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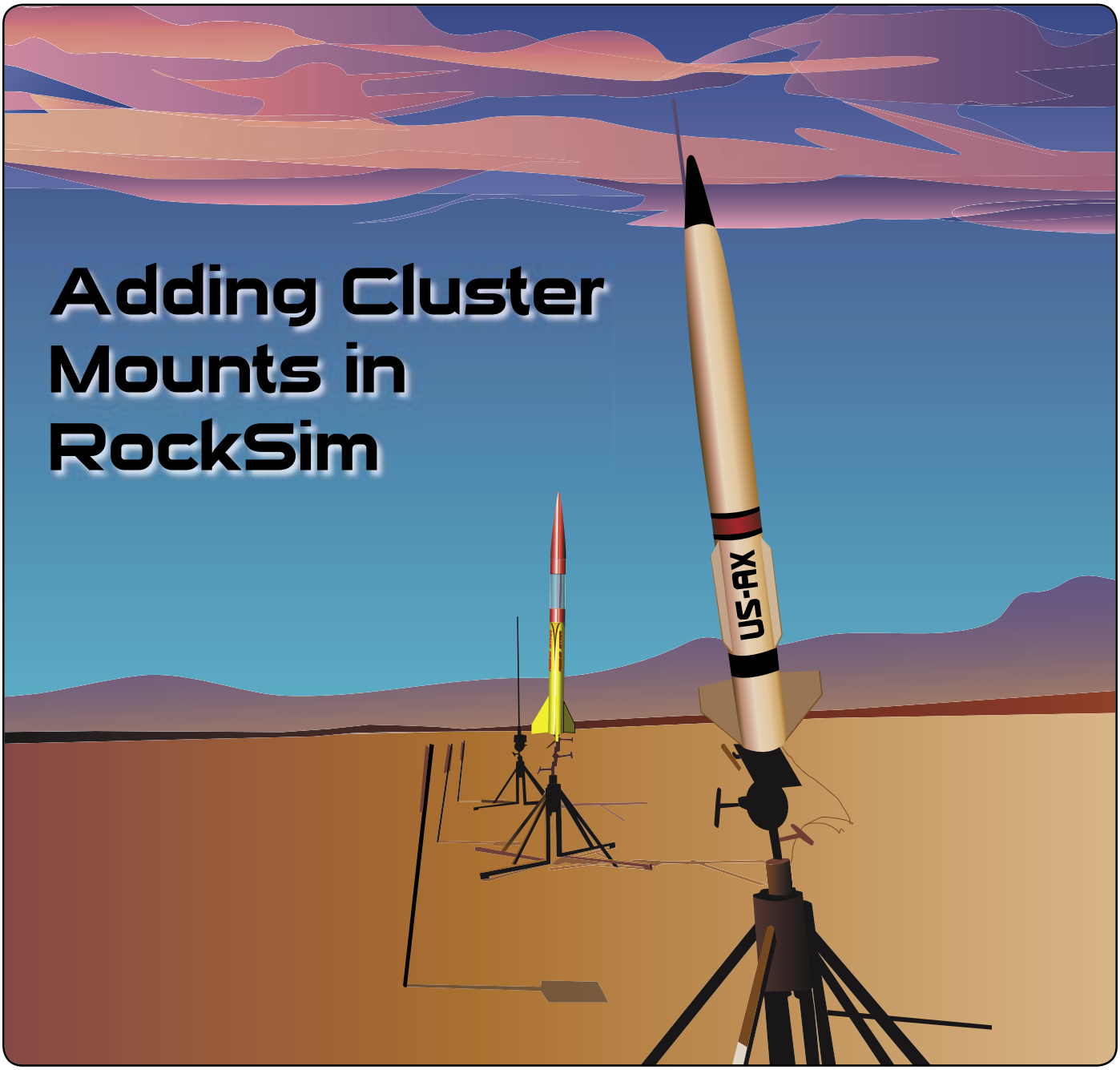
APOGEE PEAK OF FLIGHT NEWSLETTER



Adding Cluster Mounts in RockSim

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How to Create Complex Clusters In RockSim

By Tim Van Milligan

I always thought creating a complex cluster in RockSim was pretty easy. It isn't an often-asked question, so it was never added to the FAQ page of the Apogee Components web site. But every now and then, someone asks me how it is done. So I thought I'd give the step-by-step procedure here in this article.

