***Technical Publication #7***



# Gliding Parachute Plans

## The parawing has the potential to dramatically decrease the descent rate of rocket parachutes

By Tim Van Milligan

This technical publication builds upon the information presented in Technical Publication #3 — *Increasing the Descent Time of Rocket Parachutes.* That publication left off with a theory that performance increases in parachute duration would most likely come from “gliding” parachutes. The background for that theory was fully described in that publication, but it was left for the reader to design and build their own gliding chute.

This publication describes some of the work first done by Dr. Francis Rogallo in the 1950’s and 1960’s. His early work was centered around a single sheet canopy which was shaped by the arrangement of shroud lines. In the early 1970’s a newer type of gliding parachute was developed, called the ram-air parachute. It differed in that the canopy was made of two sheets of material that inflated to form an airfoil when air entered between the sheets. This airfoil was much more efficient than Rogallo’s original design, and this new design has become quite popular on full size, man-rated parachutes.

In model rocketry, particularly in small models, the parachute hasn’t changed much since the inception of the hobby. This publication will try to promote a change in parachute design for those situations where a lower descent speed is desirable.

The design presented here will be based on Rogallo’s original gliding parawing, since it is simpler to construct than the ram-air parachute. In actuality, the parawing is based on a design studied and reported on by Paul G. Fournier of Langly Research Center. The series of test parawings is described fully in NASA TN-D-5965 (October, 1970); “Low-Speed Wind-Tunnel Investigation of All-Flexible Twin-Keel Tension-Structure Parawings.” The

