



Take Your Apogee Aspire To Supersonic Speeds!

Technical Publication #29

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YES, you can take your hobby models to super sonic speeds. Model rocketry is the only hobby on the planet where you can do this. Isn't that way cool?

We are often asked how to modify the Apogee Aspire kit so that it can withstand the extreme forces that occur at super sonic speeds (Mach 1, the speed of sound, is approximately 761 mph at sea level). The Apogee Aspire is a perfect rocket for this task. It is minimum diameter for 29mm diameter high-thrust rocket engines, and it has a sleek shape that is just made for cutting quickly through the air.

In this publication, I thought I'd show you how to take the stock Apogee Aspire kit, and with a few simple modifications turn it into a supersonic cruising model. I want to stress that you don't need any special materials or adhesives to do this. As you will see below, the only real difference is to cover the fins with skins of paper. Yes, ordinary photocopy paper that you have in your hands.

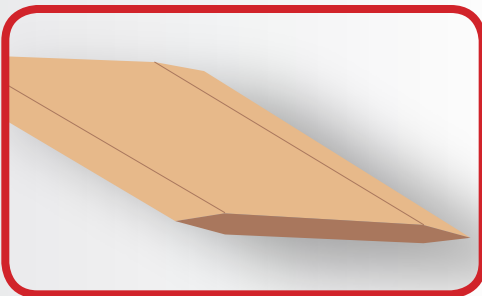
1. Stack sand the edges to make sure all the fins are identical size.
2. Sand the flat surfaces with fine-grit sandpaper to knock off any fibers that are standing up. This will make it easier to spread the glue later.



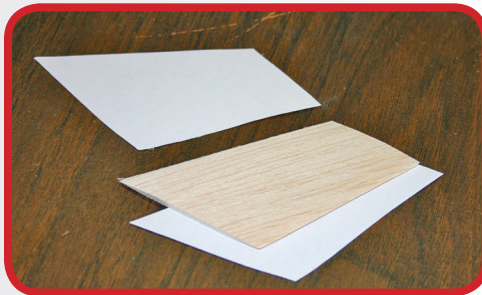
3. Sand the leading and trailing edges to a point. This is the double-diamond shape. It is a good compromise between extra strength (which comes from thick fins), and a good supersonic airfoil.

It is important to make sure all the fins have identical airfoils. If one is different, it could cause the rocket to veer off in flight. That will cause a great increase in drag, and probably prevent the rocket from achieving supersonic speeds. I recommend the airfoiling technique shown in the video book: "Building Skill Level 2 Model Rockets."

http://www.apogeerockets.com/skill_level_2_book.asp



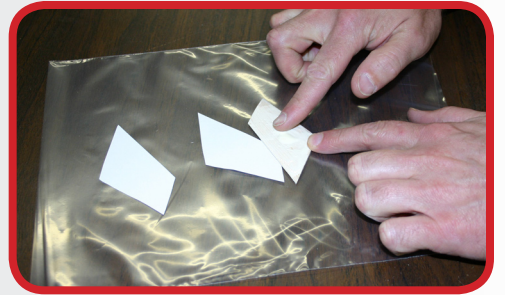
4. Cut the paper skins from ordinary loose-leaf paper. Cut them a little larger than the fins themselves.



5. Cover your work surface with a large sheet of plastic. Have ready a bunch of paper towels to clean up the excess glue, a wet rag to wipe your fingers, and a dry cloth to dry off your hands after using the wet cloth.



6. Spread wood glue over the surface of the wood. Squeegee it off with your finger. Do not leave any puddles on the wood, you only want a thin film that will grab to the paper skin.

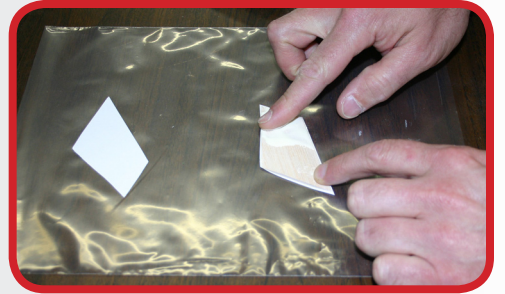


7. Lay the skin on the wood. Center it so that an even amount of paper hangs over the perimeter.

8. Quickly clean off the glue from your fingers with the wet rag. The glue may dry quickly, leaving globs of glue on your fingers which will come off on the next fin that you apply glue to.

9. Quickly repeat the skinning process on the other side of the first fin.

10. If you have any bumps or bulges under the skin of the paper, that means you had too much glue on the surface. Try to smooth them out without tearing the paper skins.