First of all, the procedure is the same for v8 as it was in the previous v7 and v6. If you have an older version of RockSim, these steps will still work, even though I'm using v8 to create the images for this article.

I guess the hardest step in the whole process is realizing that you CAN'T put all the motors into the rocket in one single step. That's right, you have to break it down into a series of mini-installations. But trust me, it isn't too hard once you grasp the key concept.

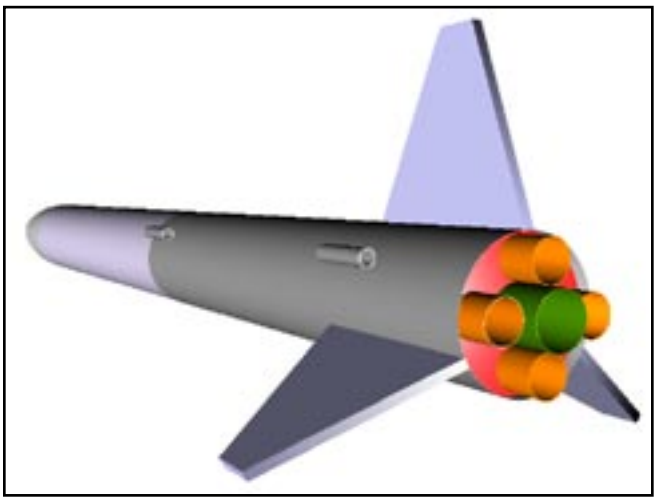

Figure 1: An example of the complex cluster that is easy to create in RockSim.

Key Concept: Sizes and Patterns

When inputting clusters into RockSim, we have to break the complex pattern down into manageable chunks. We'll break them down based on motor sizes, and patterns.

For example, take a look at Figure 2(A). It shows the rear view of a complex cluster pattern. You have a single big motor in the middle (red circle), which is surrounded by four mid-size motors (the green circles), and also two smaller engines out further from the middle (the yellow circles).

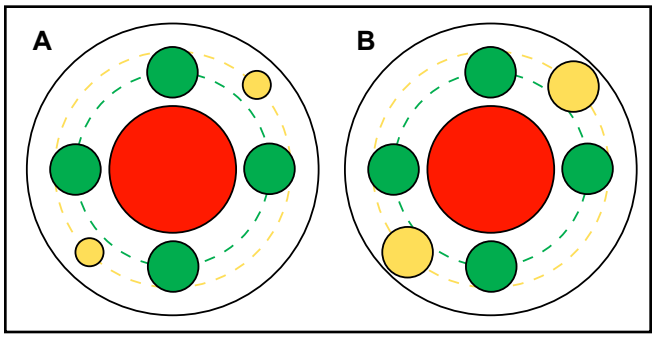

Figure 2: Two cluster configurations, both would be set up the same way in RockSim.

In this example, we'll break the complex cluster up into three steps. First the middle motor, then the mid-size motors, and finally we'll add the two smaller motors. Simple, huh?

In Figure 2(B), we have a similar cluster configuration, but this time the yellow motors are exactly the same size as the green motors. Even though they are the same size, we'll still break this down into three distinct steps, because the "pattern" of the motors isn't symmetrical. We'll start by placing the central red motor, then the four green motors, and finally the two yellow motors.

If you understand this strategy, entering any type of cluster configuration will be simple. In the rest of this article, I'll give you the step-by-step procedure for placing the mo-

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Create Complex Clusters

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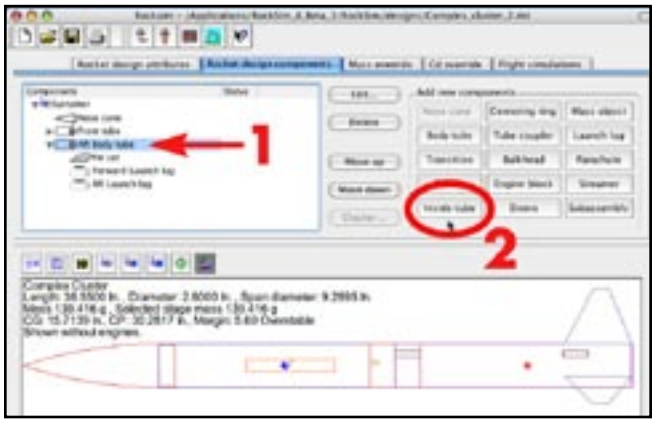

Figure 3

tors, and show you how RockSim's "Cluster Wizard" button simplifies the process. I'll create the cluster pattern shown in Figure 1 on the previous page.

