ISSUE 39

APOGEE

PEAK OF FLIGHT

NEWSLETTER

# Selecting Rocket Motors for Your Models: Part 2

In the last issue, we started the basic discussion on how to select rocket motors. In this article, I'll start to talk about the different elements of the flight profile, and why they are important.

The most important element of the flight profile is the information associated with the deployment of the parachute. The reason it is important, is that if the deployment doesn't occur, or if it occurs too late, the rocket will be coming down in a ballistic trajectory. This means the rocket could be falling (pointy end down)at over a hundred miles per hour. Impact with objects (including people) on the ground could be catastrophic. This is something that needs to be avoided.

So start your motor selection process by deciding when and where you want the model to deploy the recovery device. Most of the time, we want the rocket to deploy right at the peak altitude. The reason for this is that the stresses imposed on the parachute are the lowest. This is because the rocket is traveling the slowest at peak altitude.

Figure 1 shows how you can get this information from the RockSim computer program. The flight summary screen will show you the optimum delay.

The “velocity at deployment” shown in Figure 1 is the

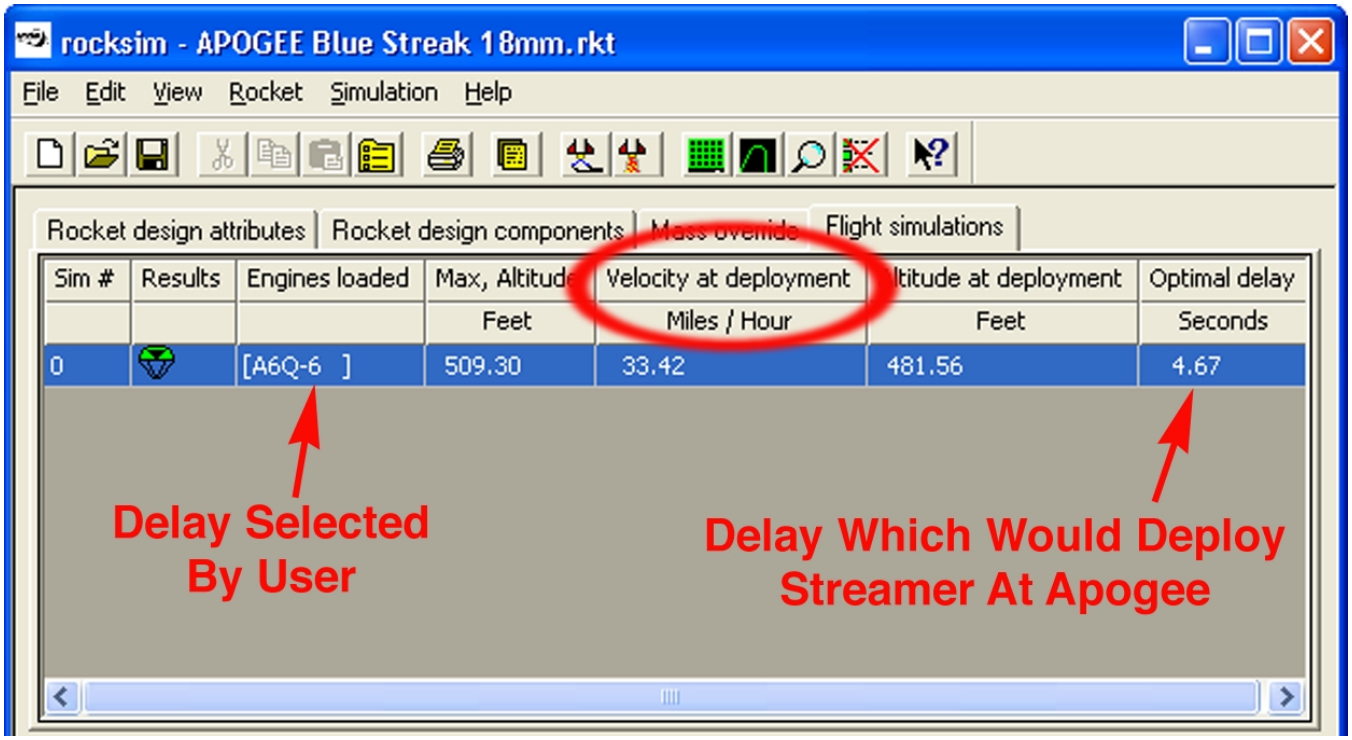


