

# PEAK OF FLIGHT

## NEWSLETTER

ISSUE 492 | April 2nd, 2019

### IN THIS ISSUE

## Build Your Own Helicopter Parachute - Part 1

[www.ApogeeRockets.com/Rocket-Kits/Skill-Level-2-Model-Rocket-Kits/Rising-Star](http://www.ApogeeRockets.com/Rocket-Kits/Skill-Level-2-Model-Rocket-Kits/Rising-Star)

### Apogee Components, Inc.

Your Source For Rocket Supplies That Will Take You To The "Peak-of-Flight"

4960 Northpark Drive Colorado Springs, Colorado 80918 USA

www.ApogeeRockets.com e-mail: [orders@apogeerockets.com](mailto:orders@apogeerockets.com) Phone: 719-535-9335 Fax: 719-534-9050

**APOGEE**  
COMPONENTS

# PEAK OF FLIGHT

## Build Your Own Helicopter Parachute - Part 1

By Dave Flanagan

### Introduction

Rotating parachutes like the Rotafoil and the Rotasail were presented in a previous issue of Peak of Flight #194 <https://www.apogeerockets.com/education/downloads/Newsletter194.pdf>. These are parachutes with specially designed vents or gores that make the chutes spin as they descend. They don't look much like helicopter rotors.

The helicopter parachutes presented here have "rotor blades" that make them look at least a little like the rotors of a helicopter. They are based on a parachute called the Vortex Ring Decelerator (VRD). The VRD was invented in the late 1950's but never made it big in the real parachute world.

Aerodynamically, the VRD seems pretty efficient. A regular parachute might have a drag coefficient of 0.8. By contrast the drag coefficient of the VRD can approach twice that. The opening shock of the VRD is only 2/3 of that of a regular parachute under the same conditions. And it is very stable. The VRD oscillates no more than  $\pm 2$  degrees during descent. Regular parachutes can oscillate as much as  $\pm 30$  or even  $\pm 40$  degrees [3].

The modeler should read through this entire article before building a model VRD. Construction is straightforward, but there are many options from which to choose.

There are two main adaptations the original VRD. The variations are called the "asymmetric gore" and the "symmetric gore" versions. The author developed the asymmetric gore version first and

presented the model in an old NAR magazine called "American Spacemodeling" almost 30 years ago [5]. The symmetric gore version (never published until now) followed later.

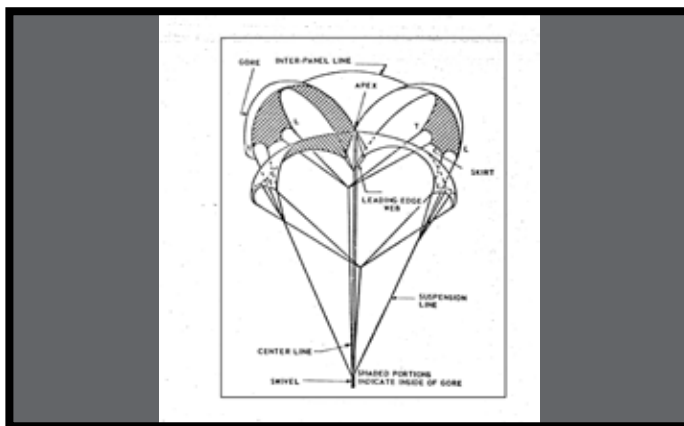


Figure 2. A line drawing of the full scale Vortex Ring Decelerator is shown [4].

### The Asymmetric Gore VRD

#### Building the Asymmetric Gore VRD

#### The Canopy

The VRD is based on an octagon. Octagonal parachutes with their eight sides, eight triangular gores, and eight suspension lines are a familiar sight on the rocket range. However, in an asymmetric gore VRD four alternating triangular gores of the octagon are completely missing, and the remaining four are modified! See Figure 3.

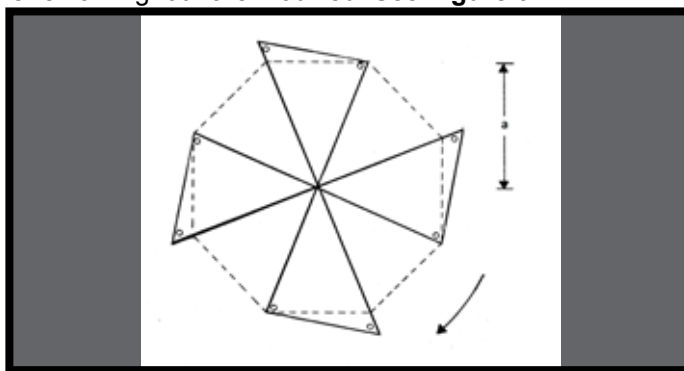


Figure 3. Canopy diagram (called a "planform" by parachute engineers) of the asymmetric gore VRD is shown. The solid lines are the four modified gores (often called "lobes") that make up the actual canopy. The dotted lines represent the "source" octagon upon which the VRD is based. The direction of rotation shown is clockwise.

