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APOGEE PEAK OF FLIGHT NEWSLETTER

Simulating Short, Wide Rockets in Rocksim 8.0 Pt. 3

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- Reloading Motors Quickly in Rocksim

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Simulating Short, Wide Rockets in Rocksim - Pt. 3

Creating Pyramid and Saucer-like Designs, Plus The Application of the Additional Base Drag Consideration for Odd Shaped Rockets With Less Than a 10:1 Length to Diameter Ratio.

By Bruce Levison

This is the third part of an article that was submitted by Bruce Levison See Newsletter 154 for part one http://www.apogeerockets.com/education/downloads/Newsletter154.pdf and Newsletter 158 for part two http://www.apogeerockets.com/education/downloads/Newsletter158.pdf

Bruce S. Levison has asked us to share this article with other RockSim users. It describes a method that he feels will help to simulate the Short-Wide Rockets (like spools, cubes and pyramids) in RockSim. While this treatment is based on wind tunnel data collected for spool shaped rockets, Bruce feels that the CP will be in the right location on these other types of rocket designs. Please note: The user assumes all risk for the information obtained with this method.

Refresher

This and the previous two articles in this series are based upon the assumption that the dynamic center of pressure (CP) of flat plate lying perpendicular to a flow, lies about 2.2 diameters behind the plate behind the plate along its central axis, due to a base vortex that forms when the air begins flowing over its surface. This is a conservative estimate for the CP value since other mathematical extensions of the wind tunnel data seem to indicate the CP may even be further aft! Again, any inaccuracy in this CP value will drastically affect the simulation results using this approximation.

Base Vortex Effect

Previously I had shown how this estimate for the CP value of a flat plate could be used to simulate an additional base vortex effect on the CP for short fat rockets like the Estes FatBoy (see figure 1). The idea is to

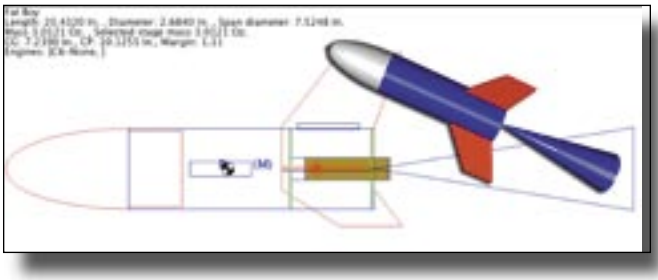

Figure 1

add a mass-less transition to the aft end of the FatBoy design, the same added transition that would cause a flat plate of the same body diameter to exhibit a CP 2.2 diameters aft. This trick involved adding a mass-less aft cone pi-times-the-body-tube-diameters long with a minimal (0.001 inch) upper or forward diameter, and a base (or aft) diameter the same diameter as the body tube, see figure 1. By applying this correction to the Estes Fatboy launched on a C6-5 motor I was able to bring the calculated stability margin up to 1.14, which is by rule of thumb indicates a stable design in contrast to the stability margin for the unmodified simulation of 0.67.

In part two of the series I show that on a rocket with a tail cone, you can subtract of the length of the tail cone from the added mass-less aft transition to account for base drag. It's as if the base drag transition starts at the widest point of the tail cone (forward end) and continues on for pi-diameters from that point. I was able to extend this concept and simulate a Sputnik design as seen in figure 2.

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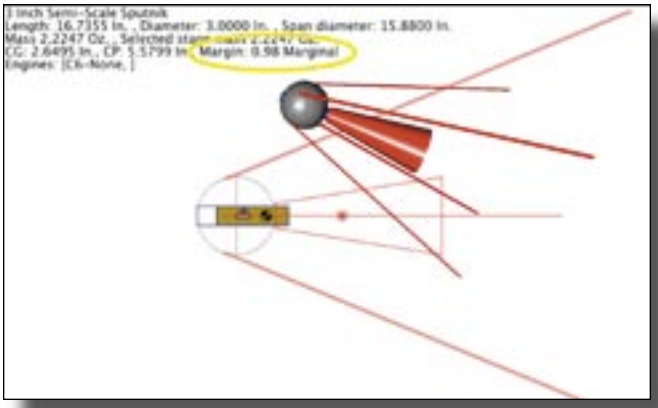

Figure 2

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First Annual Apogee Components' Rocket Photo Contest: "Fun With Apogee Products!"

