PEAK OF FLIGHT

NEWSLETTER

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Apogee Components, Inc. — Your Source For Rocket Supplies That Will Take You To The “Peak-of-Flight”
3355 Fillmore Ridge Heights
Colorado Springs, Colorado 80907-9024 USA
www.ApogeeRockets.com e-mail: orders@apogeerockets.com
Phone: 719-535-9335 Fax: 719-534-9050

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Building a Better Baffle

By Tim Van Milligan

I got a new toy, and I'm really giddy about it. It is a laser cutter (technically, it is called a laser engraver).

Laser cutters have been around a long time. I remember the first ones coming on line when I worked at Estes Industries in the early 1990's. They were expensive back then, and so we continued to design rocket kits using die cutters.

I guess I'm close to 25 years behind the times, but I finally broke down and made the investment to buy one for Apogee. I really should have done it a long time ago, but I wasn't convinced that I could justify the investment. The big reason was that many of our suppliers have laser cutters and therefore we could get our needed parts from them. Apogee Components has been purchasing laser cut parts from other suppliers for at least 10 years. So I just didn't see the urgency of getting one of my own.

The impulse for finally getting the laser cutter began last summer when a local friend invited me over to play with a laser cutter that he owned. I think the machine itself sold me on the idea of making the investment. The eleagance of the machine in motion, as it cut effortlessly through plywood, was mesmorizing.

From that first day, I was hooked. If you noticed our inventory, it was at that time that we greatly expanded our selection of laser-cut parts. These were all cut on my friend's laser system (I leased time on the machine to make the parts myself).

Changed by Technology

One thing that I should point out, is that the laser changed me personally. It changed the way I thought about how to design a rocket. In the past, I thought very conventionally about the parts that go into a rocket. For example, there are traditional laser cut items in a rocket like fins and centering rings. And for the most part, that is what other manufacturers use when they produce parts for rocket kits. But to be honest, those are expensive parts, because they can be produced cheaper using other methods. The only only advantage is the precision of the parts - they are exactly the same, and the fit into the rocket is very nice.

And that points to the real advantage of laser cut parts:

Photo 1: Tim discusses the new laser cutting machine with Erin.

ease of assembly of the rocket. Parts that fit together without any gaps or slop, are easier to work with because you don't have to fill the gaps with glue. Since the glue joints are tighter, it grabs faster. You end up with a stronger joint that took less time to assemble. People love rockets with laser cut parts!

After you have basic parts, and you realize they fit together better, you start to wonder if you can enhance the joint by making interlocking parts. And that is where slots and tabs come into play. You start designing fins with tabs in them that interlock with slots in the tube and in the centering ring. The strength of the joint increases substantially, while the weight is hardly affected at all. In fact, you can easily cut away the excess material to reduce the final weight. That is why you'll see lightening holes in centering rings.

At this point, your brain is starting to think in three dimensions. You now consider how the each part will engage other parts in the rocket.

It should be pointed out that the cost of the part isn't changing much, but the perceived value of the rocket is increasing substantially. Because of this, my whole mindset is changing in how I design rocket kits. Every part can be optimized for the rocket, and enhanced to make it lighter or

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Newsletter Staff

Writer: Tim Van Milligan
Layout / Cover Artist: Tim Van Milligan
Proofreader: Michelle Mason

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stronger. You can even optimize it to "perform" better. And the best way to illustrate this, is by designing a simple part for a rocket. In this case, I'll create a baffle for a rocket.

Designing a Better Baffle

First off, when I say a "better" baffle, I'll couch that by saying this may not be the "best" baffle. My intent is only to show something a little bit better than what was available previously. You can perform many iterations in a design, with each pass making it slightly better. Eventually, you'll have something that is far superior than what was the original design. For this illustration, just remember that you can probably make something better than what I'll describe here.

What Nuisance are You Trying To Fix?

Before I put my two cents into a new design, the first thing I do is to step back and consider the nit-picky problems that I have with a baffle. What can be fixed that would make things better?

Off the top of my head, I think that there could be two problems that might be fixed. The first is that with a traditional baffle, you can't attach the shock cord to the engine mount. I like to attach to the engine mount because that is the strongest part of the rocket. This is an easy fix to make, as we can put a screw eye right into the top bulkhead of the baffle.

But before you go sticking a screw eye in the middle of a bulkhead, you have to make sure that the bulkhead is strong enough that the screw eye won't be ripped out when the shock cord pulls on it at parachute deployment.

