Apogee Components

PEAK OF FLIGHT

NEWSLETTER

In This Issue

Design a Fixture to Conform to an Odd Shaped Nose Cone

Shrox Plan: "Sniple"

Cover Photo: The Rising Star from DynaStar. Get your own at: https://www.apogeerockets.com/Rocket_Kits/Skill_Level_2_Kits/Rising_Star_Rocket_Kit

Apogee Components, Inc. — Your Source For Rocket Supplies That Will Take You To The "Peak-of-Flight"
3355 Fillmore Ridge Heights
Colorado Springs, Colorado 80907-9024 USA
www.ApogeeRockets.com e-mail: orders@apogeerockets.com
Phone: 719-535-9335 Fax: 719-534-9050

ISSUE 393 JUNE 16, 2015

Design a Fixture to Conform to an Odd Shaped Nose Cone

By Tim Van Milligan

This problem doesn't occur often, but on occasion, you might find that you have to build a structure on the outside of a nose cone. What makes it difficult is if that structure has to conform closely to the surface shape of the nose cone. This is the problem I faced recently, and I needed to know how to solve it.

On the Apogee egg capsule (https://www.apogeerockets.com/Building_Supplies/Nose_Cones/Low_Mid_Power_Nose_Cones/Egg_Capsule_18_and_24mm_Shoulders) there is a plastic shoulder that has to be glued onto the base of one of the capsule halves. The issue is how to get it on perfectly straight so that the egg capsule isn't skewed over on the rocket. If it was skewed over, then it would cause excess drag, and possibly make the rocket deviate from a straight trajectory.

Figure 1: Putting the shoulder on crooked will cause the nose cone to be skewed.

In the past, I've just eye-balled the installation of the shoulder onto the bottom of the egg capsule. But this time, I had several egg-lofting rockets to build and I decided to build a fixture to help align the shoulder to the nose cone bottom. Half of the rockets were to be built by my kids, so I wanted something that they could use and get their rockets perfectly aligned too.

In my mind, I felt that the solution would be to have a fixture that conforms exactly to the nose cone so that the shoulder could only go one one way. That would be easy if the nose was a easy shape, like a cone. But this egg capsule doesn't have a mathematical shape that would make it easy to duplicate the curvature. When I made the egg capsule mold about 20 years ago, I just chucked up a piece of aluminum rod in a lathe and eyeballed a shape that I felt would be usable for holding an egg. There was no mathematical equation or even blueprint that I used to make the nose. So now I have a problem.

The remainder of this article explains how I solved the problem. It essentially involves tracing the shape of the nose cone from a photograph, and using that to develop the alignment fixture. Incidentally, this isn't the first time I had to match the shape of a nose cone. I think this is the third time in the last few years that I had to use this strategy. I used it to create the foam padding for eggs (https://www.apogeerockets.com/Building_Supplies/Payload_Protection), and a mold to make fiberglass nose cones. It is old-school engineering, but it works.

Figure 2: The finished fixture constrains the installation of the shoulder on the egg capsule.

A picture of the completed fixture is shown in Figure 2.

By the way, using jigs and fixtures to help assemble your rockets is something you might want to consider more deeply. While it does take time to develop the specialized tools, it pays off in the model flying straighter and performing better. Parts that are aligned correctly are less likely to break off, so it also increases the safety of the flight. I use a lot of specialized jigs, like fin alignment jigs and wing dihedral jigs. I think some time in a future newsletter article, I'll show you the stockpile of tools that I have created for my own use. You'll think I'm crazy to have all of them, but when you build a lot of rockets, it makes assembly faster and more enjoyable.

Step 1: Photograph the Nose Cone

The purpose of photographing the nose is to get the

Continued on page 3

About this Newsletter

You can subscribe to receive this e-zine FREE at the Apogee Components web site (www.ApogeeRockets.com), or by sending an e-mail to: ezine@apogeeRockets.com with "SUBSCRIBE" as the subject line of the message.

Newsletter Staff

Writer: Tim Van Milligan
Layout / Cover Artist: Tim Van Milligan
Proofreader: Michelle Mason

Continued from page 2

Make A Nose Cone Holding Fixture

shape into a computer so that you can design around it. "Computer Aided Design" (CAD) starts by getting the design into a computer where precision is greatly increased. That is what we'll be doing here, computer design. But I'm not going to use a CAD program, since I don't have one. The tool I use is a drawing program. I personally use Adobe Illustrator, but you can use anything that allows you to draw precision lines. Other programs that are available are Corel Draw, and the free program called "InkScape."