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1. The products in the pictures should be any items that we sell on our website, whether it be kits (Apogee or otherwise) or scratch-built rockets using our parts. The key is that they must be items that we sell on our webstore.

2. The pictures should include people with the rockets and may be adults, children, and anybody in between. You may enter more than once!

3. The photos should show some kind of action in them. Examples of this would be rockets taking off, customers setting up rockets on pads, people waiting and watching for the rockets to take off, etc. Photos that would not be a good choice are those that simply have customers or kid simply holding a rocket.

4. Pictures should be sent by e-mail to johnm@apogeerockets.com. They should be as high of a resolution as possible for good photo quality.

5. By submitting a photo you grant permission to Apogee Components, Inc. to post your photo on our website. Your photo may or may not be used on the web.

6. The photos need to be submitted by July 14, 2006 in order to be eligible.

While this is very cute, we'd like to see action shots!

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First Place: Full Version of Rocksim 8.0 (a $99.95 value)
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Third Place: Building Skill Level 1 CD (a $14.78 value)
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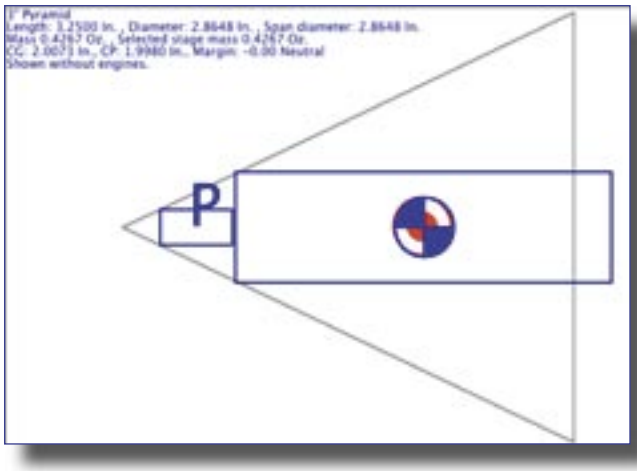

Figure 3

Simulation of Pyramid-shaped Rockets Using a Cone with the Same Frontal Area.

For the simulation of pyramid-shaped designs you can create a simulation of a cone that has the same frontal cross sectional area as the pyramid. Thus for a 3 inch square pyramid (four sided with a square base) the frontal (or base) area is $3^2 = 9$. A circular cone with the same frontal area has $r = (9/\pi)^{0.5}$, or r = 1.6926; the cones diameter = (2•r) is 3.3851.

If you simulate this cone without a base drag correction you get a design where CP = CG with no margin of stability or neutrally stable design. If you load motors into this simulation you get at best an unstable flight, see figure 3. Adding in a mass-less aft transition that accounts for base drag with a front diameter of 0.001", rear diameter 3.3851" and length = π • diameter or 10.6347" gives a simulation with the CP about 3.7 inches behind the pyramid indicating a stability margin of 1.63, see figure 4. Loading any motor keeps the stability

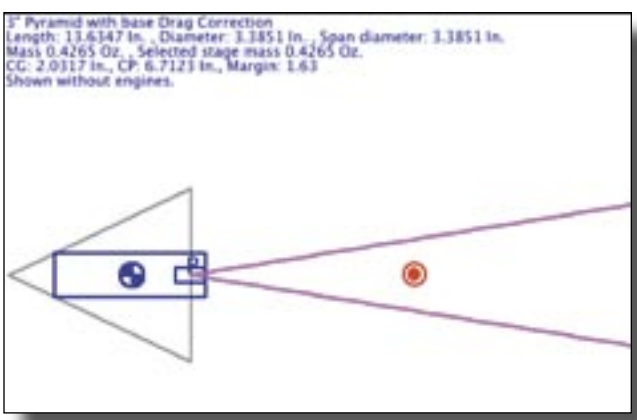

Figure 4

margin nearly the same and gives stable flights, as you would expect. This may seem contrary to what is known for the CP of a cone shape which still has a static CP 2/3 the way down its' length. Keep in mind base drag is a dynamic (as opposed to the static 2/3 CP) correction that will only come into play once the rocket starts moving. For short wide designs like the pyramid it is important to consider the dynamic effect of base drag on the center of pressure.

