PEAK OF FLIGHT

NEWSLETTER

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Entering Custom Fins Into RockSim

By Tim Van Milligan

Occasionally, someone will ask me about how to enter a non-standard rocket design into RockSim, and they will wonder how I go about adding the fin into the design. The background is that they have a kit that is already built - so they don't really have the fin pattern to work with. The fin is already attached to the rocket.

How to Trace a Fin

I don't know what they are teaching in grade school anymore, but it seems like the process of tracing shapes onto a piece of paper is getting lost. Basically, that is what we have to do in this situation. We have to trace the shape onto a piece of graph paper.

I do prefer graph paper for tracing fins, because it really does help in speeding up the process. The one thing you do have to be careful about is that the edge of the one column of squares must be on the very edge of the paper. In **Figure 1**, you see that the grid doesn't start with the edge of the paper.

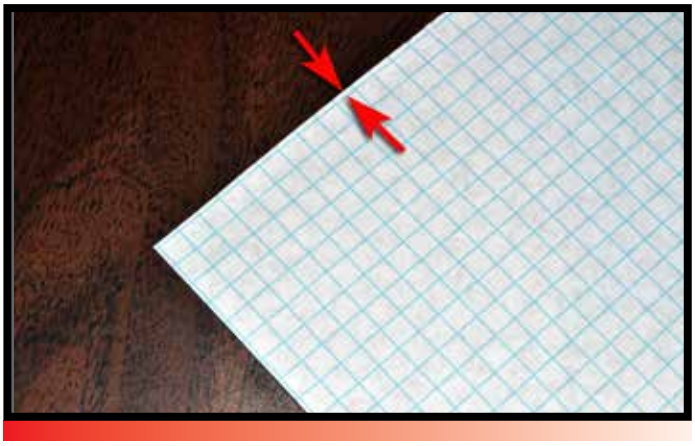

Figure 1: The paper's edge doesn't start on the grid line. This excess has to be cut off.

What you have to do in this situation is to cut off the excess, so that the line of one column is on the very edge. I use a metal straight edge and a hobby knife to trim the paper, so that I know it is as straight as possible (**Figure 2**).

Next, we have to trace the fin. But since it is attached to the tube, it is a little harder. You have to butt the tube against the edge of a table so that you can get the fin to sit flat on the table.

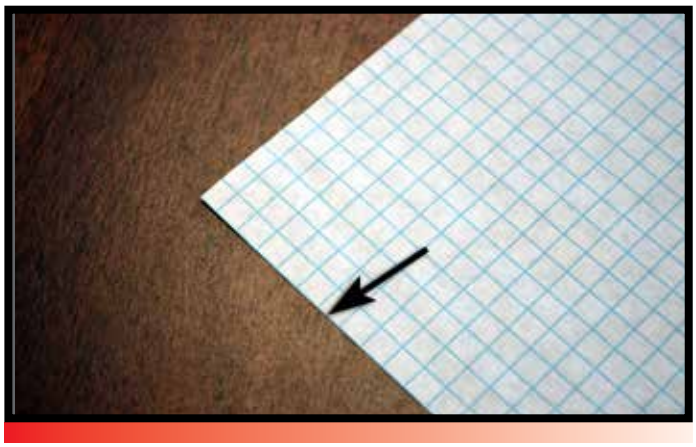

Figure 2: The excess was trimmed off so the edge starts at a grid line.

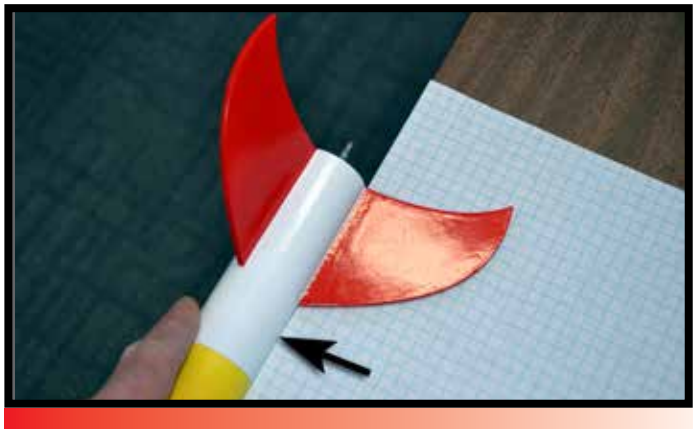

Figure 3: Butt the tube against the edge of a table so that one fin lays flat. Push the edge of the paper so it touches the body tube of the rocket.