Figure 1. One of the few parachute jumps with a Vortex Ring Decelerator is shown [2].

### About this Newsletter

You can subscribe to receive this e-zine FREE at the Apogee Components website [www.ApogeeComponents.com](http://www.ApogeeComponents.com), or by clicking the link here [Newsletter Sign-Up](#)

### Newsletter Staff

Writer: Dave Flanagan  
Layout/Cover Artist: Chris Duran  
Proofreader: Michelle Mason

Continued on page 3



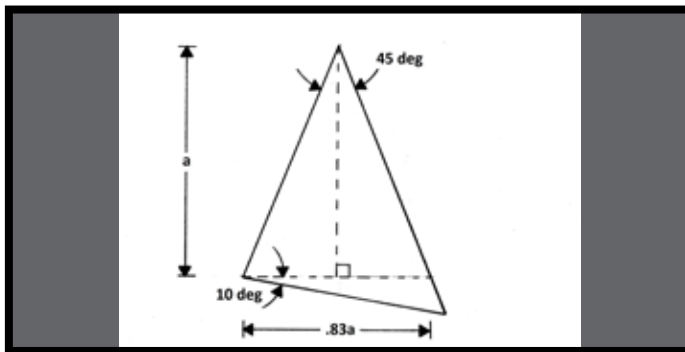
# PEAK OF FLIGHT

## Build Your Own Helicopter Parachute - Part 1

Continued from page 2

Since the VRD is based on a regular polygon, the radius of the polygon's inscribed circle is a good reference dimension for scaling. In geometry this dimension has a special name – the “apothem” – which is symbolized by ‘a’.

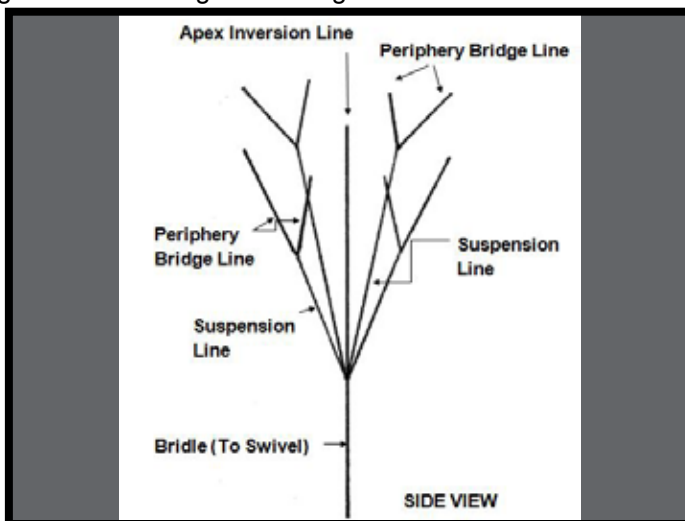
An individual triangular gore of an asymmetric gore VRD is shown in Figure 4. The modeler chooses the size of the VRD by selecting a value for the apothem ‘a’.



**Figure 4.** The dimensions of a single gore are shown in terms of the apothem ‘a’ of the “source” octagon. Four such gores are required. During rotation the short side of the gore is the leading edge. The long side of the gore is the trailing edge. The length differential is what makes this VRD rotate.

### The Suspension Line System

The suspension line system of the VRD is unique. Consider the canopy. Four gores of the octagon are completely missing. These gaps around the periphery of the canopy must be connected. To connect the tips of the gores or lobes together “bridge lines” must be installed

