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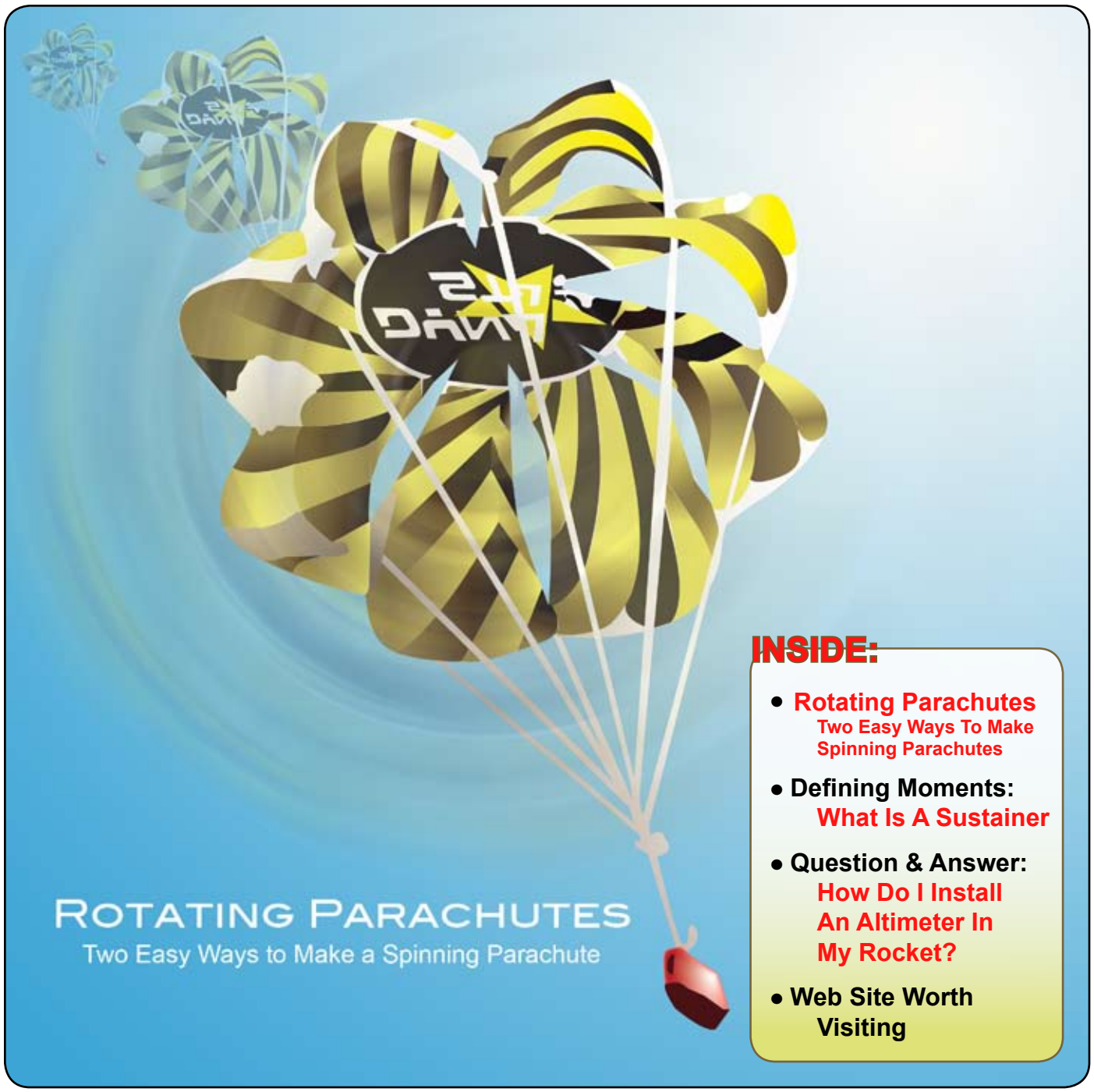

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Rotating Parachutes

Two Easy Ways to Make a Spinning Parachute

By David T Flanagan

Rotating Parachutes

Parachutes that rotate or spin during descent were invented more than fifty years ago. There are several varieties. Although some small spinning parachutes are found in military ordnance, they are not otherwise widely used. In larger sizes (10 ft and up) rotating parachutes in general have problems with irregular deployment and with canopy "wrap up" during descent. But in small sizes they are neat to play with and they make parachute recovery a lot more fun.