Before you can start tracing, you have to line up the graph paper underneath. Slide the paper under the fin and push it right up against the tube (**Figure 3**). You want that nice straight edge to just touch the tube so that you capture the shape of the fin, especially that portion that is closest to the tube.

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Also shift the paper along the fin so that the leading edge of the fin, where it meets the side of the tube, is at an intersection point on the graph paper. This will be the zero coordinate on the graph of the shape.

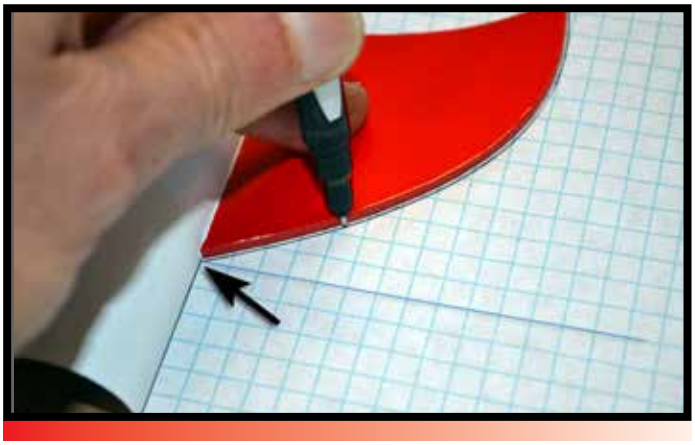

Figure 4: The intersection of the leading edge and the root edge must be at the corner of a grid on the paper. This is the zero-zero point. Then use a fine point pen or pencil to trace around the perimeter of the fin.

When you have the fin properly positioned on the graph paper, use a sharp point pen or pencil to trace around the edge of the fin. Note that a skinny barrel on the tip of the pen/pencil will give you the truest shape of the fin. If you uses a fat tip, the actual line will be offset from the actual fin, and the area of the shape will be larger than the area of the actual fin. Ideally, you want to be as accurate as possible when tracing the shape.

Next, you can remove the rocket, and start putting labels along the axes on the graph paper. I start by labeling the whole inch lines as shown in **Figure 5**.

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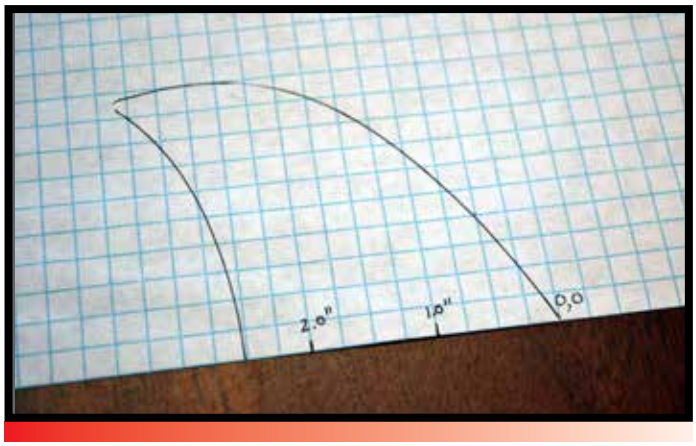

Figure 5: Each square on this graph paper was ¼-inch, so every four squares equals 1.0 inches. I label the lines to make it easier to measure the locations.

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I'll do the same thing for the Y-axis, and label the major whole-number divisions. If you look at **Figure 6**, you'll see that my x-direction is going to the left direction, instead of the right. Had I flipped the rocket over when tracing the fin, it would look like the typical RockSim orientation when drawing the custom-shaped fin. But this orientation will work too. Just remember that positive numbers go to the left

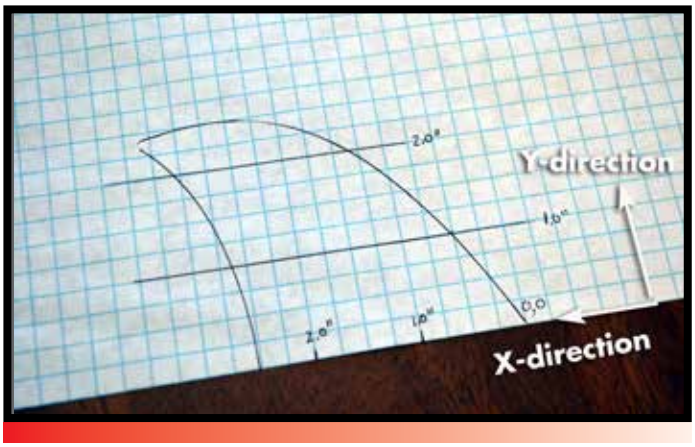

Figure 6: The whole number inch divisions on the Y-axis location are also marked.

