Australian Parachute Federation Ltd

Canopy Pilot Guide

Includes the 1997 PIA 'Dual Square Report', Brian Germain's Downsizing Guidance, and replaces the APF guides: 'High Performance Canopies' and 'Elliptical Parachutes and Canopy Control'.

VERSION 2A – ISSUED 18 APRIL 2018

STATUS: ADVISORY

This document is offered as a free download to APF members.
Alternatively, contact the APF Office for a paper copy at a cost of $5.00

Warning

Parachuting and flying in parachuting aircraft can be dangerous.

High performance canopies contribute to that danger. Performance of some of the actions described in this guide may result in injury or death, even if performed as described.

Individual parachutists should check the information in this guide and assess the risks involved before carrying out any of the manoeuvres described.

About this Publication

This Guide is produced by the Australian Parachute Federation Ltd (APF) for the information of APF members. The information it contains is based on the opinions of the writers: it does not represent APF, APSC or PD policy. While the writers have attempted to ensure that the information in this guide is correct, it may contain information which is out of date or incorrect. If you want more information or copies of this guide for yourself or your friends, please ask the instructional or coaching staff at your DZ or contact the APF Office.

Version Control

It is important that members refer to the current version of this Guide, which is current only at the time of download. See cover page for date of publishing. This version makes minor changes for consistency with new regulations. The current version can be found on the APF website.

Credits

This Guide was produced with the help of many jumpers from Australia and overseas whose assistance is gratefully acknowledged.

Thank you to Jules McConnel for her effort developing this document, and to Rob McMillan and Craig Bennett for assisting with its updating and combining the material in APF's existing suite of canopy guides – which included content by John LeBlanc of Performance Designs, Jerry Sobieski, Bill von Novak and the PAI Dual Square Report.

This Guide incorporates verbatim, Brian Germain's Canopy Downsizing Chart, its explanation and many of his "Essential Manoeuvres". It also includes images and diagrams shared within the industry for training purposes, including some from BPA.

Cover photo: A highly experienced pilot swooping in at Ayr in North Queensland.

Contact the APF

Australian Parachute Federation Ltd
Postal Address: PO Box 1440, Springwood QLD 4127, Australia
Street Address: Unit 3 Portal Office West, 2994 Logan Road, Underwood QLD 4119, Australia
Telephone: (07) 3457 0100 Facsimile: (07) 3457 0150
Web site: www.apf.com.au Email: apf@apf.com.au

Contents:

PART 1: INTRODUCTION

1.1 Function

(a) Purpose

This Canopy Pilot Guide (**Guide**) is an educational tool for all parachutists seeking to improve their knowledge and understanding of how to fly parachutes.

It is not just aimed at the student or novice, as all parachutists will fly a variety of canopies and can learn to improve their piloting skills of those varying and different canopies.

This guide has been produced to:

- Help you to learn to fly your canopy safely;
- Increase your understanding of the principles of flight;
- Help you understand the flight characteristics of your canopy;
- Assist in identifying the limits of your canopy's flight characteristics without suffering some of the consequences; and
- Promote a sense of responsibility in your flying so that you are able to fly in a busy ecosystem of other parachutists. (This final point includes the examples you set by word and action to others who may imitate your actions without understanding the implications).

> If you are learning to fly a high-performance canopy, your learning curve is long and serious. You will not remember all the tips and hints contained in this guide during that time with only one reading. It is therefore crucial that you revisit this guide on a regular basis to allow yourself the best chance to assimilate the information contained within

(b) The basis for this guide

The basis for this Guide is the content from three prior publications:

1. APF High Performance Canopies – A Guide to their Characteristics and Handing;
2. APF Elliptical Parachutes and Canopy Control; and
3. PIA Dual Square Report;

plus selected content from:

4. Brian Germain's Canopy Downsizing Criterion and Essential Manoeuvres.

Following the APF Symposium in May 2016, a small group of canopy piloting experts workshopped updated content for this Guide, which now replaces these earlier publications.

(c) What this guide does not do

This is not a do-it-yourself guide. You should seek expert guidance before carrying out any of the procedures described here and should ascertain that your proposed actions are consistent with your experience and competence, your equipment and local rules and conditions.

Attending a canopy piloting course is highly recommended to learn the practical components and techniques described in this guide.

Piloting of ram-air canopies is not an exact science and techniques may change. Information in this guide may not be applicable to all types of ram air canopies available now or in the future.

(d) Interpretation/Definitions

Appendix A contains a list of canopy related terms. See the 'Dictionary of Definitions' on the APF website (reproduced in Regulatory Schedule 50) for a list of definitions for terms used in rules and regulations.

When you fly your parachute, you are a 'canopy pilot'. This title has been adopted as being consistent with all aircraft pilots, including others in sport aviation, e.g. ultralight pilots and balloon pilots.

In other APF publications and the regulations, you will see references to 'canopy control' (as in controlling a vehicle, at the controls) and 'canopy handing' (as in how to handle a particular vehicle). In various contexts in future, you'll see more references to 'canopy piloting'.

1.2 Important Resources

(a) User Manuals

Pay particular attention to any instructions or guides put out by your canopy manufacturer. By the time you are first connecting your parachute to risers, the manufacturer will have completed thousands of data collecting test jumps, as well as possibly hundreds of thousands of jumps done on the same canopy by fellow skydivers all over the world. Taking the time to learn from this collective experience will save you incalculable trial and error time of your own. You can only profit from this experience.

Be fully acquainted with the manufacturers' manuals for all the component parts of your rig, that includes your container, AAD and reserve as well as the main.

(b) Other References

- Parachute and its Pilot – Brian Germain www.bigairsportz.com/publishing.php
- BPA Canopy Handling Manual
  http://www.bpa.org.uk/training-and-progression/canopy-handling/
- The Canopy Pilot's Handbook – Brian Burke (PDF)

(c) Your Instructors, Packer A, Rigger and Canopy Coach

Your starting point for advice should be your DZ's instructors. Talk with your Chief Instructor and/or DZSO if you are thinking of purchasing any canopy, new or second hand, to first check that you have accumulated enough of the right canopy flying experience to jump it safely and that it is the most suitable choice for your current skill level and your canopy flying goals. At any DZ, you need the DZSO's approval to jump your equipment.

Your CI may or may not be able to advise on comparisons between all the various canopy models, but they will be able to start you towards the right information and the most correct choices.

> Equipment maintenance is critical. Your Main canopy and its control lines will sustain wear and tear that require constant scrutiny.

In this guide, references are made to maintenance or changes to your canopy and other equipment. Always employ a Packer A or Rigger to perform this work. When your reserve is due for its 6-monthly inspection and repack, remember this is also an excellent opportunity for a full inspection of the rig and its components.

You should conduct routine checks and maintenance on your gear, particularly your main, on a regular basis. If you don't know what to look for, or how to start this process, ask an instructor or your local Packer A. They will be happy to help; the whole purpose of acquiring knowledge is to share it with others.

A Canopy Coach will work with you on the practical exercises associated with this Guide. (The Canopy Coach is not to be confused with a CRW Coach – Canopy Relative Work Coach).

PART 2: SOME OF THE FORCES WHICH AFFECT YOUR CANOPY

2.1 May the Forces be with You

It is a complex relationship of forces that keep a canopy flying. This section will introduce a simplified version of them to allow a basic understanding.

Lift results from the on-coming airflow separating over and under the canopy. This creates an area of relative low pressure above the canopy.

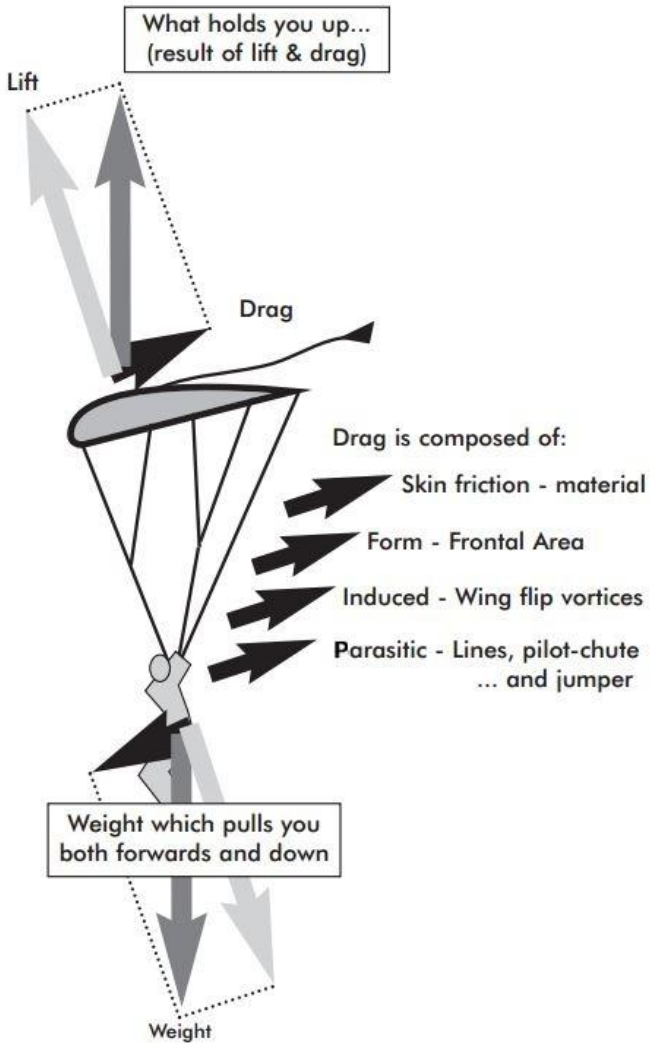
Drag is the total result of all the different and quite specific types of drag created by the wing in flight added together.

Your weight suspended under the canopy acts as two forces, one pulling you down and one pulling you forwards.

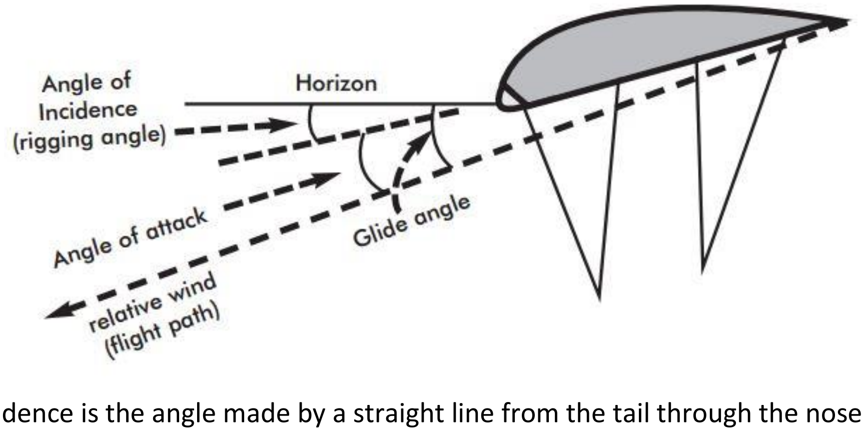
The force pulling you forward is equal and opposite to the total drag. The force of your weight pulling you down is countered by the force generated by the lift.

These only remain "equal and opposite" while you are flying at a constant speed. If you do something with your toggle or risers, then you upset the balance of the forces and change to a new speed.

An increase in weight will also produce an increase in forward speed. This will produce a corresponding increase in lift. So a heavier jumper on the same wing will fly the same glide angle – but faster.