When you photograph the nose cone, the important thing is that you try to be a perpendicular (90°) to the object. If you're at an angle to the object, you'll skew the shape. For example, try taking a picture of a rectangular object, like a book. If you're not pointing straight down at the book, the image will not be a true rectangle, but a trapezoid (Figure 3).

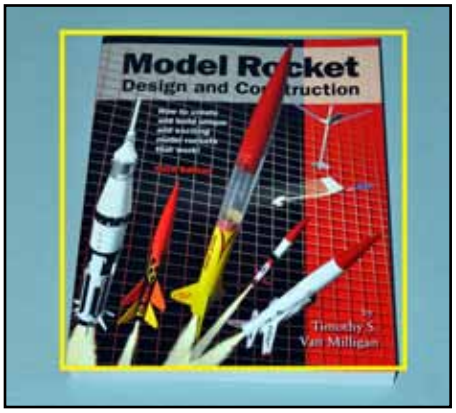


Figure 3: The shape of the object is distorted if you don't position the camera perpendicular to the object. The yellow line shows a true rectangle.

In the case of the nose cone, you have to tape it down to the surface it is lying on (Figure 4), so that it projects parallel to the table. You can tell how close you got, because you want the open end to be a straight line in the photograph, and not have any curve to it.

Also try not to get the camera lens too close to the object. Again, this will skew the shape of the final photograph.

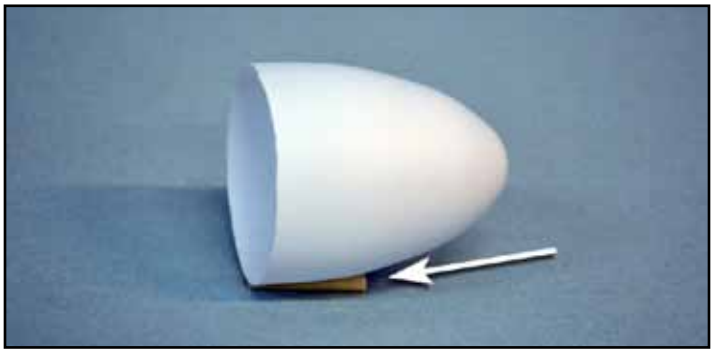


Figure 4: Tape the nose cone to the table so that the tip is parallel to the surface.

The other thing is to put a reference object in the photograph too. I use a metal ruler placed next to the nose (Figure 5). This will come in handy later when you have to scale the drawing to make sure the printed image is the exact same size as the nose cone.

Step 2: Trace the Outline of the Nose In the Drawing Program

Once I have the photograph of the object, I import the image into my computer. Then I drag it into the drawing program so that I can begin the process of tracing the

Figure 5: The photo of the nose cone along with a ruler to show the size.

Continued on page 4

Wanted: Your Rocket Products

If you're a manufacturer of rocketry products, like kits, electronic payloads, parts, construction tools, motors, launch equipment, or something totally cool, we're interested in talking to you. We're always looking for new products to sell.

So why have Apogee sell your products?

- *We have the best customers that are looking for something new.*
- *We provide the product support for the customers, so you don't have to.*
- *We take care of all of the hassles, so you can focus on what you do best.*
- *We are a volume seller - Our web traffic means buyers will find you easier.*
- *Our endorsement means you sell more and make more money!*

APOGEE COMPONENTS

www.ApogeeRockets.com

If you're not getting enough sales, let's talk.

Continued from page 3

Make A Nose Cone Holding Fixture

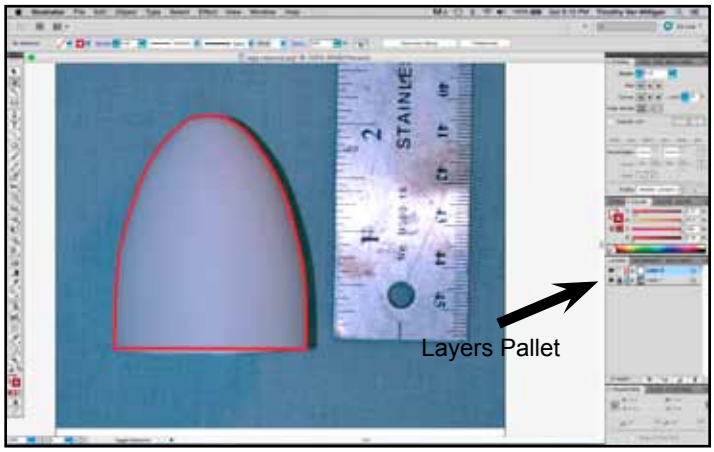


Figure 6: The shape (red outline) is traced in the drawing program. Note that the picture is on a different layer than the lines.

outline. (Figure 6).