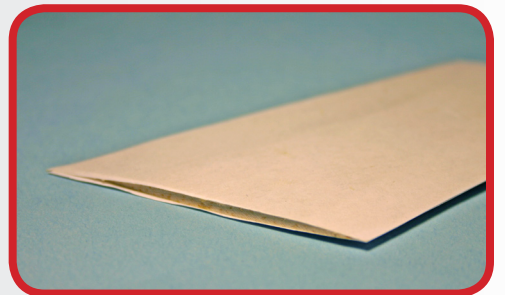


11. Set the fin aside to dry. You can lean it up against a box or other tall object, so that air can circulate around both sides of the fin as the glue dries.

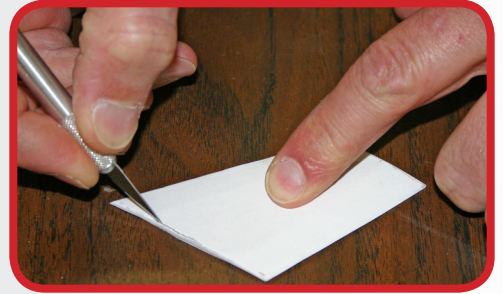
12. Repeat for the other fins on the rocket.

13. As the glue dries, the surface of the fin will feel cool due to evaporation. Check it a few times during the first hour to make sure it is not warping. You can bend it back while the glue is still wet to take out the warp. But if you were sparing with the glue, this shouldn't be a problem.

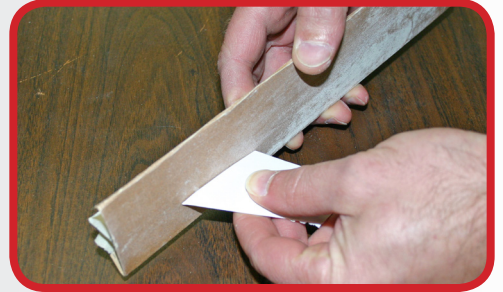
14. Let the fins dry completely overnight.



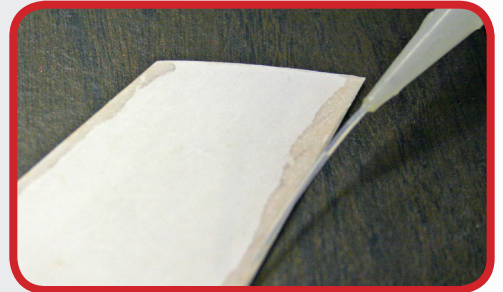
15. Using a sharp hobby knife, trim most of the overlap of paper off of the fin. In the next step, you'll clean up the edges even better.



16. Sand the edges to remove the overlap of paper from the root edge and the tip edge.

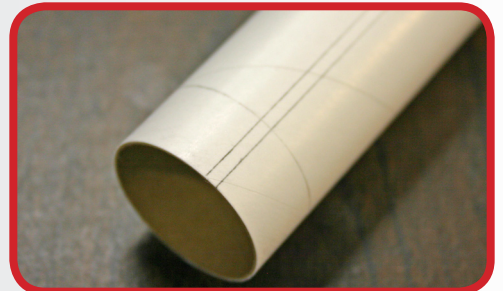


17. Using water-thin CyA adhesive, saturate the fibers of the paper on the leading and trailing edges of the fins. This will stiffen up the paper making it easier to sand the edges to a sharp point.

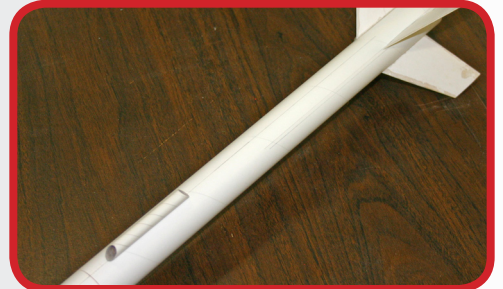
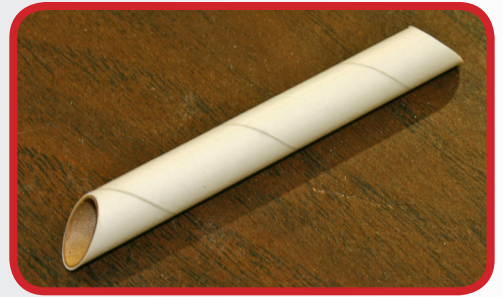


18. Because the point at the leading edge may not be exactly in the center of the fin (because of sanding errors during the air-foiling process), you should draw parallel lines on the tube to guide you as you place the fin on the rocket. If you draw just one, the fin may be canted slightly. The fins must be aligned perfectly straight. If one is canted a little bit, the rocket will start corkscrewing in flight, causing a large increase in drag. As the drag goes up, your chances of going supersonic go down. I recommend the technique shown in Building Skill Level 2 Model Rocket Kits to make sure you've got them on perfectly straight.

