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APOGEE

PEAK OF FLIGHT

NEWSLETTER

Feature Article:

How To Design and Build Oblique Nose Cones

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APOGEE

PEAK OF FLIGHT

How to Design and Make Oblique Nose Cones

By Tim Van Milligan

Making paper nose cones is always tricky. But since we've covered how to make transitions from paper in *Apogee Peak Of Flight Newsletter* #125, I'm confident that you can now do it. The only difference between a transition section and a nose cone is the latter comes to a point at the tip. From a construction standpoint, you only have to worry about rolling the tip sufficiently to get a nice sharp point.

While it does take a little practice to get a good-looking point at the tip, I know that the readers of this newsletter can do it. Apogee customers are better builders than the average rocketry hobbyist. Don't you believe this about yourself?

In this article, I'm going to ratchet it up a few notches. I am going to show you how to design an "oblique" nose cone.

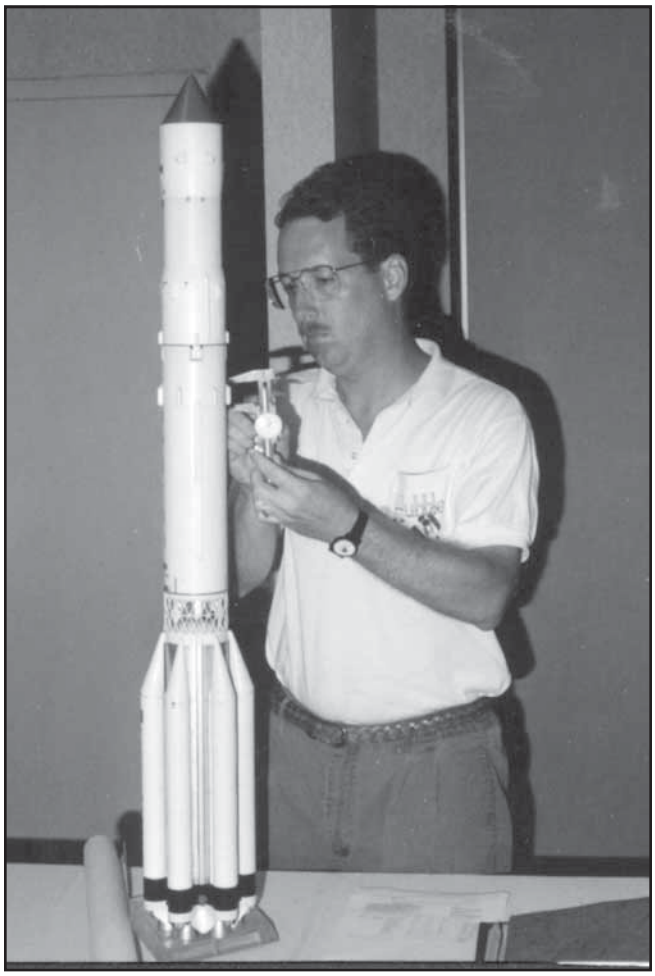


Figure 1: The Russian Proton rocket use oblique nose cones on the strap-on boosters.

The difference between a "regular" conical nose cone, and an oblique one is that the point is off to the side—it is not directly in the middle of the tube.

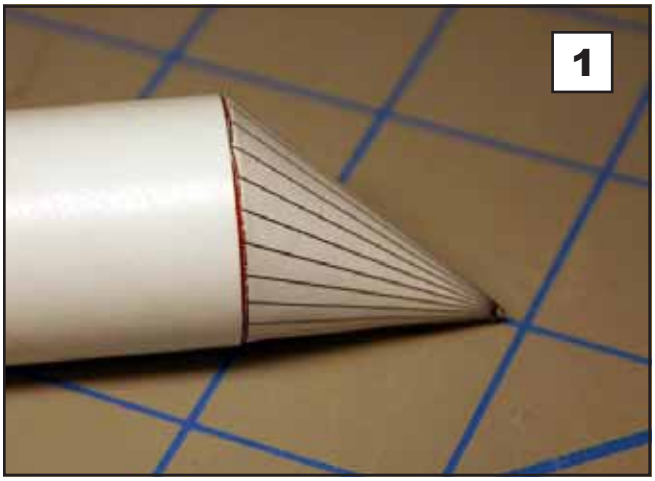
The oblique nose cone is most often used on "strap-on" booster rockets that are attached to the sides of a rocket. In real-world rocketry, the European Ariane 5, Japan's H2, and the Russian Proton rockets all use them. They are used because the reduce drag, allowing the rocket to be more efficient.