This article describes two rotating parachutes; a variation of the original full scale "Rotafoil", and one of the author's own creations called (for lack of a better name) the Rotasail. Both can be made from the parts of a six or eight sided plastic kit chute and, in fact, the Rotafoil can be made directly from a kit chute that is already assembled!

Both parachutes for this article will be made from a stock plastic 32" Dynastar kit chute. This canopy is shown in Figure 1 already cut out from the stock material on which it is printed.

Figure 1

Figure 1. **A stock plastic 32" Dynastar octagonal canopy ready to be made into a Rotafoil or a Rotasail.**

The Swivel

Before building a rotating parachute note that one disadvantage of rotating parachutes is that they rotate! A swivel or other method must be used to absorb or otherwise accommodate this spinning, or the suspension lines of the parachute could wrap up and collapse the chute. The best way to prevent this is to install a swivel between the rocket and the chute. If a swivel is not used and the expected descent time is short, a very long bridle line between the chute and the rocket will work. The bridle will "wind up" but hopefully not enough to wind up the suspension lines and collapse the chute before touchdown.

It is always a good idea to "toss test" a new chute before using it in a rocket. You will not need a swivel just for the toss testing.

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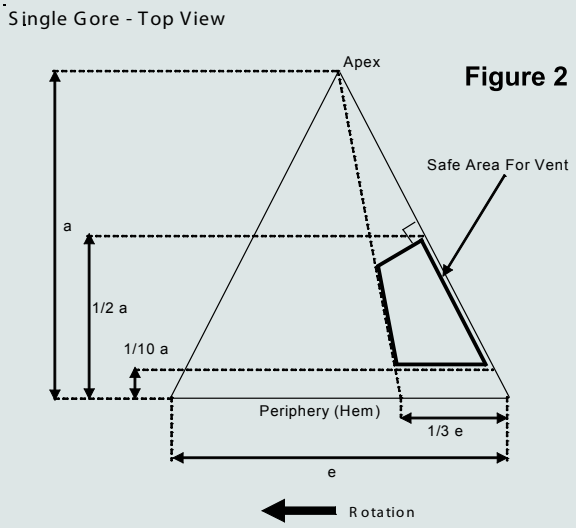
The Rotafoil

The Rotafoil is a simple adaptation of a standard parachute. Basically identical vents (holes) are cut near one edge of each of the triangular gores of the canopy. The exact shape of the hole is not important but some guidelines are as follows:

- Most of the area removed should be as near as possible to a line drawn between the apex and the suspension line attachment point.
- Do not remove any material from the top half of the gore.
- Use rounded corners – square corners are "stress-risers" (in engineer speak) and should be avoided. A canopy is more easily torn at such stress points. (This practice was not followed during the construction of the rotafoil described here….!)
- All of the gores must be identical. Use the same size and shape and location of the vents in each gore.

See Figure 2 for the recommended maximum "envelope" for the vent. Do not exceed the envelope shown – it can make the canopy rotate so fast it becomes deformed, although such deformation may also depend on the total weight the canopy is carrying. Note also you can choose to have two or more vents in each gore as long as they both are within the border of the recommended area shown in Figure 2.



The best way to make sure the vents in all the gores are identical is to first make a pattern of the gore from cardboard. Then place the pattern on each gore in sequence and trace out the vent area. A Sharpie™ lab marker or similar pen works well for this. Use a hobby knife to cut out the vents in the canopy.

Figure 2. **Sketch of a single triangular gore showing the area in which the vent should be located. Vents may be smaller than shown but absolutely not larger.**

Figure 3. **The pattern placed on the canopy ready to trace out a vent in one gore.**

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Figure 4

Figure 4. **All the vents cut are out and the canopy is ready to have the suspension lines installed in the normal fashion.**

If you think about how the parachute will look when it is inflated you can see that air will be deflected out the vents in one direction. This causes the parachute to rotate in the other direction. The parachute in Figure 4 will rotate clockwise as viewed from above.

