Apogee Components

PEAK OF FLIGHT

NEWSLETTER

Selecting Rocket Motors Based On Visual Effects

Enhance the flight by choosing a plume color that matches the rocket's decor.

Useful Building Tips

A fixture you can use to draw a straight line down a transition.

Question and Answer Corner

How to set up a transtion between stages in RockSim.

EMRR Corner

Mad Cow Rocketry's Sea Wolf Missile. A 4-inch diameter hi-power rocket with a 38mm engine mount. www.ApogeeRockets.com/Madcow_Sea_Wolf.asp

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Selecting Rocket Motors Based On Visual Effect

By Tim Van Milligan

It hasn't happened yet, but I'm sure I'll eventually get the question about choosing rocket motors based on the flame colors and other visual effects.

Up to this point, all my reports that cover engine selection were based on the safety aspects. In other words, can any given motor safely lift a particular rocket into the air and recover it so that it can be flown again? This is a great question, and I can say with certainty that safety will ALWAYS be the overriding criteria for selecting rocket motors for a rocket. As a flyer, it is your responsibility to make sure that the motors you select for your rocket can safely launch the rocket in the air.

How do you do this? Start by reviewing the step-by-step motor selection procedure that I wrote in Apogee Technical Publication #28 (http://www.apogeerockets.com/technical_publications.asp#TP28_anchor). It will walk you through a repeatable process that will weed out the motors that you should not use in your model.

As that report mentions, when selecting motors, you'll find that you have several different options available. It is when you get to this point that you may want to consider the visual effect of the propellant on the flight, and I believe that this is a legitimate selection criteria. Why is that?

We fly rockets for more than the roar and the speed of the rocket as it takes off. We also love the visual aspects of the flight, as well as the sound that the rockets make when they rise to the sky. So there is nothing wrong when trying to optimize that part of the flight too.

It is the variety of propellant types available from the various rocket manufacturers which allow us to enhance the visual aspects of a rocket launch. It then makes sense to describe what is available in propellant formulations so you can make your choice.

In this article, I will use the Aerotech propellant formulations as my example. The reason is that Apogee Components currently sells Aerotech motors and I am familiar with some of their characateristics. But there are other manufacturers that are making different formulations too, like Cesaroni, Animal Motor Works, Loki Research, and Road Runner. There seems to be a lot of overlap in the colors and the visual aspects that are available from all the manufacturers. I suppose this has to do with the specific chemicals that are added to the recipe that gives the different flame effects. For example, there are many motor manufacturers that are making red-flame rocket motors.

Here are a list of the propellant types that we currently carry at Apogee Components from Aerotech:

Blue Thunder™: Produces a pale blue flame, whispy smoke, and a very loud roar. If my memory serves me, Blue

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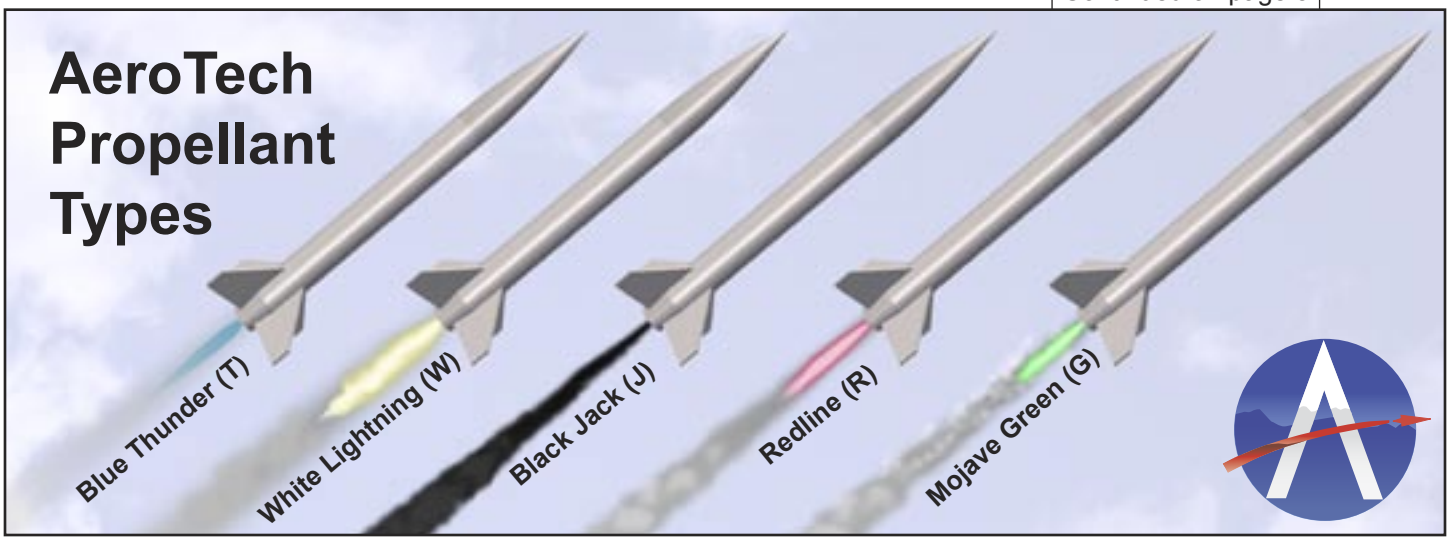