Step-by-Step Process · Adding the Central Engine Mount

In my example, I have a big tube, and I want to place a 5-engine cluster mount. We'll start by going to the *"Rocket Design Components"* tab on the main screen of RockSim. Our first objective is to add the central engine mount.

1. Highlight the big tube in the parts tree. This is the tube where all the motors will be added.

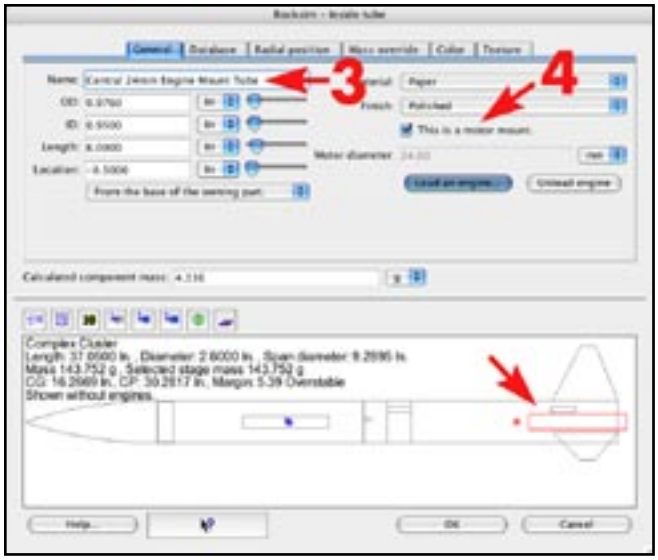

Figure 4

2. Not we'll add a motor mount tube, just like we'd do for any single-engine rocket. Click on the INSIDE TUBE button, which will then bring up the component editor screen for body tubes. You can select from the database, or create your own tube. In Figure 4, I've selected the size tube, and changed its length.

3. CHANGE THE NAME OF THE TUBE! This will become important later when you go to add engines to the model. If all your tubes are called "body tube" you will have a tough time telling them apart. This is particularly important in a complex cluster configuration.

4. Click the little checkbox that says, "This is a motor mount tube." If you don't, you won't be able to install motors into it later when you want to run your flight simulations.

5. To speed things up, I'm combining basic steps here, but go ahead and add any parts associated with the central engine mount tube at this time. If Figure 5, you'll see I've added an engine block, and a mass object to account for the weight of the engine hook.

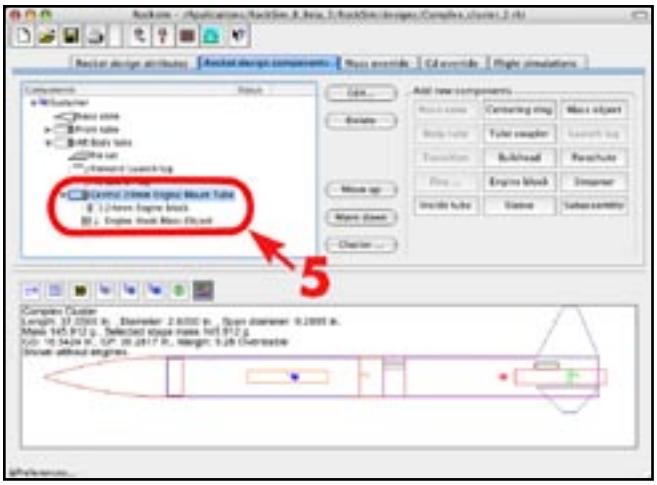

Figure 5

Add The Outer Engine Tubes In the Cluster

6. We'll now repeat steps 1 through 5, and create a single (yep, just *ONE*) engine mount tube for the outer cluster ring of motors. It should look like the 3D picture (inset on Figure 6). The green tube will be duplicated by the cluster wizard process, so don't worry that you don't have enough engine mounts yet.

Also note that I've added the engine block and the engine hook to this single tube. If we add them now, they will also be duplicated automatically during the cluster wizard process, and it will save us a lot of time.