But, I think they just look cool.

The rest of this article will take you step-by-step through the process of designing and constructing the oblique nose cone. As I mentioned earlier, this is one of the more challenging undertakings in model rocketry. But that by itself is the reason you have to do it; you want to prove to yourself that you are an expert modeler.

Why is this a challenging endeavor? Because you have to draw on more than one design skill. Not only is there is a bit of drafting work, there is a little trigonometry too. But when you are done, you'll be quite proud of your oblique nose cone.

Our main tool in this project is a computer. We'll need a drawing program (not a "paint" application). The difference is that a drawing program creates "vector" artwork, like lines and curves. A paint-program creates pixel images, like photographs. We need a drawing program, because we need to make



accurate lines and curves.

For the illustrations in this article, I used Adobe Illustrator. But there are many others that will work, like Corel Draw, or Apple Computer's "Apple works."

It will also be helpful to have a spreadsheet program to

Continued on page 3

Oblique Nose Cones

Continued from page 2

help calculate the line lengths. The alternative is that you can chug through the equations using a calculator.

How to Get Started: Preliminaries

What we are going to do is make a "pattern development." That means you're going to take a flat sheet of paper, and create a pattern sheet that will be rolled into a nose cone shape. If you recall the article on making diagonal cutting patterns in *Peak of Flight Newsletter #121*, you'll be familiar with this concept.

In Step 1 photograh, shown on the previous page, you see the nose cone that we want to make. It is an oblique nose cone that is 1.1 inches long, and fits onto a 24mm body tube. While this is the size we are designing in this example, the steps are the same no matter what size tube you use.

In the photo, you'll notice that there are lines that radiate from the point. At the base of the nose, the lines are equally space apart. This will help guied us as we design and actually build the nose.

We'll now switch to the computer, and begin the design process.

Up to Step 9, our goal is to make a list of the true-lengths of each of the lines in the 2-D drawings. From these, we'll

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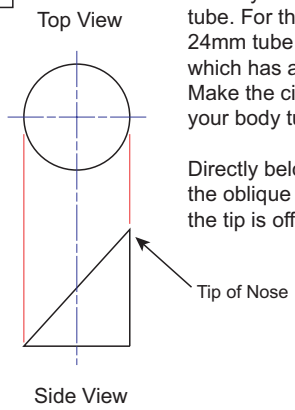
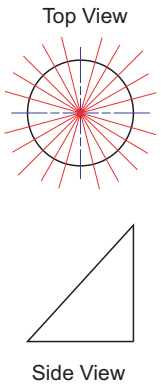


Start by drawing a top view of the tube. For this example, I'm using a 24mm tube (Apogee P/N 10099), which has an O.D. of 0.976 inches. Make the circle exactly the size of your body tube.

Directly below it, draw a side view of the oblique nose shape. Notice how the tip is off to the side of the tube.

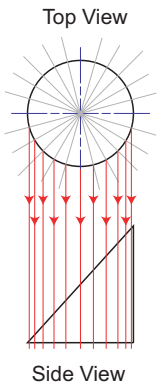
3



Divide the circle into equal parts. The more segments you have, the more accurate the final pattern will be.

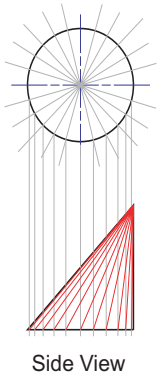
In this example, I divided the circle every 15°, for a total of 24 equal parts.

4



Extend the lines down to the side view, starting from the intersection of the radial lines and the edge of the circle.

5



Draw lines from the tip of the nose cone, down to the points where the vertical lines from Step 4 touch the base of the nose cone.