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Thunder was one of the first propellant types that Aerotech made. It is a high-efficiency formulation, which means you get more total impulse out of a chunk of propellant. That is because it is a relatively fast burning propellant, and it burns at higher temperatures. The military likes these types of propellants, since you don't want a lot of smoke from your rockets to give away your launch position. But for model rockets, the lack of a significant amount of smoke can be a detriment, since it makes it hard to track the rockets as they fly really high into the air.

Motors that use the Blue Thunder propellant formulation are designated with the letter "T" following the total impulse of the motor. For example, the F42T-4 (which may also be labeled as the F42-4T) motor uses the Blue Thunder formulation.

Black Jack™: This type of propellant produces a very dense black exhaust smoke that makes it really easy to track the ascent of the rocket. I assume it was developed to overcome the problem of whispy tracking smoke from the Blue Thunder propellant. The Black Jack propellant is a slower burning than the Blue Thunder formulation, so your rockets will accelerate slower on the launch rod. On the other hand, you'll get a longer burn time, which can also be impressive. I suppose the one disadvantage of the Black Jack is that all the dense smoke leaves a blast deflector that is covered in soot too. The designation of Black Jack is the letter "J" following the motor name.

White Lightning™: This propellant type produces a really brilliant exhaust plume that is white in color. It also has a deep throaty roar when it takes off. When this propellant type first became available, it was an instant success because it really added to the visual appeal of the rocket at launch. The visible flame can be nearly as long as the rocket itself. If you want a flame effect that mimics real rockets, then this is a logical choice. I saw a monster-size Saturn V fly at LDRS last week, and if it weren't for the large white flame, I don't think it would have been nearly as impressive as it was.

White Lighting, like the Black Jack, is a relatively slow burning propellant. So motors that use it can have longer burn times, and lower thrust levels mean the rocket will take off a little slower. The designation of White Lightning is the letter "W" following the motor name.

Redline™: The Redline formulation produces a vivid scarlet red flame and a column of white smoke that really gets noticed because it is still relatively new (less than 5 years old). It has a burn rate that is faster than White Light-