Images courtesy of BPA



The angle of incidence is the angle made by a straight line from the tail through the nose (chord), when measured against the horizontal. This is built into your canopy by the manufacturer and can only be changed by you pulling the risers down.

The angle of attack is the angle between the angle of incidence and the relative wind. This can be changed by use of the toggles, front or rear risers. Pulling down on a toggle or a front or rear riser increases the angle of attack.

The changes that are being achieved in performance with the newer canopies are due to design improvements in two principle areas.

2.2 The Basics

To understand the differences between canopies, it is necessary to understand the basic aerodynamic trade-offs. These five factors are the main things that designers are able to manipulate in order to achieve the flight characteristics they are looking for: Airfoil, Trim, Aspect ratio, Wing loading and Wing planform (the shape of a canopy).

The possible combinations of varying these factors are almost limitless! The different design aspects are also interdependent. This means altering one aspect will not just isolate the changes in performance to that one aspect of the wing, but will, to varying degrees, affect the performance of the other aspects too.

1. Airfoil

The airfoil is the cross-sectional shape of a wing. Its curved surface creates the lifting capability of a canopy. From a jumper's point of view, the airfoil mostly affects the landing ability and stability of a canopy. There is also a slight effect on the speed, but not as much as most people think.

2. Trim

The trim refers to the nose down angle of the canopy, which creates the forward gliding motion of the canopy. This trim angle is designed into the canopy by varying the length of each row of suspension lines. It must be trimmed within a certain range in order to fly! Within that range of useable trims, a designer has a choice: pointing the canopy more nose down results in more speed but a poorer glide, while more nose up results in a flatter and slower glide. This will also affect the landing characteristics. Some very flat gliding parachutes do not land well unless they are flown very aggressively to build up enough energy (speed) to get the canopy to flare. Others are trimmed a bit more nose down, so the necessary energy (speed) is built in to the normal full glide approach.

3. Aspect Ratio

This is the relationship of the span (wing-tip to wing-tip) of a canopy to its chord (front to back) measurement. A wing 15 feet across and 10 feet from nose to tail has an aspect ratio of 15:10, or, expressed in its lowest form, 1.5:1. For a skydiving wing: 1.9 is a low aspect ratio; 3.0 would be high. *(High performance rigid gliders operate at 50.1).*

4. Wing-Loading

Wing-loading is the biggest determinant of speed and rate of descent. In addition to the speed, wing-loading also affects the handling of a canopy.

If you divide the total weight in pounds (you and all your gear including main canopy and clothing) by the wing area, you get the wing-loading. A 170-pound person whose rig and clothing weigh 20 pounds has a total suspended weight of 190 pounds. A 190 square foot canopy will give a wing-loading of 1.0 pound per square foot. A 300 square foot canopy with a total suspended weight of 150 pounds gives a wing-loading of 0.5 pounds per square foot.

A lower wing-loading creates slower speeds, a lower rate of descent, slower, more sluggish control response, slower landing speeds and a create a generally more forgiving experience for the pilot.

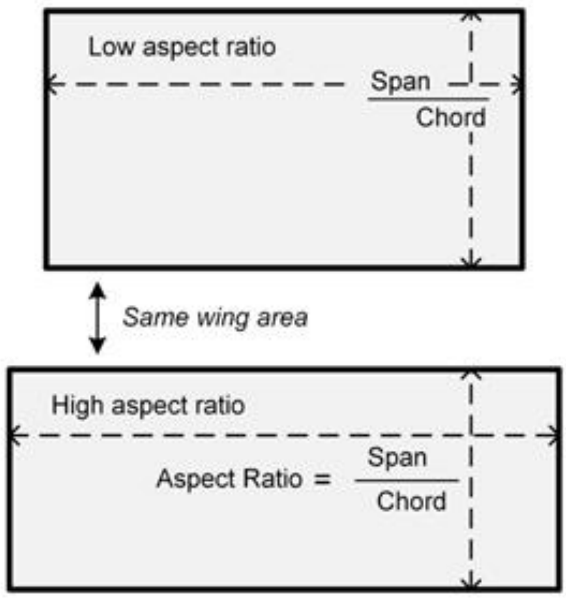
A higher wing-loading creates higher speeds: much higher rate of descent, higher speed, faster control response, sharper stall, faster landing speeds, less forgiveness. The controls become crisper and more responsive. Even slight control movements can produce very significant changes in the flight path. The higher the wing-loading, the lower the margin for error and the higher the consequences of mistakes.

Only move to a smaller canopy if you're sure you want to go faster and you are absolutely able to handle the responsibility of the greater speeds involved. **Only go one size smaller at a time.** Choose the wing-loading that gives the best combination of flight characteristics and landings that you want and are able to handle in all conditions. See Part 6: Canopy Downsizing for more information.

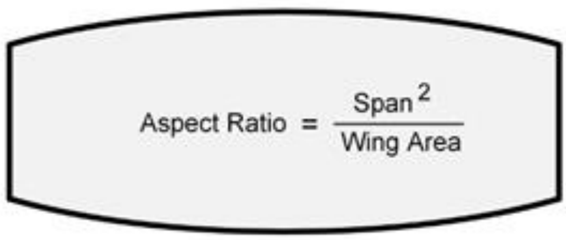
There are many people (and even some parachute companies) who believe that a wing-loading must be very high on a “high performance canopy” to “get it to perform correctly”. This is simply not true. A larger high performance canopy will offer a little less speed, but more forgiveness than its smaller contemporaries. There is a wing-loading which is so low that the canopy becomes unmanageable, especially in high winds and turbulence. However, that wing-loading is far, far lower than most people imagine, and is rarely approached with high performance canopies, if ever. Look at student canopies. Do they “perform”? You bet! If they are in good condition, they open, fly, turn, flare, and most importantly LAND, very well.

Importantly, when discussing the differences in performance and flight characteristics of a given set of canopies, they must be compared at with similar wing-loadings to get a good representation of actual differences.

For instance, the same sized Sabre 2 flown next to a Safire 2 with the same wing-loading will fly quite differently. The Sabre 2 has a steeper glide path and will get to the ground more quickly. These flight characteristics are built into the canopy with respect to airfoil, trim, aspect ratio and wing planform.



Rectangular canopies



Elliptical canopy

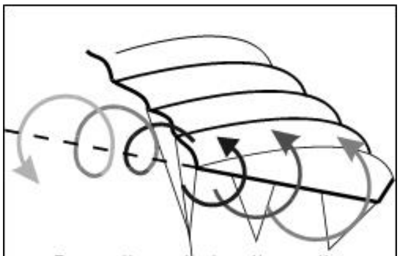
5. Wing Planform

The overall shape of the wing when viewed from the top is known as the “planform” of the wing. See diagram.

Most ram airs use the rectangular planform, commonly called square, but others are tapered towards the tips, which are commonly called elliptical. This taper redistributes the lifting area into a shape that creates different handling and performance.

Technically, this makes the wing a more efficient lift producer, if it is not tapered too much.

Without getting too technical, this is because the centre of the wing produces lift most efficiently with the least drag, while the ends of the wing suffer reduced lift and increased drag due to the airflow spilling around the end of the wing. Tapering the wing towards the tips makes the tips smaller, so the inefficient part of the wing produces less drag, while the more efficient centre part is made larger so it produces the bulk of the lift.



Formation of wing tip vortices at each side of your canopy

Theoretically, the taper makes the canopy a little more efficient, but the increase is only slight for skydiving canopies. However, the taper changes the handling in some very dramatic ways, the most notable being the greatly increased rate of turn and rate of roll. As with most other aerodynamic factors, too much taper can be a problem.

It can be over-done, resulting in very strange handling!

2.3 So what is the difference in performance and handling?

Let's say you have two canopies that have the exact same airfoil, aspect ratio, trim and wing-loading, but one is square (rectangular) and the other is elliptical. In general, the comparison looks like this:

- The elliptical canopy will roll into a turn much quicker than a square, usually requiring less toggle input as well.
- The quick turn rate occurs even at low speeds, because very little toggle differential is needed. (The more elliptical the canopy, the more this tendency occurs.)
- The elliptical canopy will usually roll out of a turn more slowly than the square after returning the toggles to a level flight position. (The more elliptical the canopy, the more this tendency occurs, with the tendency almost unnoticeable on very slightly elliptical canopies.)
- The elliptical may be rolled out of a hard turn very quickly by using the opposite toggle without killing much speed, but this technique usually kills lots of speed on squares.
- If allowed to roll out of a steep turn by itself after releasing toggles, the elliptical will usually continue to dive more than a similar square.
- The elliptical canopy is very sensitive to body position and sitting in the harness.

  Shifting weight in the harness is something that most people do naturally when making turns, and this greatly affects how much of these turning characteristics they will feel. A person who naturally leans to the inside of a turn when rolling out of the turn will find the canopy is slow to stop a turn. However, a person who naturally leans to the outside of a turn when rolling out of a turn will find the turn will stop much faster.

In general, all of these characteristics become more pronounced as the canopy becomes more and more tapered. A very slight taper feels similar to a normal square, while a canopy with a great deal of taper can be somewhat unmanageable and not much fun. This is one of many reasons why the ellipticals are all so different from one another. We will see even more differences in the handling of elliptical canopies in the future, as designers create more ellipticals to suit the very different flying styles that exist.

2.4 What good is all this turn rate?

Most modern canopies can already turn so quickly that it is usually not possible to make a turn with one toggle all the way up and the other all the way down without producing an unstable situation.

There exists some limit to how fast the canopy will turn by pulling one toggle down with the other one all the way up. Going farther than this does not make the canopy turn faster, but can make some strange things happen! When tapered canopies reach that limit, they achieve a faster turn rate, but with even less toggle input being used! Then what good is all that turn rate potential if you can't use the excess control range? Answer: The extra control range comes in very handy when flying slowly.

With high aspect ratio canopies, the controls get sluggish at slow speeds. The turn rate can get really slow when flying in the brakes. Since the elliptical canopy needs much less control input to turn, the turn rate at low speeds is much better than the square. A radical canopy pilot may not be concerned with slow flight characteristics, but they are very important! There are situations where you must fly and manoeuvre at slow speeds. This can help when:

- setting up for a landing in a tight area;
- when dealing with congested landing areas; or
- trying to adjust the set up position prior to making an accurate swoop landing.

2.5 What other differences can I expect to feel?

It will depend on some of the specific differences between canopies, but between canopies of a similar size, aspect ratio and with a similar wingloading:

- The elliptical canopy will usually be only slightly faster, and may have a slightly better glide;
- The elliptical will feel more rigid than the square, especially in deep brakes (If there is a big difference in aspect ratios, the canopy with a lower aspect ratio will feel more rigid);
- When flown in brakes, the elliptical will usually have a lower rate of descent;
- The stall will usually be more abrupt on the elliptical canopy;
- The elliptical is usually less forgiving of small piloting errors on landing. On many squares, the built-in forgiveness can allow sloppy flying to become habit. These habits become problems when changing to an elliptical canopy, especially on landings; and
- It is easy to over control an elliptical canopy, especially in the roll control. When you want to turn any ram air, the canopy will first roll (bank) over to one side, before it actually starts turning. So if you make quick left and right toggle movements, it produces a quick left and right rolling tendency, while the parachute flies basically in a straight line! (The more elliptical the canopy, the more this tendency occurs, especially at high wing-loadings.)