After you cut out the vents the parachute may be assembled in accordance with the manufacturer's instructions, except don't forget to install the swivel!!

Figure 5. **The Rotafoil during toss testing shortly after opening.**

Figure 5

Figure 6

Figure 6. **This rotafoil is now rotating so quickly the picture is blurry and the gores have begun to be deformed. This is because the vents are borderline "too big," or the parachute is carrying too much weight (one pound.) It is rotating counterclockwise as viewed from below.**

Packing the Rotafoil for use in a rocket is done just like any other parachute. Just be careful not to trap any suspension lines or canopy material in the vents. Hold the canopy by the apex, let the payload dangle, and pull all the gore material out away from the center of the chute. Failure to do this can and often will cause a malfunction.

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Rotasail

Unlike the Rotafoil, the Rotasail cannot be made from a completed kit chute but it can be made from parts of a kit chute.

As with the Rotafoil, each gore of the Rotasail canopy is modified, so it is best to make a pattern from cardboard so all the gores turn out the same way. The pattern should reflect the following:

- Adjacent gores should be cut apart almost to the apex. Do not cut within 15% of the distance near the apex or the parachute may fall apart.
- A triangular part of the bottom of each gore is removed. It should be cut on an angle of ten degrees as shown in Figure 7.

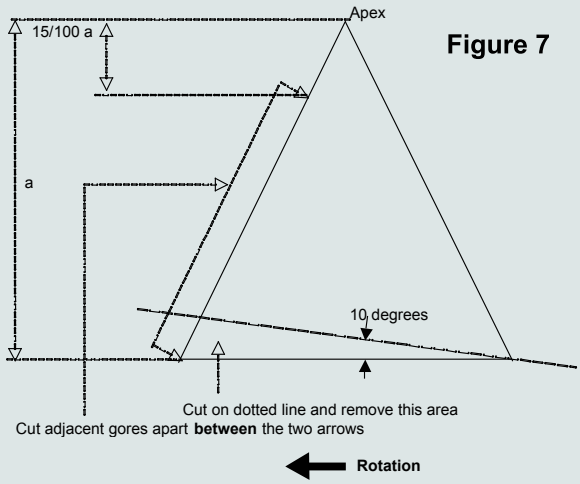

Figure 7

Figure 7. Sketch of a Rotasail gore pattern.

Technical Note: The value of ten degrees was tested on one eight-sided parachute. Two other identical parachutes but with angles of five degrees and fifteen degrees were also built and tested These latter two parachutes functioned correctly, but rotated (subjectively) somewhat too slowly and much too quickly respectively. Furthermore it can be shown mathematically that the value of ten degrees is likely to produce approximately the same tendency to rotate (within 5%) in parachutes of 6 to 24 sides.

Figure 8

Figure 8. The pattern is placed on the canopy and the gore is traced out.

Place the pattern on each gore in turn and trace out the cut lines with a Sharpie™ lab marker or similar pen (Figure 8.) Use a sharp hobby knife to cut the plastic parachute material.

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Figure 9. **The gores are "sliced and diced" and the canopy is ready for the next step in which the long side of each gore is mated with its neighboring short side.**

Once the modifications have been made to each gore the canopy will be loose and flopping all over. Lay it out flat once again (Figure 9.) At each point where adjacent gores meet there will be a "long side" and a "short side." Place the corner of each long side on top of the corner of the neighboring short side so that it overlaps slightly. Tape it securely in place in one spot only at the very tip (Figure 10.)

Figure 10. **Taping the tip of the long edge of one gore to the tip of the short edge of the neighboring gore.**

It is clear now that when the parachute inflates the long edge will balloon up or "sail", and deflect the air passing through it. This causes the parachute to spin in the opposite direction.

Figure 11. **The canopy is ready for the installation of the suspension lines. Notice that once the gores are taped together the canopy cannot be laid flat.**

Once the canopy of the Rotasail is completed, attach the lines. Lines will attach to the canopy right where the gores are taped together. And again, don't forget to install the swivel!