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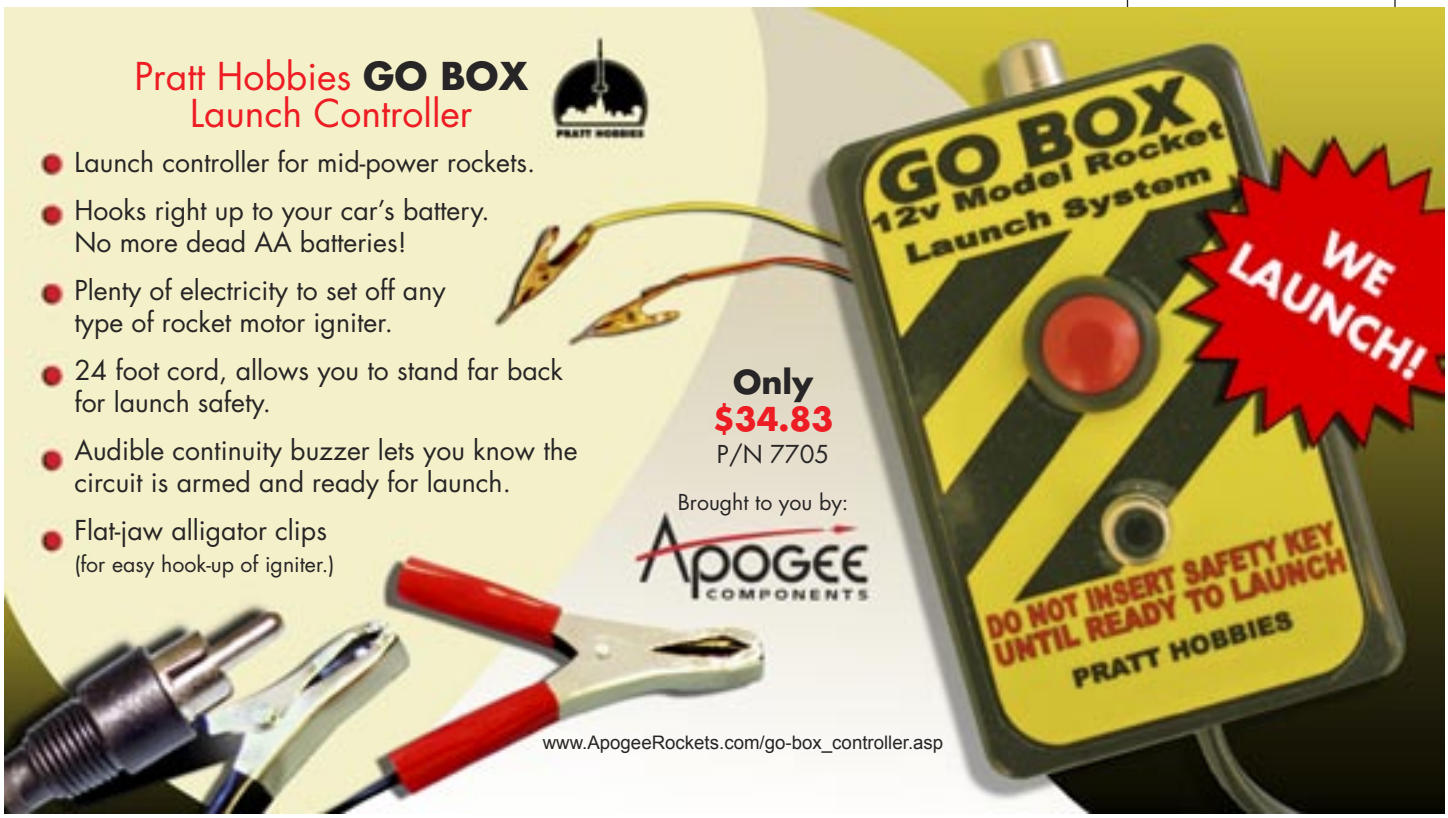

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ning or Black Jack, so you'll typically see it on higher thrust, shorter burn duration motors. The designation of Redline propellant is the letter "R" following the motor name.

Mojave Green™: This type of propellant produces an eerie-looking fluorescent green flame and a column of white smoke. This is one of the newer formulations that Aerotech has released, particularly for motors that are G-size and smaller. Other manufacturers have had green-flame formulations for some time in higher powered engines. The availability of the green-flame producing formulation in the smaller motors has really been the accelerant that has boosted the popularity of this formulation. At LDRS last week, I witnessed a huge number of rockets sporting green flames. The designation of Mojave Green propellant is the letter "G" following the motor name.

Other Propellant Formulations

The one formulation from Aerotech that we don't currently offer here at Apogee Components is their "Warp-9" propellant. This is because they don't yet offer it in a small motor (using a 29mm diameter case). Warp-9 is AeroTech's fastest-burning propellant and is said to produce a yellow-orange flame studded with mach diamonds. But usually it takes off so fast that it is hard to get a picture of it. The fast burn rate makes it possible to use it to make end-burning motors that have a very flat thrust-curve profile, similar to those made from black-powder propellant. The designation of Warp-9 propellant is the letter "N" following the motor name.