Canopy pilots are seen doing this rolling back and forth thing on base or final approach, and it shows poor understanding of canopy control! The people following this person to the landing area have no idea what is going to happen, or what direction this pilot will go.

People who fly like this probably think that they are building up speed, but actually they are only creating a high rate of descent and making the canopy more susceptible to turbulence. This makes the possibility of a good landing less likely.

2.6 Fly smooth!

The landing characteristics are as varied in elliptical canopies as they are with squares. The precise characteristics are a function of many subtle aerodynamic qualities beyond the five factors being discussed here. Manufacturers can prioritise these in different orders to suit individual canopies and consumer preferences, and this is where the “magic” comes from. Choose the right size and model to suit your preferences, and the landings can be a lot of fun! Most people choose too small.

2.7 Density Altitude

The conditions that you fly in will never be exactly the same from jump to jump. While we all appreciate the obvious changes in the wind there are less obvious changes taking place in the air all of the time.

(a) The environmental factors

1. Temperature

The hotter the air – the thinner the air. A temperature increase of 8°C is equivalent to an altitude change of approximately 1,000 feet higher.

2. Pressure

Pressure changes with altitude; it also changes as weather patterns move around. Standard pressure at sea-level is 1013 mbar (millibars). Jumping in a low pressure system with a sea level pressure of 1000 mbar is passing through is equivalent to landing about 400 feet higher.

3. Humidity

The amount of moisture in the air also changes its density. Strangely enough, the more humid the air, the thinner it is (Yes, really). So again, the effect on a humid day is of jumping at a higher altitude.

(b) Their effect – Density Altitude

The effects of these environmental factors can be combined to produce an equivalent density altitude. These effects are cumulative and should also be added to the true altitude of your drop zone (some Australian drop zones are 2,000 feet or more above sea level).

(c) What does all this mean and what does it do to your canopy's performance?

A 2,000 feet increase in density altitude will alter your canopy performance by 3%. This means that since the air is 3% less dense, your true airspeed will be 3% higher (although it will not feel any different) so your landing distance required will increase, and you will lose 3% more height in a turn. This may not sound like much, but being six feet too low on a 200-foot hook turn will cause serious problems.

And the accumulated effect of hot, high and humid on the same drop-zone between summer and winter conditions could easily total 5,000 feet and a change in your canopy's performance of around 8%.

Not a lot for sure, but it could make all the difference!

2.8 "G" Forces and how they affect your Flight

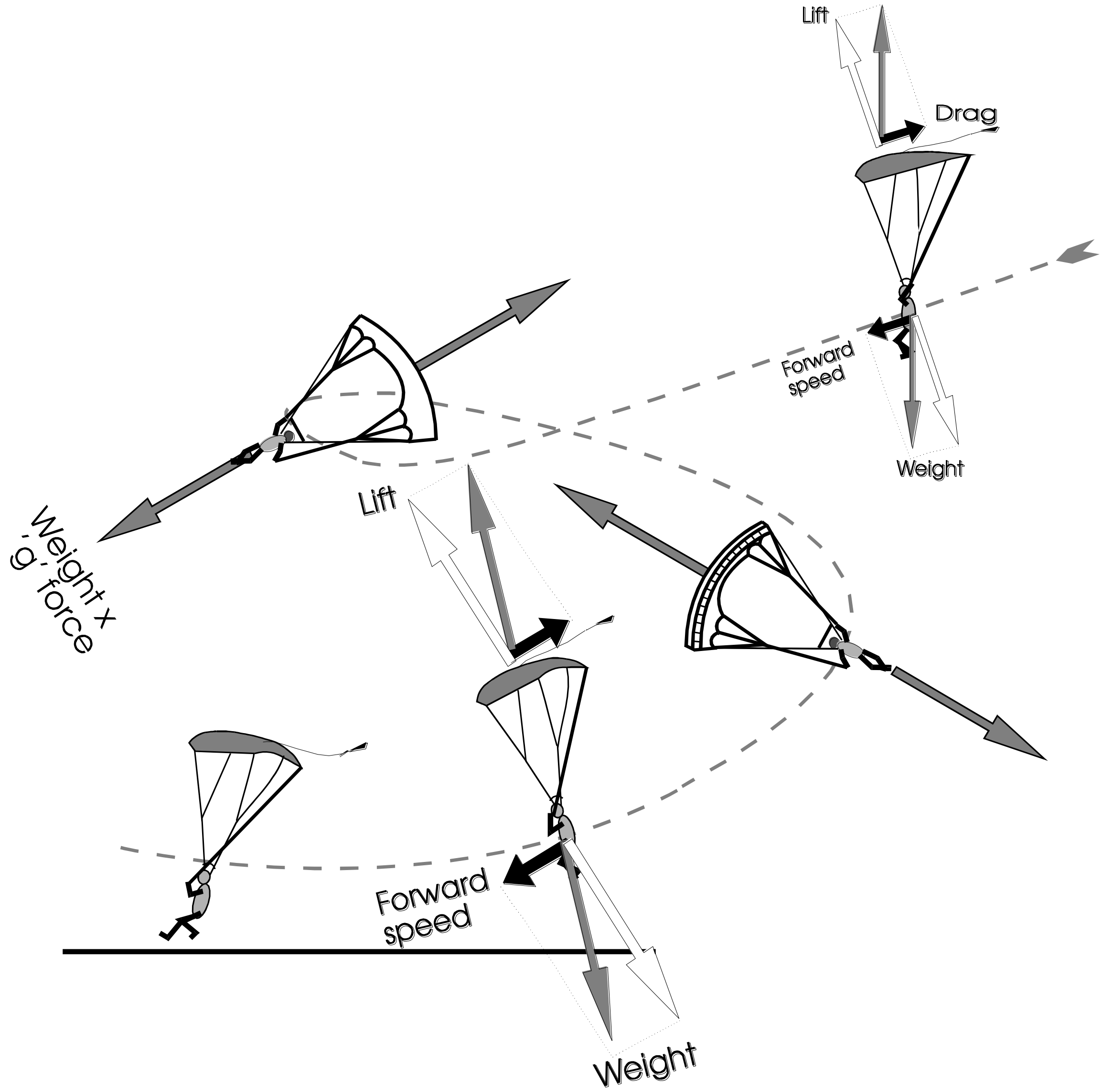
As explained earlier, the weight underneath your canopy directly affects your forward speed. If you are heavier, the canopy flies faster. This increases the lift which counters the increased weight. You will fly the same glide angle, just faster.

This is why correct wing loading is so important.

**During a turn, the g-forces acting on the jumper increase which results in an increase in the jumper's apparent weight. A 90kg jumper in the middle of a 2g turn will appear, to the canopy, to weigh 180kgs. This will result in a doubling of the wing loading and a subsequent doubling of forward speed and descent rate.

Add to this the fact that not a lot of the lift force is actually holding you up, but is directed inwards to counter the turn.

From this, it is easy to see where the extreme downward speed and increased forward speed comes from while you are turning. Note too that the forward speed is directed at a steeper angle towards the ground while the canopy is diving prior to your flare.



PART 3: CONTROL INPUTS

3.1 Introduction

Part 3 describes tasks for the canopy pilot to develop a strong foundation of essential skills.

The "Essential Manoeuvres" highlighted in grey text boxes in this Part and later in Part 5 Landings were written by Brian Germain and are available at www.bigairsportz.com/publishing.php They include:

Here in Part 3:

- Pitch Control Exercises
- Stall practice
- Slow-Flight Practice
- Rear Riser Flight
- Front Riser Input
- Dive Arrest: Front Riser Dive
- Harness Turns;

Later in Parts 5 and 6:

- Precision Landing Pattern
- Heading Changes in the Landing Surf
- Accuracy Landings.

These in-flight manoeuvres are essential to safe flight. These tasks must be performed regularly, so that the pilot will have the ability to perform these manoeuvres without thinking. "Learned Instincts" must be developed for such tasks, so that when situations arise requiring immediate action, the programmed responses will be the correct ones.

- **All exercises should be performed above a safe cutaway altitude, in the event that the pilot inadvertently induces line-twists and loses control of the parachute.**
- **All exercises should be performed on the current size and planform before downsizing or transitioning to a more responsive design.**
- **All exercises should be performed on dedicated jumps, opening above 5000 feet AGL. Opening high following a relative work freefall may allow sufficient time to perform the manoeuvres, but dedicated jumps are preferable as a learning experience.**
- **Video should be used whenever possible for debriefing and evaluating landings and in-flight manoeuvres.**

Your first flights on any different canopy should be high-opening canopy familiarisation jumps only. Do not complicate matters with RW, possible low openings, or other canopies in close proximity.

Use these jumps to reprogram your instincts and reactions as much as possible, performing the manoeuvres described below.

It maybe that your DZ has a formal progression table you are required to work through in order to be endorsed on this canopy type. Check with the DZSO.

3.2 Straight and Level Flight and Toggle Turns

(a) Straight and Level

Fast, isn't it? Note the glide path. This is the direction the relative wind on your face is coming from. How far could you fly?

Smoothly apply the brakes; note the toggle pressure. Until you get into deep brakes, the glide ratio will remain pretty much the same; just your airspeed down the glide slope is reduced. Of course, your ground speed is something else. This reduced airspeed helps in the case of a long spot. Hold some brake on, and the extra time you spend in the wind will help you to float back closer to the target. Find the stall point; look where your hands are. How “touchy” does the stall feel? Practice a controlled recovery and get the canopy flying smoothly again. Do this a few times: you need to re-program your senses about this – if this is a high aspect ratio canopy then the range of toggle movement is probably less than you are used to.

> Learn this – You do not want to bury a toggle by instinct if you need to take evasive action near to the ground.

(b) Toggle turns

Try some turns from full drive: do they feel controlled? Does the canopy stop when you let the toggle up or do you need to input opposite toggle to stop the turn cleanly?

How fast are the turns? A high aspect ratio canopy can probably turn faster than your body can, causing line twists. This means you cannot get the toggle back up again, so before you ever try this make sure you have enough height to cut away!

Do some turns in combination, 90° left and right. How does it handle the change of direction?

Try a slow 180° and then a 360° turn. How much height did you lose?

Now do a more aggressive 360° turn. How much altitude did you lose, how much speed did you gain?

Flare. What was the toggle pressure like and how much toggle input did you need? How fast did the canopy pull up? What was the “g” force like?

> Practice performing an aggressive turn and immediately going into deep brakes, (i.e. do not let your hand up, bring the other one down to match it), but do not stall the canopy.
> If you ever input a radical toggle movement and immediately realise you have made a bad mistake, this may be your only option and it needs to be instinctive.

