Building a Model Rocket Parachute Recovery System

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This letter was written to a student interested in recovering his rocket with a parachute after the rocket's powered flight. The question was: "How large should the parachute be?"

We based our answer on the following design philosophy: Since rocket payload needs to be kept small, the parachute should be designed as small as possible. Also, using a small chute implies a more vertical and faster descent. In other words, using a large parachute usually leads to more horizontal drift due to winds aloft... i.e. more chances to lose the rocket in neighbor McNasty's backyard.

So how small should the parachute be? It depends on how much shock the rocket can take on landing since the faster the descent, the more risk for damage.

So here is the rest of the letter:

.....we can't answer your question about your deployment problems. We need more details (are you using solid rocket motors that are commercially available? Usually these motors ignite at the top for chute extraction once the thrust at the bottom has been exhausted).

Parachute design: how big the chute?

It depends on two factors:

1. payload + chute weight allowable
2. descent speed under parachute

Usually, you want the smallest (or lightest) chute to accomodate payload requirements. But, the smaller the chute the faster the descent. the harder the rocket hits the ground (...although it would not drift away from the drop zone as much during a windy day...).

To estimate the max descent speed your rocket can take under parachute, you could do this: drop the rocket (or an old prototype) from height "d" -without the parachute. The velocity reached when it hits the ground is given by

$$V = \sqrt{2gd}$$

g = 32.17 ft/sec^2 (English units; American Standard units) or 9.81 m/sec^2 (Metric)
d = height in feet (English) or meters (Metric)

v = velocity in ft/sec (English) or m/sec (Metric)

The maximum drop height from which the rocket can be dropped without breaking determines the max parachute descent velocity. Once you have determined that max velocity, use the following formula to find out the chute's optimal surface area:

$$S = \frac{2W}{\rho C_D V^2}$$

where

C_D = parachute drag coefficient which is approx 0.75 for a chute without holes or slits cut in the fabric; same value in both Metric and English (and American Standard) unit systems

ρ = air density; at sea level it is equal to
0.00237 sl/ft^3 (English units) and 1.225 Kg/m^3 (Metric);
near 4000 ft or 1219 m above sea level it is equal to
0.00211 sl/ft^3 (English units) and approx. 1.07 Kg/m^3 (Metric)

W = weight of the parachute + load, in *pounds* (English) or *Newtons* (Metric); Note – this is the *same* weight that was used in performing the previous experiment to determine the maximum landing speed.

V^2 = square of the vertical descent velocity, where V is expressed in ft/sec (English) or m/sec (Metric)

S is the parachute's surface area when measured on a flat surface, in ft^2 (English) or m^2 (Metric).

What is the diameter of the chute when it lays flat on the floor (*assuming that it is a circular piece of fabric*)?

$$D = 2\sqrt{\frac{S}{\pi}}$$

To improve on the stability of the chute during descent it would be a good idea to cut a hole (covering about 10 percent of surface area) at the apex of the canopy. That way the rocket won't oscillate too much and the descent will follow a straight line.

There are other designs to improve stability besides cutting a vent at the apex, see article by Dr. C. W. Peterson in *Physics Today*, August 1993 The magazine *Physics Today* can be found at university and college libraries.

Making a model rocket parachute

Constructing a model rocket parachute is very simple: just cut a piece of fabric in the shape of a circle. The fabric type (for experimental/toy parachutes only of course!) can be:

1. cut from a plastic garbage bag (which is OK but won't last very long and will puncture easily, or even better,

2. cut from the nylon fabric used on tents. (Real parachutes use a reinforced version of that nylon).

For detailed info about parachute design and rigging:

- D. Poynter, The Parachute Manual-Vols 1&2, Para Publishing , Santa Barbara, CA
- T.W. Knacke, Parachute Recovery Systems Design Manual, Para Publishing , Santa Barbara, CA

Also, see the following web page:

- Aerodynamic Decelerator Technology