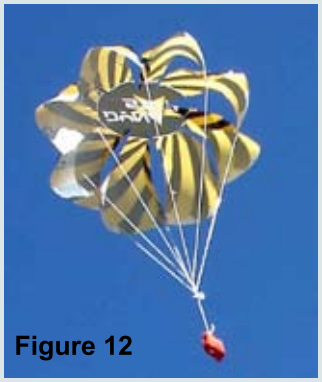

Figure 12. **A Rotasail during toss testing. A view of the huge slits in a Rotasail canopy.**

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Packing the Rotasail for use in a rocket is done just like any other parachute but it is even more important to keep the canopy material from getting tangled in the slits. The slits in the canopy are huge (see Figure 13) and it is easy to do. Figure 14 shows what happens to a Rotasail or a Rotafoil if you fail to prepare them carefully.

Figure 13. **A Rotasail with canopy material tangled in one vent during packing. This can also easily happen with Rotafoils. This configuration does not have a high drag coefficient.**

Future Work

Design

As noted, rotating parachutes haven't been very widely used, especially in rocketry. Very little is known. There is plenty of potential for improving existing designs. Here are some interesting questions. Many could lead to science projects.

- What is the drag coefficient of each of the two designs?
- Do they produce lift as a result of rotation?
- Does the amount of weight matter? Will they rotate faster or slower if the weight is changed? Rotafoils seem to be more affected than Rotasails by too much weight.
- Do the number of gores matter? Would sixteen gores be better than eight?
- What is the best shape, size and location for the vent in the Rotafoil?
- Is the angle of ten degrees really the best angle for the Rotasail?
- Can these parachutes be made from fabric as well as plastic?

References

The Rotafoil is briefly described in "Performance Of and Design Criteria For Deployable Aerodynamic Decelerators, The Aerojet Company, 1963." Similar information is found in "Parachute Recovery Systems Design Guide", NWC-TP-6575, March 1991.

About The Author

Mr. Flanagan holds degrees in life sciences and mechanical engineering and is a registered professional engineer in several states. He has held both research and engineering positions with contractors at NASA -JSC, and is currently with Jacobs Engineering at NASA - MSFC supporting the Experimental Fluids and Environmental Test Branch. He is a licensed airplane pilot, ultralight pilot, an expert scuba diver and a former Army paratrooper. He has had a life long interest in parachutes and made his first sky dive at the age of 17. He has made several hundred parachute jumps, holds a master parachute rigger certificate from the FAA, and has completed the University of Minnesota Parachute Technology Short Course. He continues to monitor developments in the field of "aerodynamic decelerators", has made models of most types of parachutes, and has flown most of them in model rockets. He lives in Madison, Alabama, with his wife and two cats.

Question & Answer

How do I install an altimeter into my rocket?

Before you start, understand that altimeters need to be installed in a payload bay of a rocket. This protects them from the heat of the motor's ejection charge. We recommend the Rising Star http://www.ApogeeRockets.com/rising_star.asp.

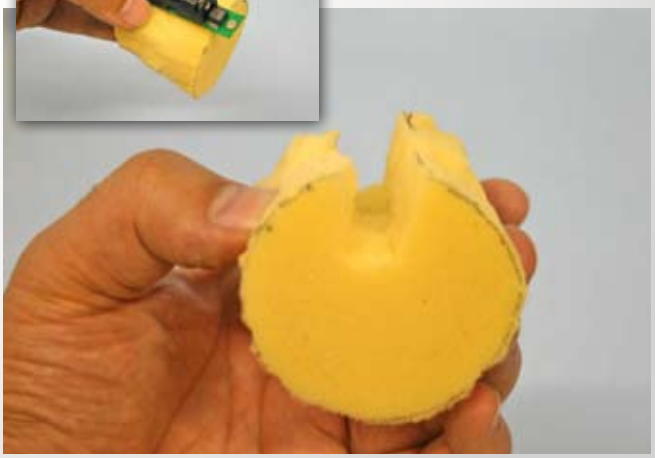
Once you have the right rocket for the job, the first step will be to find a scrap piece of foam. This foam must be soft so that it can be squeezed into the payload bay. You can use a sponge if you cannot find anything else.

