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Software Simulation Tricks for Rocketry

Using the "Engine Editor" Program to Trick *RockSim* into Performing Odd Simulations

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Introduction

Apogee Component's *RockSim* software is a very powerful program for "designing" model rockets, but many people do not realize that the "simulation" aspects are just as great. The importance of a good simulation program is that it will give you a close approximation of how high the model will fly, what speed it will reach, how far downrange it will go, how slow it will descend on its parachute, and when the ejection charge will fire. All of this information could be critical to the success of your rocket's launch.

However, most simulation software can handle only rockets with traditional flight profiles. If you deviate from this – such as trying to simulate "air-start" cluster motors, the software may not be able to cope, and you don't get any usable results. In this article, I'll show you techniques to get around some of these barriers.

The key item that unlocks the software limitations is a program called "EngEdit." This piece of software comes bundled with the *RockSim* program, and it allow the rocketeer to trick the software to accept unusual launch simulations.

The EngEdit Software Program

First, let me explain what "EngEdit" does. This software opens, creates, modifies, and saves all "rasp.eng" motor data files. You may have seen them on the internet. One place where you might find them is: http://www.thrustcurve.org

A rasp.eng file contains pertinent information about the rocket motors. Included is data such as: Motor Name, Manufacturer, Length, Diameter, Initial Mass, Propellant Mass, Delays Available, and a representation of the thrust curve shape. The latter item is saved in data points – thrust produced, and time points along the curve.

The thrust curve portion is often very limited in information because it was time consuming for the original person creating the rasp.eng file to enter these data points manually into the document (they didn't have the EngEdit software). For example, the thrust curve of the Estes A8-3 is only represented by 10 data points. Obviously, this cannot be as accurate as the modeler would like.

So the first thing someone who is serious about accurate simulations would want to do is open up the rasp.eng file using the EngEdit program and update the curve to include the most accurate profile. If you would like to do this, you'll need to get the NAR Standards & Testing thrust curves. These can be ordered from NARTS – on the NAR web site. For your information, the maximum size of a thrust curve created by EngEdit is 200 data points.

And modifying or creating a thrust curve in EngEdit is very simple. You simply draw a new thrust curve on the graph, and/or drag the points around until you get the desired shape. The software automatically calculates the total impulse of the motor, and its average thrust – so it gives you extra information to make a comparison against the real NAR S&T curves.

As mentioned previously, the data documents saved by EngEdit are in the standard rasp.eng format (text files), so you should be able to open them in other simulation programs.

One exception is *RockSim*; it needs more data – such as average thrust and total impulse, and also that the data be arranged differently (equations describing the line segments connecting the points on the thrust curve). Because of this, the standard rasp.eng file needs to be compiled into the format that *RockSim* needs.

But this is not really a problem, because the *RockSim* program also comes with such a compiler program. Running this program takes about 30 seconds. When you run this program, be sure to include all the rasp.eng files you want to use in *RockSim*; not just only the ones recently created or modified.

Simulation Tricks with EngEdit

Changing the thrust curve is key to advanced simulation techniques. For example, "air-started" motors – like sometimes used in cluster arrangements can be simulated in the *RockSim* program by altering the thrust curve in EngEdit. The simple way to do this is to open up the thrust curve in EngEdit, and click on the "display data" button near the top-right of the screen. This will bring up a dialog box that lists the data points on the thrust curve. On this dialog box, you can select a data point and edit either its Force or Time. When making a "Air-Start" motors, you'd simply add the desired delay time (in seconds) to each point on the curve.

