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Methods To Add Drag To Your Rocket

By Tim Van Milligan

It is typical in rocketry to want your rocket to fly higher and faster. But there are instances when you want to slow things down and keep the rocket closer to the ground. The typical reasons that people tell me that want their rockets to fly slow are:

1. Taking photos – Slower rockets are easier to photograph

2. Small sized launch field – A high flying rocket is more prone to drifting in the wind than a smaller one, and therefore could easily land outside the boundaries of the recovery area.

3. Enhanced auditory effects – Rockets that rise slower allow the sound of the motor to linger around longer, which makes them louder, and the smoke more dense.

4. Majestic flights where you have time to say: *"Go baby! Go!"* And so you sound just like the capcom on the Apollo 11 launch.

In *Peak of Flight Newsletter #315* (www.ApogeeRockets.com/Education/Downloads/Newsletter315.pdf) I talked about what the minimum speed should be for a model rocket flight. In this article, I'll go over some of the more common ways that you can use to get down to that speed.

As before, I'll lead into this with a reminder that too slow can be dangerous, and that a high lift-off speed is good. Higher lift-off speeds means that the rocket won't weathercock as much and will go upwards instead of upwind. You can see an example of a scale model that weathercocks at: http://www.youtube.com/watch?v=hkJWkPXUGoI

The Three Methods Of Reducing Speed

There are only three ways of reducing speed of a rocket: increasing its weight, using a less powerful rocket motor, or increasing the drag.

I rarely recommend increasing the weight, because most times it isn't necessary. The one instance where it may be necessary is when you have no other choices to increase the stability of the model. This can occur in scale models like in the V2 missile, where you need the extra nose mass to make sure it has enough stability margin.

If a scratch-built model needs nose weight, it should be redesigned before it is flown. This is relatively easy to correct by making the rocket longer, or increasing the fin size.

Why isn't adding weight recommended to slow down a rocket? The answer is "safety." Remember, what goes up, must come down. Having a heavy rocket go upward means that a heavy rocket is going to come down too. Even a heavy rocket coming down slowly can have a lot of kinetic energy.

Ideally, if you have to add weight to the rocket, you'd like to disperse that extra mass before the rocket comes down. The primary ways of doing this is to dump the extra mass out of the rocket. An example of this is tracking powder that is poured into the rocket prior to launch, and then is blown out at ejection.

The one problem with tracking powder (like powered chalk) that is simply poured into the tube prior to flight, is that it can clog the tube and prevent the parachute from being deployed. That results in the rocket coming down

Figure 1: Tracking powder is disposable mass that also helps in spotting your rocket in the sky.

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nose first on a ballistic trajectory. This is far worse than not having any tracking powder at all.

And on large rockets, the amount of tracking powder needed to ensure stability would probably be more than could be stuffed into the tube anyway. Tracking powder has fairly low density, so you need a lot of it to add sufficient mass to the rocket to affect the stability.

A better system, particularly for bigger rockets, is to have the model separate into multiple pieces. Each piece would then have its own recovery device. And even if one of the chutes didn't open fully, the one un-deployed piece would still come down safer than a ballistic trajectory.

Using a Less Powerful Rocket Motor

I like the method of using a less powerful rocket motor to reduce the speed of the rocket. There are many choices that customers have these days, and the selection of motors seems to get broader over time.

The only thing you have to watch out for, is having the rocket have a too-slow lift-off speed. You don't want to go slower than that minimum threshold speed mentioned in *Peak-of-Flight Newsletter #315*.

Slow it Down Using Drag

I also like adding drag to the rocket to reduce the flight speed. It is easy to do, and it doesn't have a lot of drawbacks.

For example, the aerodynamic drag force has very little practical effect on the lift-off speed of the rocket. The amount of time it takes for the rocket to clear the launch rod is miniscule compared to the time the rocket is in the air. In other words, the drag doesn't have a lot of time to build up while it is still on the rod. But once it clears the rod and is gaining speed, aerodynamic drag builds up quickly, and really affects the maximum speed of the rocket.

An example of this are those high-drag UFO style rockets. Their initial acceleration is just as fast as other rocket, but the faster they go, the higher the drag force is created that causes them to slow down.They'll hit their maximum speed at about the time they clear the top of the launch rod.

Additionally, if the parachute doesn't deploy properly on a high drag rocket, the model will still come down a lot slower than a high efficiency rocket. While no one wants to be underneath an incoming ballistic rocket, I'd rather be under a high drag rocket, because it will be coming down slower than a low drag rocket. That gives you more time to step aside and get out of the impact zone.