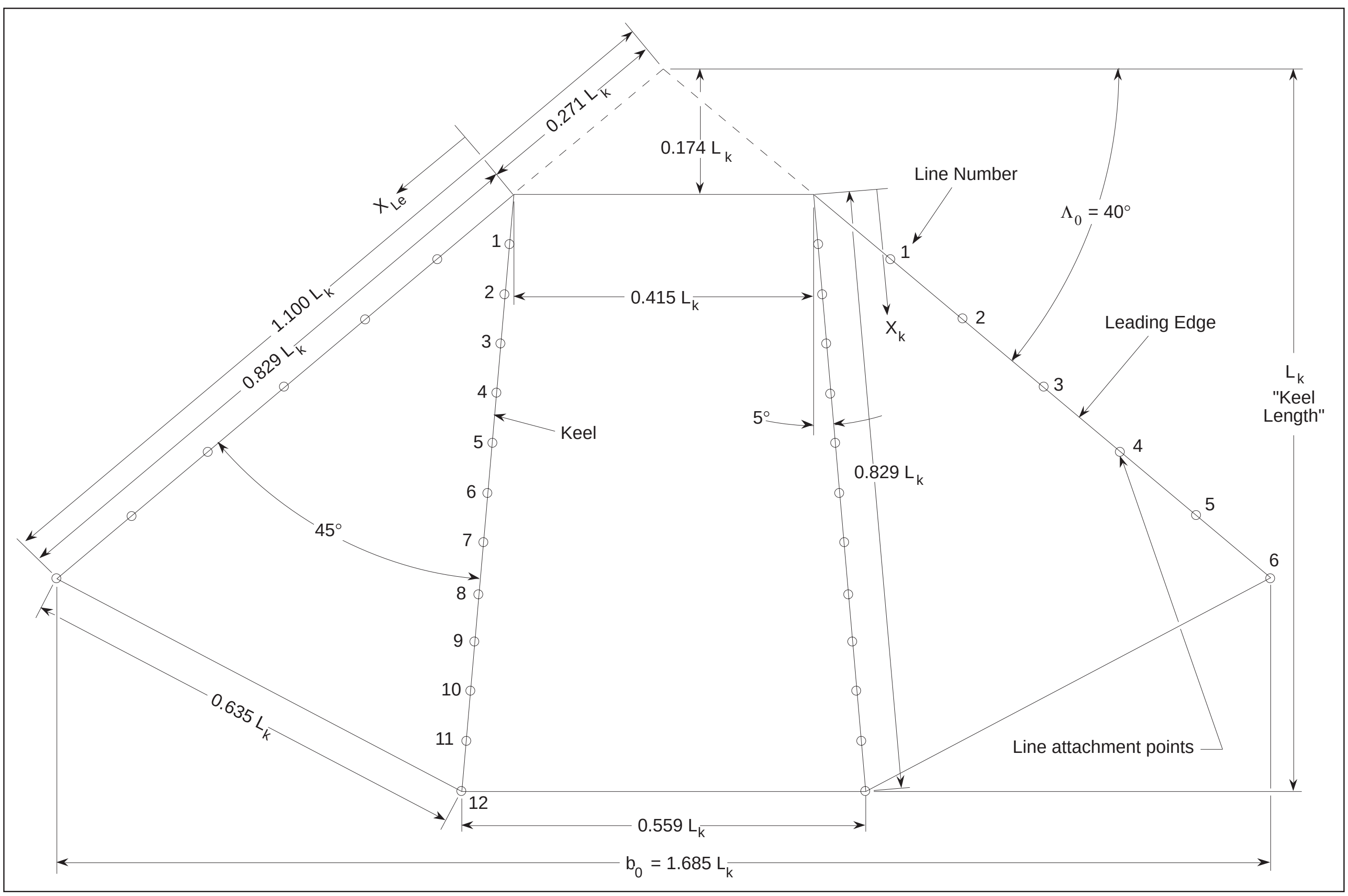



**Figure 1: Flat planform details of the twin-keel parawing (model 19).**

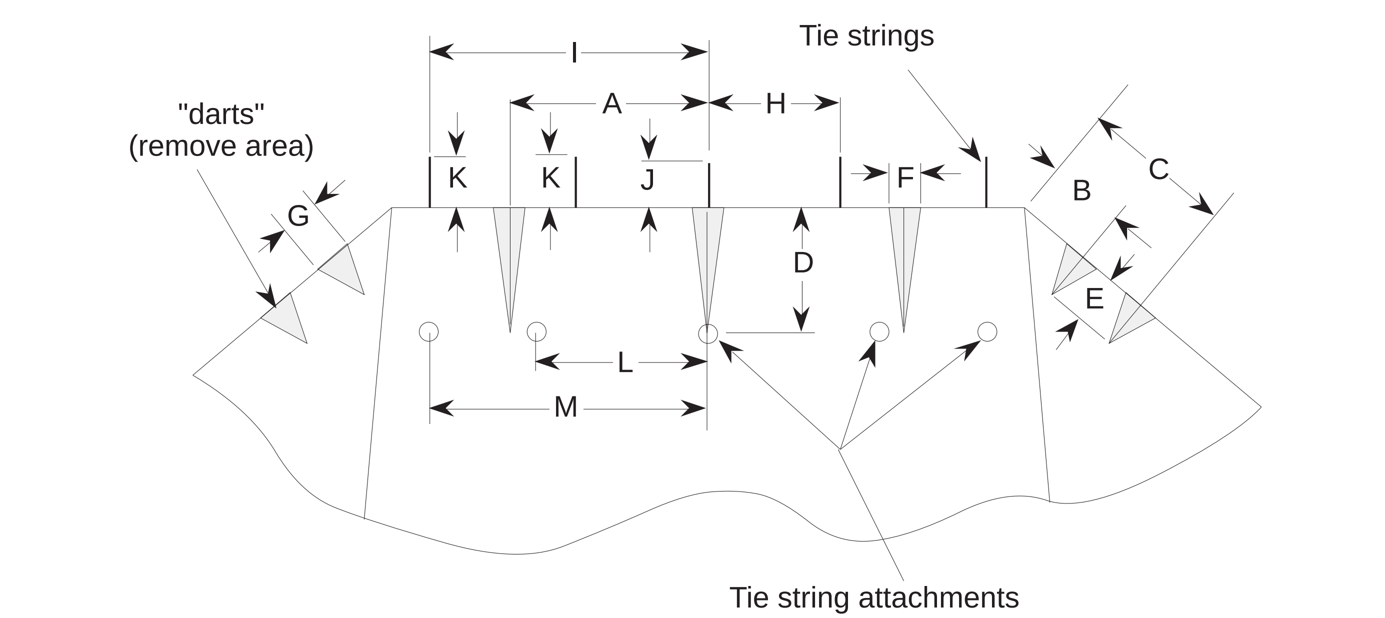



**Figure 2: Details of the contoured nose of the twin-keel parawing.**

parawing selected from that publication is known as "model 19."

