FRUITY CHUTES

Rocketry Recovery Technology

- **Types of Parachutes**
- **Packing Density – predicting packing volume using chute weight**
- **Deployment & Packing Methodology**

Types of Rocketry of Parachutes

- There are many styles of parachutes. We'll discuss the various styles, the advantages and disadvantages of chutes used for Rocketry

  These include:
  - Cruciform – shaped like a cross
  - Flat Sheet Chutes – Top Flight
  - Rocket Man and TARC Style
  - Elliptical and Spherical (FC, and Spherachute)
  - Pull down Apex, Toroidal (the Iris Ultra)

Challenge in Comparing Types

- Before we start there are challenges in comparing designs:
  - Inconsistency in how chute size is measured
    - Flat chutes are fabric diameter
    - Rocket Man chutes are measured across the top and sides.
    - Cruciform is distance across chute
    - Spherachute is circumference of canopy
    - All FC chutes measured based on projected frontal area, i.e the opening diameter
  - Trying to spec Cd varies as a side effect of this
  - Aerospace industry always specs the Cd in terms of projected frontal area being the gold standard in measurement
  - Choice of material greatly affects the bulk and packing volume

Cruciform – shape like a cross

- Advantages:
  - Very good high speed stability, stays above the load
  - Very strong
  - Simple design
  - Good as a high speed drogue parachute
  - Used by the Aerospace industry on sonobuoys and other high speed deployment systems
- Disadvantages:
  - Inefficient, Cd of approximately 0.4, and Cd is difficult to measure accurately
  - Bulky for a given load

Sheet Chute – like Top Flight

- Advantages:
  - Simple Design
  - Low Cost
- Disadvantages:
  - Inefficient, Cd of approximately 0.7
  - Bulky for a given load
  - Poor Stability, can oscillate above the load
  - Lower strength – this is partly due to materials selection

Rocket Man and TARC Style

- Advantages:
  - Good stability, stays above the load
  - Very strong, usually have over the top riser connections
  - Better efficiency than cruciform
  - Fewer risers to tangle – easier to untangle if they do
  - Probably most popular HP Rocketry style currently
- Disadvantages:
  - Moderate, Cd of approximately 1, no published info on this
  - Use heavier webbing for shroud lines (fewer connections to carry the load)
  - More complex design, two to three patterns shapes needed. Use a lot of tape reinforcement on edges and on all seams.
  - Can rotate under load due to variations in symmetry.
  - Can sometimes breathe under slower descent (similar to a jellyfish)

Elliptical and Spherical

- Advantages:
  - Good stability at lower speeds, stays above the load
  - Good strength to weight compromise
  - Good efficiency, Cd of about 1.5 – 1.6
  - Packs into smaller space
  - Repetitive design, one pattern shape, minimal room for variation
  - Great shape for scale projects, looks nice in the air
- Disadvantages:
  - At high speed it can wobble – always connect with a length of shock cord
  - Multiple gores means more sewing and higher cost

Toroidal - Pull Down Apex

- A few facts – Design originally from 1890's! Rocket Rage sold these for awhile. Popular as reserve chutes for jumpers and hang gliders because of tight packing.
- Advantages:
  - Good stability at lower speeds, stays above the load
  - Good strength to weight compromise
  - Very high efficiency, Cd of about 2.2 – 2.4
  - Packs into smallest space, lightest weight
  - Simple repetitive design – only one pattern shape needed
  - Good anytime space and weight are critical
  - When efficiency is factored in then cost / load capability is the same as Elliptical
- Disadvantages:
  - Not intended for higher speeds
  - Very fast opening, but this is mitigated by using a slider ring
  - More complex to make, pull down adds to complexity

Packing Density

Predicting packing volume using chute weight

- Since we started five years ago, the two most common questions are:
  1. What size chute do we need?
     A simple equation will tell us this as long as we know the Cd – no guessing
  2. How much space does it need? Now this is a trick to determine!

So we started to measure this by jamming a given size parachute into a piece of airframe and calculating the volume.