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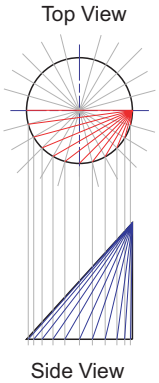
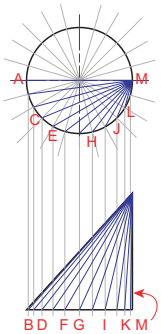


In the top view, draw lines from the point (tip) location, to the intersection of the radial lines and the circle (created in step 3).

You'll only need to do the bottom half, as the top will identical.

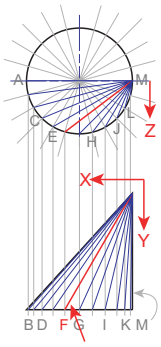
7



In this step, I want to label each of the lines, just so they don't get confused later.

I could have put all the letters in either the top view, or the side view shown at the bottom. I just spread them around because they are a bit hard to distinguish if they are all smooshed together in one view.

8



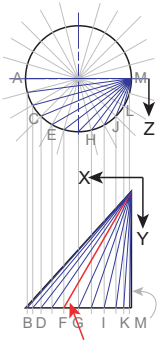
This is the part where we have to do a bit of trigonometry. We have to find the "true" lengths of all the lines.

For example, say we want to find the real (true) length of line "F."

It has a distance in the X, Y, and Z directions. The "True Length" is given by the equation:

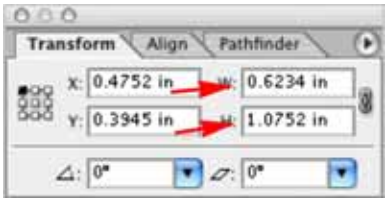
$$F \text{ (true length)} = \sqrt{X^2 + Y^2 + Z^2}$$

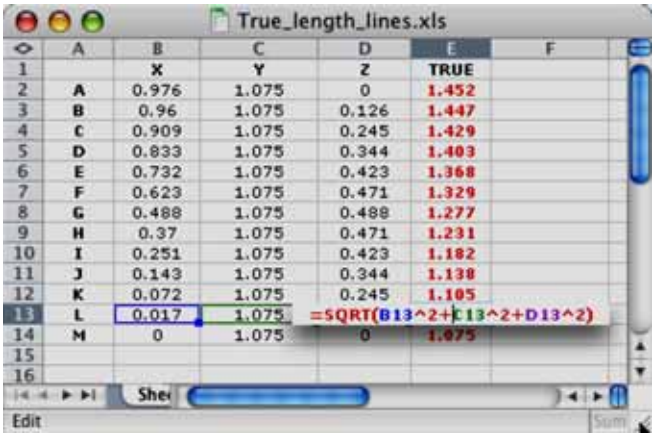
9



To get the lengths of the lines, you'll need to hi-lite them with the pointer tool of your drawing program, The lengths can be found in the information box, as shown below.

In this case, the Y distance is 1.075 inches, and the X distance is 0.623 inches. To get the Z distance, you'll hi-lite the F line in the Top View, and write down the "height" length from the information box.





	A	B	C	D	E	F
1		X	Y	Z	TRUE	
2	A	0.976	1.075	0	1.452	
3	B	0.96	1.075	0.126	1.447	
4	C	0.909	1.075	0.245	1.429	
5	D	0.833	1.075	0.344	1.403	
6	E	0.732	1.075	0.423	1.368	
7	F	0.623	1.075	0.471	1.329	
8	G	0.488	1.075	0.488	1.277	
9	H	0.37	1.075	0.471	1.231	
10	I	0.251	1.075	0.423	1.182	
11	J	0.143	1.075	0.344	1.138	
12	K	0.072	1.075	0.245	1.105	
13	L	0.017	1.075			
14	M	0	1.075	0	1.075	
15						
16						

Figure 2: This little MS Excel spreadsheet shows the X, Y, and Z component measurements of each line. The last column runs a simple equation to find the true length of each line segment.

create the actual pattern sheet.

Starting the actual pattern sheet begins on the next page in step 10. You'll first need to draw all the true length lines. You'll find that using the "Transform" feature of the drawing program you are using will greatly speed up this step.

When you're done, you'll end up with something like that shown in Step 11.