The construction of the parawing is fairly complex; at least the first time you build one. I recommend that several chutes be built the first time, so that you become familiar with mounting and cutting the shroud lines to length. The "model 19 " parawing canopy has 36 shroud lines, each a different length, which doesn't help to simplify the complexity level. But once you built the first one, additional copies can be built a lot faster.

For construction of multiple canopies, it is easier to make a single cardboard template of the planform, so that cutting out the canopy and marking the shroud line locations can be accomplished at a much faster rate.

The material for making the chute is up to you, but you may want to consider using 1/4 mil mylar or polyester sheet (from a dry cleaner's bag) for the canopy. This allows the chute to be folded into a small package so it will fit into the body tube. I also personally chose very light nylon thread and adhesive mylar tape to secure the lines to the canopy. I also suggest using two snap swivels to gather the two sides of the shroud lines together. It seemed to help a little bit in keeping the lines from getting tangled.

Before you start, you will need to select the size of the chute. I suggest starting small. The chute is more efficient than the standard round canopy, so you won't need as much material to get the same descent velocity. You will be doing a lot of test flying to get the chute to properly open and transition into a steady glide. A gliding parachute is a lot like a gliding airplane, it needs to be trimmed to get it to fly properly. This takes some practice. A small chute allows the quicker prepping, so it can be flown more often. Because it is smaller, it can be flown in smaller and less expensive models, using less expensive rocket motors.

Figure 1 shows a diagram of the canopy planform. Notice that no dimensions are given, as all the lengths are a percentage of the keel length ($L_k$). With this, you can make your chutes any size you want. For your first parawings, I suggest a keel length about 12 inches (30.5 cm) long. Table 1 shows the line attachment locations — again expressed as a percentage of the keel length. To get your locations, you multiply the chosen keel length by the number shown in the table. Before starting, make a chart showing the line number, its location, and

**Line Attachment Location**
(in fraction of keel length $l_k$)
see Figure 1

| Keel | Leading edge |
|---|---|
| 0.083 | 0.167 |
| .167 | .333 |
| .250 | .500 |
| .333 | .667 |
| .417 | .833 |
| .500 | 1.000 |
| .583 | |
| .667 | |
| .750 | |
| .833 | |
| .917 | |
| 1.000 | |

**Table 1**

**Line Locations and Lengths**
(fraction of keel length $l_k$)

| Line No | Keel string Length |
|---|---|
| 1 | 1.074 |
| 2 | 1.072 |
| 3 | 1.058 |
| 4 | 1.060 |
| 5 | 1.056 |
| 6 | 1.051 |
| 7 | 1.051 |
| 8 | 1.039 |
| 9 | 1.029 |
| 10 | 1.015 |
| 11 | .992 |
| 12 | .941 |

| Line No | Leading Edge string length |
|---|---|
| 1 | 1.037 |
| 2 | 1.013 |
| 3 | .983 |
| 4 | .936 |
| 5 | .859 |
| 6 | .706 |

**Table 2**

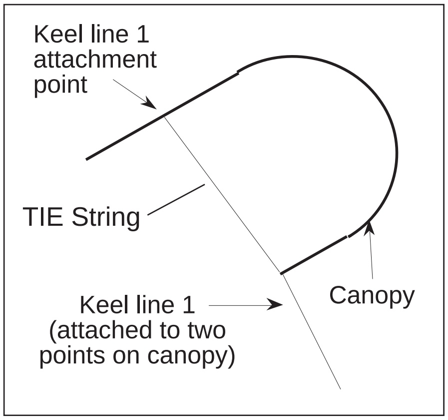



**Figure 3: Cross section view of the keel at the nose during flight. The Tie strings allow the leading edge to be tucked under to create a nose.**

its length on a separate sheet of paper. This will allow you to work much faster when construction begins.

The line lengths are the crucial part to getting the parachute to glide properly. Table 2 gives these line lengths as a percentage of the keel length. It is best to cut the lines long, and measure them after they are attached to the canopy. To keep the lines distinguishable; so that the left side isn't mixed with the right side, the lines are marked with two different colors of soft tip magic markers. Make the mark at the lines correct length, so when the time comes to gather the lines, you pick up the string at the "colored" point.