It takes time to trace an object, and in this case, I put in a lot of extra effort to try to be as exact as possible. The success of the project depend it being as close as possible.

Because of this, I took the time to examine my drawing and I decided that the right side of the image more closely matched the photograph better. The shadow from the camera flash made the right side easier to trace. In hindsight, I should have used a darker colored background so there was higher contrast around the entire perimeter of the nose cone.

In this case, I cut the image down the middle and discarded the left side of the nose cone (Figre 7).

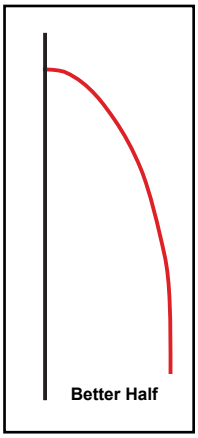


Figure 7: The right side better matched the real nose cone shape.

Next I duplicated the line and flip it over to the other side of the centerline (Figure 8). This assures me that the nose cone is perfectly symmetrical on both sides of the center line.

Step 3: Add the method of alignment

Here is where my engineering brain started to work. I now had a near exact shape of the nose cone that I wanted to add the shoulder to. But how would I align the shoulder?

I figured that a plate with a hole in it (such as shown in Figure 2 on page 2) above the nose cone would hold the shoulder in an upright position. So I drew onto the drawing a coupler and a top plate. The higher above the nose cone the plate was, the straighter the shoulder would be. The limiting factor was

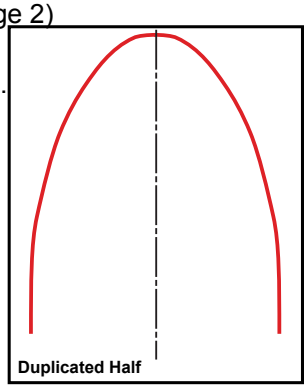
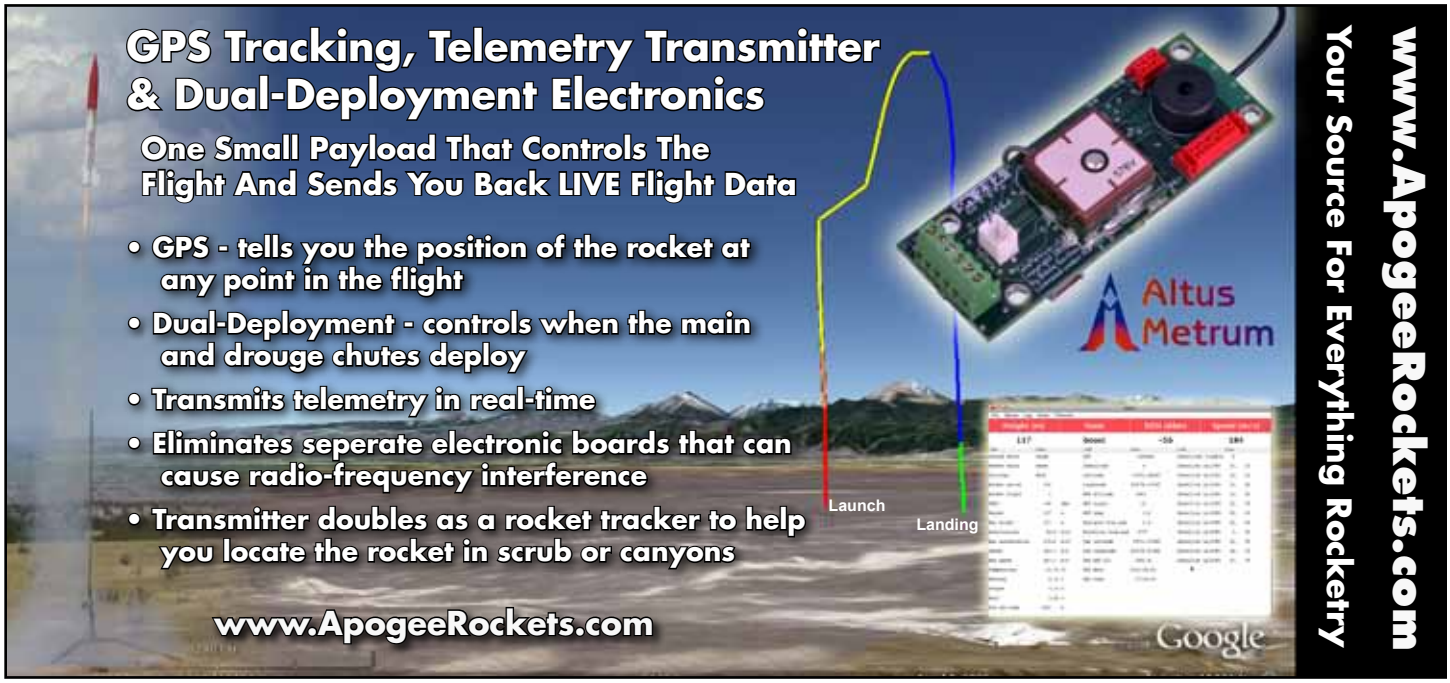