You'll also need one extra spacer line. This is used to seperate the bottom ends of the lines as you join them together. The length of this spacer line is dictated by the circumfrence of the tube you are placing the nose cone one. In this case, the body tube is 0.976 inches in diameter. The circufrence is π (3.14) times the diameter. In our example, this comes out to 3.066 inches. Now, take this number, and divided it by the number of sections you divided the circle into—which was done in step 3.

In our example, we used 24 sections. So the spacer line length becomes 3.066 ÷ 24 = .1277 inches.

Once we determine this, we go on to step 12 and start joining together the lines.

When you're done joining the lines, you'll have something that looks like Step 17, shown on the page 6.

Assembly of the Nose Cone

At this point, the pattern sheet is done. All that is left to do is to print it out, cut it out, and finally assemble it using rubber cement (*Hint:* always use rubber cement when making

Continued on page 5.

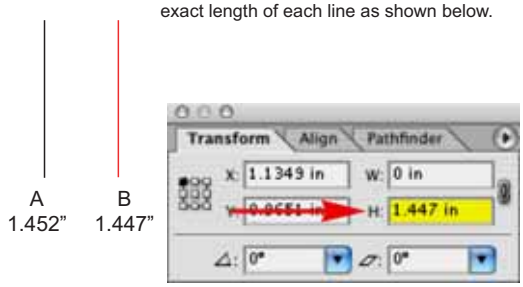
Oblique Nose Cones

Continued from page 4

10

Start the pattern sheet by first drawing all the True-Length lines. For example, from the chart we made previously, line A is 1.452 inches long. Line B is 1.447 inches long.

Use the "transform" input box to set the exact length of each line as shown below.



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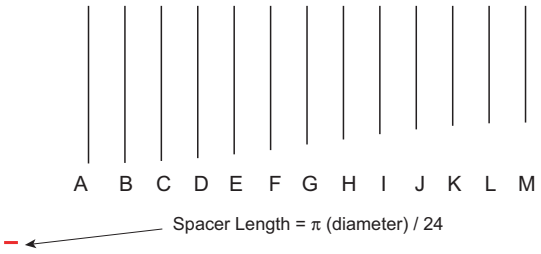
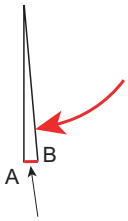
We also need a spacer line. This will be used to join the ends of each line segment. The length of this spacer line is equal to the perimeter of the tube, divided by the number of radial segments.



12

Rotate the B line segment, so that it touches the top of line A. Be careful not to change the length of the lines as you move them around on your computer screen.

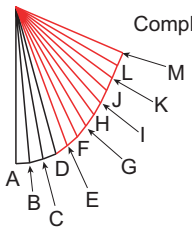


Now instert the spacer line at the other end of "A" line segement. Now go back, and continue to rotate B line-segment, so that it touches the spacer line. You'll have to tweak the rotation of the spacer line too.

13

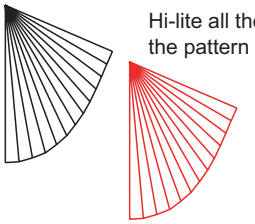
Continue to add lines to the top of A line segement. The spacer line length is also added at the bottom.

14



Complete the line segments as shown.

15



Hi-lite all the lines, and simply duplicate the pattern on your screen.

paper cones — it gives you a much better looking part.

If you want to try your hand at putting one together prior to designing your own, you can print out the full-size pattern shown in Figure 3 on page 6.

Figure 4 shows that it works best to use a hobby knife to cut out the pattern. The reason is that you can use a metal-edged ruler to cut the straight portions. Even though the "curve" is made of straight segments, when you cut it out, your hand will naturally put a curve into the part.

Before applying the rubber cement to the two edges being joined, you should pre-curl the part. I use two dowels. I start with a large diameter dowel (approximately 1/4 inch diameter), and use that to curl the base of the cone. If you're careful, you can use the handle of your hobby knife as a dowel.

Curling the tip portion requires a smaller dowel. As shown in Figure 5, here I'm curling the point of the cone over a 1/8 inch diameter wood dowel.

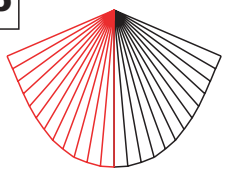
At this point, you can apply the rubber cement, and stick

Continued on page 6.