Simulation of Cubes with Corners Pointed Up

This method of using an equivalent cone for the rocket simulation can be extended to rockets that are shaped like cubes open at their base with one corner pointed in the upward direction (for designs like Art Applewhite Rocket's Qubit, Stealth and Similar http://www.artapplewhite.com). A cube projects a hexagonal

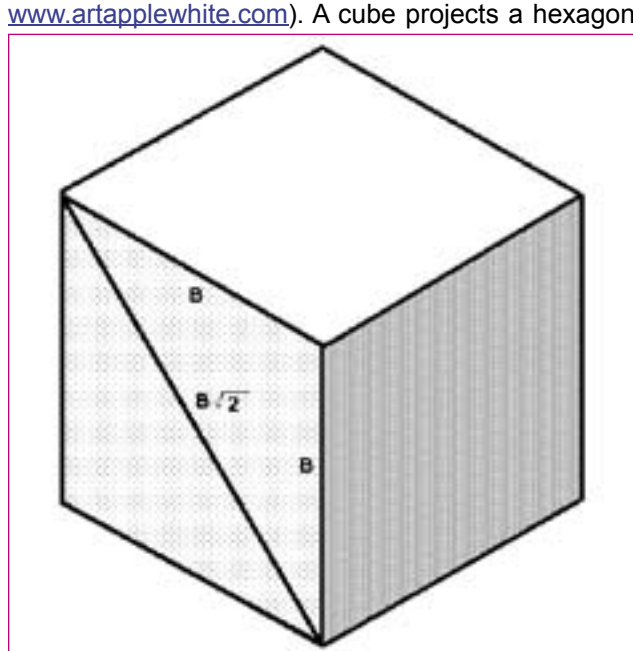

Figure 5

shape looking at a corner pointing directly towards you (normal to one of its corners) as seen in figure 5. The area of a regular hexagon is $(3(3)^{1/2}/2)R^2$ or $2.5981R^2$ where R is the radius of the hexagon. The radius of the hexagon formed by a cube with a corner pointing up is $S/2(2)^{1/2}$ where S is the length of the sides of the cube, see figure 6. Since the radius of a hexagon equals the length of its sides R = S substituting this in for the radius frontal area of a cube with a corner pointing straight up is $3/4(3)^{1/2}\ S^2$ or $1.299\ S^2$ as seen in figure 6. The

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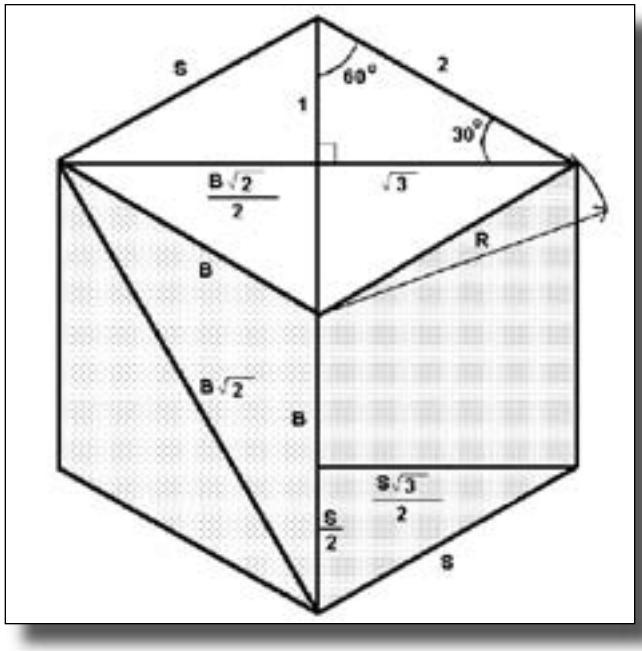