If it isn't strong enough, how might you make the disk stronger? The easy way is just to double up on the thickness of the wood. But it really only needs to be strong

Photo 2: Doubler disk is added to strengthen the area around the hole so the screw eye can't be easily yanked out of the disk.

around the screw eye itself, so a small disk can be added.

The second problem that annoys me about baffles, is that they trap crud in them from the ejection charge. The crud comes from the clay cap on the motor, or the little plastic top on composite motors. When you pick up a rocket after the flight, it rattles from the stuff inside of it. Unfortunately, it is hard to clean out this residue. You have to shake it up and down to try to get the crud to fall out through the holes.

It would be nicer if you could just tilt the rocket to the side and all of the junk could easily roll out. If you look at photo 2 above, you can envision how putting the holes at the side of the disk can make it much easier to pour out

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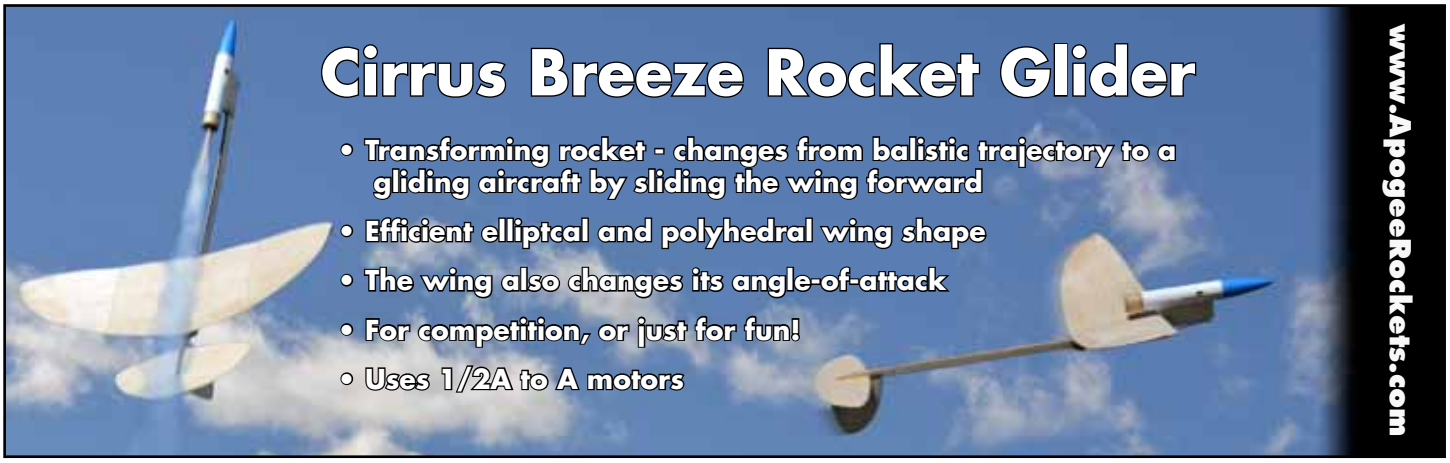

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Photo 3: When the glue on the doubler (hidden on the back side of the disk) dries, the screw eye can be inserted.

the residue after the flight (See also Photo 4).

At this point, the design is pretty much done, but there are a couple of other things you can do to make a better baffle. These are done during the assembly phase.

Obviously, beefy glue fillets on both sides of the bulkheads are preferred when assembling the baffle. These take a lot of abuse from the ejection charge, so you want to make sure they are strong.

Photo 4: The forward disk is glued into the tube coupler, and fillets added to increase the strength.

Next, you'll want to coat the surface of the aft disk, which faces the motor mount, with some 5-minute epoxy. This helps protect the wood from the direct impingement of the ejection charge. Epoxy makes a good ablative heat shield (see Newsletter #365 at www.ApogeeRockets.com/Education/Downloads/Newsletter365.pdf). Just make sure you don't clog any of the holes. So you'll want to scape the insides of the holes with a small wood dowel while the epoxy is still in its liquid stage. The epoxy will also settle out to the sides, and create a great fillet on that aft bulkhead.