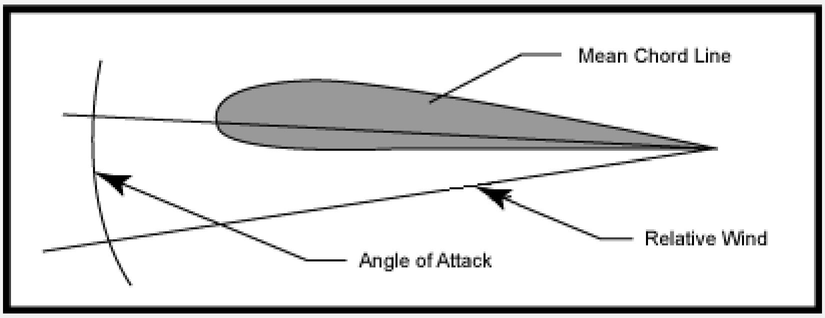
3.3 Pitch Control Exercises

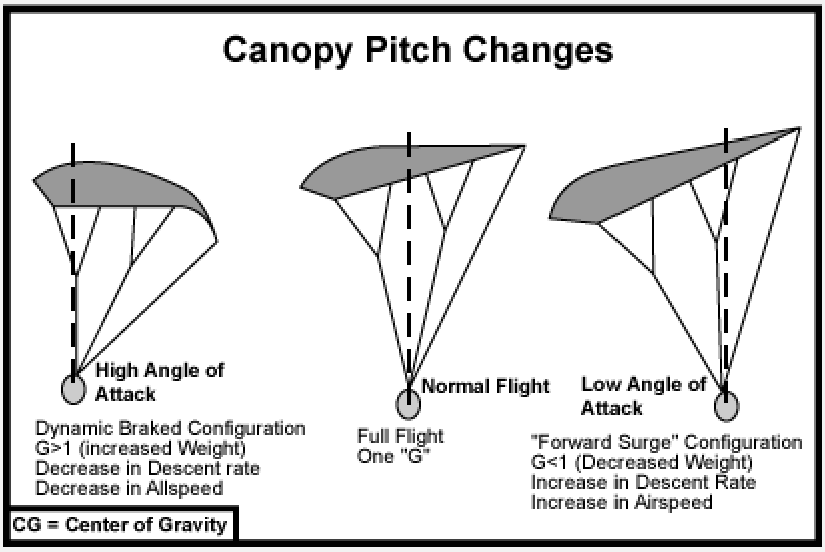
The Essential Manoeuvre: Pitch Control Exercises

- Manipulate the canopy on the pitch axis using the brakes.
- Look at canopy to notice the amount of pitch axis change.
- Notice the amount of slack in the brake system when in the full flight mode.
- Notice the difference between “soft” and “sharp” inputs:
  {slow application vs. quick}

Why?

Controlling the pitch angle is how we manipulate the Angle of Attack of the wing. Without a dynamic change to the angle of attack, the pilot will be unable to increase the lift of the parachute enough to change the direction of flight from its normal full flight glide to level flight. This manoeuvre is therefore essential for safe landings.





3.4 Stalls

(a) Stall Characteristics

The stall is one of the least explored and most feared aspects of flying. Avoidance of this flight mode causes many canopy pilots to be uncomfortable with flying slowly, and unpracticed in this important art.

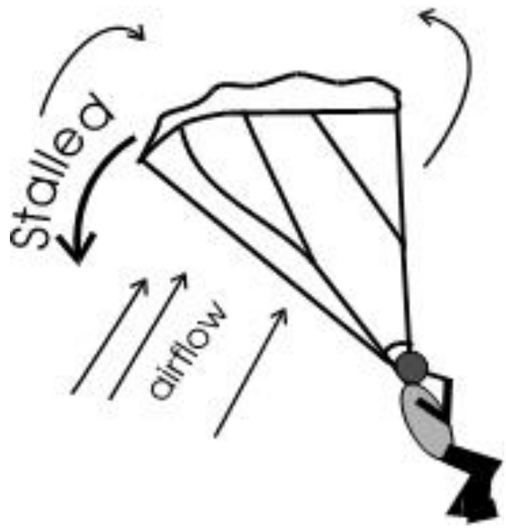
First we must explore what a stall is. The assumption made by most canopy pilots is that the stall is caused by slow speed flight. This is not true. It is correlated with low speed flight, but a wing can stall at high speed too. A stall is caused by an excessive angle of attack. When the relative wind flows over an airfoil, it is bent in the general direction of down. This causes an opposite force called "Lift". When the orientation of the airfoil is changed to a higher angle with respect to the relative wind, it is said to have an increased angle of attack.

Air is quite cooperative. It is willing to be redirected and still flow in a fairly organised manner…up to a point. At a specific angle, all airfoils fail to bend the air into submission. This discrete angle of attack is referred to as a stall. It is coupled with a sudden drop in lift, and thus a significant increase in decent rate. Whether you are flying an F-16 or a Lotus 190, recovery from a stall is always the same: the pilot must reduce the angle of attack. On an aeroplane, this requires forward pressure on the yolk or stick. On a parachute, we are simply required to let off the downward pressure on the toggles or rear risers that has increased the angle of attack in the first place.

Each parachute stalls and recovers differently. Depending on several governing variables, some parachutes will recovery nicely from a stalled configuration no matter what the recovery technique, while others will require very careful execution. Let's take a look at these issues one by one.

The characteristics of a stall on any ram air canopy are based on two main variables, and several lower order variables. The most significant governing variable is the flight mode when the stall is reached. If the canopy is in a sink, rather than level flight (zero decent surf), it will tend to stall in a more forgiving and docile manner. The second primary variable is the attitude about the roll axis when the stall is reached. In other words, if there is any bank angle when the stall precipitates, it will cause the lower wing to stall first, resulting in significant yaw energy, which can result in line twists.

There are several other things to consider when testing the stall of a canopy, including: canopy design, density altitude, wing-loading, aggressiveness of the control input, and most importantly, recovery technique. This will be discussed next.



If the wing is allowed back into forward flight quickly, it will dive aggressively toward the ground, causing a drop in the angle of attack, as well as the lift and therefore the overall line tension. This may allow the wing to surge below the suspended weight (you), and possibly cause a jumper/canopy entanglement. Further, if the release of the brakes is asymmetrical, the lack of line tension can allow the wing to surge unevenly about the yaw axis, causing line-twists.

The key to stalling any wing is to enter the stalled configuration in a sink, with the wing level and static about the roll axis. As soon as the stall is reached, the toggles (or rear risers) should be released only a few inches to allow for only a slight drop in the angle of attack. As soon as the brakes are released, the jumper should be prepared for a sudden increase in toggle pressure, as the tail of the parachute is about to get hit with a pulse of relative wind. If the pilot is unprepared for this, the toggles will usually be pulled upward and possibly in an uneven manner, often resulting in an aggressive stall recovery that may result in line twists.

When the brakes are released quickly to the full flight position, the wing doesn't have much drag. This means that there is very little to prevent it from surging forward in the window. When the brakes are released slowly, and then held down just above the stall point, the wing has a great deal of drag. You have two big barn doors at the back of the wing helping to prevent and aggressive surge.

Further, as you become more familiar with the stall and recovery characteristics of your wing, you may begin to fly "actively" with respect to the recovery process. In other words, as soon as the wing begins to fly forward in the window, the pilot jerks on the brakes to dampen the forward surge. It is important to do this minimally enough to prevent re-stalling the wing. A well-timed reapplication of the brakes during the recovery process will significantly reduce the amount of altitude lost in the stall. This can be very useful in the event of a low altitude stall. This manoeuvre can be practiced in relative proximity to another canopy in deep brakes. Be sure to keep your distance when you do this. By definition, a stall is a loss of control of the wing.

Rear riser stalls tend to be sharper at the onset, but quicker on the recovery. Therefore it is advisable to stall the parachute on the rear risers first before attempting to stall it on the brakes. Further, such manoeuvres should always be performed at an altitude that will allow for a safe cutaway.

(b) Stall practice

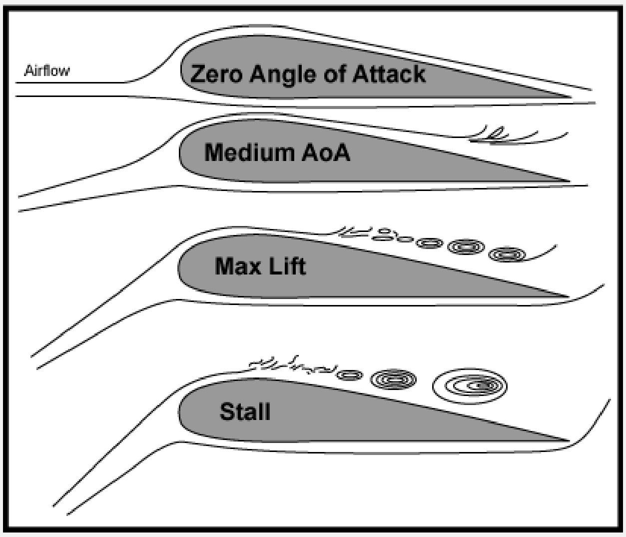
The Essential Manoeuvre: Stall practice

- Find the stall point using both the brakes and the rear risers
- Recovery with minimal altitude loss and loss of heading
- Controlled recovery must be demonstrated, using a slight reduction in the angle of attack, rather than an aggressive release, which can result in a collapse of the wing or line-twists.
- Any modern parachute design is capable of stalling and recovering safely with proper technique.

Why?

The stall point represents the highest angle of attack that a particular wing can utilize prior to a loss of control. This discrete angle of attack, when approached slowly, also represents the slowest airspeed available to the pilot. When landing in no-wind conditions, it is necessary to diminish the airspeed as much as possible in order to achieve the lowest possible groundspeed for the touchdown. On smaller, high airspeed parachutes, this ability is essential.

Further, deep brake flight is often necessary for approaches into small landing areas. If the pilot is unfamiliar with the flight characteristics of the parachute in the high angle of attack mode, there is significant risk of a stall or spin at low altitude.



By rehearsing slow flight and beyond to the full stall condition, the pilot becomes more comfortable with dynamics of the canopy in the steep descent flight mode.

If the parachute stalls, quick recovery has become a learned instinct, increasing the chances of survival significantly.

3.5 Flight and manoeuvring in brakes

Bring the canopy into full brakes. How does it fly? Does it hold the heading or drift? Is the toggle pressure higher or lower close to the stall point? Slowly let one toggle up an inch or two. How does it react? It should seem to circle slowly around the braked side of the canopy.

From deep brakes, let one toggle up enough to smoothly turn 90°. How much altitude was lost? How does this compare to the height lost doing toggle turns from full drive? Could you do this on final to avoid another canopy?

The Essential Manoeuvre: Slow-Flight Practice

- Place the canopy in 90% brakes and hold for 60-90 seconds.
- Make controlled heading changes of 45-90 degrees.
- Notice the difference in responsiveness as compared to full flight turns.
- Notice that lifting a toggle on the outside of the turn reduces the risk of stalling the wing on the inside of the turn.
- Notice the diminished roll axis stability in the deep brake mode, requiring smooth control inputs and slow recovery of the roll angle.

Why?

Most pilots spend the majority of their canopy ride in full flight. This means that the feeling of the canopy in this mode is most comfortable to most people. It also means that flying in deep brakes places many out of their comfort zone. In other words, most people are somewhat uncomfortable just prior to putting their feet on the ground on every single jump.

Anxiety in slow flight often causes pilots to hold their breath which diminishes their cognitive capacity due to oxygen deprivation. The impatience caused by the discomfort usually results in looking down and offsetting the steering toggles toward the end of the landing to get to the ground sooner. They simply want this part to be over.

To land with great consistency, we must become intimately aware of the flight performance of our parachutes in very deep brakes. The more time we spend in this flight mode, the more comfortable we will be.

3.6 Using Risers for Flight and Turns

(a) Rear Riser Flight

Essential Manoeuvre: Rear Riser Flight

- Perform rear riser evasive turns immediately after opening with the brakes stowed.
- Perform rear riser turns with the brakes released.
- Perform rear riser flares and stalls.
- Apply collective rear riser input to flatten glide without a significant loss of airspeed.
- The benefits of such exercises are significantly enhanced by having a relative reference such as clouds or another parachute flying in no contact formation.