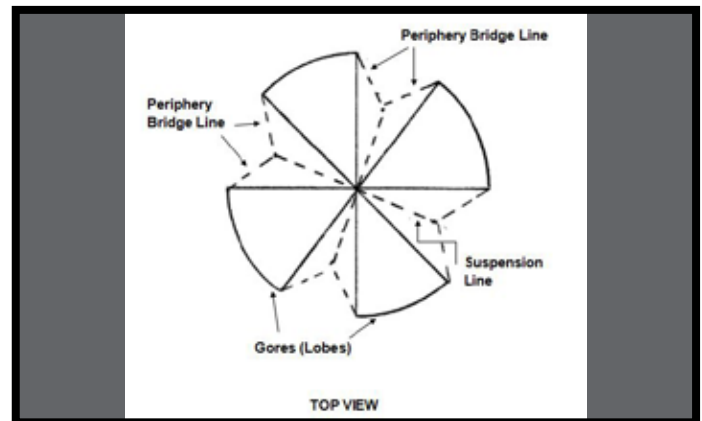


**Figure 5.** A sketch of the suspension line system of a VRD from the side is shown (gores not included).

from the trailing edge of one gore to the leading edge of the adjacent gore. These are called Periphery Bridge Lines (PBL's).

Only four Suspension Lines (SL's) are needed. Each attaches to the middle of a PBL.

One Apex Inversion Line (AIL) is also needed to complete the suspension line system.



**Figure 6.** A schematic of a top view of the inflated VRD (with gores) is shown. The AIL and the Bridle Line (BL) cannot be seen in this view. Notice that the SL's are attached to the center of the PBL's. The various line lengths are shown in Table 1.

Component	Finished Length
Periphery Bridge Line (PBL)	$.83*a$
Suspension Line (SL)	$1.25*a$
Apex Inversion Line (AIL)	$1.66*a$
Bridle Line (BL)	$\geq 1.0*a$

**Table 1.** Line lengths of the suspension line system components are given in terms of the value chosen for the apothem ‘a’.

Continued on page 4

Model Rocket Design Software for Mac & Windows

**ROCKSIM**

[www.ApogeeRockets.com/RockSim/RockSim\\_Information](http://www.ApogeeRockets.com/RockSim/RockSim_Information)

# PEAK OF FLIGHT

## Build Your Own Helicopter Parachute - Part 1

Continued from page 3

The length of the Bridle Line shown in Table 1 can vary. Longer BL's will let the parachute continue to rotate for some time even if the swivel should seize up. Swivels may be eliminated if the BL is long or the expected descent time is short.

A value of  $a=25$  cm, or about 10" would be a good choice for a first VRD. Use thin polyethylene material for the canopy and fibrous twine for the suspension lines.

**Figure 4** (Page 2) shows how to create a cardboard pattern for a gore once the modeler has selected a value for 'a'. Making a pattern is always a good idea. Use the pattern to cut the four gores from the canopy material. The result will look something like **Figure 7**.



**Figure 7.** Four gores and the (orange) pattern used to create them. (The white square on the pattern is the output from an Excel design spreadsheet. Given a value for 'a' the spreadsheet calculates the rest of the dimensions per Table 1.)

Next, align the gores at ninety degree angles with their apices touching. Since the plastic gores here are translucent, a simple cross on a piece of paper serves as an alignment guide. See **Figure 8**.



**Figure 8.** Gore alignment. The apices of the gores are touching. The midlines of the gores are at 90 degrees to each other. (The edges of the gores can also be used.)

With small plastic VRD's the apices of the gores can be secured by two pieces of scotch tape. Tape the apex of each gore to the one opposite. If this is done correctly there will be sticky surfaces of the tape exposed on the underside of the canopy.

Continued on page 5

### New Mid-Power Tube Assortment



You get:  
(4) AT 29/13  
(4) AT 41/18  
(2) AT 56/18  
(2) AT 66/18  
(1) AC-56  
(1) AC-66

[www.ApogeeRockets.com/Building\\_Supplies/Body\\_Tubes](http://www.ApogeeRockets.com/Building_Supplies/Body_Tubes)

### The classic tubes-o-plenty



You get:  
(6) AT 13/18  
(6) AT 18/18  
(6) AT 24/18  
(6) AT 33/18

## Looking for SHOCK CORDS?

[www.ApogeeRockets.com/Building\\_Supplies/Parachutes\\_Recovery\\_Equipment/Shock\\_Cord](http://www.ApogeeRockets.com/Building_Supplies/Parachutes_Recovery_Equipment/Shock_Cord)



Check out our website for a selection of: Kevlar, Elastic, Rubber Ribbon cords  
Low Power, High Power