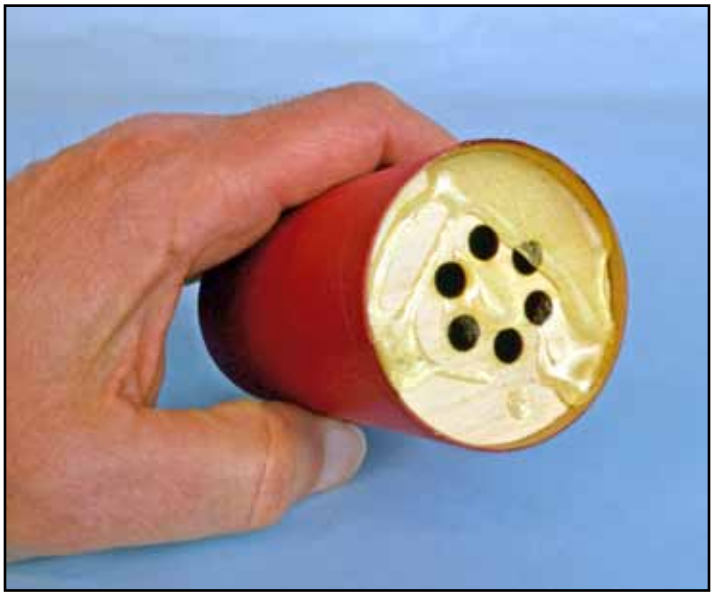

Photo 5: Coat the surface of the disk that faces the motor with epoxy. This helps protect the wood from the heat of the ejection charge.

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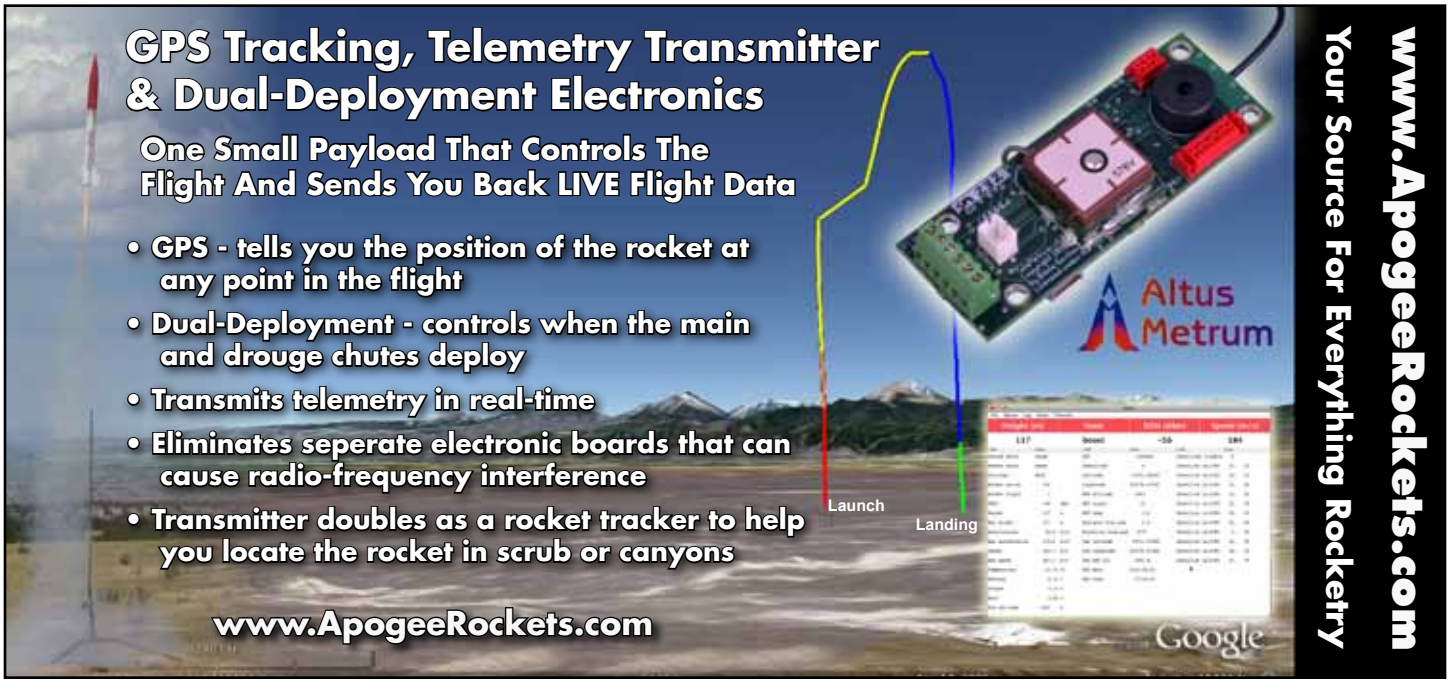