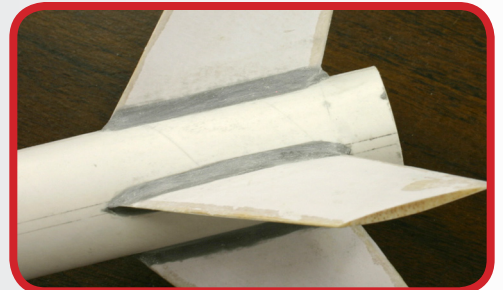
http://www.apogeerockets.com/skill_level_2_book.asp



19. It would be best to fly the rocket without a launch lug. But this may not be practical if you don't have a tower launcher to hold the rocket on the pad. In this case, cut the launch lug leading and trailing edges so they are angled. This can be done with a very sharp razor blade. Then glue the launch lug on the rocket.



20. After gluing the fins onto the rocket and allowing it to dry, mix up some of the Fix-It epoxy-clay (<http://www.apogeerockets.com/epoxy-clay.asp>), and make fillets for the root edge of the fins. Spend some time sculpting the clay into smooth and consistent fillets. Do the same for the launch lug. Good fillets here will cut down on drag and allow the rocket to reach higher speeds.



21. At this point, finish up the assembly of the rocket as directed in the instructions. You shouldn't have to make any other deviations to get it ready to go supersonic.

22. Achieving a smooth surface finish is more important than the little bit of extra mass you'll be adding by painting the model. So really do a good paint job on the rocket. The added benefit is that you'll have an easier time finding the rocket after the flight.

Because the fins are covered with paper, you shouldn't need to do any type of balsa sealing to get rid of the wood grain. That is another benefit of having paper skins.

I finished my rocket by first spraying it with sandable primer paint. I like to put it on really thick. When it dries, I sand about 90 percent of it off. This technique fills in all the tiny gaps in the spirals of the tube, and along the edges of the fin fillets.

I then put on second heavy coat of primer, and this time I wet-sanded the primer. Wet sanding with the special black-colored "wet/dry" sandpaper will really give you a smooth surface without all the deep scratches of regular sandpaper. I use 400 grit paper for this step, with plenty of water to lubricate the surface.

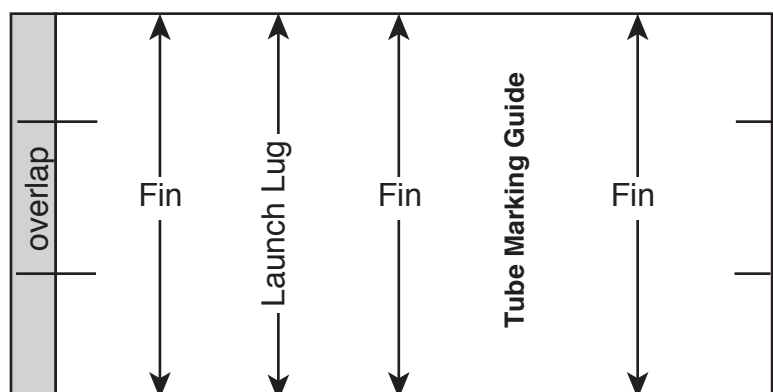
After wet-sanding, I put on the white undercoat of paint. A day later, I added the red paint. If you look closely at the photo, you can't tell where the epoxy fillet starts at all. That is what I wanted, because reducing the drag will really make this rocket scream when it is launched.



Other important things to consider.

1. The rocket is going to go really fast, even if it doesn't achieve supersonic speeds. There is a very good chance (probably 75% or more) that you're going to lose the rocket. It is small, and it will go so fast that it will be difficult to track. Because of this, don't use a reloadable rocket engine; you could end up losing the expensive aluminum case too.
2. I recommend the single-use G77R-10 "LOADABLE" rocket engine from Aerotech. I ran some simulations in RockSim, and it actually will fly slightly faster than the G80T-10 motor. And the benefit is that these motors are available in more locations because they can be shipped through the postal system without an expensive hazmat fee. NOTE: You need to be at least 18 years old to buy and use the G size motors.
3. The Apogee Aspire has 4 fins for aesthetic reasons. If you want a little more speed out of the rocket, you can turn it into a three-fin model. The stability of the model drops slightly from 2.65 calibers to 2.44. But this is still plenty of margin, so the model will still fly nice and straight. According to RockSim's simulations, the rocket will pick up another 13mph (0.02 Mach) of speed. It doesn't sound like much, but every little bit will help.

Number of Fins	CP Location
3	27.03
4	27.2932



4. Don't forget to put your name and phone number on the rocket if you really would like to have it back. To increase your chances, put the word "REWARD" on it too.
5. Verifying the rocket went supersonic is difficult. It will require you to modify the rocket a bit more to include a payload bay. You could drop the Perfectflight Altimeter into it and after the flight, you would have to download the flight data into your computer using the Data Transfer kit. These can be purchased at: <http://www.apogeerockets.com/Altimeter.asp>

Apogee Components

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