# PEAK OF FLIGHT

## Build Your Own Helicopter Parachute - Part 1

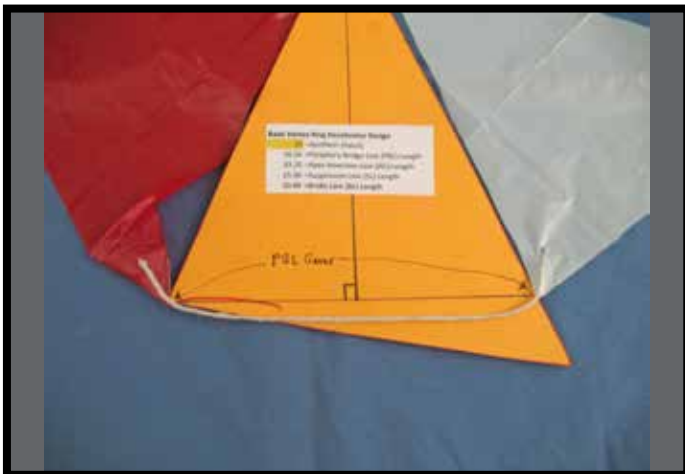
Continued from page 4

Use baking soda or flour to “foul” the sticky surfaces. See **Figure 9**. For larger plastic models filament tape can be used instead of scotch tape. For very large VRD's (or ones made from fabric) the four apices are bundled up and bound together with suspension line material that would then become the AIL.



**Figure 9.** A view of the underside of a VRD canopy is shown. After securing the apices of the gores together with tape the exposed sticky surfaces of the tape are intentionally fouled with flour or baking soda so that no other part of the parachute can stick to it. There may be other ways to avoid this such as also using tape on the bottom of the chute. It is the modeler's choice. Locate and eliminate any sticky surfaces.

Now install the PBL's in one of two ways. The traditional way is to cut them to length and install them as shown in **Figure 10**. If a pattern has been made the modeler does not need to measure them individually. The pattern can serve as a PBL length gauge as shown.



**Figure 10.** The base of a triangular gore from the “source” octagon is the same length as the PBL so the pattern can be used to guide the installation and length of the PBL.

When all PBL's are installed in the traditional way the asymmetric gore VRD should look like **Figure 11**.



**Figure 11.** Installation of the PBL's is complete. The AIL and the four SL's are not yet installed. The top surface of the parachute is shown.

An alternate method the author prefers creates the PBL's as follows: Cut one shorter piece of line and install it on the tip of one gore. Cut a longer piece of line and install it on the tip of the adjacent gore. Mark both lines at one half the required length of a PBL, and tie them together at that point with an overhand knot. Trim the excess from the short line. The long line then becomes the SL. See **Table 2** for dimensions.

Component	Finished Length
One Half of a PBL (shorter line)	.42*a
One Half of a PBL plus SL (longer line)	1.67*a

**Table 2.** Line lengths for the alternate method of creating PBL's are given.

Continued on page 6

**Check out our Facebook page**  
[www.facebook.com/ApogeeRockets](http://www.facebook.com/ApogeeRockets)

**CHECK OUT THE APOGEE**  
**You Tube PAGE**  
**SUBSCRIBE HERE**

# PEAK OF FLIGHT

## Build Your Own Helicopter Parachute - Part 1

Continued from page 5



**Figure 12. (a)** One shorter and one longer line are cut, attached to adjacent gores, and both are marked to length. **(b)** The PBL is created by tying the lines together and trimming the excess from the shorter line. The longer line becomes the SL.

**Figure 12** shows how this works. Next install the AIL. For a small model, punch one hole in the center of the crossed pieces of tape that secure the gores at the apex. Route the AIL up through the hole from the bottom and tape it to the top of the apex. One or more knots can be tied at the end of the AIL before taping it in place to help prevent failure. For larger plastic models that use filament tape to secure the gores together, simply tie the AIL around the tape joint in some convenient fashion.

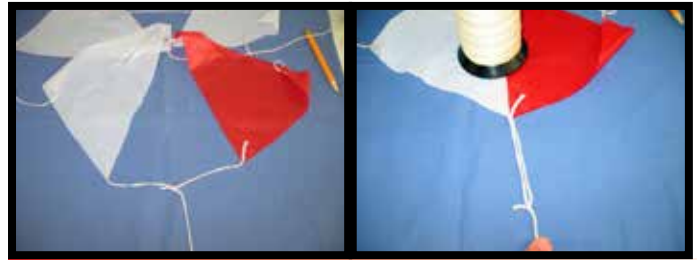


**Figure 13.** The AIL is installed by routing it up from beneath the canopy through a hole punched in the tape that secures the gores. It is taped down to the top of the apex.