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Create Complex Clusters

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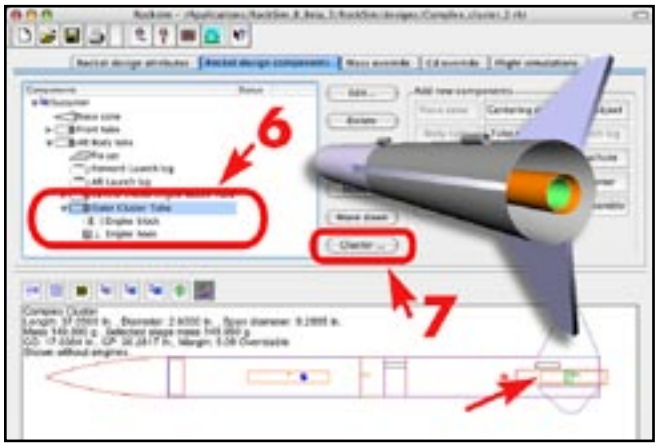

Figure 6

7. After highlighting the outer cluster tube that you want to duplicate, now click on the Cluster Wizard button. This will walk you through a series of screens that will actually duplicate and reposition the tubes in the set. The first screen is show in Figure 7.

8. RockSim has eight different cluster patterns that are standard. It also will allow you to create a new pattern of your own specifications. This is the button that is circled in Figure 8. I'll go ahead and show you how it works. After clicking on it, you'll see a new screen shown in Figure 9.

9. Now specify the number of tubes in the set. I've chosen four for this example (you can choose any number that you want). Now we need to figure out how far off the center of the big external tube we need to position them. I don't know off hand. So rather than guessing, I'll click the button "Calculate the Maximum Radius." I know that this may be too far, but it will give me a starting distance. We'll come back and tweak this value later. So don't worry about getting it exact at this point. Go ahead and click the "Next >" button.

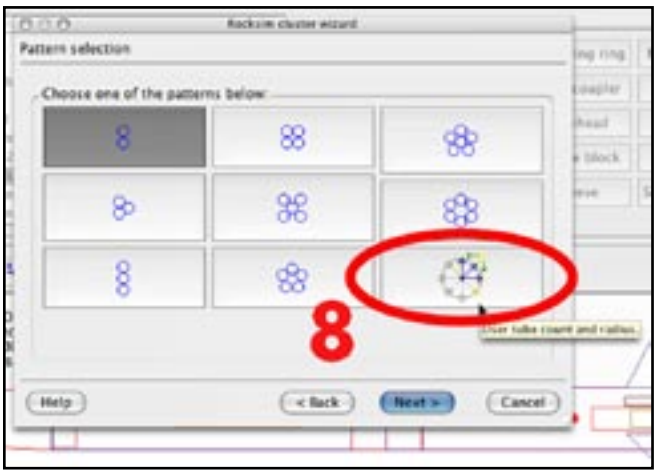

Figure 8

10. Now we need to give the tubes a name. I'm calling mine "Outer Cluster Tube." When RockSim is done, it will rename all the tubes and designate them 1, 2, 3, etc. We'll see this later.

I'm leaving the rotation angle alone for this design. But you may have to play with this if you have multiple tube sets. When you're satisfied, you can click the "Next>" button.

11. Now you'll see a picture of the cluster, like shown in Figure 11. NOTE: at this point, it will not be perfect. You will now have to click the "< Back" button to go and tweak the radius dimension and the rotation angle.