Figure 8: The symmetrical nose cone.

Continued on page 5



Continued from page 4

Make A Nose Cone Holding Fixture

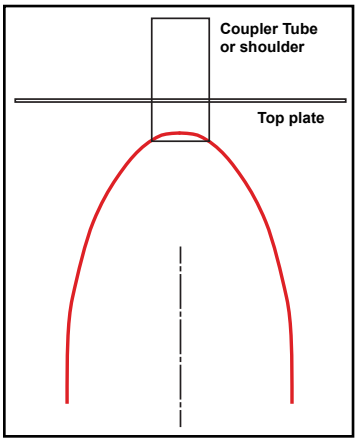


Figure 9: I added the coupler and a top plate to hold it upright.

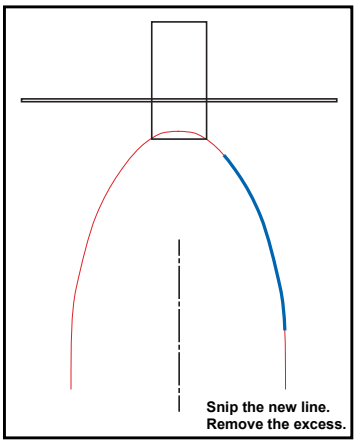


Figure 10: Duplicate the egg line (blue color), and snip off the parts that are not needed.

the length of the shoulder. I didn't have any specific dimension in mind when I put the top plate in the drawing. I just used my intuition, and said "it looks good here" (see Figure 9).

Step 4: Start Making the Side Plates

The next step was to duplicate the shape of nose cone and decide how much of the nose shape to use. Again, how much of the side surface to use was chosen by intuition and what looked good. In hindsight, I probably should have made it longer than what is shown in Figure 10. The more the side plates are in contact with the surface of the nose, the harder it will be to skew the nose cone in the fixture.

In Figure 11, you can see how I sketeched out the shape of the side support plates. I didn't want the base to be like a knife tip, so I squared off the bottom. The extra width does help to give the side plate a little bit more bending resistance too. I didn't want to the plates

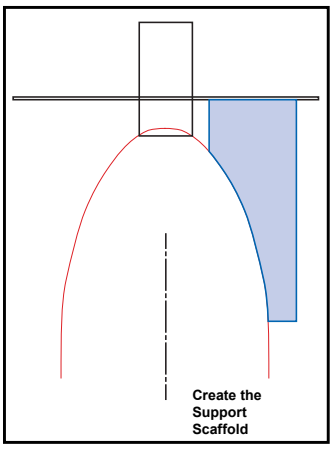


Figure 11: Rough sketch of the side support plate.

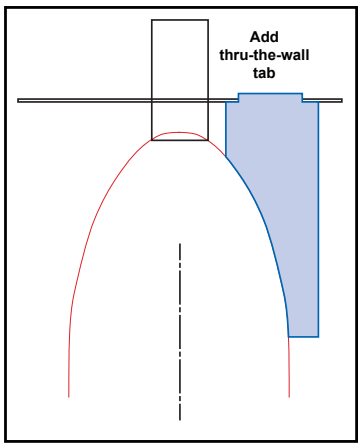


Figure 12: I added a tab on the top of the vertical plate to engage the top plate.

to bend when placed over the nose cone, or that would allow alignment errors to creep into the system.