Next, I noticed that my pen didn't stay down on the paper as I went around the sharp corner of the fin near the tip. There is a slight gap in the line as seen in Figure 6. I decided to just put a point (dot) on the paper to indicate where the exact point of that tip will be (**Figure 7**).

The next task is to mark off various points along the perimeter of the fin outline. I try to choose points along lines on the graph paper since I know for certain either the X or Y measurement.

In **Figure 8**, the numbers shown with lines under the number were the best guess of the measurement that I could make. I could have gotten out a caliper and actually measured them, but you don't really have to get so specific.

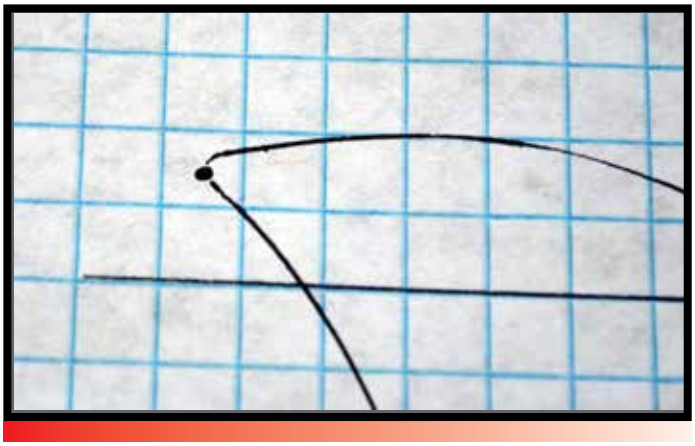

Figure 7: Mark any major corners on the fin with a dot to signify their importance.

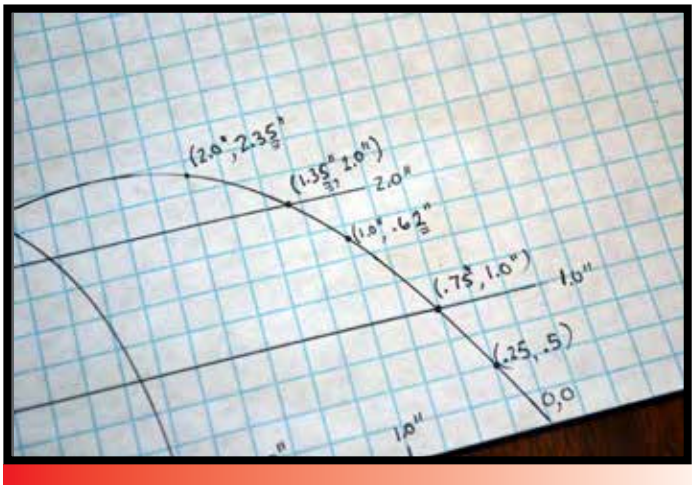

Figure 8: Pick points on the curve (usually along grid lines), and write down their X-Y locations.

How many points you select and label on your sheet is up to you. The more points you have, the smoother your fin will look in RockSim. But it is more work. If you plan on sending the file to a friend and having them recreate the rocket from the design, you might want to add more points so that they get a nice smooth pattern when they print it out.

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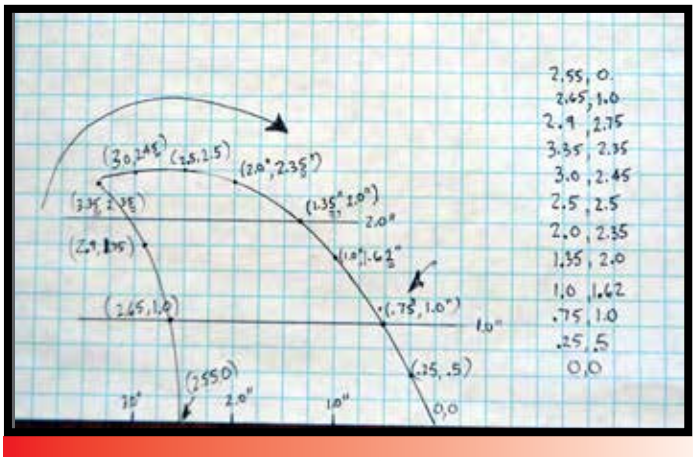

Figure 9: Make a table (shown on the right) of all the points. This may help you keep them organized for entering them into RockSim.