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Figure 7

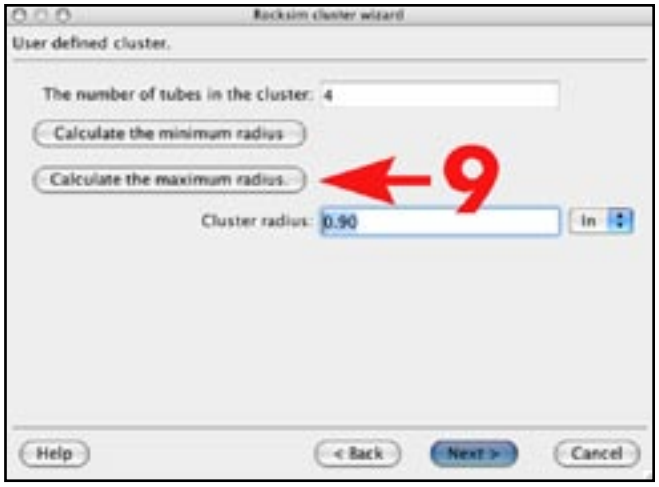

Figure 9

Create Complex Clusters

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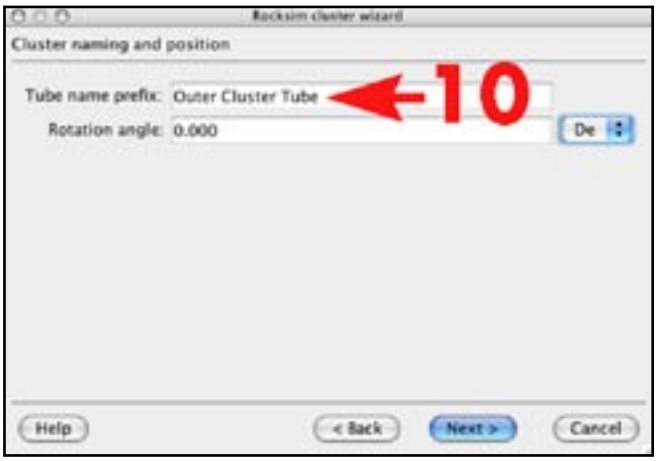

Figure 10

If you have RockSim v8, you can right-click with your mouse on the screen to bring up the "Context Menu," which will then allow you to zoom in on the image (see inset in Figure 11).

At this point, you want to make sure that you don't have overlapping tubes, and everything fits into the main tube. If you can't get it to fit, you may have to cancel out of the Cluster Wizard process, and change the diameter of the tube being added.

When you are satisfied with the position of the new tubes in the cluster, you can click the "finish" button. Until you click this finish button, RockSim won't duplicate the tubes for the cluster pattern. So you still have time to back out of things.

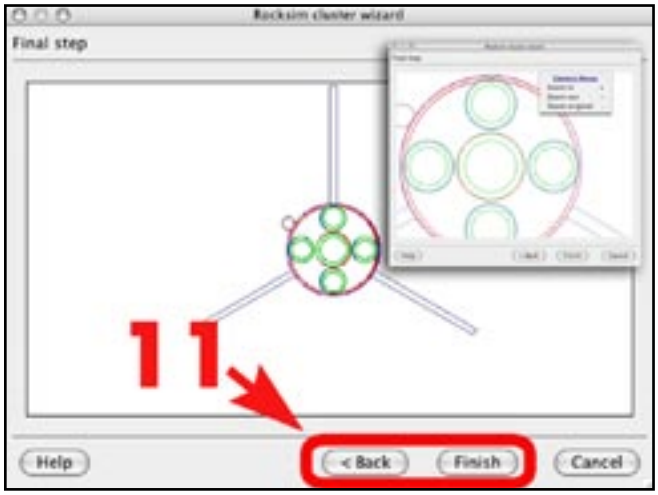

Figure 11

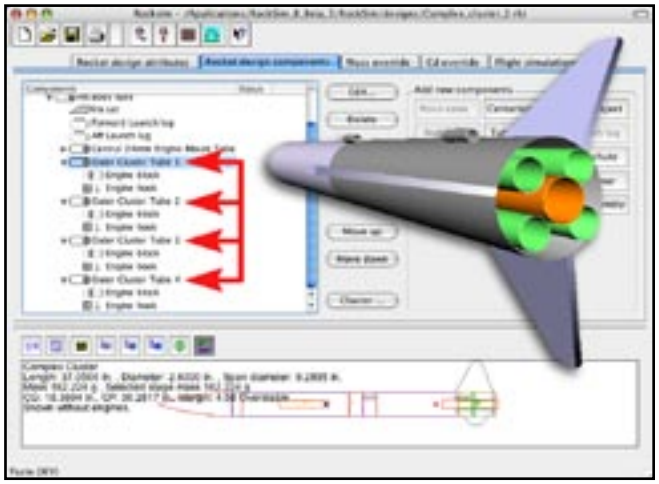

Figure 12

In Figure 12, you'll see how RockSim has duplicated the outer ring of engine mount tubes. It gave them each a distinctive number, so you can tell them apart when it comes time to load the rocket motors. It also duplicated the engine blocks and the engine hooks in the tubes!

The 3D inset in Figure 12 shows what the back end of the cluster will look like.

Add Centering Rings

12. At this point, we're ready to add in our centering rings that will hold all those tubes in the cluster in the right position. Highlight the outer tube again, since this is where the ring will fit (see Figure 13).