I then added a tab to the top edge where it would mate with the top plate (Figure 12). This would help give the plate strength (just like through-the-wall fins), and also set the distance from the centerline accurately during assembly of the fixture.

Step 5: Scale the Drawing to 100% Size

At this point, it occured to me that I wasn't working in 100% scale. The photo (Figure 13) wasn't resized when I brought it into the drawing program. I was actually tracing a larger-than-

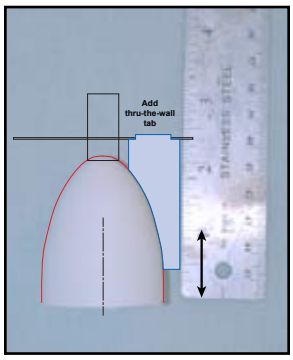


Figure 13: I turned the layer with the photo back on so I could see the ruler and draw a 1-inch long line.

Continued on page 6

Continued from page 5

Make A Nose Cone Holding Fixture

life photo. The advantage of tracing a big photo is that you have better accuracy of the lines.

But I really should have scaled the image as soon as I was done tracing it. Regardless, here are the steps to scaling the image in the drawing program.

First, draw a line in the photo next to something of know length. This is where the ruler comes in. I know exactly how long the ruler is, right? So I drew a line on the ruler (see Figure 13) from the zero point to the 1-inch line. In real life, this line should be exactly 1 inch.

In the software, I looked at the actual height of the line (see Figure 14). The software told me that the line was 2.0419 inches long. Basically, this tells me that the drawing was more than twice actual size. I will have to shrink it

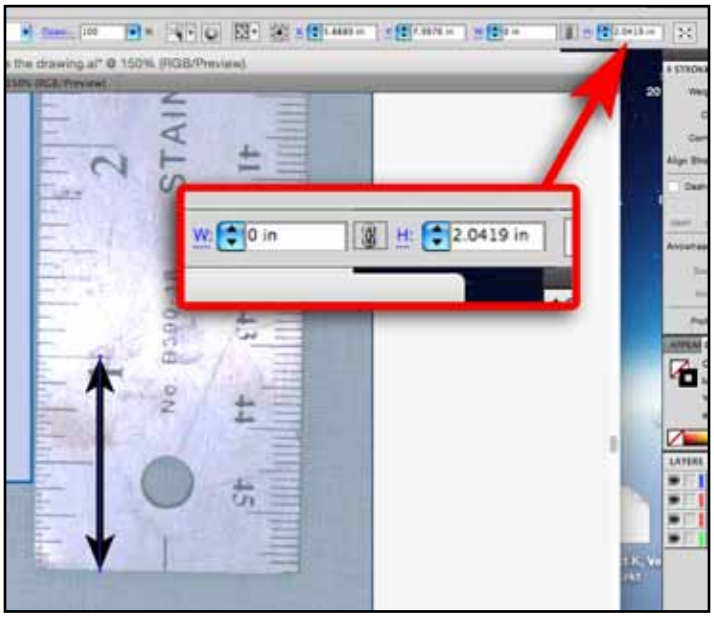


Figure 14: The length of the line in the program was 2.0419 inches long.

down to the correct size. The formula for finding the percentage to shrink the drawing is:

$$\text{Scale} = \frac{\text{What it should be in real life}}{\text{Length it is in the photo}} \times 100\% = \frac{1.00''}{2.0419''} \times 100\% = 48.974\%$$

While it is not shown here, there is a feature in every drawing program to scale the image. I just had to find it, and type in the scale factor of 48.974%.

As soon as I did that, I realized I should have done this scaling previously. It dawned on me that the shoulder that I drew previously on the base of the nose cone was the wrong size. When I drew it originally, I made it the actual real-life size. Now after scaling the drawing, I saw that it was too small.

I had to correct this error, so I double checked the shoulder size. In my case, I was going to use a 24mm tube coupler as the shoulder, because I wanted to put an altimeter inside it.