**Figure 1: The summary screen in RockSim will tell you what delay time would deploy the recovery device exactly at apogee of the trajectory.**

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speed at which the rocket is flying the instant the ejection charge is deployed. Many people ask me what this number should be. It really depends on the strength of your recovery device. A parachute with whimpy shroud lines is going to shred if the speed is too high.

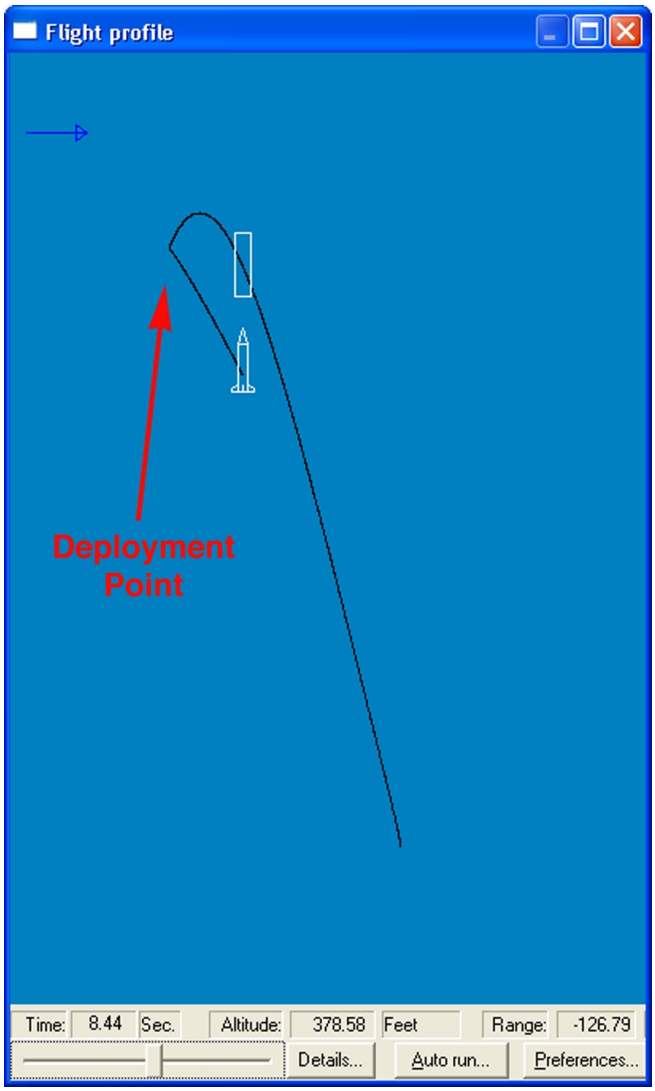


**Figure 2: This is the flight profile of the rocket simulation from Figure 1. We can clearly see that the rocket was heading downward when the streamer was deployed.**

Another way to see where the recovery device is deployed is the "Flight Profile" screen in RockSim. See figure 2.

Since we don't know how much deployment speed our recovery device can handle, what we try to do is keep the ejection within 1 second of the apogee point. If you notice the "Results" column on the summary screen (See Figure 1), you'll see a little parachute icon. If there is an arrow inside it, it tells you the deployment didn't occur within 1 second of apogee. The direction of the arrow tells us if the rocket was travelling upward or downward when it was ejected out of the rocket. In Figure 1, the rocket was heading downward. Again, this can be seen in Figure .