13. Now click on the "centering ring" component button to add that type of component into the design.

14. Making this ring is similar to making any other cen-

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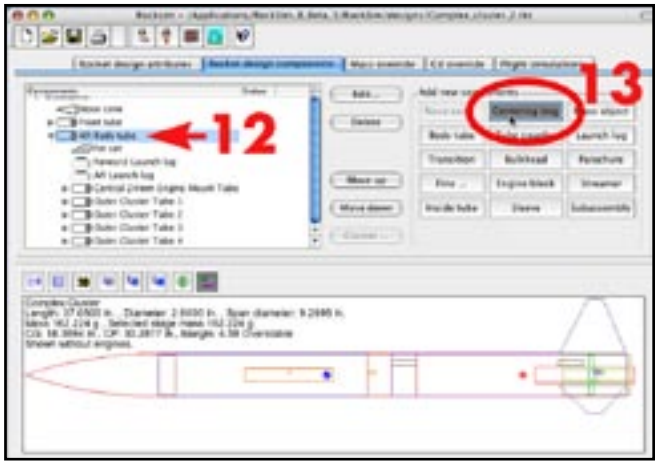

Figure 13

Create Complex Clusters

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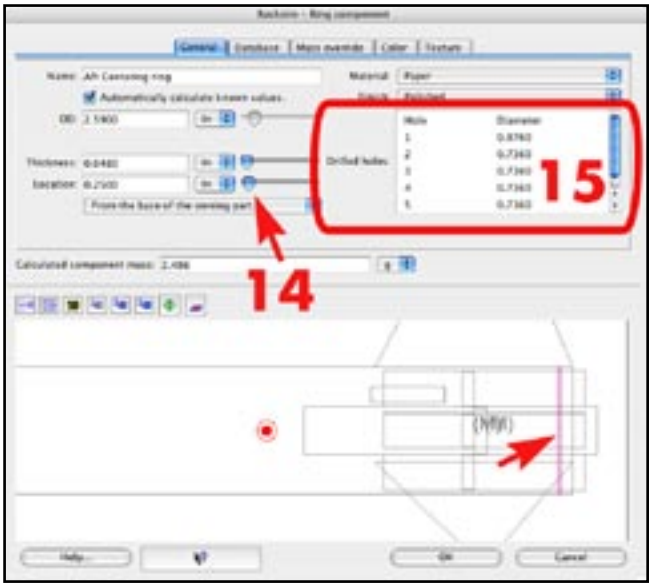

Figure 14

tering ring. But a special thing happens when you position the centering ring disk over the cluster tubes (Figure 14).

15. When the disk is slid over the top of the engine tubes, a "Drilled Hole" menu will pop up on the screen. This indicates that RockSim sees that this ring will have multiple holes in it for the cluster tubes. You can't edit the hole sizes,

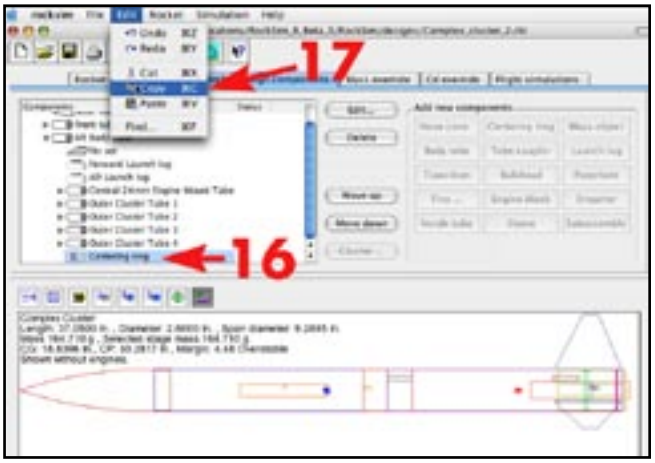

Figure 15

but you can see that they are there.

16. When you are satisfied with the ring, go ahead and highlight it in the components parts tree (see Figure 16).

17. We can now perform a copy and paste, which will save us time in creating a second ring for the rocket. When you paste it back in, make sure to highlight the outer body tube first. Then open the new ring up in the component editor screen, and reposition it to where it should go. Be sure to change the name of the ring so you can tell it apart when it comes time to print out your ring.