Why?

In the event of traffic after opening, there is little time to alter the canopy's heading, and the process of releasing the brakes requires time. Having the ability to safely manoeuvre the parachute with the brakes stowed is essential to safe parachuting. Experimenting with the performance tendencies of each parachute brings to light individual issues relating to over-steer and allows the pilot to take precise evasive action.

Performing rear riser turns with the brakes released prepares the parachute pilot to properly deal with a broken steering line. Further, by rehearsing rear riser flares, the pilot will be better equipped to handle such situations. Attempting to land a parachute using the rear risers with no prior high altitude rehearsal is unadvisable and may lead to injury.

Lastly, application of collective rear riser input allows the pilot to increase the True Glide of the canopy, reducing the risk of off-field landings, as well as altering the flight path to improve accuracy.

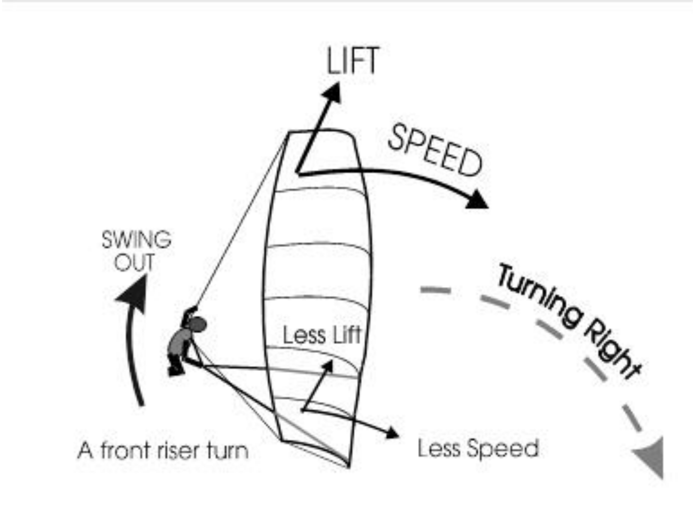
(b) Using Front Risers

Pulling down on both front risers will increase the airspeed of the canopy because you are reducing the angle of attack (also the angle of incidence). This reduces the lift produced and lets gravity have its way. You are trading height for speed.

So why does a canopy turn when you pull down one riser?

When you pull one riser down, you reduce the lift of that part of the aerofoil, just as you did when you pulled on both front risers. However, now you have a canopy with more lift at one end than the other. This will start the canopy turning and you will swing out from underneath and turn with it.

Because the wing is turning, the air is travelling at different speeds across it at each end; so the lift at the faster (outside of the turn) end is increased even more compared to the inner, slower end.



This produces more lift at that end of the canopy and make the turn even steeper and centrifugal force keeps you swinging around the canopy.

However, it should be noted that this lift is mostly holding you into the turn, and not holding you up (as described in the section on g-forces).

If the riser turn is held, the canopy will accelerate into a diving turn which can become a corkscrew spiral, losing as much as 500 feet per revolution. Again, you are trading height for speed.

Since almost all canopies are rigged with the 'A' and 'B' lines on the front riser, pulling one riser down does not smoothly change the camber of the wing in the same way as pulling on a toggle. After only a few centimetres of movement a noticeable "step" is induced in the aerofoil and this can have a couple of very undesirable effects:

- Initially it can cause the airflow over the canopy to separate from the canopy surface causing the canopy to bounce and buck.

- If more deformation is applied, then there is a real possibility that the top surface of the canopy could be pulled down and exposed to the airflow. This would cause that half of the canopy to immediately tuck under (nose roll). Some canopies are more prone to this than others but turbulence could make this happen to any canopy. This is why turbulence and front risering is not a good combination.

Get used to trying to predict where you may encounter turbulence. The loss of a significant proportion of your wing with a sudden increase of drag on one side can have spectacular results (see the section on Turbulence).

Practise smooth turns

Handles or dive loops on your front risers make your grip more secure and less tiring.

When you reach for your front risers, keep a firm grip on your toggles. Check that pulling on the front risers does not pull on the brake lines. If it does, get your brake lines lengthened slightly. You do not want to confuse the canopy by causing control input at the front and back at the same time.

With plenty of height, practice pulling a few centimetres (no more than 5 cm initially) of front riser while keeping a secure grip on your toggles, making a wide carving turn, and then smoothly transitioning to toggles and plane out. Smooth is important here, you need to maintain the airflow over your canopy with no sudden jerks throughout.

If you cannot accomplish smooth turns, either you are pulling down too much on the risers or your canopy is out of trim. Fix one or both before you try any of this below 2,000 feet.

Do not use front risers in turbulent conditions.

Essential Manoeuvre: Front Riser Input

- Perform straight front riser dives.
- Perform single front riser turns.
- Perform offset double-front riser turns.

Special Considerations

Front riser input should be applied with the toggles in the hands. Given this, this manoeuvre requires forethought and planning on exactly how to hold and release the risers without risk of inadvertently dropping a toggle. The risk of dropping a toggle near the ground can be significantly reduced by inserting all four ringers into the toggles and tightly grasping the toggle with the pinkie and ring finger at all times. This allows freedom of the index and middle finger for insertion into the front riser dive loops.

Front riser pressure increases as a function of airspeed. Therefore, attempting front riser application in full flight or faster is extremely difficult or impossible. To reduce front riser resistance, application and subsequent release of ¼ brakes is usually sufficient to diminish the resistance to within workable limits

Why?

Reduction of the angle of attack is necessary for many flight manoeuvres including: upwind penetration (improving relative glide ratio), canopy relative flying, accuracy, as well as high performance approaches.

Essential Manoeuvre: Dive Arrest: Front Riser Dive

- Place the canopy in a dive using the front risers.
- Rehearse dropping the front risers and quickly stabbing the brakes.
- Rehearse both straight front riser dive recovery as well as turning dives.

Why?

What keeps pilots alive is the judgment and skills necessary to save them when they dive too close to the ground. If a pilot rehearses the solutions to the dangers, the likelihood of a dive resulting in serious injury is dramatically reduced.

Dropping the front risers allows the pilot to keep their hands down, ready to stab the brakes aggressively to arrest a dive. A short, sharp, “nudge” on the brakes is usually all that is necessary to place the jumper back under the wing, and to the higher angle of attack that saves their life.

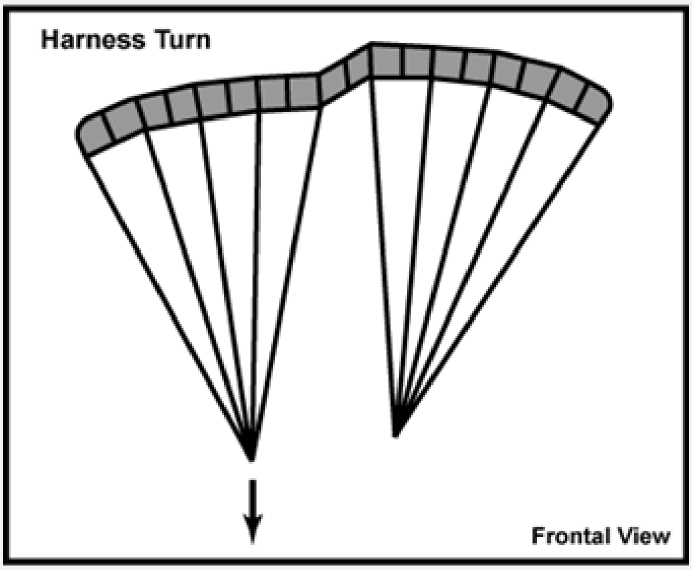
3.7 Harness Turns

Essential Manoeuvre: Harness Turns

- Harness turns with the brakes stowed
- Harness turns in full flight
- Harness turn follow-through after other inputs
- Harness turns to adjust the flight path on final approach.

Turning on the harness is accomplished by leaning to one side or the other, and lifting the leg on the outside of the turn. The capacity for the harness to load the canopy on one side is limited by chest strap tightness as well as canopy design and wingloading. Utilising asymmetric harness input in order to effect a turn is more effective on parachutes of sufficient wingloading and elliptical taper.

Harness input can be used to initiate a turn as well as enhance or extend the heading change of another type of input such as toggle, rear riser or front riser.



Why?

Immediately after opening, the harness can be utilized to steer away from traffic or toward the landing area prior to unstowing the toggles. Although the turn is not as fast about the yaw axis as a toggle or rear riser input, the immediate access of this kind of turn makes it a useful technique.

Another use of the harness turn is for heading changes in turbulent conditions. While all other methods of turning distort the airfoil and alter the pitch axis of the wing (which effects many variables such as airspeed and decent rate), the harness turn is neutral in this regard. This makes the harness turn the safest method in turbulence, reducing the chances of an abrupt decrease in the angle of attack resulting in a loss of control and or collapse.

Harness turns can also be used to enhance or extend the effects of other turning methods. While front riser turns may become difficult as airspeed increases, the heading change may be continued with the harness even after the pilot is forced to let off the front riser input.

On final approach, adjustments to the heading should not affect the glide angle. Unlike toggle inputs, harness turns will not result in pitch and roll axis oscillations. Therefore, harness manoeuvring can be a superior control input to other options.

PART 4: WORKING ON SURVIVAL

4.1 Improving separation prior to opening

If you are jumping with other people, good tracking becomes more important. You need all the space you can get. You cannot afford a low break-off and slack track which may cause you to open close to another jumper.

Always be prepared to take evasive action on opening. Get control of your rear risers as this is the fastest way to achieve directional control. Have a quick look around before you check your canopy.

Do not allow yourself to develop tunnel vision down your own glide path. A canopy on a collision course with you will probably be at the same height as you, or may even be above you.

Release your brakes, and continue to assess and adapt your position relative to everyone else on the load so as not to crowd the circuit and landing area.

> Once open, head up and look around. Always be looking around at where you are going and where you want to go. (Good tip: Look at your shadow occasionally: the sharpness of your shadow varies with your height. A canopy near you at the same height will cast a shadow close to yours that looks the same.)

Improving your tracking

The aim is a flat, belly-to-Earth track, generating maximum lift and distance. Track away from the centre; Keep your eyes open for others; Keep your head on a swivel, looking down and ahead, over each shoulder and between your legs; No short tracks; Be obvious when you are about to pull, with clear wave-off.

(a) To improve your tracking, first improve your attitude: be dissatisfied!

You must be dissatisfied with your present tracking, or you will have no real incentive to improve. Satisfaction with your tracking is a trap and an ego protection device. This ego protection device helps you make your bad excuses for poor tracking more believable.

(b) With your attitude changed, now experiment with technique.

Many people have not really experimented with body positions for tracking, so you often see poor tracking. I suggest that you occasionally devote an entire skydive just to tracking. You'll have plenty of time to experiment. Make sure you track away from the line of flight, to avoid conflicts with other jumpers.

(c) Avoid these common errors:

Arching: This is OK for a beginner, but it causes a steep track. De-arching makes the track flatter. Try bending a little at the waist.

Knees and ankles bent: This slows the track, making it mushy and steep. Straight knees and pointed toes are better, and they should push down onto the relative wind.

Arms up, streamlined with relative wind: This causes a steeper track also. The arms should be pressing down onto relative wind to make the track flatter.

Legs and arms too close together: This does not help the speed much, and usually causes difficulty avoiding a rolling motion side to side. A slightly spread position, with feet almost shoulder width and hands 6"-12" from torso is better because it aids in stability and makes it easier to deflect more relative wind.