Figure 6

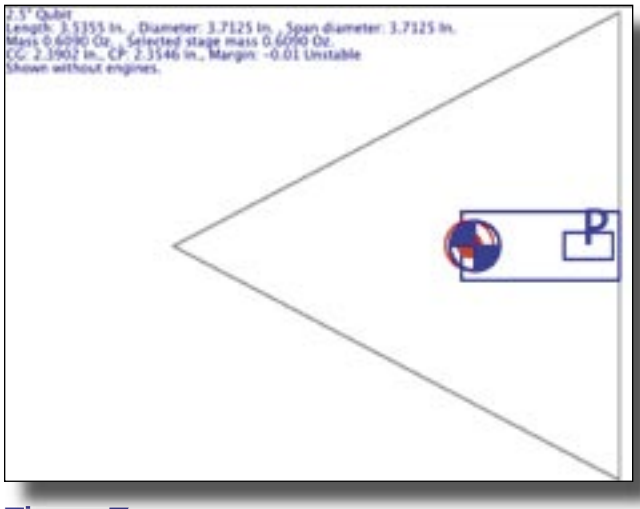

Figure 7

equivalent cone calls for a diameter of $(3(3)^{1/2}\ S^2/\pi)^{1/2}$ 1.286S and of length of S, see figure 7. Applying the base drag correction to this cone gives a design where the simulated CP is 1.18, see figure 8, as opposed to -0.04 (unstable) without the base drag correction. For cubes flying with one of their flat sides pointing up you need to use a different type of simulation that will be presented in part four of this series of articles.

Simulation of Flying Saucer Designs

Art Applewhite Rocket's Delta series of flying sau-

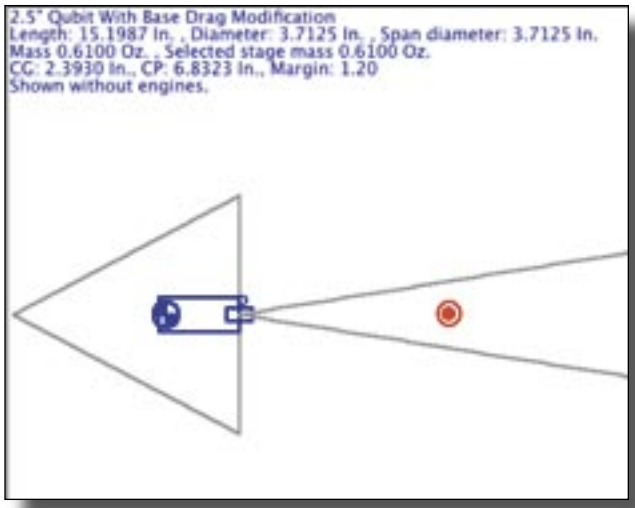

Figure 8

cers are simulated similar to the Sputnik design in my previous article. A mass-less tail cone can be added to the aft cone of the saucer design in an analogous fashion to that for the aft hemisphere of Sputnik. The added mass-less aft cone is truncated as if the added mass-less tail cone starts at the widest point of the saucer and shortened by the length of the bottom transition, as before the diameter at the top of the truncated added

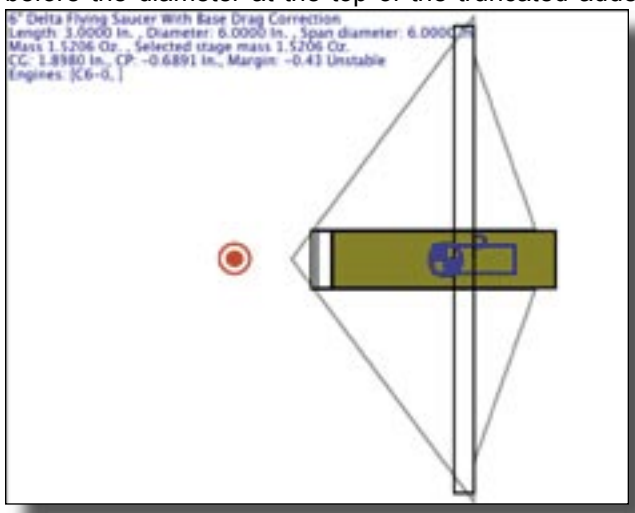

Figure 9

mass-less transition is the length of the bottom tail cone divided by pi. Note that a nose cone had to be used in place of the top transition in this design to force the RockSim software to run the simulations properly. Figure 9 shows the Delta saucer design with a C6-0 motor loaded has an in-stability margin of –0.43. Figure 10

continued on page 7

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By subscribing to the Peak of Flight Newsletter, you are priviledged to be the first to hear about the new Dynastar Sky Torpedo! This is the first DynaStar kit to use the BT-80 size body tube. We'll be releasing it officially later this summer (everything but the color packaging is ready to go). We are offering it to you as a summer special along with the Apogee Blue Streak! It is a perfect combo-package deal; one rocket for dad, one for lad!