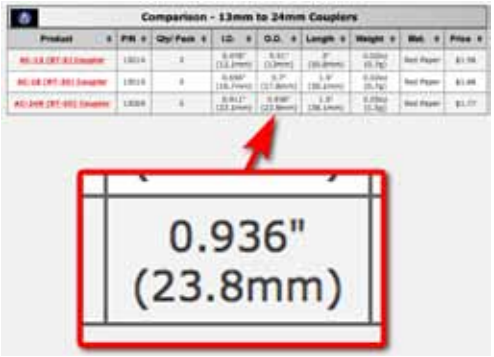


Figure 15: The diameter of the coupler (the shoulder) was found on the Apogee web site for a 24mm tube coupler.

If you need to find out a dimension of the coupler, you can visit the Apogee web site (www.ApogeeRockets.com). We try to have have all the coupler dimensions there for this very type of design situation (see Figure 15).

Changing the dimension of the shoulder in the drawing

Continued on page 7

We're Paying Cash

For Great Articles for This Newsletter

Are you a writer looking for some serious pocket change? We're paying up to $350 for good how-to articles for this newsletter. If you're interested, see our submission guidelines on the Apogee web site.

www.ApogeeRockets.com/Newsletter/Newsletter_Guidelines

Continued from page 6

Make A Nose Cone Holding Fixture

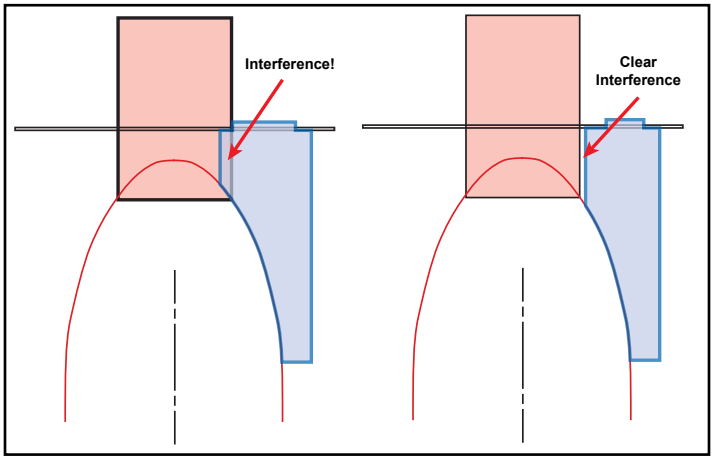


Figure 16: The shoulder was interfering with the vertical support plate (left). The plate had to be made skinnier for the coupler to slide past it (right).

was easy enough to do. But when I did, I discovered that the shoulder now interfered with the vertical support plate (see Figure 16).

The fix was to adjust the size of the vertical support plate to make it skinnier. To fix the problem, essentially I had to go back to Step 4 and re-draw the piece. It was actually easier to do that than to try to move the corner points around. Had I scaled the drawing before I started drawing the shoulder and top plate on the image, I wouldn't have to go through this extra step.

Step 6: Draw a Top View

With the side plates complete, I only needed to draw the top view so I could see what the top plate would look like.

Figure 17 shows the top view. The top plate could have been square, but I decided to make it circular shape. I

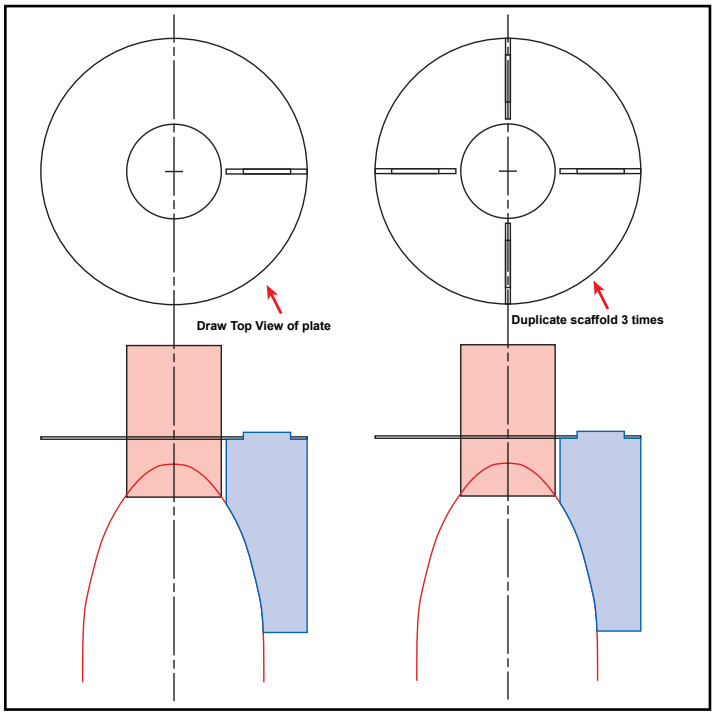


Figure 17: Drawing of the top plate. The left side shows a single vertical plate. This is duplicated three more times and rotated to 90° apart (right side).