A common pattern showed up quickly, we could estimate the volume as a factor of the descent weight rating.

Packing Density
Predicting packing volume using chute weight

- Refinement #1
  1. The descent weight rating is directly related to the canopy area
  2. The canopy area is directly related to the weight

So why not just cut out the middleman and just weigh the chutes? That should correlate packing volume.

Packing Density
Predicting packing volume using chute weight

- Refinement #2

  But people pack the chute differently and some methods are more dense than others.

  A study done in June 1962 researched various methods of packing a chute and the achievable packing density. They found that putting a given type of material (such as nylon) under a given amount of pressure measured in PSI always results in the same lb/ft^3. For example, 15 psi gives you 30 lb/ft^3.

  They also found that it is a non-linear relationship. It takes 100 psi to get to 43 lb/ft^3

  That the material at high pressure begins to "flow," but at too high a pressure there are abrasion issues and the material loses its integrity. 100 psi is a lot of pressure!

Packing Density
Predicting packing volume using chute weight

- Refinement #3

  So I try it myself! I had an idea that we can pack our Iris chutes into a canister using a Pneumatic Press (the Peregrine IDS). So I made a test canister from 4" airframe and found I could pack my IFC-72" chute at 15 psi and into a volume that is equivalent to 30 lb/ft^3 (0.28oz / cu in). I went back to the report and this exactly corresponded to their measurements done 50 years ago!

Packing Density
Predicting packing volume using chute weight

- Converging on the Conclusion

  I went back and looked at the empirical measurements we made over the years and finally determined that by using the correct packing density factor I can predict the packing volume accurately for any chute, any manufacturer, any style – now that is simple!

Packing Density

Predicting packing volume using chute weight

- Where's the beef you ask?

  Here are the factors we currently use and the packing method:

1. 0.13 oz/in^3 - Fold and wrap – This is the most common technique used by Rocketry folks
2. 0.16 – 0.18 oz/in^3 – Soft Pack - Pack into a deployment bag packing as hard as possible by hand.
3. 0.22 oz/in^3 – Jam pack by hand pressing into a piece of airframe. Use your hand as a press!
4. 0.28 oz/in^3 – Hard Pack – Use a pneumatic press to pack the chute at 15 psi force. This technique is used by the Peregrine Integrated Deployment System. A 4 inch airframe needs 185 lb of packing force to achieve this. A 6 inch airframe needs 450 lb.

Packing Density
Predicting packing volume using chute weight

- What it means – look at the Iris Ultra "Kevlar " chute

The Iris Ultra K uses Kevlar shroud lines and harness, and it's very light and compact. Here are a few examples of how much space is needed:

- IFC-72-K, 3.9"D x 2.6"L, rated at 29 lb at 20 ft/s
- IFC-120K, 3.9"D x 7.4"L, 83 lb at 20 ft/s
- IFC-192K, 5.99"D x 7.5"L, 205 lb at 20 ft/s

Packing Density
Predicting packing volume using chute weight

- The Conclusion

  This technique holds up for any manufacturer with any style. If it's nylon, it's simply a matter of weight.

Deployment Technology in Brief
Also known as getting the laundry out!

- We will discuss several methods of chute deployment:
  - Traditional fold and wrap
  - Deployment Bags
  - Integrated Deployment using the Peregrine

Deployment Technology in Brief
Traditional Roll and Wrap




- Simple to do and good when you have the space. Probably 90% of folks flying high power use this

But…

- Can tangle if wrap is not neat
- Hard to get the wrap correct for the diameter – loose or tight fit
- Can unravel once in airframe
- Lowest density and can take the most space
- Not good if the packing length aspect ratio is over about 3:1 – can jam up…

Deployment Technology in Brief

Deployment Bag




- Recommended when the chute is large or the packing space is long and narrow (high aspect ratio)
- Guarantees organized deployment, no tangles
- Chute opens slower, less opening shock
- Packing density higher than you can get with fold and wrap
- Adds extra protection against BP burns.