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shows the same design with the added mass-less tail cone giving a stability margin of 1.52 referenced to the maximum diameter of the saucer design.

The original Art Applewhite rocket's saucer design with an open channel through the middle can be simulated in a similar fashion. First two transitions representing the forward and aft saucer parts of the design

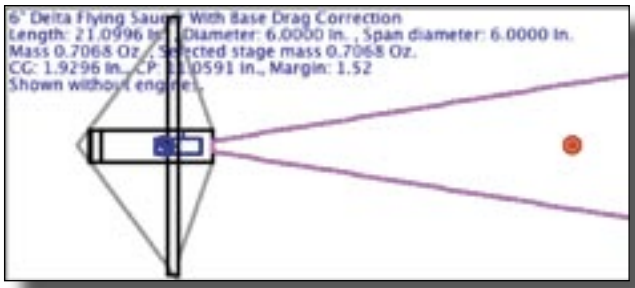


Figure 10

are created then the motor mount and supporting struts are added inside. The central motor mount needs to support the struts (fins) this is created from an inside tube (and motor mount) in the forward transition. The inside tube is created then reassigned as an outside tube using a word processor as mentioned in my Simulating Fins on Fins article at: http://www.apogeerockets.com/education/downloads/Newsletter113.pdf.

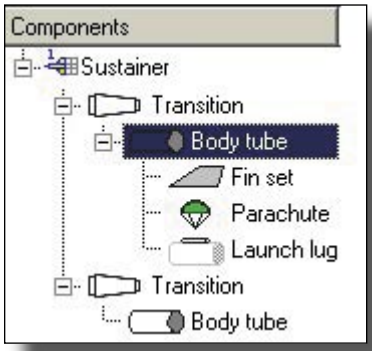


Figure 11

The struts, which are drawn as fins, are then placed on this central tube see figure 11. The recovery device is simulated as a parachute equal to the diameter of the model with one 0.001" length shroud line as was done in part two of this article for the Sputnik model. Since the central core of this model is open, a spill hole with the same diameter as the central opening is specified. The Cd of the recovery device was set to the Cd of a cone with an equivalent height and diameter (1.00) from the CD analysis under the Rocket menu. The Cd of this faux parachute should be the same as that of the rocket; this trick should provide an accurate simulation of the tumble recovery phase of the flight see figure 12.

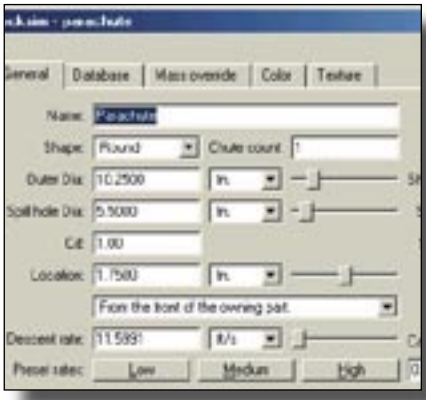


Figure 12

The mass-less aft cone for this design is created from the inside and outside diameters of the transition sections. The added base drag cone's forward diameter is equivalent to that of the inside opening of the saucer

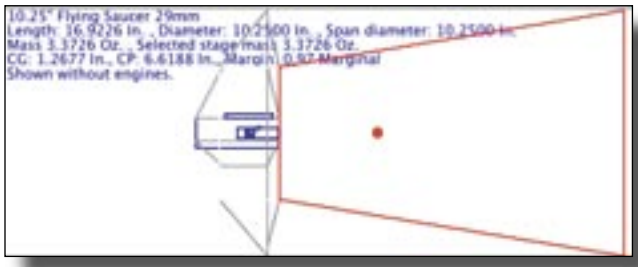


Figure 13

(5.5 inches). The base drag cone's aft diameter is set to the outer diameter of the saucer (10.25 inches). The length of this aft cone is set to the difference between the diameters of the inside and outside of the saucer 10.25 - 5.5 inches = 4.75 inches times pi = 14.9226. The length of the aft transition is then subtracted out 14.9226 - 0.5 inches = 14.4226 and is then used as the length of the added mass-less aft transition.