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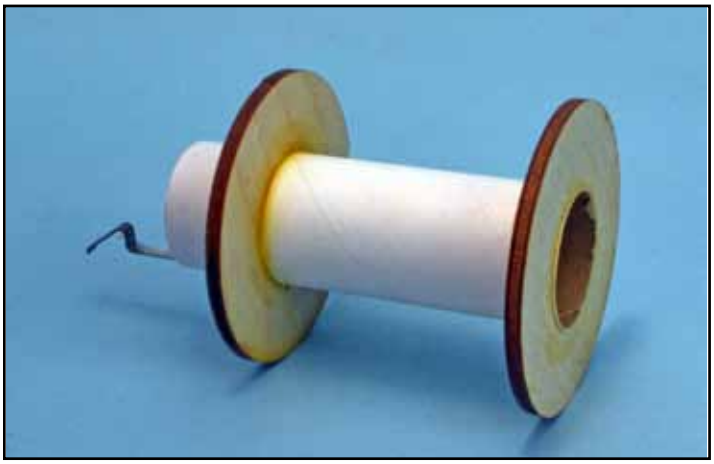

Photo 6: Put the forward centering ring on the engine mount at the very edge of the tube. Sand it flush so it is perfectly flat.

Next, when building your engine mount, position the forward centering ring at the very front edge of the tube, and sand it smooth, so the surface of the ring is absolutely flush with the edge of the tube. The reason for this is to help get the crud out of the cavity between the engine mount and the baffle. If the tube extends forward of the ring, the crud will be nearly impossible to remove. You'll have to shake the rocket up and down to try to get it to bounce out of the engine tube.

Unfortunately, you won't be able to put a glue fillet on the front of the ring, so it won't be as strong. To account for this, put a bigger fillet on the aft centering ring. Better yet, use through-the-wall fin tabs, where the root of the fin will bond to the engine mount tube.

Finally, I would recommend positioning the aft bulkhead disk of the baffle at least one body tube diameter in front of the engine mount tube. This will allow some space for the gasses to cool before having to go through the lower bulkhead disk. Further is better, but you don't always have the extra room.

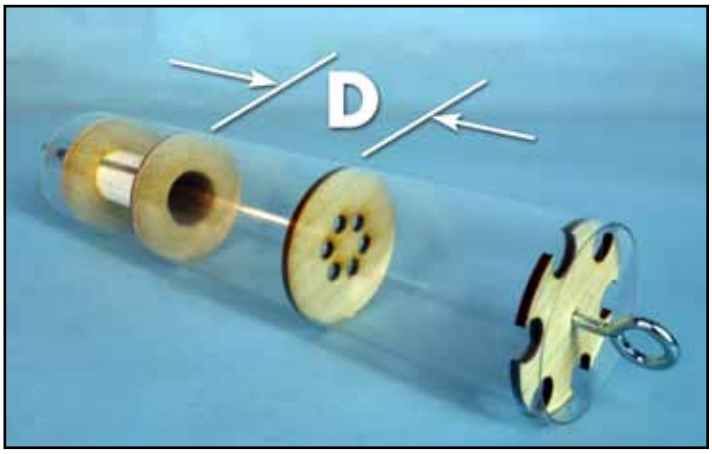

Photo 7: Cut-away view of the disks in the rocket. Position the aft bulkhead disk of the baffle at least one body tube diameter in front of the engine mount tube.

Is this a Better Baffle?

While this may not be the best baffle you've ever seen, the purpose of this article was to illustrate how my design philosophy has changed because of the way parts can be produced.

Ever since I borrowed my friend's laser cutter in the summer of 2013, I feel my level of creativity has jumped considerably. It may just be that I can do things with a greater level of precision at an affordable price than I had in the past. For example, with the laser, you can create some complex assembly fixtures out of very inexpensive and somewhat inconsistent materials. I would have never been able to make the wing dihedral fixture for the Cirrus Breeze kit using a conventional die-cut method. It just wouldn't

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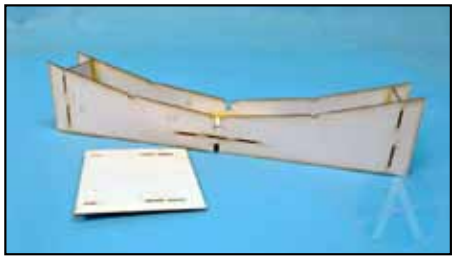


Photo 8: The wing dihedral fixture from the Cirrus Breeze rocket kit.

have been accurate because the metal cookie-cutter blades bend and shift in the backing plate. With a laser, it is both cheap and accurate, every single time a part is made.