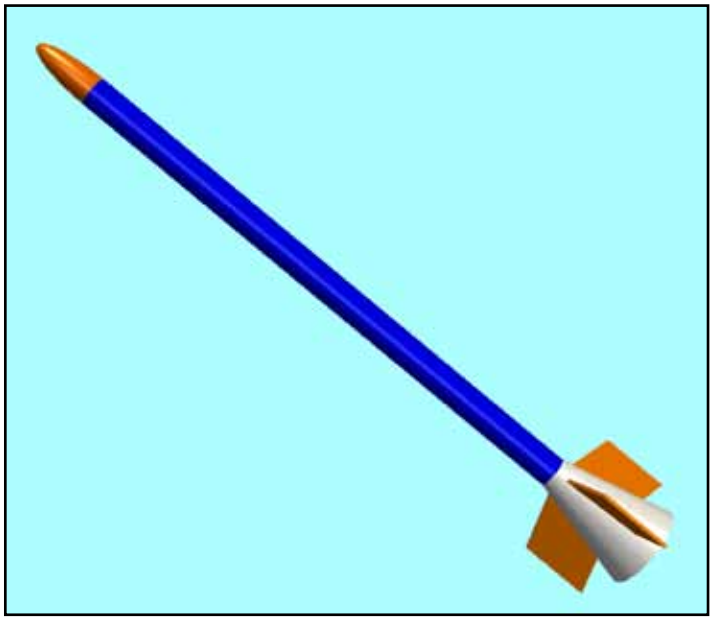

Figure 2: A transition on the base of the rocket can increase the base-drag, and slow the model down.

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Methods of Adding Drag To A Rocket

The first method of adding drag to the rocket is to increase the size of the rocket, particularly the diameter of the model.

Those big UFO style rockets have large frontal area because of their large diameters. This really increases the drag on the model.

The other thing about those style models is that they also have a huge amount of base drag. Base drag created by a blunt back end of rocket creates a small vacuum underneath that prevents the rocket from going fast. If you wanted to reduce this drag, you'd add a boattail to the model to make the base smaller. If you wanted to make it greater, you'd add a wider base to the rocket as shown in Figure 2.

Figure 3: Odd-rocs usually have high drag configurations.

Another way to add drag to the rocket is to increase the planform drag. An easy example is to increase the number of fins, such as going from 3-fins to 4-fins, and to make them larger. In addition to adding more drag, the fins also help increase the stability of the rocket.

Odd-rocs are usually very high-drag models. The planform shape of the body or nose cone is not conducive to smooth airflow.

Adding bumps and protuberances to the rocket, like simulated ribs that are on vacuum form wraps, also add drag that will slow the rocket down. In addition to adding more planform drag, they also add to the skin-friction drag.

Skin-friction drag comes from a rough surface finish on a rocket. So if you don't paint your rocket and don't sand your fins, you're basically adding skin friction drag to the rocket.

Besides adding wraps to the rocket to increase skin-friction drag, you might intentionally make the surface rougher. That is what my daughter did for her fifth-grade science fair project on the surface finish of a rocket. She sprinkled sand onto the wet paint of her rocket to give it a

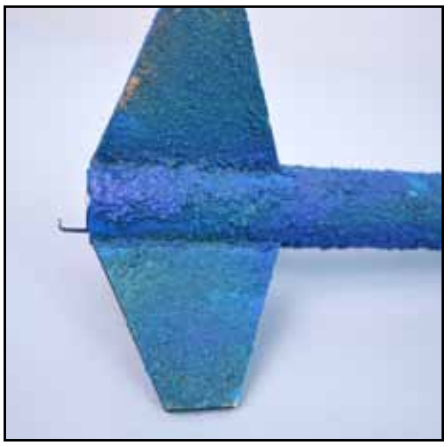

Figure 4: A rough surface greatly increases the skin friction drag.

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Figure 5: A spinning rocket will fly straight, but not very high.

very bumpy surface finish. The result, as expected, was that the rocket with the rough surface finish didn't fly as high as the nice smooth-finish rocket.

A fun way to add a lot of drag is to cant the fins over, so that they cause the rocket to spin as it ascends. This spinning sucks energy from the forward motion of the rocket. The faster the spinning, the more drag the rocket will have. Spinning also has the effect of adding stability to the rocket, making it fly straighter. It is a great visual effect, and sometimes it makes a cool noise too.

A final way of adding a lot of drag without adding a lot of weight is to attach small streamers to the trailing edge of the fins. I've seen this done with big streamers for a dramatic effect, but even small ones can add a lot of drag to the rocket. It is like adding fringe to the rocket, and the more you add, the higher the amount of drag you get.

Conclusion

Adding drag to a rocket is can be a lot of fun. If you want your rocket to fly low and slow, this is probably the best way to do it.

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.