Without this added aft transition this design shows an instability margin of –0.31 with a G20-0 motor installed, see figure 12; adding the base drag cone gives a stability margin of 1.09 with a G20-0 motor see figure 13.

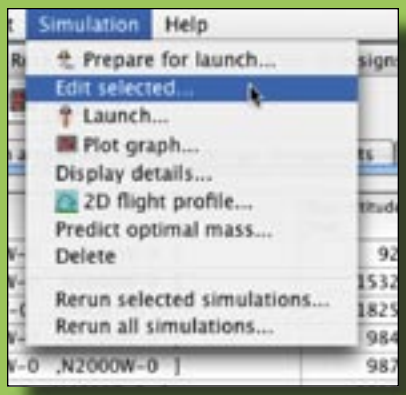
About the Author

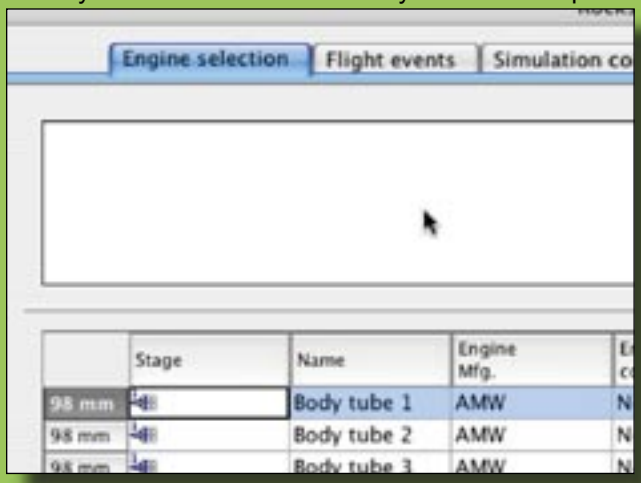
Bruce S. Levison (NAR #69055, MTMA #606) is a rocketeer from Ohio and a member of the National Association of Rocketry (NAR). He has published numerous articles on model rocketry, related to many practical aspects of the hobby. Bruce enjoys tricking RockSim software into performing simulations of non-standard rocket designs. Bruce earned an advanced degree in chemistry and works as a research scientist at the Cleveland Clinic. Foundation.

TIP OF THE FIN

The Quick Way to Reload Engines From Previous Simulations.

Suppose you open a design you made two weeks ago, and you wanted to look at the flight of a previously run simulation. They are the ones listed at the top of the summary screen. But you don't want to go through the steps to load an engine, and setting up the launch conditions. How do you get around this? This is easy. First, highlight the particular simulation you're interested in. Then, from the "Simulation Menu" at the top of the screen, select "Edit Selected." What RockSim does next is to reload the engine in the simulation and it resets the launch conditions to what was previously run before. The screen that pops up will show you the engines selected, so that you can confirm everything is correct. Then you can click on the "Launch" button or the "Flight Profile" button to see the results of that simulation. This doesn't seem too much quicker for simple rockets. But it really saves a lot of time when you have multiple engines in the rocket, such as a multi-stage design or a cluster-configuration engine mount. In those complex rockets, loading each motor can be tedious and time consuming.





QUESTION AND ANSWER CORNER

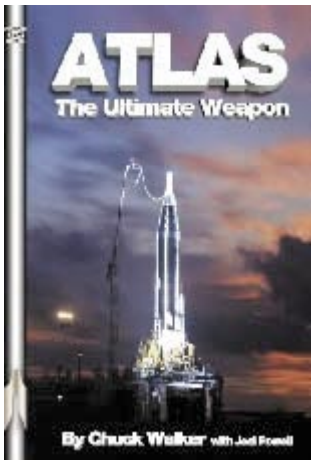
How do you create decals in Rocksim? The answer is as follows:

You first create the artwork in a drawing or paint program. Save it as a JPG or PNG file format. You can use the attached Roll Pattern as an example. Then in RockSim you edit a component, like a tube. Click on the texture tab and browse for the decal file you want applied to that part. You'll then play with the dimension controls to position the decal like what you'd want. See the attached image.