But if you are just doing it for your own simulations, then I wouldn't get too worried about the smoothness of the pattern. You're probably doing more work than you'll get back in accuracy of the simulation.

Once you get all the points you want, make a table of points, starting at the back edge of the fin and work towards the front (**Figure 9**).

I like to make the table so I can keep them organized in my mind. And it also helps me count the number of points that I should end up with once I enter them into RockSim. You can see from my table in **Figure 9**, that I have twelve points.

When you go into RockSim, and enter the fin by choosing "custom fin," RockSim will automatically generate a trapezoid for you. It does this just to help get you started. When you click on the graph, it will add a new point wherever you click. But instead, click on the button "show points." You'll then see the "fin plan points" in a dialog box. Since the generic fin has just four points, that is what you'll see in the dialog (**Figure 10**).

Note that in the fin plan points screen, the back point on the fin is listed at the top and the front point is at the bottom. I hope that you see why we made the chart starting from the back point on the fin and not the front point. The reason is that it matches what you see here on this particular screen.

At this point, you can start entering your numbers from your table into the table on your computer screen. Click into the (X) column and highlight the number and just type over it. Then hit the tab key and type in the (Y) value. When you want to finish a row, you have to hit the "ENTER" key on your keyboard for RockSim to accept the (Y) value.

Hitting the tab key doesn't work for this. It has to be the "enter" key.

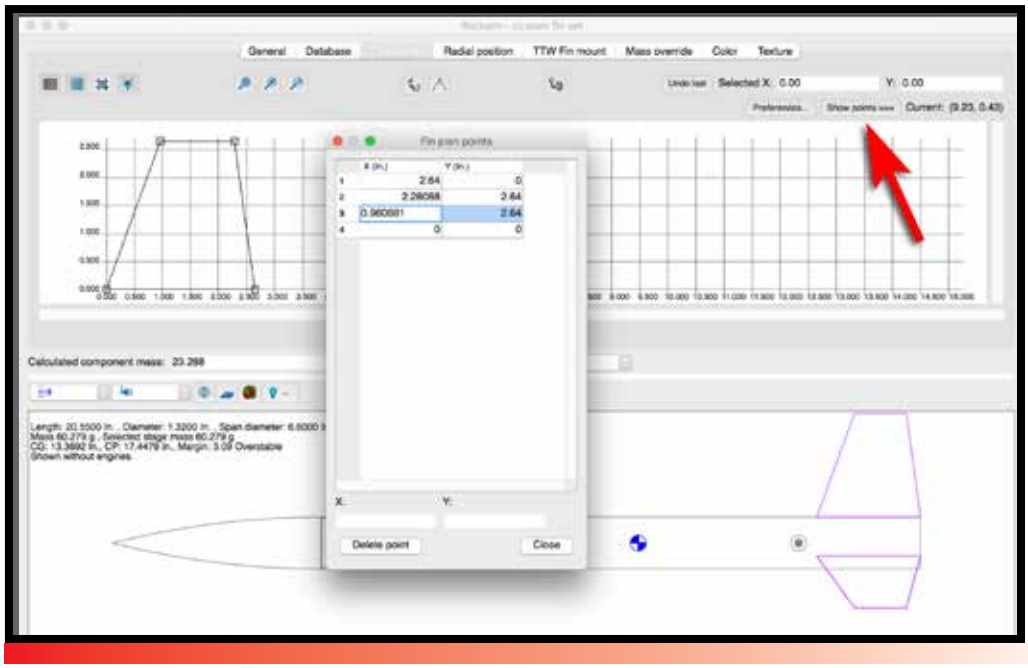

Figure 10: The Fin Plan Points dialog box.

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Since the table only has four points on it so far, you'll have to eventually go back to the graph screen and add points. We have to add 8 more points to get up to a total of 12, so I just randomly clicked on the screen eight times to add the extra points as shown in **Figure 11**.

Then go back into the Fin Plan Points dialog box by again clicking on the "Show Points" button. Finish adding the exact locations in the dialog box.

As shown in **Figure 12**, I have one point that doesn't look like it is in the right spot. It just looks out of place, right?

Sure enough, I wrote down the number incorrectly. If you look back at **Figure 9**, you'll see that I should have written down the position of the point as (0.55,1.0) not (0.75,1.0). It is an easy fix to make.