When working in EngEdit, you also need to change the burn time on the main screen to reflect the new burnout point of the motor (the old burnout time plus the additional delay time). In the data points dialog box, you also need to create a new "zero thrust" point where the

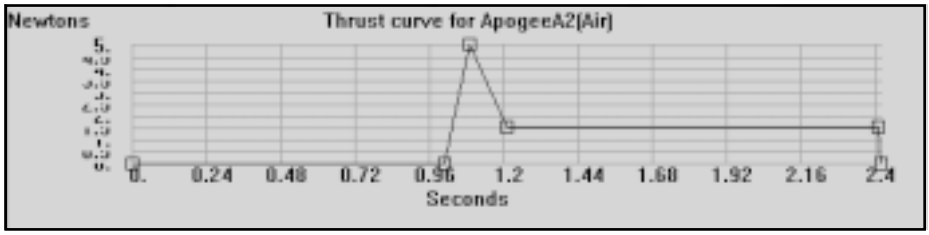

Figure 1: An "air-start" motor; which might be used in a cluster arrangement, is created by shifting the thrust curve to the right as shown here.

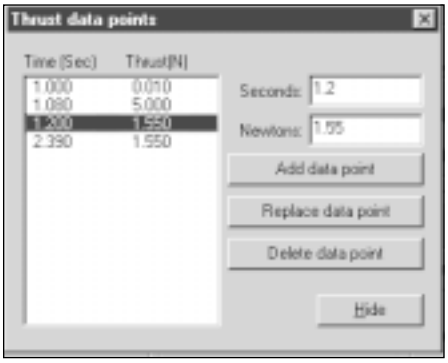

Figure 2: Manipulating the exact position of the data points is easily done with the text editor.

delay period is over and the thrust phase begins. Finally, rename the motor so you don't overwrite an existing motor curve. The name can be anything; something like AirC6. This will allow you to recognize the modified motor when you load the motor while in the *RockSim* software. To simulation programs, the name of the motor has no significance and it doesn't matter what it is called (a motor with a "C" designation does not necessarily means it has 10 N-s of total impulse). The software determines that the motor has 10 N-s of total impulse by looking at the data points of the thrust curve.

For dissimilar clusters (mixing different diameter motors in the same stage), the process is even easier. In this case, you only need to go into the EngEdit and change the "diameter" field of the motor to account for the different size. For example, if you wanted to use micro A2 motors (10.5mm dia) along with A10T motors (13mm dia), you would change the diameter of the 10.5mm A2 to 13mm. Again, save the motor with a different name – like A2/13mm. If a motor adapter is being used with the motor to make it fit into a larger motor mount tube, you may want to also increase the "initial mass" field to account for the increased weight due to the adapter.

Sometimes it is necessary to actually alter the thrust curve of the motor. One such case is for competition models launched off piston launchers. The piston launcher increases the base pressure at the moment of ignition. This increase in pressure augments the initial thrust spike of the motor, giving the rocket a higher liftoff velocity. To model this on a thrust curve, you need to increase the height of the spike by about 5%. This is a rough estimate, but it will give you an approximation of the extra kick that a piston launcher imparts to the model.