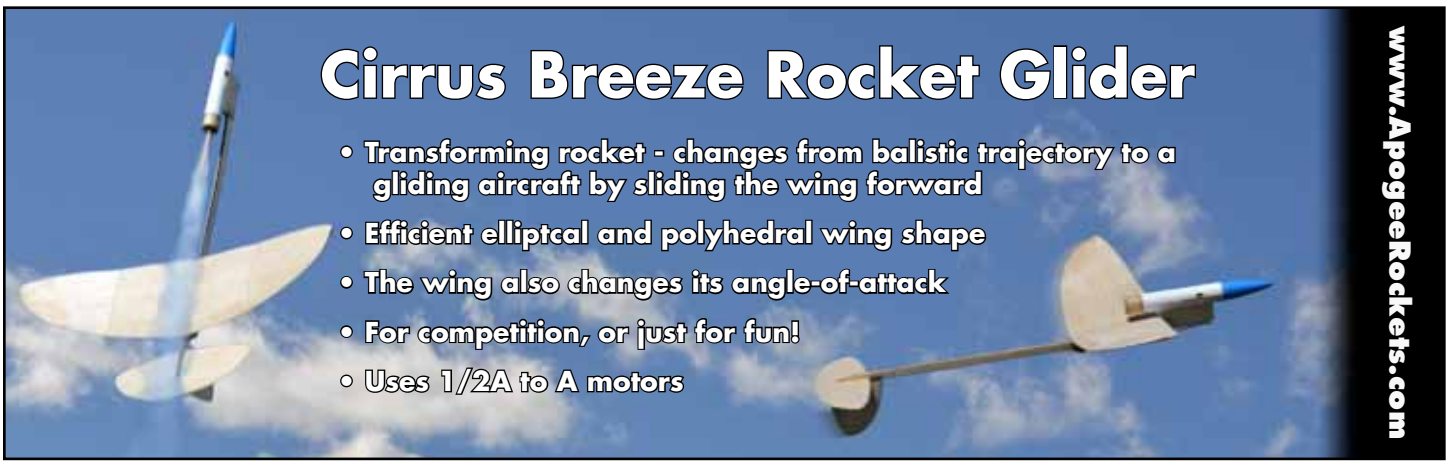
started by projecting the top tab of the vertical support plate up to the top view. This was then duplicated and rotated 90°. This was done twice more to create four vertical support plates in the top view.

To save time, I didn't project the other vertical support plates back down to the side view. If this was an actual engineering drawing, I would have. But it was just for me, so I left them off.

Step 7: Clean up the Drawing

Before the parts could be sent out to be made, I had to

Continued on page 8



Continued from page 7

Make A Nose Cone Holding Fixture

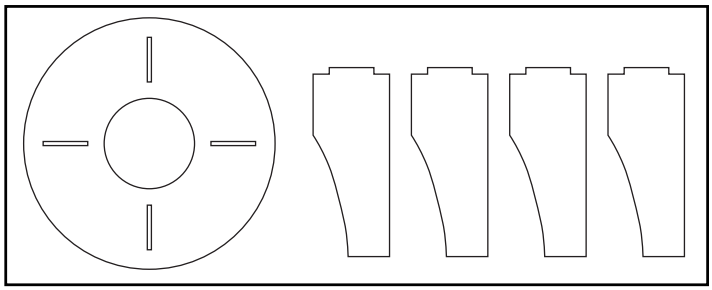


Figure 18: The final parts ready to cut out to make the assembly jig.

clean up the drawing and remove the excess construction lines that I had used to help generate the drawing. I then duplicated the vertical support plates to make four total. Figure 18 shows what it looks like when I was done.

Step 7: Make and Assemble the Jig

In the past, I would simply print out the parts on a plain sheet of paper. This could then be transferred to a final material (heavy cardstock) with some spray adhesive applied to the back of the paper.

This could then be cut out with a hobby knife.