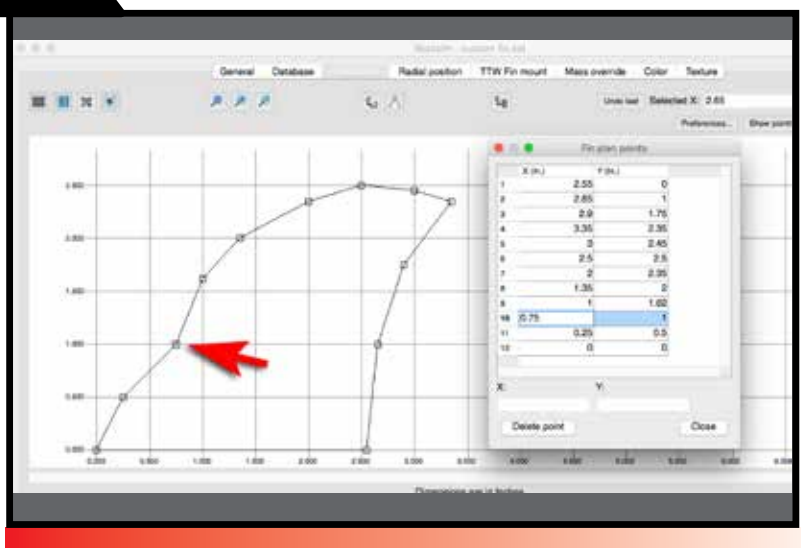

Figure 12: One point just doesn't look like it is in the right spot. This visual observation is a good way to check to see if you wrote things down correctly.

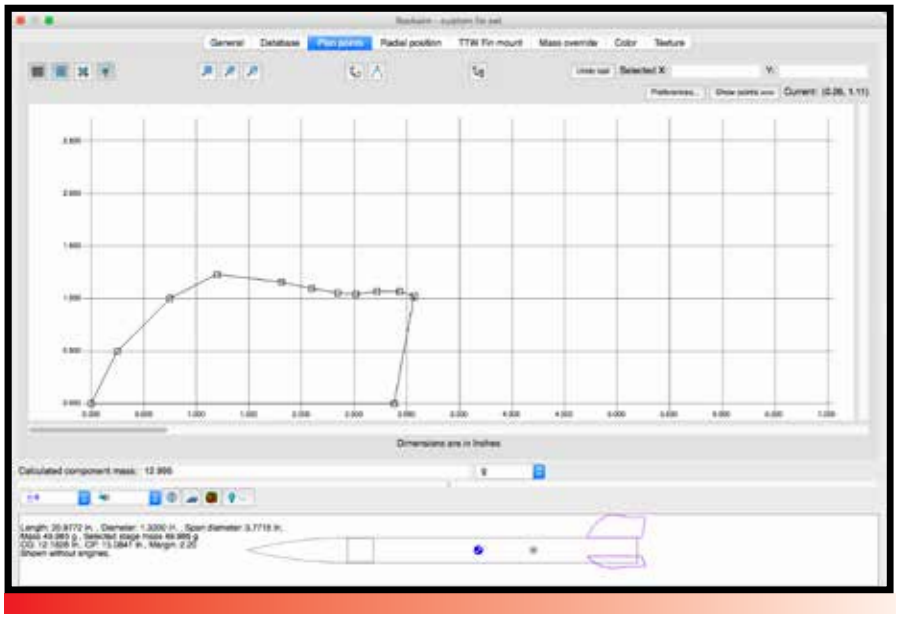

Figure 11: Click on the screen anywhere to add the extra points you'll need for the fin.

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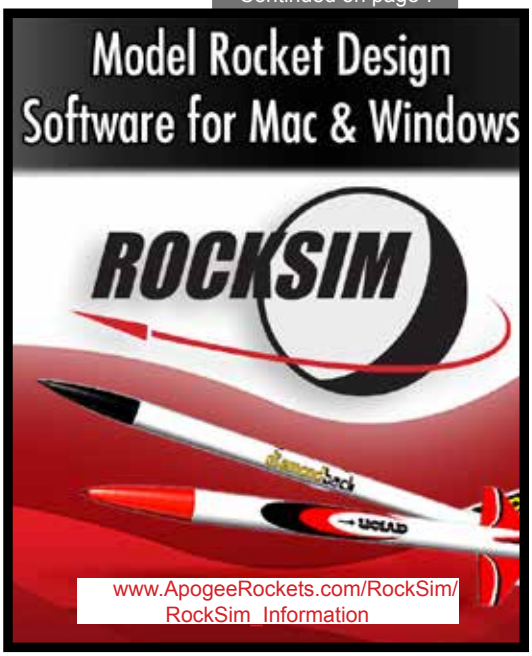