(d) When you leave a formation and track up and away, rather than down and away, you're starting to get the hang of it! On most jumps the fall rate is fast while doing RW, and the body is arched. Since the track should be de-arched and flat, a good track may actually have a lower descent rate than the formation!

4.2 Approach Techniques

A well-planned approach makes good landings easier to accomplish, with most bad landings coming from a poor approach. It follows then, that working on improving a variety of approach techniques is the first step.

(a) Control your canopy with smooth toggle movements

Fly your downwind, base, and final approach smoothly, keeping control inputs to an absolute minimum. This makes it easier for others to predict what you are doing. The canopy will fly more efficiently, and it also helps to make the canopy more stable in turbulence.

Once you're pleased with your landings, experiment with making approaches at various speeds. Learn how slowly you can approach and still get a reasonable landing.

Landing well after a slow approach requires practice and considerable work on flaring technique. How slow you can make a safe approach depends on your wing-loading, the parachute design, and how good your technique is. It takes a lot of practice to get good landings after a slow approach, but the result is more options for different landings, and greater safety.

Even if you are conservative, learn how to make a straight-in approach using a small amount of front risers. Make sure your canopy is very stable in this flight mode first. Just 1 to 3 inches of riser will produce quite a change in the approach speed and landing. By becoming familiar with the slightly higher speeds of this approach, you will be better prepared for when you downsize to a smaller canopy.

> Remember, you must flare your parachute with your toggles for landing! (This may sound obvious, but there have been several incidents where people have landed with their hands still on their front risers, taking no action to flare!) Repetitive practice up high transitioning smoothly from front risers to toggles while taking particular attention to altitude loss must be done before attempting close to the ground.

If you are an aggressive canopy pilot and like swoop landings, it is very important to practice straight-in approaches at various speeds.

You may have to make a slow approach one day, and you need to stay good at it. You may not even realise how slow you can approach and still be safe. It's better to practice in good conditions so that you are prepared for the worst. All new canopies can be flown straight in, even at very high wing-loadings, with proper technique. If you can't do it, you probably need to work on technique.

(b) High speed approaches

1. Learn when to say No to a high speed approach.

There are times when high speed approaches are unsafe, due to heavy traffic in the air or on the ground, when you are angry or tired, when you are disappointed with your performance, or when the weather conditions are marginal. Make sure you err on the cautious side!

You can’t make that swoop landing on a later jump when conditions improve unless you survive this jump!

2. Verify that the technique you wish to use works well with the canopy you are using.

Some canopies have unusual flight characteristics that can take hundreds of jumps to fully explore. Use the time up high to do as much experimentation and practice as you can. Remember, some canopies can become unstable using certain techniques.

3. Stay with straight-in approaches, working on flaring technique for many jumps to obtain the longest swoop possible before attempting any turning approaches.

Many people do not work long enough on improving their technique before trying aggressive turning approaches. Many tend to react too late to changing circumstances, and then over-control afterwards. The result is reduced canopy efficiency, which reduces the distance of the resulting swoop. It also indicates that the jumper is past their limit of safety.

4. If you are doing turning approaches, try to develop several different techniques for controlling the rate of altitude loss compared to the rate of turn.

Over a period of many jumps, find out how much you can vary the altitude loss in a turn by using different control inputs. In these experiments you will find that some techniques will produce:

- extreme altitude loss with only a moderate rate of turn, e.g. steep front riser spiral;
- low altitude loss, even with a fairly high rate of turn, e.g. steady toggle turn;
- practice these techniques up high initially (above 2000 feet), using a digital altimeter to determine how much height you lose in each configuration, before trying close to the ground.

Crash landing by Johan Grobler, South Africa

5. When setting up for your turning approach, try to set up for a turn that will allow for a great altitude loss with very little turn rate being required.

If you're sure you've set up your approach high enough, start the high altitude loss turning technique. As you make the turn, evaluate the altitude loss. Always be ready to change the turn into one that produces less altitude loss. Starting real high and knowing many turning techniques allows you to have plenty of outs.

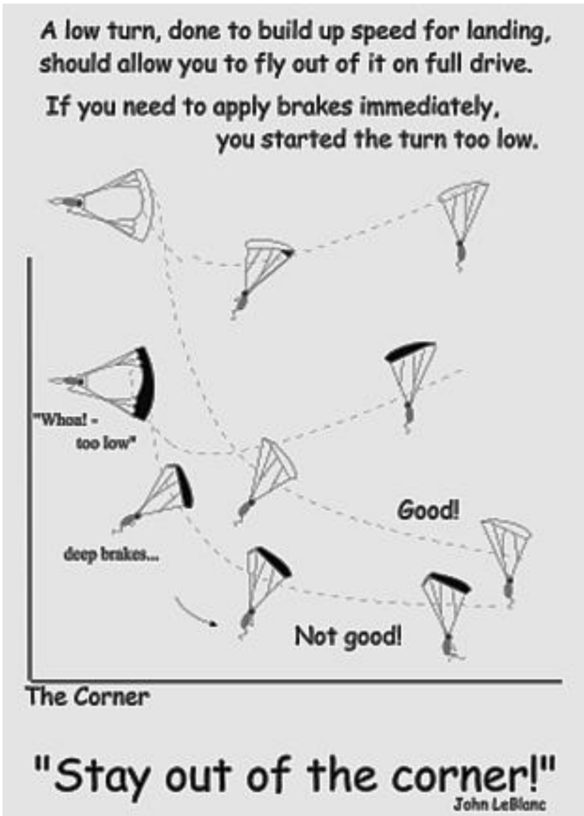
Beautiful image, but…. This is NOT what an inexperienced canopy pilot should be facing!

Start all your turning approaches with enough altitude to make the high altitude loss turn safe. Choose the turning method you feel is appropriate.

If you notice during the turn that you do not have sufficient safety margin, change the turn technique to one that allows for less altitude loss. Now you have your margin for safety back again.

If you are sure you are too low to try the high altitude loss turn, and even a medium altitude loss turn does not look like a good possibility, consider landing slightly crosswind, if traffic permits. Avoid the low turn! If it looks like you need to start with a low altitude loss turn method, you are in a dangerous situation!

If you turn anyway, and you do survive, slap yourself for being so stupid! Vow to never get caught in that situation again!



6. **Avoid becoming trapped into the habit of using only one turning technique that requires an exact starting altitude for success.**

Favouring one turning technique, especially a low altitude method such as a sharp snapping toggle turn followed by burying both toggles, is very risky. Because the canopy tends to pull out of the dive almost the same way each time, you require an exact starting altitude and perfect judgement each time. Nobody can be that perfect! One day your judgement will be a little bit off, and you will crash. Or you may have some turbulent air, which will affect your approach, and you will crash.

7. **Don't judge your approach technique as 'good', just because you walked away from the landing!**

Do not fall into the too common trap of thinking that you've completed the learning process! No one has!

4.3 Learn the concept of the "Corner" and stay out of It!

The corner represents the change from a vertical diving approach to a horizontal swoop. Make that corner as round as possible. A large radius pull-out started higher is safer than a sharp pull-out started lower.

Highly experienced pilot swooping in at Ayr in North Queensland

If the canopy's natural tendency to pull out gets you to level flight without pulling any toggles at all, then you were not very far into the corner. This is the safer method.

- If you need to pull the toggles down to get out of the vertical part of the approach before you can start your flare, then you were too vertical too close to the ground! This is better than hitting the ground, but it's very dangerous and should be taken as a severe warning.

  The biggest problem with this is that the average experienced jumper does not see this as being as dangerous as it really is. Slap yourself for being so stupid, and promise not to get caught like that again. Instead, do everything higher, and start the pull-out earlier. Again, the idea is to prevent having to be perfect just to survive.

- As you can see, the measure of safety on your swoop is how little toggle it takes to get to level flight. If you are pulling toggles down hard and late, you need to start the turn much higher, so that you don't require any toggle input to pull out of the dive. You may also need to learn how to perceive far sooner that you are getting too far in to the corner. This way you can apply a little toggle up higher, rather than a lot of toggle at the last instant. In other words, you need to work more on better planning of the approach. Probably a less steep approach would help!

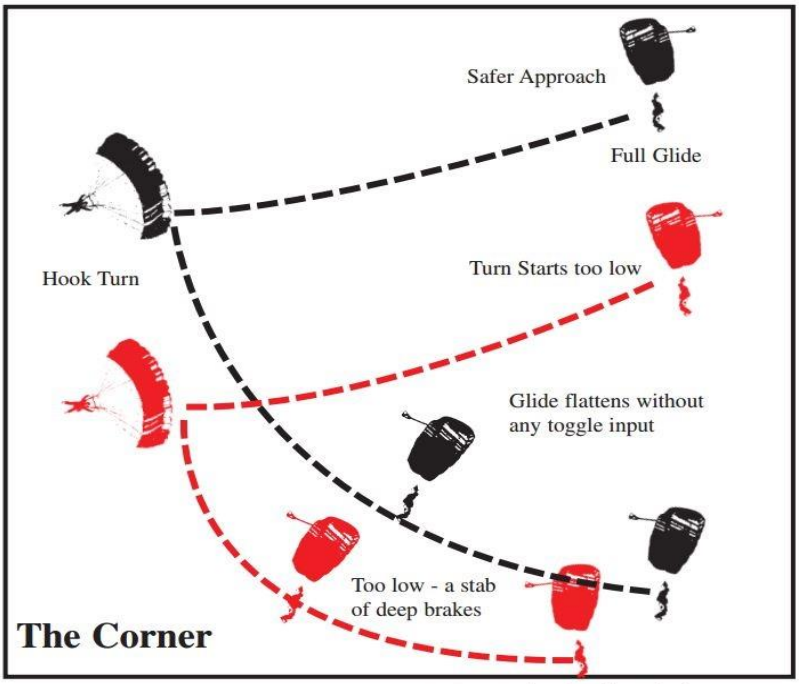


Diagram by John Leblanc of Performance Designs

Avoid these hook turn traps:

(a) The courtesy trap

You can only pay so much attention to being courteous to others while under canopy. Do not pay so much attention to others that you forget to leave yourself plenty of safe options too.

(b) The dropping winds trap

This is one example of failing to adjust for the changing conditions as the day progresses. People who have been flying the same downwind approach to the landing area all day tend to get very used to the sight picture that they have.

As the wind drops, this sight picture will change as the wind will no longer be helping you get back to the landing area so quickly; but you may continue to try and fly the old sight picture. If you are getting caught by this, you will feel you are sinking faster than you expected while on downwind, so you try and float in the brakes a bit more than previously.

In an attempt to keep the same landing spot as earlier, you may find yourself trying to float downwind a little farther as well. All this adjusting eats up airspeed and altitude, both of which are needed to turn into the wind.

If you are also tired from a day of jumping, you might find yourself ignoring these signs, turning too low to survive.

(c) The "I'm really gonna swoop this time" trap

This is a situation where the jumper is so enthusiastic about their swoop landings, that they forget about everything else! They see their desired approach as the only possibility and will attempt that approach regardless of whether there are problems with traffic, spectators, winds, or turbulence. They forget that other options exist, and are very likely to have an accident.

(d) The race horse trap

A jumper making the mistake above has often also fallen into the race horse trap. Race horses sometimes wear blinders on their eyes to restrict their vision. Sometimes jumpers pay so much attention to their own approach that they don't see anything else, just like the race horse. Collisions near the ground are often caused by this, so it's very dangerous.