Oblique Nose Cones

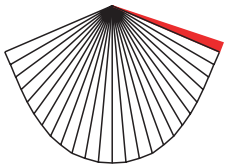
Continued from page 5

16



Flip the duplicated lines, and align them to the other side of the pattern as shown.

17



To complete the pattern, add a glue tab to one edge.

the edges together.The technique is the same as assembling transition sections, which was described fully in *Peak of Flight Newsletter #125*.

Once the cone is put together, you can glue it to either a tube couple, or a small centering ring, like shown in Figure 6. I'd use a tube coupler if you intend for the nose cone to come off the rocket, like a regular nose cone. If it will be glued on, use the centering ring, as it will save weight.

Don't use wood glue when attaching the cone to the coupler. When wood-glue touches the paper, it shrinks as it dries. So you will end up with a little pucker around the rim.

CyA is OK, but it does have its drawbacks too. Particularly, it can set too fast. So if you don't have the cone in the right place as it sets on the lip of the ring (or coupler), it could be glued at an angle. Epoxy is another alternative, but it has its drawbacks too; such that it stinks and cause an allergic reaction in some people.

To make the nose cone rock-hard, coat the inside with the Fix-It epoxy clay. I really can't say enough about this stuff. Every modeler should have some in their inventory of building supplies. You can get it from Apogee Components at: http://www.ApogeeRockets.com/epoxy-clay.asp.

It only takes a very thin layer of the Fix-It epoxy clay to make the nose as hard as steel. Avoid the urge to fill the whole thing up. Remember, always keep the weight down! It is a safety issue.

As shown in Figure 7, first flatten the clay into a thin sheet, and then cut it into wedge shaped pieces. This allows you to get the epoxy way down deep into the nose, and also keeps you from using too much.

After the epoxy-clay has hardened, you have the option of sanding the tip down to give it a rounded appearance. This will work great for scale models like the Russian Proton.

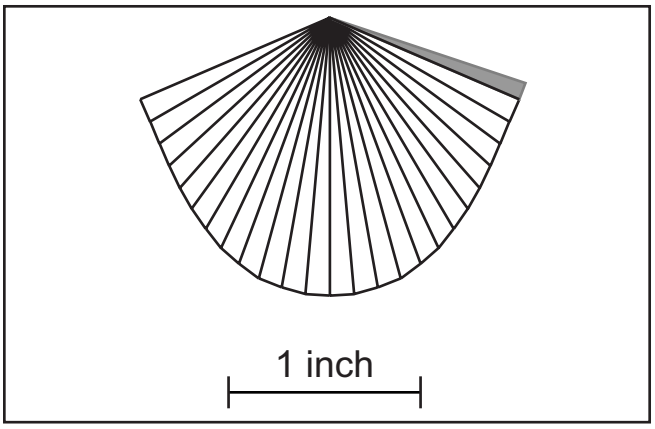


Figure 3: This is a full-size pattern that will fit on a 24mm body tube.

Additional Information

If you found this article useful, here are some links to other "build-it-yourself" publications:

Model Rocket Design & Construction: The ultimate blueprint that guides you through the design and building process. It breaks everything down to simple steps to insure your success. You want rockets that grab attention and respect from spectators, don't you? You can't go wrong getting this book, as there is something for everyone; from beginners to master craftsman. Invest in your copy today at: http://www.ApogeeRockets.com/design_book.asp

Building Skill Level 1 Model Rockets: Vince Lombardy, the legendary football coach that built the Champion Green Bay Packers used to start every season by telling his players: "Now this is a football..." The reason is that he knew you had to master the basics if you wanted to end up a champion. Rocketry is no different. To build rockets that others drool over,

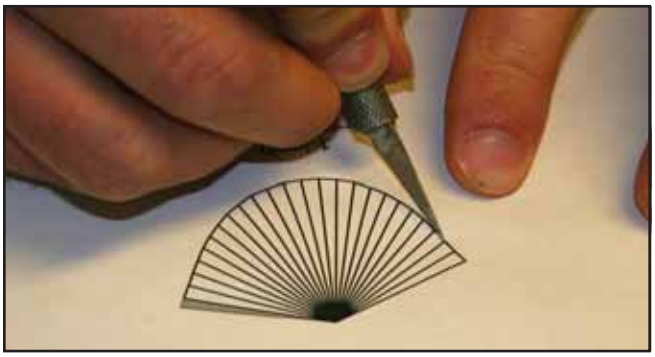


Figure 4: Cut the pattern using a sharp hobby kive. Work slowly to get a smooth edge.