The one other propellant formulation that is commonly available from a number of manufacturers but not from Aerotech are the "sparky" propellants. These emit a shower of white sparks and a column of dark grey smoke. They are always impressive to see in big rockets. The one downside to these motors is that the sparks travel quite a distance from the motor and often cause small grass fires near the launch pad. This aspect means that extra precautions must be taken when they are launched to make sure that any fires are extinguished quickly.

Now that you know what types of propellants there are and what kind of visual effects they produce, it is possible to match the flame to your rocket. For example, if you were flying a scale model rocket, then the White Lightning propellant would probably be a good choice. But if you were going for peak altitude and the flame effect is not a big deal for you, then I'd suggest going with a motor that uses the Blue Thunder formulation. You'll get more thrust to weight with that type of propellant.

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The formulations that produce the red and green flames seem to go best with your everyday "sport" models. The same would probably be the case for the smokey propellants like the Black Jack motors.

The Next Question

I'm guessing that your next question might be: "why doesn't Aerotech make the same motor with different flame effects?" For an example, why doesn't the G77, which is a Redline formulation, also come in different flame effects like White Lighting, Mojave Green, and Black Jack?

That is a great question. I'd say it comes down to two different reasons. The first is the technical aspects. Each propellant type has a different burn rate, so the same configuration of mass of propellant would not give the same results from one formulation to another. For example - in very, very simplistic terms – say it took 60 grams of Redline propellant to make a G motor. In White Lighting it may take 65 grams of propellant. This means the physical size of the motors would be different for the same G77 motor.

Now it may be possible to add some additional chemical to the White Lighting propellant to get it to match the G77 made from Redline propellant. But now you've modified the formulation for the G77. If you wanted to make a G80W, that same formulation for the White Lighting would be completely different.

This problem of constantly tweaking the chemical mix-up of a given formulation of propellant type gets expensive. That is the second reason that you don't see the same motor available in different propellant types. The manufacturer couldn't afford to make 300+ different types of formulas and store all the extra chemicals he needs to make them. Anything is possible if you have enough money. As the saying goes: "No bucks... no Buck Rogers."

The best you can affordably hope for is to get motors of different propellant types that are close (enough) to each other and will work in your rocket according to the primary engine selection process that is based on the safety aspects. You may not get the exact thrust curve and efficiency you desire for a specific project, but you'll get the flame effect that you think matches your rocket.

A good example of this is the following mix of motors: G53J, G64W, G67G, G71R, G77R, G79W, and the G104T. They are all reasonably close enough, except maybe that G104T on the end. And of the available propellant types available from Aerotech, all the different chemical formulations are represented. This allows us to enhance the flight by making it more visually appealing.

But to make this work, you have to be very concious of the variables that have a big effect on motor selection. The big one is rocket weight. A heavy rocket is going to have fewer motor choices that will safely work than a lighter weight one.

Conclusion: Build Light and Strong

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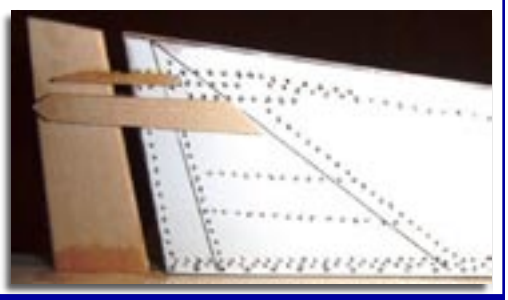
REVIEW CORNER EMRR

Scale Rocket Rivets and Bolts

Excerpt from Chan Steven's Featured Tip: ...In order to properly locate all the rivets and bolts, I simply ran off several copies of the scale drawings supplied in the kit (Roachwerks Nike-Hercules) on computer paper, and glued the printed skins to each fin surface.

