown in the Peak of Flight article "Make a fixture to draw lines down a boat tail" [Peak of Flight #217 ApogeeRockets.com/education/downloads/Newsletter217.pdf]

Figure 42

(Figure 43): I cut slots in the fin tabs to clear the support discs. I also cut clearance for the engine hook wrap.

Figure 43

(Figure 44) (Next Page): Here are the fins installed. Once fillets are applied, and the rocket is painted, you can hardly tell the nose cone and boattail are paper

I found some other Peak of Flight articles that might help with construction. "Connecting Together Paper Transition Sections" [PoF #138 ApogeeRockets.com/education/downloads/Newsletter138.pdf] shows how to make the shrouds overlap, which would provide a smoother joint.

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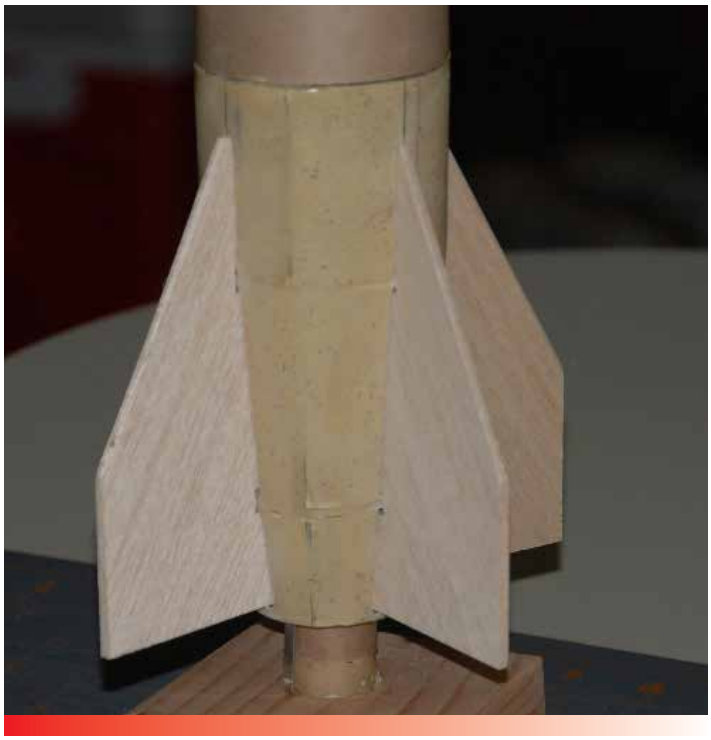

Figure 44

"Make a Super Shroud" [PoF #349 ApogeeRockets.com/education/downloads/Newsletter349.pdf] covers methods to stiffen the shrouds.

Another method to stiffen the cones would be to use the shroud pattern to cut out fiberglass panels and apply them. I doubt this method would be needed for a LPR or even an MPR. Soaking the cardstock with CyA makes a very stiff cone.

I have found this technique to be very handy building nose cones for odd-ball tubes or tubes with limited cone availability from the vendors. After some practice, you can obtain surprisingly good results without a lathe.

References

Nose Cone Design https://en.wikipedia.org/wiki/Nose_cone_design

Tool Plan - Make foam nose cones! Peak of Flight #087 ApogeeRockets.com/education/downloads/Newsletter87.pdf

Make Your Own Transitions Peak of Flight #136 ApogeeRockets.com/education/downloads/Newsletter136.pdf

Make a fixture to draw lines down a boat tail Peak of Flight 217 ApogeeRockets.com/education/downloads/Newsletter217.pdf

Connecting Together Paper Transition Sections #138 ApogeeRockets.com/education/downloads/Newsletter138.pdf

(The full article is contained on the Technical Publications CD-ROM)

Make a Super Shroud Peak of Flight #349 ApogeeRockets.com/education/downloads/Newsletter349.pdf