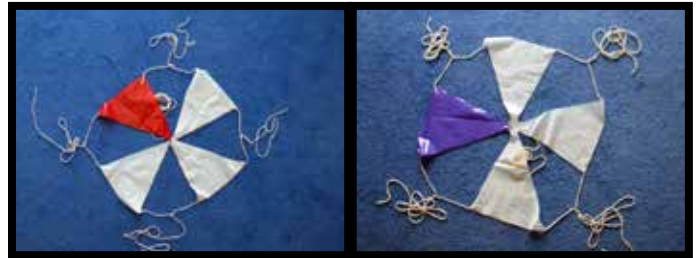
On small models where a simple overhand knot is used to tie the lines together at the payload, it is useful to make the AIL much longer than shown in **Table 1**. Once the overhand knot is made, the tail of the extra long AIL can then serve as a Bridle Line (see **Figure 5** on **Page 3** for how this would work).

The importance of having a strong joint at the apex and installing the AIL securely cannot be overstated. Failure of any gore at the apex or failure of the AIL instantly converts the rocket from parachute recovery to streamer recovery.

If the SL's have not been installed using the alternate method of creating PBL's noted above, they are installed on the PBL's next. Cut them extra long – they will be trimmed later. Each is fastened to the exact center of a PBL as shown in **Figure 14**. To keep them in position a drop of glue on each knot is recommended.



**Figure 14. (a)** A suspension line is installed on a PBL. **(b)** One way to make sure it is at the exact center is to secure the tips of the adjacent gores together and tug lightly on the suspension line until it slides into place. Secure with a drop of glue.



**Figure 15. (a)** The model on the left used the traditional method of tying the SL's to the center of the PBL's. **(b)** The model on the right used the alternate method in which the PBL's were created during the attachment of the SL's. The AIL's have been installed in both models and are partly hidden under the gores. The top surface of each of these parachutes is shown.

Measure each line to the proper length (the AIL and all four SL's), gather all five lines together and tie an overhand knot. Remove excess line and install a swivel on the Bridle Line. Details on the "Symmetrical Gore VRD" next in Build Your Own Helicopter Parachute - Part 2.

Continued on page 7

**Minimum Diameter Motor Retainers!**  
**Apogee is your one stop shop for your minimum diameter rockets projects!**

- Fly High
- Fly Fast
- Impress Your Friends!

**We Have:**

Issue 492 | April 2nd, 2017

- Minimum Diameter Retainers
- Motor Extenders
- Threaded Forward Closures
- Adapters for Cesaroni Cases

[www.ApogeeRockets.com/Building\\_Supplies/Motor\\_Retainers\\_Hooks](http://www.ApogeeRockets.com/Building_Supplies/Motor_Retainers_Hooks)



# PEAK OF FLIGHT

## Build Your Own Helicopter Parachute - Part 1

Continued from page 6



Figure 16. Measuring and marking the SL's to the correct length.



Figure 17. (a) The completed asymmetric gore Vortex Ring Decelerator with traditional PBL's. (b) The same VRD during toss testing.

### About the Author

Dave is a registered professional engineer with well over twenty years of aerospace experience at NASA's JSC and MSFC. He holds bachelors and masters degrees in engineering and a bachelors degree in science, and while at MSFC supported NASA's University Student Launch Initiative. Although no longer actively jumping, he holds an expert skydiver rating and is a former Army paratrooper. Dave is a master parachute rigger and has completed the AIAA Parachute Systems Technology Short Course. He is a licensed private pilot and a certified ultralight pilot. Dave is retired and spends most of his time scuba diving and kayaking but does occasionally fly model rockets, usually ones recovered by weird parachutes.

Model Rocket Design Software for Mac & Windows



[www.ApogeeRockets.com/RockSim/RockSim\\_Information](http://www.ApogeeRockets.com/RockSim/RockSim_Information)

## Experienced HPR Builders Use Thrust Plates

- Eliminates Shear Forces on Centering Rings
- Mates with AeroPacks Flanged Engine Retainers
- Fits Standard HPR Tubes, Blue Tubes, and Fiberglass Tubes
- Made from Aircraft Grade Aluminum

[https://www.apogeerockets.com/Building\\_Supplies/Thrust\\_Plates](https://www.apogeerockets.com/Building_Supplies/Thrust_Plates)

## Rocket Parachutes

We have a variety of options

Low-Power • Mid-Power • High-Power • TARC  
Nylon • Plastic • Drogue

[www.ApogeeRockets.com/Building\\_Supplies/Parachutes\\_Recovery\\_Equipment/Parachutes](http://www.ApogeeRockets.com/Building_Supplies/Parachutes_Recovery_Equipment/Parachutes)