But…

- You also need pilot chute
- Still need nomex blanket
- Adds cost of the bag to your overall project cost.
-

Note: About ½ of our larger chute work best with deployment bags. Not too scary once you know how they work!

Deployment Technology in Brief
Getting the Laundry Out

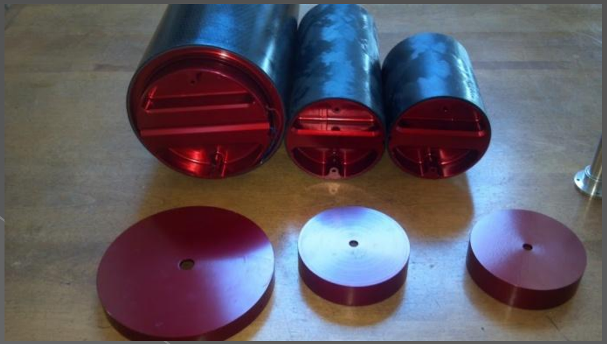


- Black Powder Ejection
  - Very simple and reliable

  But…
  - Not for higher altitudes (> 20 k) unless measurements are taken
  - Lots of heat generated that can damage the chute
  - Deposits corrosive residue on everything – sulphur smell!
- CO2 Deployment
  - Very clean
  - No altitude limit

  But…
  - Weight impact
  - Some complexity to assemble
  - CO2 is a little slower to apply pressure. Make sure you ground test!