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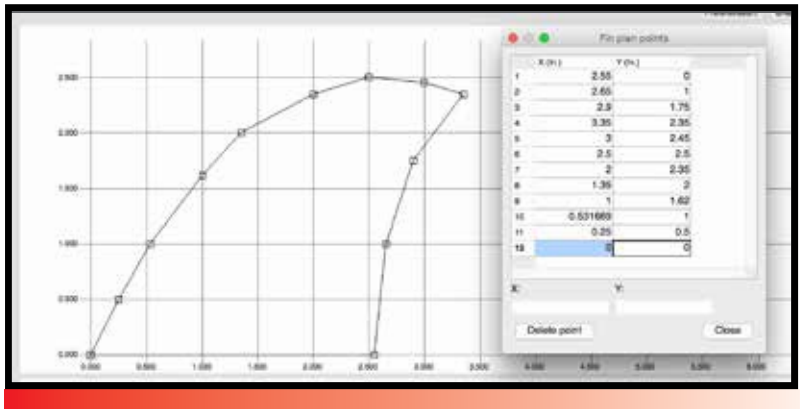

Figure 13: The final fin shape in RockSim. It looks very close to our original fin from Figure 3.

Figure 13 shows the final fin shape. It now looks much better and more closely matches our actual fin shape.

This is the exact process I use every time I build a rocket from a different rocketry manufacturer. As you know, here at Apogee, we build all the rockets that we sell so that we know what you as a customer will experience. After I get it built, I'll often have to go back and enter the rocket design into RockSim so that I can run the simulations to select which rocket motors to put on our website under the chart of recommended motors. I think people like the design files that I create, because they are pretty accurate to what the actual model is like. And I've just explained the process that I use to put them in.

Designing Rockets on My Computer

The process of putting in fins when I've designed the rocket myself on my own computer is a little different, because I don't have to trace the outline of the fin on a sheet of paper. But it is still a chore to do.

When I design a fin, I'm not typically looking for the "best fin shape." I'm looking for an aesthetically pleasing look. Take, for example, the Peregrine rocket, which I'm working on now. It is also a swoopy shape, similar to the one shown in **Figure 3** (Page 2).

Figure 14: The Peregrine rocket.

I designed the fin shape using a simple drawing program first. The nice thing about it being on the computer is that I have an exact shape. But I don't yet have the coordinates of the points along the perimeter.

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Instead of printing it out on a piece of graph paper, I physically draw a grid over the top of the fin shape, as shown in **Figure 15**.

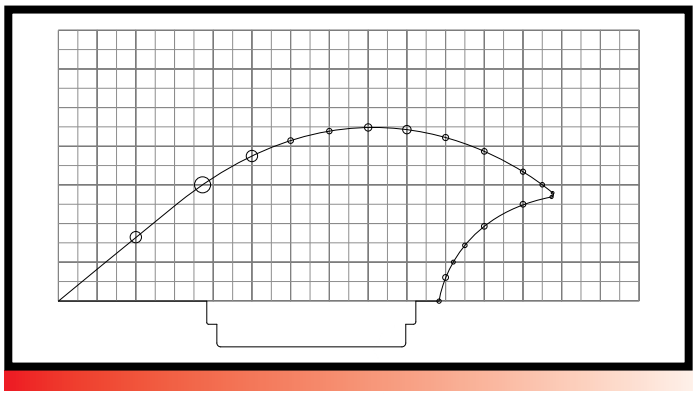

Figure 15: I physically draw a grid over the top of the fin shape instead of tracing it on a graph paper when creating my own fins. Then I draw circles around the points that I will use to plot the points in Rocksim.

I then pick the points from the perimeter, as I did when physically drawing the fin on a sheet of graph paper.

The process is then pretty much the same, taking the points and creating a table that can then be transferred into RockSim.

If you want higher accuracy, instead of picking the points off the grid, you can use the computer for a little help in displaying the actual points.

As shown in **Figure 15**, I have circles drawn around the points I want to use. I just need to know the exact center of those points, and where they are in relation to the zero-zero coordinate in the bottom left-hand corner.

What I do is have the drawing program display the ruler, which is almost always an option in graphic programs. I then move the zero point on the ruler to the corner where the fin starts.

From here, I click on the circle that surrounds the point on the perimeter of the fin, and use the transform dialog box to find the location of that point. It will be exact to any number of decimal points that you want displayed. (**Figure 16**).