Trace the diameter of the payload bay tube on the foam using a marker.

Cut out the foam piece with a long knife such as the one shown below. A hobby knife will work, but it may not be as smooth.

Once you have a foam cylinder cut, the next step is to cut a slot in it for the altimeter to sit.

Make it deep enough so the altimeter won't touch the inside wall of the tube.



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Now that you have a piece for the altimeter to rest in, you will need to cushon it on each side so it does not shift either forward of aft in the payload bay.

To make some end caps for the altimeter, just cut another foam cylinder. This time instead of cutting a slot in the foam, you will simply cut it in half as shown below.

The last step is to put all of this into the payload bay.

First you will slide one of the end cap pieces into the tube. Next you will put the altimeter into the slot you made in first piece of foam.Twist the cylinder around so it faces the vent holes in the side of the tube. Once the altimeter is in place slide it into the payload bay in front of the support. Last take the second end cap and slide it into the payload bay so you have a support on each side of the altimeter.

You're done! Put the rocket back together and follow the instructions to operate the altimeter. Check out one of the most accurate altimeters on the market at: http://www.ApogeeRockets.com/altimeter.asp

Web Site Worth Visiting

This issue's web site worth visiting comes from the city of Halberstadt, Germany. It is the personal web site of Rolf Stabroth. http://www.rolfstabroth.de. This web site is in German, so unless you can read that language, you'll need to translate itto English. This can be done using the google translator at: http://translate.google.com/

Rolf likes building big scale models, and he's really good at it, if you look closely at the pictures of his rockets. The quality is top-notch, and when he does a project, he documents it with a lot of photographs. That makes this a good place to go learn a lot of new things.

The site is also arranged quite well, and it is easy to find the really cool projects, like his big Saturn V, Russian N1, Delta II, Ariane 5, and a really neat Space Shuttle. He has come up with a lot of ingenious mechanisms on the Space Shuttle project that will be helpful if you might have a complex project in your plans.

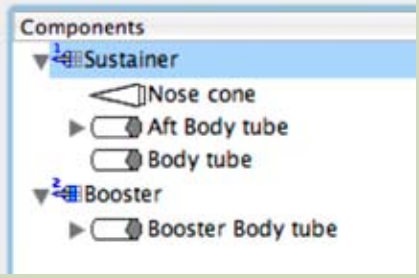
Another rocket that he has on his site is a Chinese Long March 3. I was compelled to look at it, because we at Apogee Components are now selling a 1:95th scale version of the same rocket. While ours is a lot smaller than Rolf's, I'm sure you might want to come to our web site and take a look at it.

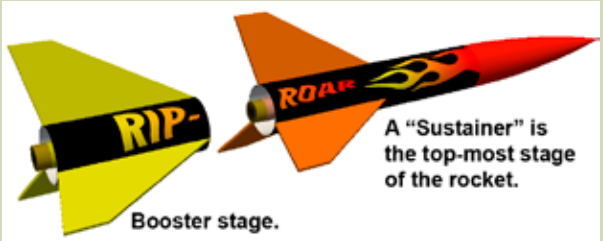
To conclude this short article, the instant I saw Rolf's web site, I knew it was going to be put in my favorite bookmarks. I recommend that you do so too. It is a great web site that is worth visiting.

DEFINING MOMENTS

What is a Sustainer?

Many new users of RockSim have question about what a sustainer is. The simple answer is it is the top-most stage of the rocket. If you look at the parts-tree of a RockSim design, you'll see that the Sustainer placeholder is at the top of the tree. In RockSim, the software needs to know what parts are in the top stage versus the lower stages. That is why you see it. You attach parts to the sustainer place-holder to let the software know that it all goes in the top section of the rocket.



The question then becomes, what if the rocket is not a multi-stage rocket. Is it still called a sustainer? And the answer is YES.

If you do not have booster stages below, you still attach parts to the sustainer stage. In RockSim, we still call the top-most part of the rocket a "sustainer," even if there is no booster stage below it.