There might be a couple of exceptions to the *"within 1 second of apoee"* deployment rule. The first would be experiments in the rocket that are associated with free fall (micro-gravity experiments). Personally, I haven't seen any mico-gravity experiments performed with model rockets, but that doesn't mean it can't be done.

The second exception might be for rockets traveling to extreme altitudes (20K feet and above). For those rockets, recovery would be significantly harder because of any wind drift. So you might want the rocket to descend quickly for a bit before deploying the drouge chute/streamer. This is becoming more popular in high power rocketry to keep the rockets from landing too far away from the launch pad.

But as I mentioned above, 99.9 percent of the time, we want deployment right at apogee.

If the rocket does deploy right at apogee, and the flight was perfectly straight, the orientation of the model doesn't matter much. At apogee, it will be stopped dead. So even if the nose was pointed downward, the opening forces on the parachute will be very minimal.

But the rocket that doesn't travel straight up is going to be at an angle as it arcs over past apogee. It will also have some forward velocity. The lower the velocity, the lower the forces will be on the parachute when it deploys. To determine the speed of the rocket, you'll need a computer simulation program, like RockSim (see Figure 1). If you don't have a copy, you can download the free demo version from the Apogee web site.

## About this Newsletter

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There are two factors that will determine if the rocket will not fly straight up. The first is the wind acting on the rocket. The wind deflects the rocket from its straight-up flight. We've all seen this happen. To a small extent, you can reduce the winds effect by the design of the rocket. Models that have a large stability margin will weathercock into the wind more than one where CP and CG are closer together.

But how do you know if this is the case for your rocket?

In the Flight Profile of RockSim (see Figure 2), you will see the trajectory of the rocket, and more importantly, how the rocket reacts to the wind. If your rocket weathercocks too much into the wind, your rocket is too stable. How much weathercocking is too much? See the related article in Newsletter 34.

The rocket motor selection plays a huge role in how the model is affected by the wind. If you use a high thrust motor, it punches it's way into the sky. It will fly pretty straight.

On the other hand, a long-burn; low thrust motor, will weathercock to a higher amount in the same wind conditions.

The other factor that will affect whether or not the rocket flies straight up is the launch angle. You set this yourself. Typically, the more you angle the rod, the further past straight-up the rocket will be at Apogee.

But there are times when you want the rod angled to counteract the winds effects. It's possible to angle the rod in such a way, that it is pointed straight up when it reaches Apogee. This is a fun simulation to play with in RockSim. It is trickier than it sounds; because it does depend on the design of the model, and the motor you select for it. To get it to fly straightest, you'll angle with the wind.

But more often than not, recovery concerns play a larger role. If you don't want the model to drift into the next country, you angle the rocket into the wind.

Motor selection will also determine the launch rod exit velocity. If the model doesn't reach sufficient speed as it clears the launch rod, it can easily be disturbed by the wind. As a rule of thumb, we want it to take off with a minimum speed of 30 miles per hour. Faster if at all possible.

The maximum velocity of the rocket is also affected to a huge extent by the motor. This speed can be crucial. If we haven't built the rocket to withstand the forces associated with very high speed flight, the rocket will shred itself to pieces when it is launched. So this is another thing you have to take into account when you make your motor selection.

The burnout location also depends on the motor selection. But most times, we really don't care where during the flight burnout occurs. About the only time I can think of that it becomes important is if you were making optical acceleration measurements of the rockets' flight (such as for a school project). In that case, you want to know where the location will be so that you set up your tracking equipment properly.

In the last article, we touched on the deployment location (altitude and downrange distance). This will affect how long it will take for the rocket to descend to the ground, as well as how far downrange it will drift. This becomes more critical when wind is involved, because recovery of the rocket becomes more difficult.

That pretty much ends the short discussion on the flight profile of the rocket. In the next issue, we'll talk about other factors to consider when making your motor selection. This includes things like drag coefficient, and size of the model.

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