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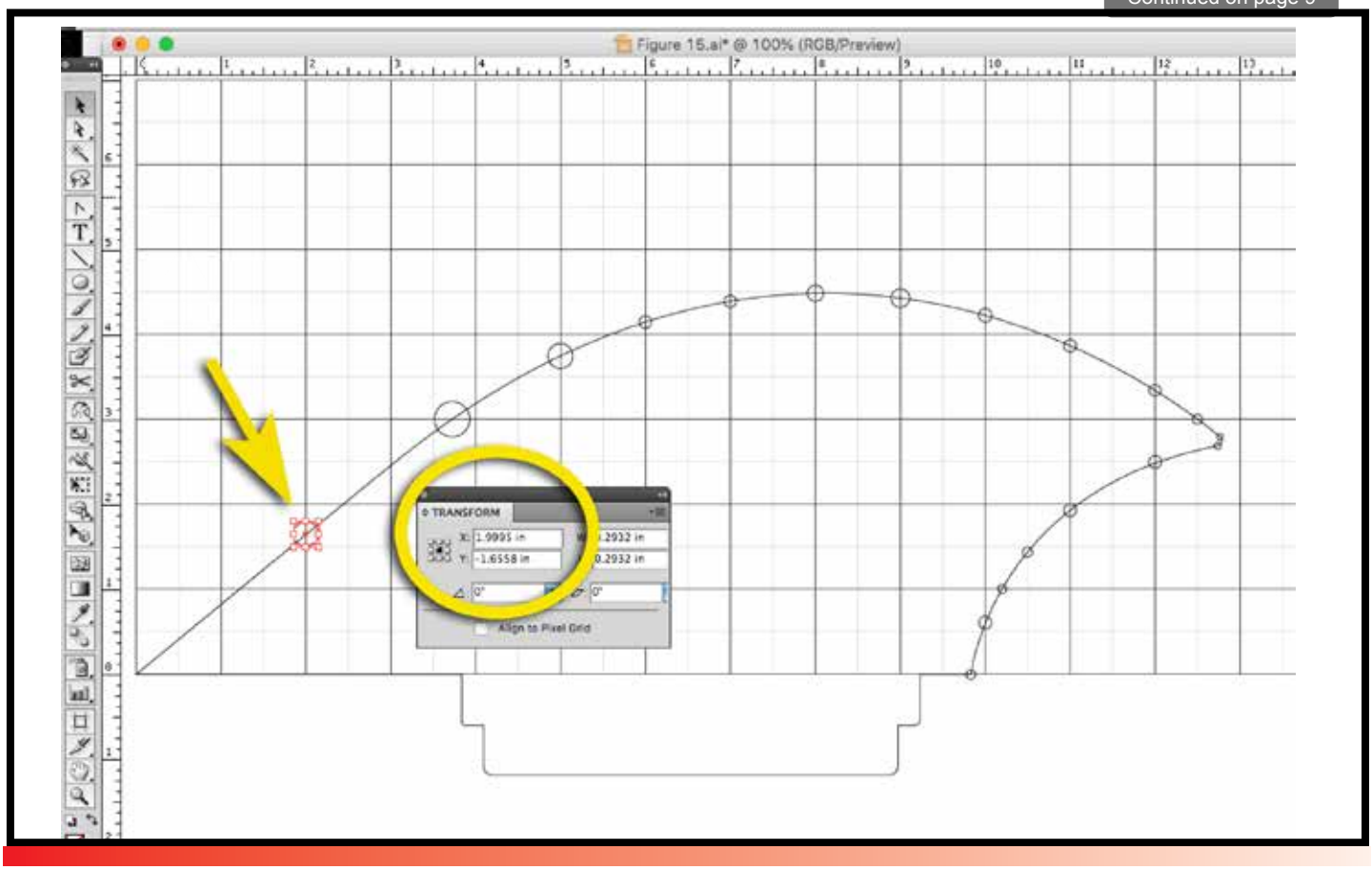

Figure 16: Using the transform dialog box, you can find the exact location in X,Y coordinates of the center of the circle that surrounds the point on the fin.

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Finally, **Figure 17** shows what the fin looks like when entered into RockSim. If you're interested in the final design, you can download the RockSim file at: https://www.apogeerockets.com/downloads/rocksim_files/Peregrine.rkt.zip

Conclusion

Entering custom shaped fins into RockSim isn't that hard. It is just a process of graphing out the position of several points on a graph, and then transferring those points into the RockSim software. Depending on the number of points you want to define the shape of the fin, it will typically take about 15 minutes to get the shape into the program.