4.4 Learn to Fly Defensively – Piloting Skill, Judgment and Decision Making

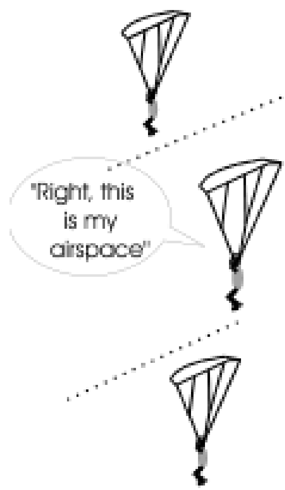
(a) Help create a safer situation for everyone, by landing in a different place than everyone else; and/or a different time than everyone else

The goal is to prevent a high density of landings occurring in a short period, in a small area. Many of the worst accidents are collisions that occur at landing time, often because there are just too many canopies going too many directions to be safe! Less traffic density means less chance of an accident.

1. Diffuse the hot landing area by taking the initiative to land somewhere else.

Walking is healthy! It's better than being carried back on a stretcher. By choosing to land somewhere else, rather than joining into the already crowded traffic on final to the "cool" landing area, you'll make it safer for yourself, as well as making the "cool" landing area a little less crowded for the others.

2. Timing: stage the approaches to the landing area.



See where everyone is. Ask yourself two questions:

(i) Are you near the top of the bunch or near the bottom?

(ii) Is your canopy loaded more heavily or more lightly than the others?

…then:

If you're more toward the bottom, and have an average wing loading for the group: You should land as soon as possible. You're trying to stretch out the time period that all the landings will occur by getting the landing process started sooner. If you don't do this, you may start crowding up the traffic behind you, just like a car driver would if he drove slowly in the fast lane.

If you're more toward the bottom, but have a big floaty canopy: The faster traffic will probably catch up and pass you. Where would you prefer this to happen? If you dive down and try to set up on final approach early, you will probably be passed during your final approach. In this case, assuming the spot is good, it might be better to float in the brakes right from the start. This will force the faster traffic to pass you while you are still quite high. Being passed up high is safer than being passed on final approach.

If you're more toward the top: You should try to float in the brakes. You're trying to stretch out the time period that all the landings will occur, by landing later. This is easy if you are on a larger floaty canopy.

What if you're more toward the top, but you have a high wing loading? If you're loaded heavily, you can still probably float in brakes quite well. Try to stay up with the big floaty canopies, until you find the biggest gap in the traffic that is below you. Then you fly down and fill that biggest gap. That gap is usually just in front of the big floaty canopies.

(b) Learn the habits of others

Anticipating the actions of others will help keep you out of trouble. Here are some examples:

1. Watch out for slower traffic below: the indecisive slowpoke.

You'll often find someone with a big canopy that likes to do sashays while in the final approach area. If you're flying a much faster canopy, don't follow this slowpoke on their downwind leg. You may get stuck behind them, needing to pass them on late final. The problem is, you may not be able to predict where they will be when you pass! It's better to pass them earlier on, or turn your base leg early, landing more up wind than them.

2. Watch out for faster traffic from above.

Some people like to set up in brakes very high over the approach area, then dive steeply down in a front riser turn and swoop landing. Unfortunately, some of these people do it every time, regardless of the traffic, and they may not be seeing you. This is a bigger problem for people at lower wing loadings who have arrived at the landing area early (see #1 above). Even though you may technically have the right of way over the higher traffic, it might be a good idea to land elsewhere if you anticipate a conflict.

3. Don't get trapped by the last-second hook-turner.

This person loves to do low toggle turns, much lower than you're willing to risk. If you're following the ‘last-second hook-turner’ back from a bad spot, don't wait for them to turn into the wind before you do! You'll probably be turning lower than you want to be! If they are following close behind you and below you, they might be obstructing your turn into the wind. Remove yourself from this situation while there is still plenty of altitude.

(c) Create good habits for yourself

1. Check the spot early during the skydive.

Many marginal spots are made worse by aimlessly wandering around for a few seconds while figuring out where you are. If you can do so quickly, check the spot during climb out if you're a floater waiting for others to climb out. Check it if you have an idle second or two during freefall. Checking the spot early and frequently will give you advance warning of a bad spot. You will know right away which direction to fly your canopy. You might even decide to break off and get safe separation earlier so you can open higher.

2. Improve your tracking.

You'll get safe separation sooner if you improve your tracking. This will help you avoid the off airport landing, and will reduce chances of a collision during opening. The higher the wing loading on the load, the more separation is required. Most people are way too comfortable with way too little separation!

Review 4.1 for details.

4.5 Conclusions

Most of the canopy survival skills are a combination of improving piloting skills, developing better judgment, and improving decision making skills. This must be a continual process.

We must not fall into the all too common trap of thinking that we've completed the learning process and are now safe from harm, as this can be a fatal error.

So keep working on developing your skills, judgment, and never stop learning!

PART 5: IMPROVING LANDINGS

5.1 Landings

(a) Straight-in approach and landing

An aggressive approach should not be required to land any canopy. All canopies, when flown with a reasonable wing loading, are designed to land nicely by making a straight, full-glide approach and carefully executed flare.

Higher aspect ratio or elliptical canopies are less forgiving of poor technique and are particularly unforgiving of poor heading maintenance during touchdown. So, when you reach for the ground with your front foot, be careful to maintain your directional control.

A common fault is to see jumpers suddenly veer to one side during landing, not due to a wind gust as they usually claim, but because they allowed one hand to move relative to the other or the leg strap on one side to be pulled down as they reach for the ground.

A word here on pumping your toggles: Don't! This does nothing to improve the aerodynamics of the situation and at worst can induce an early stall by disrupting the airflow over and under the wing.

On a new (to you) canopy, only toggle manoeuvres should be used until you are fully familiar with the flight characteristics. Perform nice easy turns and level conservative straight-in approaches for landing. High performance manoeuvres to gain extra airspeed should not be necessary to get good landings and should not be used as a substitute for having a suitably sized canopy or the appropriate skills.

Only after you have mastered a canopy using conventional techniques and have developed an intuitive feel for its standard flight characteristics should you progress to learning more aggressive techniques.

Essential Manoeuvre: Precision Landing Pattern

- Enter the pattern with sufficient altitude for the decent rate and glide ratio of the specific canopy.
- Fly a semi-linear **Downwind, Base and Final Approach** with minimal adjustments so as to coordinate with other traffic in the pattern.
- Demonstrate the ability to appropriately adapt the approach pattern to reflect the specific needs of the opening point or other issues that may affect the safety of theflight.
- Demonstrate sufficient Situational Awareness while in the pattern, not only of location and altitude, but of traffic as well.

Approach technique will vary depending on type of parachute, the pilot's experience level, as well as situational variables. While flying the pattern in full flight may be appropriate for some pilots under certain conditions, others may find more success by flying a braked approach during the Downwind and Base leg of the pattern.

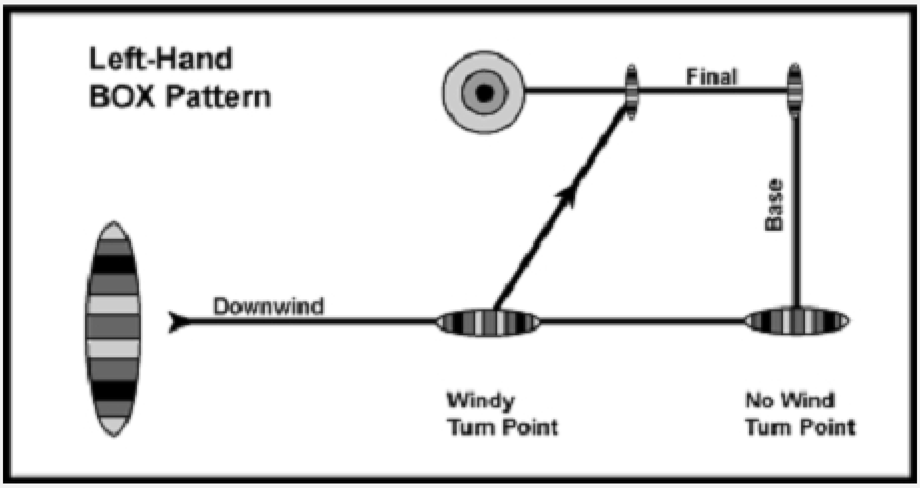
Deep brake approaches can deprive the system of the airspeed necessary for a safe landing, especially on heavily loaded canopies. Final approach, then, should be primarily flown in full glide with only subtle corrections.

* The smaller the canopy, the more altitude is necessary for a safe landing pattern. This is due to the higher descent rate, and increasing the pattern entry altitude allows for a similar amount of time in the pattern for all canopies regardless of size.

Why?

Consistency in the landing process allows a pilot to notice differences and make necessary changes to the flight path early enough to ensure safe landings. Further, by flying a predictable pattern into landing, other traffic will better be able to expect the next change to the flight path, thereby reducing the chance of collisions.

The accuracy method referred to as "S" turns are useful for approach adjustments in the absence of traffic, but create a dangerous situation when multiple parachutes are landing at the same time. Therefore a standard "Box Pattern" creates a safer situation in the landing area, and is an important skill prior to downsizing or changing planform.



5.2 What to focus on

(a) Altitude control is the key to no-wind landings

It is not so important to be exactly at a specific altitude when starting the flare, but it is very important how high you are when you finish the flare. You should finish the flare so that you have no rate of descent (or at least your minimum rate of descent) when your feet are at ground level.

(b) For the best landings, transfer the weight from harness to ground gently and gradually

If you are at zero rate of descent with feet at ground level, you can gently press your feet on the ground while you continue to sit in the harness. With the first step, you can remove a little weight from the harness, by stepping only lightly on the ground, and more heavily on the next steps, until all your weight is transferred from the harness to the ground. To do this you must have the zero rate of descent at ground level, not higher. You must also maintain adequate flying speed during this time. No parachute or any other wing is capable of supporting you at no forward airspeed!

5.3 What to avoid

(a) Avoid using your hands and arms for balancing or protecting yourself during the flare and landing

The canopy will respond to every toggle movement (or shifting in the harness), even when you are well into the transition to being on the ground.

The higher the wing loading, the more pronounced this will be.

Watch the landings of other people and get video of your landings.

(b) Look for these common errors

1. Lifting one toggle at touchdown

This is the balance trap. If you feel like you are falling to one side, you may try to stick an arm out for balance, which turns the canopy. You may think it was a side gust.

2. Extending a hand out to protect yourself

This is the protection trap. By extending your hand out to the ground to protect yourself, you unknowingly steer the canopy in that direction.

Inexperienced pilots often steer to where they are looking, and the canopy will respond to every toggle movement or shifting in the harness. Practise PLRs as an alternative to an awkward landing.

3. Stabbing the ground with your feet

This is done usually in anticipation of a hard landing. It hurts the legs and feet, and is usually accompanied by lifting both toggles backwards and upwards, which compounds the situation by causing the canopy to dive harder at the ground.

4. Fighting the wind

This is letting one toggle come up and pushing the other one down prematurely, in anticipation of difficulties in getting the canopy on the ground in high winds. This can produce some really ugly accidents. Make sure you are really on the ground first, then get the canopy on the ground.