For the recessed rivets, I used a Dremel and incredibly tiny drill bit - the kind you'll never find at the big box retail outlets, but you might find at a local hobby shop or very well stocked local hardware store. I wound up picking up a Testor's pin vise/drill bit combination pack (p/n 50629c) for about $12, which included 6 incredibly tiny drills. It took a bit of practice, but I found myself quickly falling into a comfort zone of just barely scratching into the surface with the drill rather than boring all the way through the thin fins.

For the glue dots, I picked up a set of really amazing syringes from Lee Valley Tools. They sell a 5-syringe set (p/n 25K07.31, link) for $10 that includes both 18 gauge and 20 gauge tips. I poured some thinned white glue (roughly 20% water, 80% glue) into the syringe and attached the 20 gauge tip. Applying just a little pressure to the plunger, I was able to "dot" about 100 bolt heads a minute. I had to let each side dry for a couple hours, which was fine and offered time to rest my eyes between sessions…



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Engine Selection Based On Visual Effect

Picking motors based on flame effects is something that was not possible 10 years ago. But if you want to keep your options open to be able to make motor selection based on flame-effects, I stongly suggest that you build your rockets lightweight and strong enough to handle the higher thrust rocket motors. This is possible, but you have to plan ahead and use construction methods and building techniques that will give you a high strength-to-weight ratio rockets. That subject is covered in the book: *Model Rocket Design and Construction* (http://www.ApogeeRockets.com/design_book.asp) and the video books that we've created (http://www.apogeerockets.com/Building_1_2_videos.asp).

Finally, check out Apogee's large selection of rocket motors which can help you can make a visual-based choice. For single-use motors go to: www.ApogeeRockets.com/aerotech_motors.asp

For reloadable motors visit: www.ApogeeRockets.com/Aerotech_Reload_Motors.asp

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. You can subscribe to the e-zine at the Apogee Components web site or by sending an e-mail to: ezine@apogeerockets.com with "SUBSCRIBE" as the subject line of the message.

Useful Building Tips

How to Draw a Straight Line Down The Length of a Nosecone or a Boatail

By Tim Van Milligan

In *Peak of Flight Newsletter #215* (www.ApogeeRockets.com/education/downloads/newsletter215.pdf) there was an article on how to convert an Apogee plastic nose cone into a drag-reducing boattail. One of the final steps was to draw a line down the boattail to mark the locations where the fins would be attached.

I mentioned in the article that I was looking for ideas on how to simplify this one critical step. If your line is crooked, you'll never get a straight flight from your rocket because your fins will be crooked too. I was looking for some type of universal tool that would allow lines to be drawn on nose cones of different diameters.

Jim McKim sent me a drawing of a fixture that he came up with. While it isn't exactly a "one-tool-fits-all-sizes," you can probably make several of them so you'll have one around for whatever size tube you are working with.

The critical part of this apparatus is that the thickness of the spacer must put the point of the pencil at exactly 1/2 the diameter of the tube you are using. If the spacer is too high or low, it will create a curved line as you slide it along the boattail.

Use Figure 2 to find the exact height of the spacer.

I would also suggest using a pencil that has flat sides. This will prevent it from moving around so much as you draw the line.

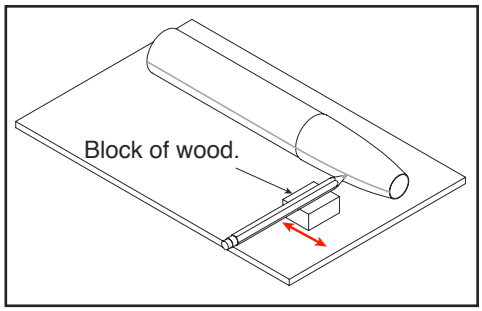
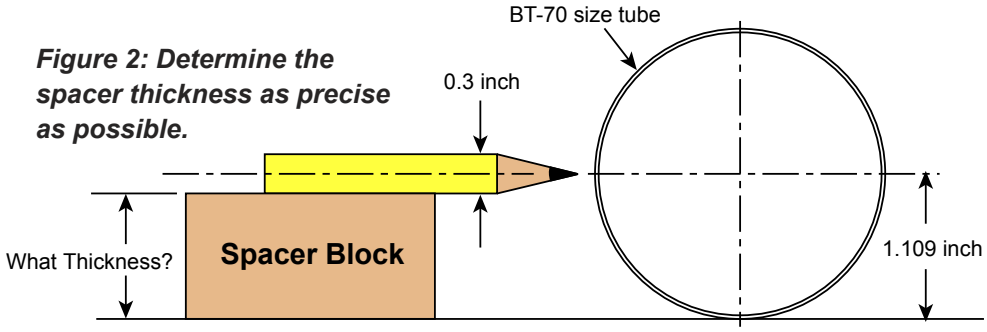


Figure 1: Fixture for drawing lines down a boattail.