About The Author:

Tim Van Milligan (a.k.a. "Mr. Rocket") is a real rocket scientist who likes helping out other rocketeers. He is an avid rocketry competitor and is Level 3 high power certified. He is often asked what is the biggest rocket he's ever launched. His answer is that 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 an 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 also the author of the books: Model Rocket Design and Construction, 69 Simple Science Fair Projects with Model Rockets: Aeronautics and publisher of the "Peak-of-Flight" newsletter, a FREE ezine newsletter about model rockets. You can email him by using the contact form at https://www.apogeerockets.com/Contact.

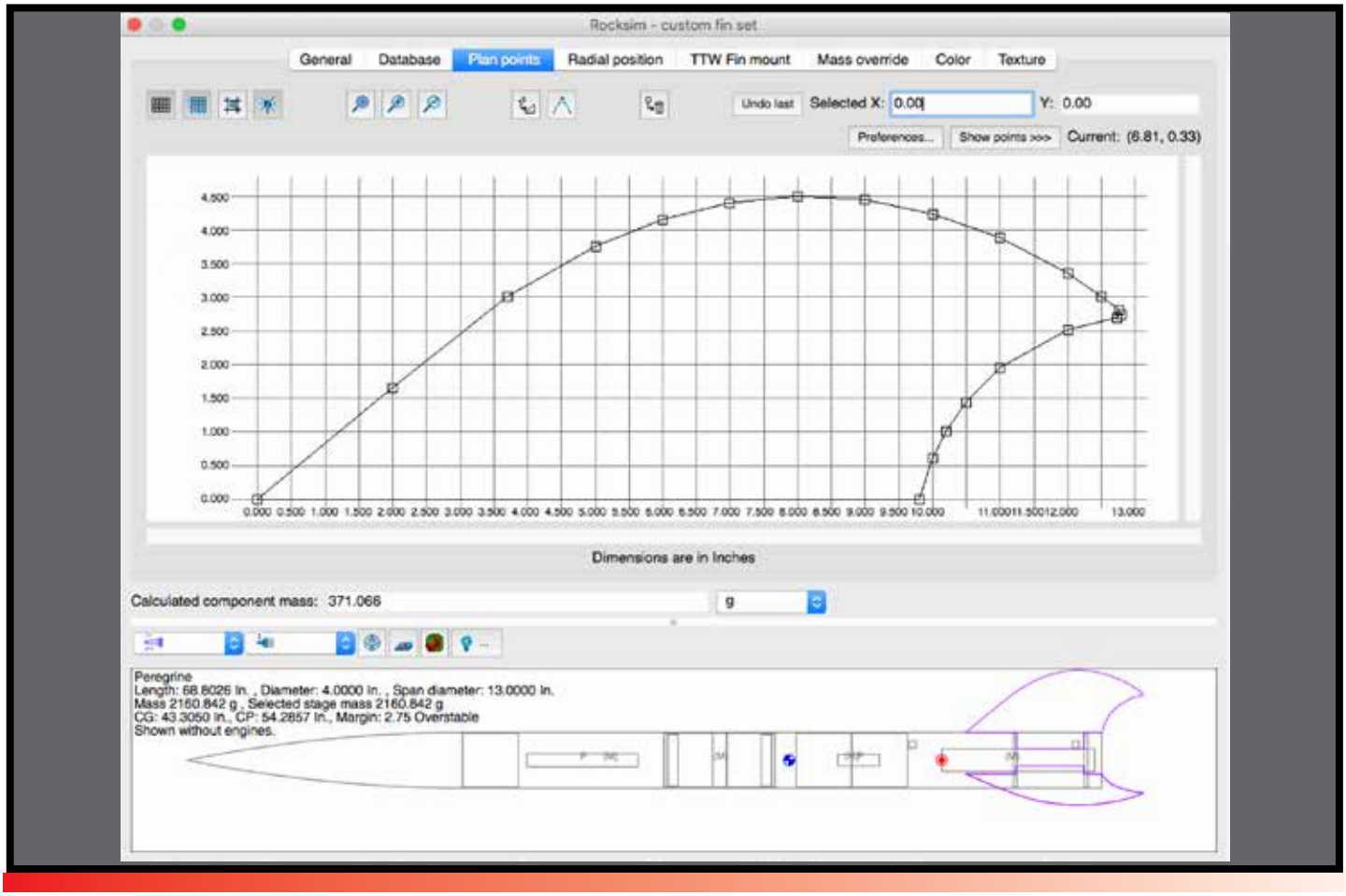

Figure 17 - The Peregrine fin shape as entered into Rocksim.