Oblique Nose Cones

Continued from page 6

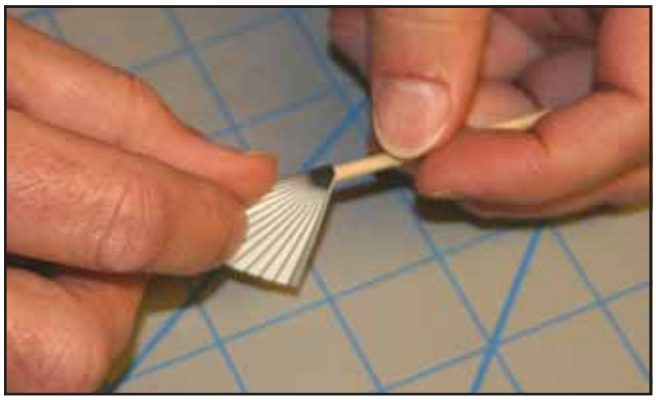


Figure 5: Curl the tip over a small dowel.

you have to be a master of the basic building techniques. You see, "Techniques" is more that just gluing part A to part B. You have to do it right, or it will result in a rocket that says a lot about you. You want to make a good impression on your friends, don't you?

The way to learn technique is by watching an expert do it. That is why this is a "video" book. You simply watch to learn the "correct" techniques. You didn't learn to tie your shoelaces by reading about it in a book, did you?

For more information, visit our web site at: http://www.ApogeeRockets.com/skill_level_1_video.asp

Making Custom Shaped Nose Cones Using Simple Hand Tools: Contrary to what is told by so-called rocketry experts, the real truth is that you DON'T need expensive machine tools like a lathe to shape balsa wood into a nice nose cone. I'll show you how to use simple things like a hobby knife and sanding block to turn a chunk of wood into a nose-cone masterpiece. Why make them yourself? To save money and to get

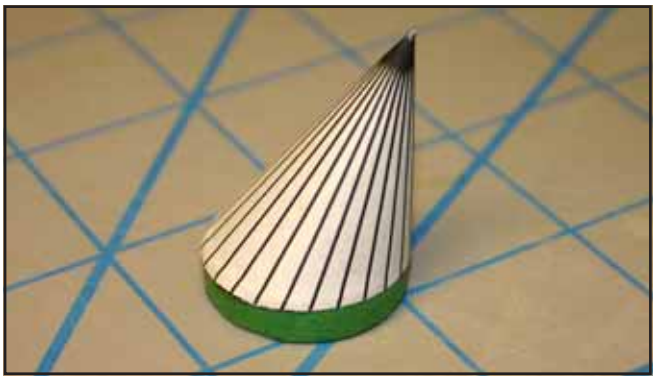


Figure 6: Glue the oblique cone to a centering ring or a tube coupler to keep the shape round.

Figure 7: Shape the epoxy-clay into a flat sheet, and then cut it into pie-shape wedges. This allows you to position it in tip of the cone without adding too much weight.

the correct shape that isn't available from rocketry manufacturers. If you like to build your own rockets, this one video book will pay for itself the first time you make your own nose cone.

Designer's Resource Pak – Creating pattern developments can take a bit of time. If you need some ideas on other shapes you can make from a flat sheet of paper, check out this item. Note: it does contain a set of oblique nose cones, so you can get additional parts to compare to the ones you've created yourself using the techniques in this article. See it at: http://www.apogeerockets.com/construction_supplies.asp#designer_pak_anchor

References:

How to Make Simulated Nozzles – *Peak of Flight Newsletter #125* (http://www.ApogeeRockets.com/education/downloads/newsletter125.pdf)

Make a Diagonal Cutting Pattern – *Peak of Flight Newsletter #121* (http://www.ApogeeRockets.com/education/downloads/newsletter121.pdf)

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