Finally, make sure the tube and the boattail do not roll on the table. Obviously, this will cause the line to be curved on the parts too.

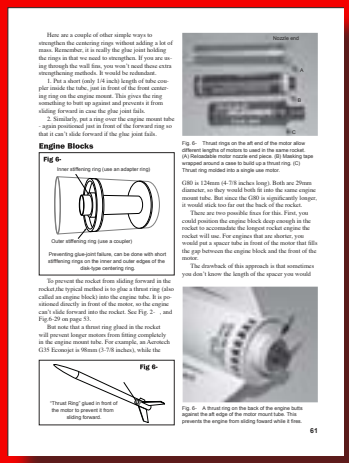
Thanks for the submission Jim!

Figure 2: Determine the spacer thickness as precise as possible.



Spacer Block Thickness = 1/2 tube diameter - 1/2 pencil diameter

Model Rocket Design And Construction



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Question and Answer Corner

In RockSim, How Do You Specify a Transition Between Stages?

By Tim Van Milligan

Q: Mark Grant asks: *"I am simming a two stage. 11.5 inch booster to 7.5 inch sustainer. The transition ends up pointing the correct direction but gets attached to the aft end of the booster. How do I make it go to the front?"*

A: I like these kind of good questions. It tells me that people are putting RockSim to the test.

The solution to the "transition at the front end of the booster stage" is to recognize how parts are ordered in the parts tree in RockSim.

I can see where the confusion might arise, since it isn't always necessary to have parts in a specific order in the parts tree. For example, it really doesn't matter when you put on the fins to a rocket, since they can be slid to the correct position later.

But in this case, the order of parts in the parts tree is critical. The very first part you have to add to the "Booster" is the transition (see Figure 1). Most times we think the first part is a tube. But it is possible to put the transition first. And in this case, that is exactly what you need to do.

What I always suggest is to think of the rocket standing on your desk. Adding parts in RockSim is like starting at the top, and working toward the bottom. If you do it in that order, you'll run into fewer problems.

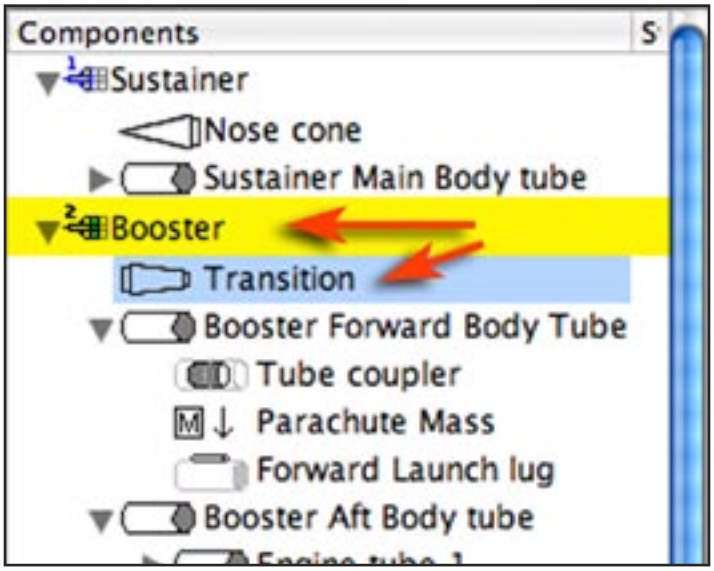

Figure 1: The order of parts in the parts tree is important.

There is a sample design that comes with RockSim that you can also look at for guidance. The file is in the "design" folder and is called: 2-stage_cluster.RKT.