Keel line #1 (on both of the twin keels) actually attaches to the chute at two points. It is the only string to do so. First: at the point shown in fig 1. And Second, after the tie strings are used to form the nose, the keel #1 line attaches to the forwar part off the canopy (at the corner). This is what is shown in figure 3.

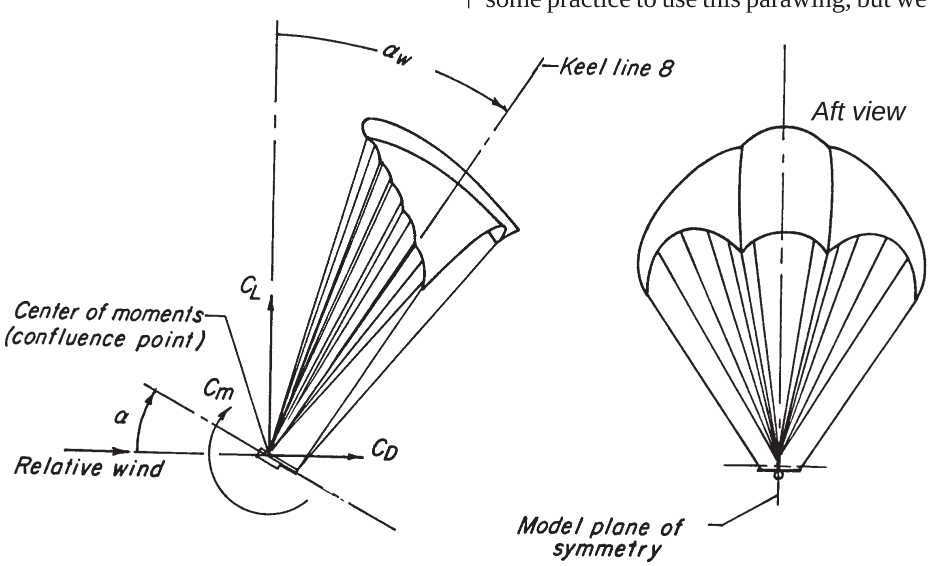
After the lines were attached to the canopy and before they are gathered together, cut and spliced the nose together as shown in figures 2 and 3. Use thin celephane tape or mylar tape to tape the splices together. It helps the glide a lot by adding the tucked nose to the parawing. Table 3 shows the dimensions (as a percentage of the keel length) of the "darts" and "ties."

The completed parawings need to be "trimmed" like any other glider. Trimming involves varying the lengths of the shroud lines. Typically this involves shortening the lines toward the nose. To perform this procedure, gather the lines together, and fly the chute as best as you can while holding on to it. Vary the length of the lines to get it to glide properly without spinning.

After the chute has been trimmed, you can gather the lines and tie them to the snap swivels. As mentioned before, it makes sense to use two swivels—one for each side, so that you can untangle the chute easier if that should become necessary.

Carefully and loosely fold the parachute for launch. Lay the excess shroud line on top of the canopy before folding. This will prevent it  from fouling in the canopy at ejection.

Good luck with this parachute. It takes some practice to use this parawing, but we think it is worth the extra effort. If you have any suggestions on making this chute easier to construct, trim, pack, or to fly, let us know, so that we can spread the news to other modelers.




**Assembled parawing.** The tip lines can be used to control the flight of the parawing by using a servo system. This is what is shown in this drawing.

**Dimensions of darts and ties**
(fraction of actual keel length $l_k$)

| Letter | Model 19 |
|---|---|
| A | 0.129 |
| B | .050 |
| C | .100 |
| D | .082 |
| E | .032 |
| F | .020 |
| G | .025 |
| H | .086 |
| I | .183 |
| J | .029 |
| K | .033 |
| L | .113 |
| M | .183 |

## Table 3

References:

Van Milligan, Tim: Technical Publication #3 - "*Decreasing the Descent Times of Rocket Parachutes.*" Apogee Components, Inc. 1995.

Fournier, Paul G.: "Low-Speed Wind-Tunnel Investigation of All-Flexible Twin-Keel Tension-Structure Parawings." NASA TN-D-5965 (October, 1970);

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