But I'm lucky enough to have a laser cutter now, so I simply sent my drawing file to the machine to cut out for me. This just saves me a bit of time cutting out the pieces, and they have sharper corners. But doing it the manual way is works well too.

I simply used wood glue to assemble the fixture.

Step 8: Test Fit The Nose Cone Into the Jig

This final step is needed to confirm that you did everything correctly and that the curved edge of the vertical support plates mate properly with the surface of the nose cone.

To be honest, I noticed a problem when I did this step. The issue I faced was that there was an air gap between the vertical support plates and the surface of the nose cone, such as shown in Figure 19.

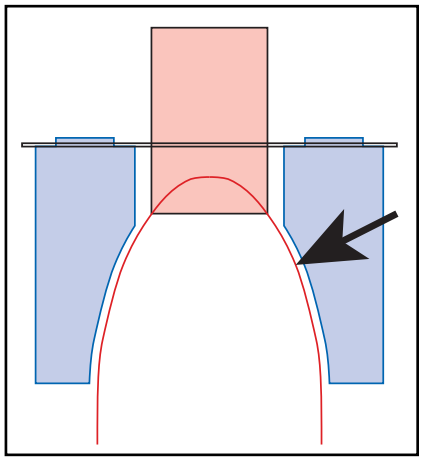


Figure 19: There was a gap between the nose and the vertical support plates.

The good news was that the curved portion of the vertical support plates matched the exact curvature of the nose cone's surface. It just that they didn't touch the nose cone when assembled.

I'm not sure where the error creeped in. My best guess is that the photo of the nose cone was skewed like shown in Figure 3 on page 3. While the length was correct, the diameter was off a little bit.

Fortunately, the fix to the problem was easy. I just had to move the tab locations on the top plate (as seen in Figure 18) to be closer to the center line. It took a couple of tries, and the fit around the nose cone was very close. It was more than acceptible.

When all the adjustments were made and the new jig assembled, I could try it out by dropping a shoulder (I used a tube coupler) through the hole on the top plate. The end result is shown in Figure 20 on the next page.

Future Enhancements

Whenever I design something, I always notice little

Continued on page 9

Continued from page 8

Make A Nose Cone Holding Fixture

Figure 20: The assembly jig fitted over an egg capsule half, and with a shoulder installed.

issues, which leads me to think of how I might do things differently if I was to make further enhancements. In this case, I did notice that the side plates had a little flexibility at the aft edges. Remember, I talked about this being one of my concerns during Step 4 of the process. It happened anyway. It wasn't bad for my purposes of assembling the nose cone for my immediate needs. But if I was making this for customers, I would make a change to stiffen it up. The solution would be to add a bottom plate to keep the plates from bending.

The other change I would do, if I had to do it again, would be to make the side plates longer. The more they are in contact with the nose cone, the straighter the shoulder would go onto the nose.

In conclusion, I hope you get a glimpse of the process you might have to take if you were designing a fixture to grab over a odd shaped nose cone.

About the Author

Tim Van Milligan (a.k.a. "Mr. Rocket") is a real rocket scientist who likes helping out other rocketeers. Before he started writing articles and books about rocketry, he worked on the Delta II rocket that launched satellites into orbit. He has a B.S. in Aeronautical Engineering from Embry-Riddle Aeronautical University in Daytona Beach, Florida, and has worked toward a M.S. in Space Technology from the Florida Institute of Technology in Melbourne, Florida. Currently, he is the owner of Apogee Components (http://www.apogeerockets.com) and the curator of the rocketry education web site: http://www.apogeerockets.com/education/. He is also the author of the books: *"Model Rocket Design and Construction," "69 Simple Science Fair Projects with Model Rockets: Aeronautics"* and publisher of a FREE e-zine newsletter about model rockets.

Looking For A Fun Rocket Kit?

Roam In Our Forest of Over 190 Different Types

- Unique and exotic kits from over 20 different manufacturers
- Skill Levels range from "easy" to "fiendish"
- Sizes from 1/4A motor to level-2-high-power
- We build & fly them to find out what they're like, saving you grief
- More new ones arriving all the time
- Educational bulk packs available too

www.ApogeeRockets.com

www.ApogeeRockets.com/Rockets_By_Manufacturers

Free Shrox Plan: Sniple

By Shrox

Download the RockSim file (which includes the parts list) and the decal file at: www.apogeerockets.com/downloads/shrox/sniple.zip