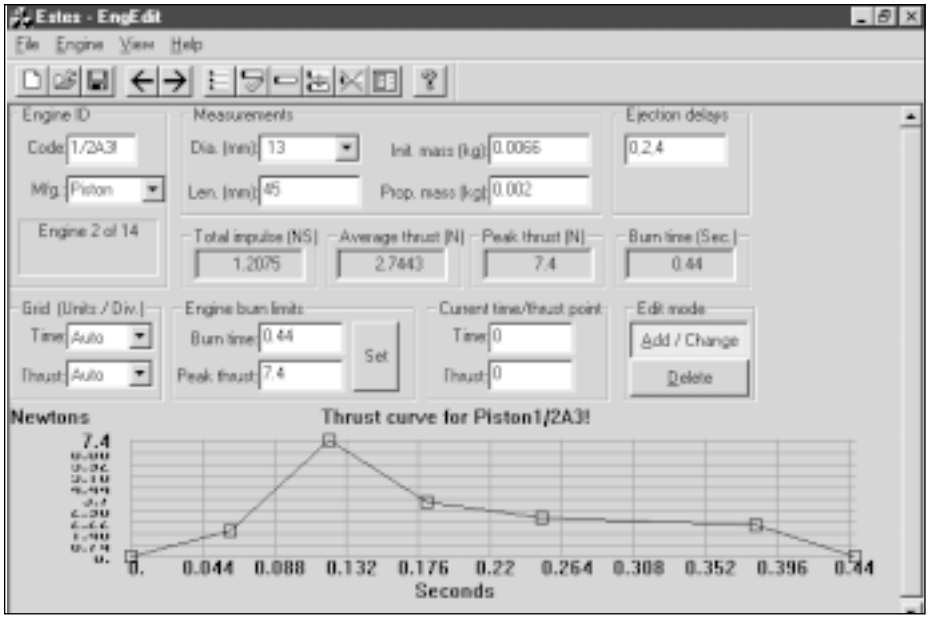

Figure 3: A piston-launched model might be simulated by increasing the power of the initial thrust spike created by the motor.

There are even times when it is necessary to create a "new" motor in EngEdit. One example of this is for a "Boosted Dart." In real life, the dart is like an unpowered 2nd stage rocket. It is typically smaller in diameter than the booster, and more streamlined in shape. Therefore, the drag on the dart is very low. At launch, the model is brought to a high speed by the booster stage. At burnout, the booster and the dart separate due to higher drag on the booster. The low-drag dart then coasts to a super high altitude.

Without the ability to create a new type of motor, it is very difficult to model the dart's flight. The solution is to create a "zero-thrust" motor for the dart. This motor can have any burn time, but it should have zero thrust, and zero mass. When the motor is loaded into the dart in *RockSim*, it tricks the program to drop the high-drag lower stage at burnout, and continue the simulation for just the upper stage. You can even model the ejection charge of the lower stage that sometimes 'kick starts' the dart. This would be a very short but powerful spike on the dart motor's thrust curve. Now you can see how high the dart will coast!

In conclusion, the *RockSim* software is a very powerful software to design a model rocket and also to perform launch simulations to find its flight characteristics. The EngEdit software that comes with *RockSim* can used to further enhance the capabilities of program to perform non-traditional launch simulations, and to improve the accuracy of the simulations. I hope that you'll give it a try.

And if you find new ways to use the EngEdit program, please let us know so that we can pass the tricks on to other users of the *RockSim* software.

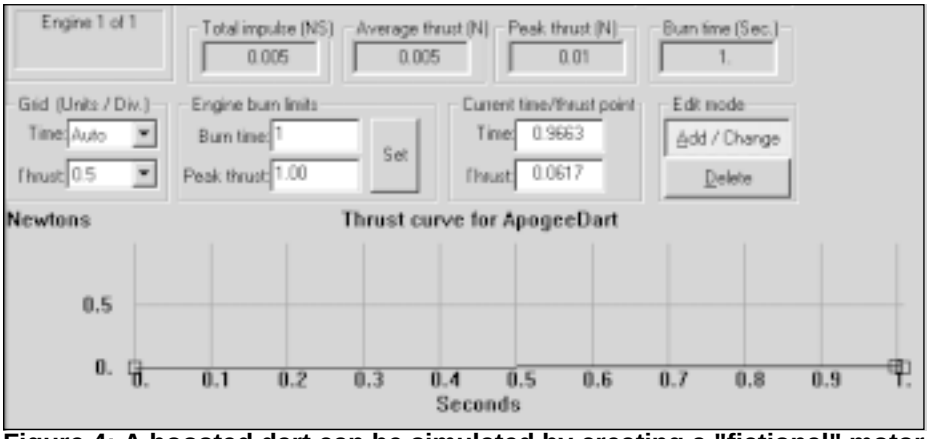

Figure 4: A boosted dart can be simulated by creating a "fictional" motor for the dart stage. It would have zero mass, and negligible thrust.