Deployment Technology in Brief
Peregrine IDS

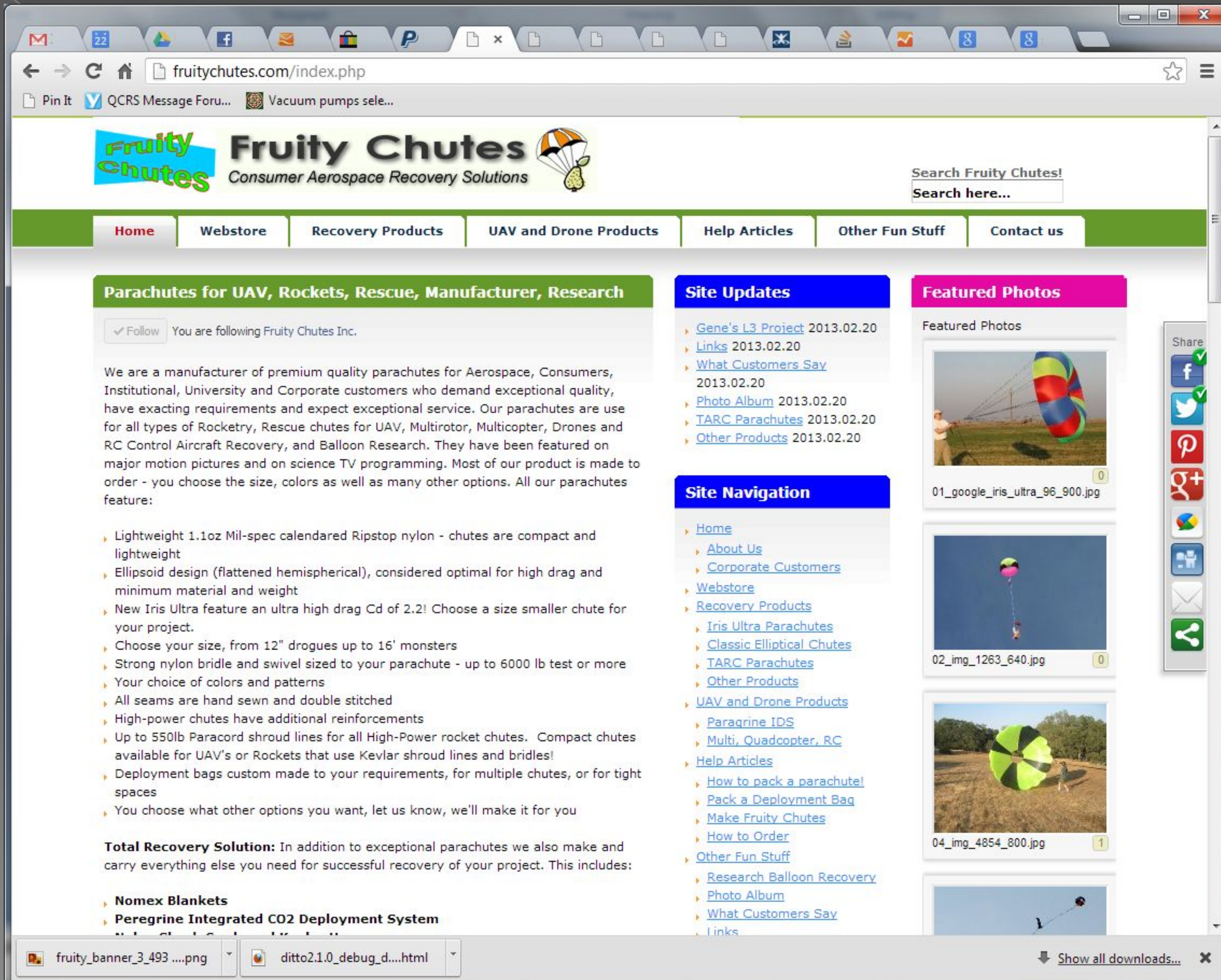




- Integrates CO2 deployment for pressure packed twist lock chute canister
- Highest packing density, similar to military tech
- Take several pre-loaded twist lock canisters into the field, no need to pack on site
- Because of pressure packing, less CO2 needed to get a good ejection! 5 inch and 6 inch units have dual CO2 units.
- Comes standard with Iris Ultra Kevlar Chute!

But…

- More costly
- Airframe needs to have compatible design
- Current Peregrine is for UAV’s. Rocket versions are coming soon!

Thank You!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We are a manufacturer of premium quality parachutes for Aerospace, Consumers, Institutional, University and Corporate customers who demand exceptional quality, have exacting requirements and expect exceptional service. Our parachutes are use for all types of Rocketry, Rescue chutes for UAV, Multirotor, Multicopter, Drones and RC Control Aircraft Recovery, and Balloon Research. They have been featured on major motion pictures and on science TV programming. Most of our product is made to order - you choose the size, colors as well as many other options. All our parachutes feature:
Lightweight 1.1oz Mil-spec calendared Ripstop nylon - chutes are compact and lightweight
Ellipsoid design (flattened hemispherical), considered optimal for high drag and minimum material and weight
New Iris Ultra feature an ultra high drag Cd of 2.2! Choose a size smaller chute for your project.
Choose your size, from 12" drogues up to 16' monsters
Strong nylon bridle and swivel sized to your parachute - up to 6000 lb test or more
Your choice of colors and patterns
All seams are hand sewn and double stitched
High-power chutes have additional reinforcements
Up to 550lb Paracord shroud lines for all High-Power rocket chutes. Compact chutes available for UAV's or Rockets that use Kevlar shroud lines and bridles!
Deployment bags custom made to your requirements, for multiple chutes, or for tight spaces
You choose what other options you want, let us know, we'll make it for you
Total Recovery Solution: In addition to exceptional parachutes we also make and carry everything else you need for successful recovery of your project. This includes:
Nomex Blankets
Peregrine Integrated CO2 Deployment System
Site Updates
Gene's L3 Project 2013.02.20
Links 2013.02.20
What Customers Say 2013.02.20
Photo Album 2013.02.20
TARC Parachutes 2013.02.20
Other Products 2013.02.20
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Corporate Customers
Webstore
Recovery Products
Iris Ultra Parachutes
Classic Elliptical Chutes
TARC Parachutes
Other Products
UAV and Drone Products
Paragrine IDS
Multi, Quadcopter, RC
Help Articles
How to pack a parachute!
Pack a Deployment Bag
Make Fruity Chutes
How to Order
Other Fun Stuff
Research Balloon Recovery
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What Customers Say
Links
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