In Figure 16, I've made the outer tube transparent, so you can see that what the final cluster engine mount will look

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Create Complex Clusters

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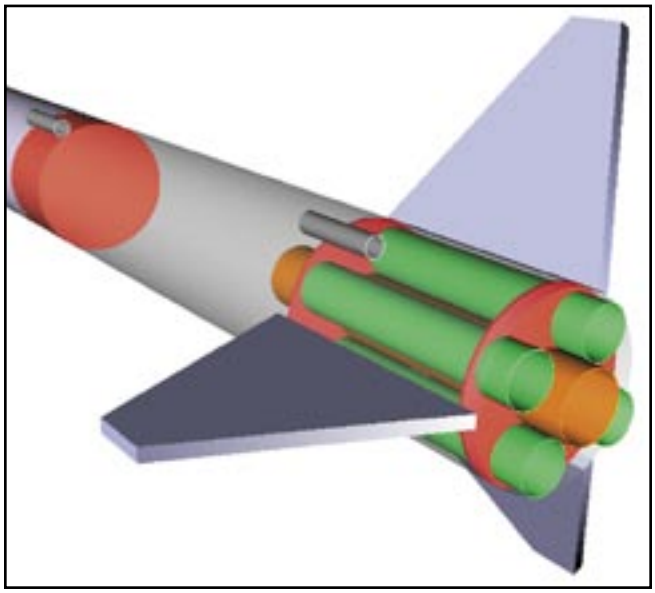


Figure 16

like. It looks really good, doesn't it? And it only takes about 5 minutes to set it all up.

Another thing to note is that once the tubes are in place in the cluster, you can edit each individual tube separately. For example, you can change the color of one tube, or its length or even its radial position in the rocket. And doing so does not affect any other tubes in the cluster. How cool is that?

In figure 17, this is an example of what the ring will look like once you print it out.

Conclusion

There really isn't a trick to making complex cluster rings. As I mentioned at the beginning, the hardest step is just realizing that you have to input it into the design as a number of small steps. These are based on the tube sizes, and the pattern in the cluster. Once you try it the first time, you'll see how easy it can be.

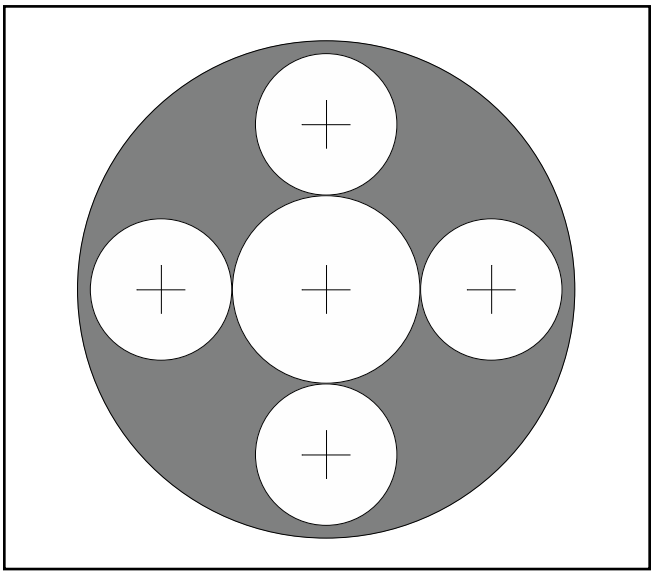
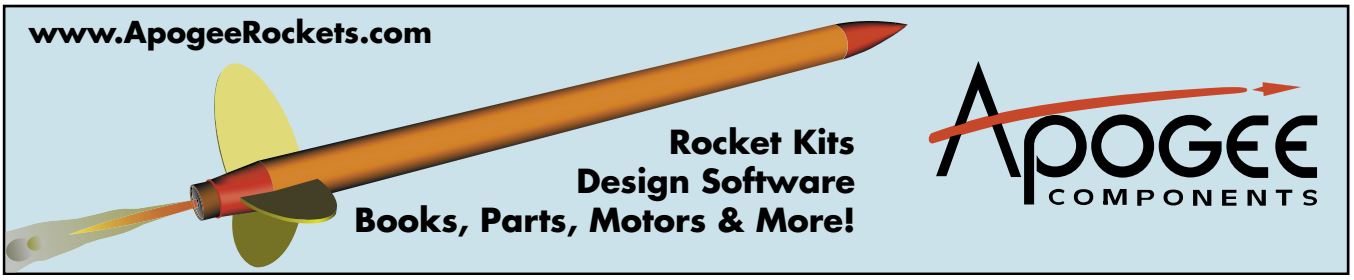


Figure 17: A printout of the final centering ring.

About The Author:

Tim Van Milligan (a.k.a. "Mr. Rocket") is a real rocket scientist who looks forward to 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 around the earth. 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.

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