The other kinds of rockets that I've been playing around with are helicopters and gliders.

In the case of the glider, an idea came to me to build an angle of attack for the wing into the fuselage. The wing has to have an angle-of-attack in order to transition into a glide. While I was contemplating that, it hit me like a lighting bolt to make the fuselage boom curved. A sliding wing could travel along the curved portion and come to rest so that the wing had the angle-of-attack built in. The result is the Cirrus Breeze rocket glider kit (www.ApogeeRockets.com/Rocket_Kits/Skill_Level_5_Kits/Cirrus_Breeze_Rocket_Glider).

The other model that was inspired by the laser cutter is the new Gyro Chaser kit (www.ApogeeRockets.com/Rocket_Kits/Skill_Level_4_Kits/Gyro_Chaser).

Photo 9: The sliding wing box on the Cirrus Breeze rocket glider is another part whose complexity was reduced because of its laser-cut parts.

I've got more models in the works, including a really cool lander that I showed at NARCON in March. A few more tweaks, and it will be done.

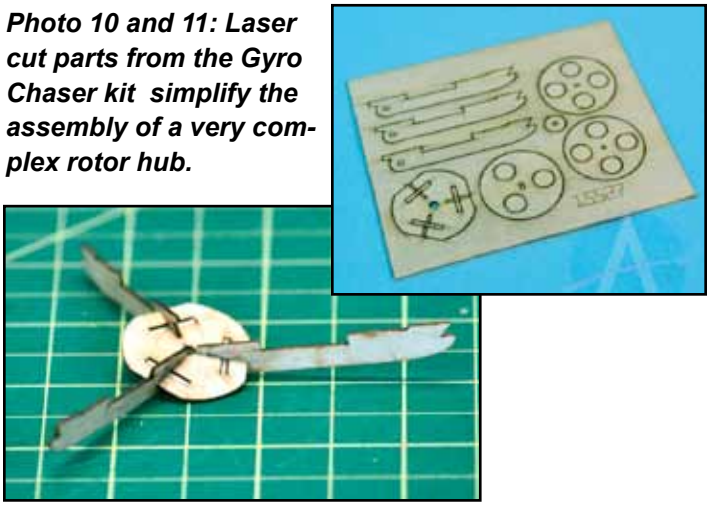


Photo 10 and 11: Laser cut parts from the Gyro Chaser kit simplify the assembly of a very complex rotor hub.

I'm really having a lot of fun designing rockets around the capability of the laser cutter. I'm kind of kicking myself for not getting one 20 years ago. I just hope that I don't wait around 20 years to get my next toy - a 3D printer.

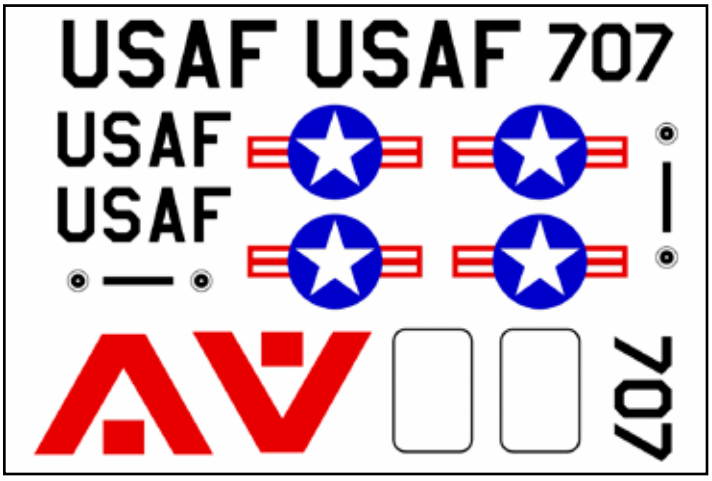
About The Author:

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.

Shrox Plan: The "Sea Snap"

By Shrox

Download the RockSim file (which includes the parts list) and the decal file at: www.ApogeeRockets.com/Downloads/SeaSnap01.zip



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