Tip: Make the part white prior to applying the decal image. Otherwise, you'll mix the colors together and it looks funky. It is a lot of fun playing with the decal feature.

I hope this clears things up for you if you have been wanting to work with the texture feature of Rocksim 8.0

If you have a question, please write to me at johnm@apogeerockets.com and I'll do my best to answer your question!



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WEB SITES WORTH VISITING

This issue's recommendation for a website is found at http://www.rocketmaterials.org. It is run by a feature writer in this newsletter; Drake "Doc" Damreau. This website is all about testing the strength of different

materials used in rocketry. There are a good variety of items that he has tested that are shown in pictures and data. Anything from body tubes and swivels to fin material and glue!

As stated on the website, Drake is a 39 year old guy living in Scranton Pennsylvania. He works at the Scranton Army Ammunition Plant, operated by Chamberlain Manufacturing. They make artillery shells for the U.S. Army, Navy, Air force, and a few rounds for NATO. They produce every thing from the 105 mm M1 HF1 for the Air Force's AC130U "spooky" gunship and 120mm mortars, to the 155mm M795 high fragmentation round and the 155mm M107 for the Howitzer. (Yes they still use the Howitzer). He is the Chief Metallurgist and The Laboratory Director. He specializes in failure analysis, but is also responsible for heat treating processes and all material specifications and testing.

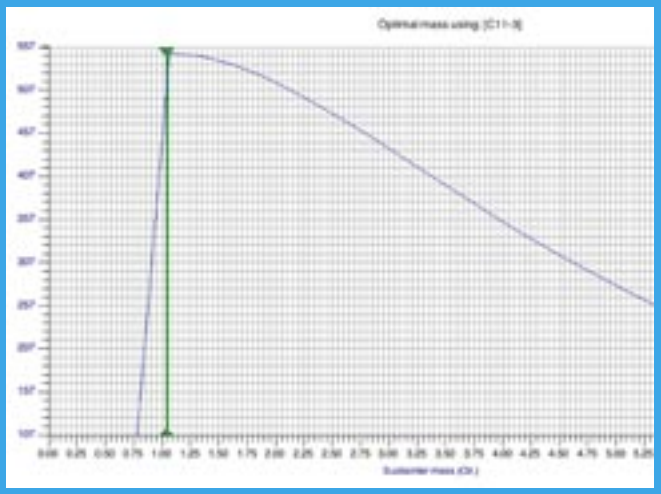
He is also a member of the NEPRA, Tripoli, NAR, and is Level 3 certified. Drake designs and tests materials for a living. His area of focus is metal alloys. He specializes in failure analysis and heat treating. Everything Drake does revolves around test data and strength of materials, so its only natural for him to bring this concept into this hobby. Drake wanted to do this for his own

purposes for building his own rockets. He says, "I'm just sharing my data with everyone in the hobby. If basket weaving was my hobby (yeah right!), I would be testing willow and reeds. I have graphs and reams (literally) of data but I can only host so much. If there is some data that you don't see, chances are I have it."

DEFINING MOMENTS

Coefficient of Drag (Cd) is a unitless number that is difficult to determine without wind tunnel tests. Cd takes into consideration several factors that contribute to the overall drag of the model. These include *Form Drag (related to the shape of the rocket), Skin Friction Drag (caused by the air particles in the air stream being slowed down by the surface of the rocket as it travels through the air), and base drag.* There are also factors such as *Induced Drag (which is produced whenever an airfoil produces lift)* and *Interference Drag (when two part of a rocket are in close proximity to each other and their combined drag is greater than their respective individual drag).* Some of the ways that you can reduce your rocket's Cd are to streamline the rocket and the fins, give the rocket a smooth surface, and add fillets to the fins and other parts that protrude away from the model.

You can also use the "Predict Optimal Mass" feature in Rocksim 8.0 to see what mass would be the best to use on any one design and motor configuration. This feature, which you can plot out in the form of a graph, takes into account the Cd of the rocket.



Optimal Mass Graph from Model Rocket Design and Construction www.apogeerockets.com