5. Tunnel vision

Though we try our best to avoid it, all of us tend to concentrate more on our flight path as we get closer to landing time. Sometimes swoopers or accuracy jumpers start having this problem much higher up. This is very dangerous! Keep looking around and seeing people!

- **Look around at your height AND look down to where you want to go.**
- **Look where you will be going.**
- **Before you turn, look to see who else might be there.**

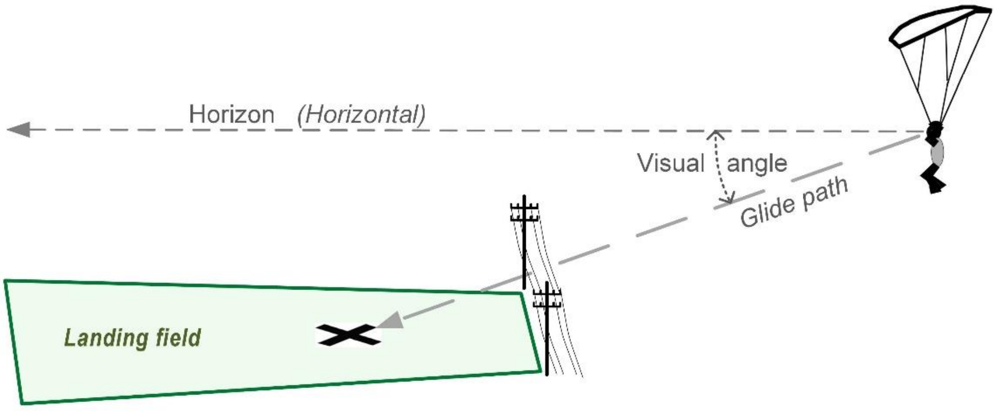
6. Flaring too slowly, too high, or too far, etc.

Experiment more while up high. Watch other people's landings and watch videos of your own landings. Usually this is a perception problem.

5.4 Avoid Landing Accidents – The Accuracy Trick

(a) Develop the perceptual skills needed for using the Accuracy Trick

You need to develop the skill of recognising a very small change in the **visual angle** to any point on the ground. This visual angle is created by your glide path, which can be sensed as the angle between the horizon and the line you are flying to the potential landing spot.



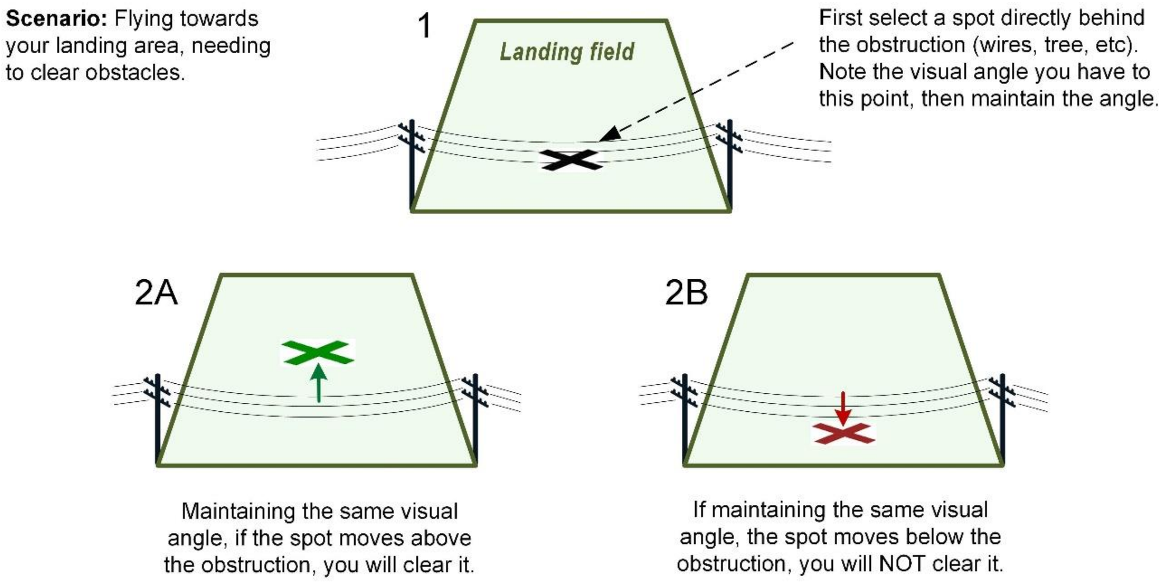
The more you hone this skill, the earlier in the canopy flight you'll know exactly where you're headed, whether the winds are causing an unexpected detour, or which flight technique works best in bad spots.

(b) Here's how the Accuracy Trick works

If the angle to a particular point on the ground is slowly becoming steeper in your field of vision, then you will fly past that point, unless something changes. If that angle is getting steeper very quickly, you're flying way past that point.

Pick another point that is well beyond the first one. If the angle to this point is slowly becoming shallower in your field of vision, then you won't make it that far, unless something changes. If that angle is becoming shallower very quickly, then you're headed way short of that point.

Between these two points, there is a third one that seems to remain at a constant, unchanging angle. Let's call that point the **"special point"** that doesn't move. If the winds never changed, and you never moved your toggles, you would end up crashing into the ground right on that special point!



If the "special point" that had been staying at a fixed angle suddenly starts to move, then at least one of three things has happened: You moved the toggles, the wind has changed, or your perception is getting better. Regardless of what caused the change, you know you are now headed somewhere else, a new and different "special point".

Video resource: Watch AXIS Flight School's 'The Accuracy Trick' here:
https://www.youtube.com/embed/5OHYTvdQdjk

(b) Using the Accuracy Trick on a very long spot with a tailwind

1. Flying at full glide looks fast, but it is not going to get you very far.
2. A simple rule such as, "On a long spot with a tailwind, fly half brakes," may be better than nothing, but it is far from the ideal. To avoid the off-DZ landing, you may need better performance than a simple guideline can give.
3. Instead of relying on a simple guideline, use the accuracy trick to discover what control position gives you the most distance across the ground in the particular tailwind you have at the time:
   (i) Find the special point, then add some brakes. If the visual angle to the special point is now getting steeper and steeper, it's because you're doing better. How much better? To find out, discover the new special point beyond the old one. The visual angle to this new point is flatter, indicating that you are doing better.
   (ii) Now add even more brakes. You're flying quite slowly now. Repeat the process of seeing the angle changing and finding the new special point. The direction the angle moves indicates if you're doing better or worse. Keep repeating the process of adding more brakes and evaluating the angle changes.
   (iii) You'll eventually find a brake position that makes the angle to the "special point" move in the wrong direction, so back off until you've reached the optimum. You'll be surprised at how deep you're in the brakes, and how flying so slowly is actually helping you go further.
4. Now you can use this process to compare the performance in brakes to the performance using rear risers. It does all depend on wind strength. Check your ground speed and altitude to assess which input is working best for you and your canopy. As a general rule in nil to light winds a small amount of rear risers will increase your forward speed best, while in strong winds using deep brakes will keep you up longer and the wind will get you back.

(c) Using the Accuracy Trick while penetrating a headwind on a long spot.

1. If you have a strong headwind, the special point that doesn't move will be quite close to you. If you need to fly past this point to get to a safe landing area, you will probably need to use front or rear risers. How much risers? Use the accuracy trick to find out.
2. Try a little front riser and the angle to the special point will change. Try a little more and it will move again. Try a little more. Did the point move the wrong direction? That's too much front riser.
3. In a light headwind, you might be surprised to find that a little rear riser input is needed instead. Which control input you need depends on your weight, the canopy, and the wind condition. It's up to you to find out what works best. What about a crosswind? The Accuracy Trick will help you discover what technique works best, including the best crab angle.

(d) Your body position will also assist getting you back from a long spot by reducing drag.

(e) Don't forget to leave yourself plenty of safety margin for setting up to land.

Use the accuracy trick in this way to get back to a safe place, but be careful to avoid fixating on the angle changes so much that you forget to keep an eye on your altitude. Look around, and use your safe options while you still have enough altitude. Make sure you leave yourself plenty of altitude and manoeuvring room to plan a safe approach and landing.

Video Resource: Watch AXIS Flight School's 'Long Spot Navigation - Relative Glide' here: https://www.youtube.com/embed/sGeTqaGS46Y

5.5 Conclusions

- Acknowledge your current limitations.
- Constantly play "what if" situations when you're flying.
- If in doubt, choose the conservative option.
- Create safe situations for yourself and others.

Vow to become a Student of Canopy Piloting again.

Have fun!

PART 6: CANOPY DOWNSIZING

Before people downsize, they should have formulated their plan for their progression in the sport, have attended a Canopy Pilot Course and have completed a set of canopy piloting tasks to develop their skill set of essential manoeuvres. The following checklist are those skills that all canopy pilots require.

6.1 The Checklist Skills

- ☐ 1. Flat turn 90 degrees at 50 feet
- ☐ 2. Flare turn at least 45 degrees
- ☐ 3. Land crosswind and in no wind
- ☐ 4. Land reliably within a 10 metre long runway
- ☐ 5. Land on slight uphills and downhills, off DZ, in unfamiliar terrain
- ☐ 6. Land with rear risers.

Skill 1: Flat turn 90 degrees at 50 feet

This is the most important of all the skills. The objective of this manoeuvre is to change your direction 90 degrees losing as little altitude as possible, and come out of the manoeuvre at normal flying speed. Coming out at normal flying speed means you can instantly flare and get a normal landing. If you can do this at 50 feet, and come out of the manoeuvre with normal flying speed at 5 feet, you can flare and land normally.

Every year, people die because they decide they simply have to turn at 100 feet and know only one way to do it – pull down a toggle. The parachute dives and they hit the ground at 40mph. To prevent this, not only do you have to know how to flat turn, but you must practice it enough that it becomes second nature. Then when you do need it, you won't have to think about it.

To pull off this manoeuvre, start by toggle turning the parachute gently. IMMEDIATELY follow that with some opposite toggle. The idea is that you want to flare just a little to counteract the canopy's desire to dive. Continue adding opposite toggle until you've stopped the turn. At this point let both toggles all the way up. If you feel the parachute accelerate after you let go of the toggles (i.e. it feels like you just flared), use less opposite toggle next time. If you feel like the parachute is diving, like you just did a toggle turn, use more opposite toggle next time. Basically you want to start the turn with one toggle, stop it with the other one, and use just enough toggle to keep the wing from diving but not so much that it does a flare.

It should be obvious that this manoeuvre should be practiced up high before you ever try it down low. If, and when, you do try it out low, start at lesser angles (i.e. try a 15 degree turn first) make sure the pattern is clear and make sure conditions are good (soft ground, good winds). Work up gradually to a full 90 degree turn. I do think it's important to try at least a gentle flat turn very low; we are horrible judges of exact altitudes when we're at 1000 feet, and it's hard to tell if you've lost 50 feet or 200 in a turn. By trying it out down low, you'll get a better sense of what it can do for you, and you'll have the “sight picture” better set in case you must use it for real one day.

A variation on this is to go to half brakes and then let one brake up. This gives you a flat turn, but by flaring first you “use up” some of the canopy's energy so you can't turn as effectively. On the plus side the turn happens more slowly. If you are about to hit a tree and want to make a last minute turn, this variation might be the way to go, as it combines a turn and a flare.

Skill 2: Flare turn at least 45 degrees

This does two things – it gives you another tool in your arsenal to dodge last minute obstacles, and teaches you to fly your canopy all the way through to the landing. The #1 mistake jumpers with new HP canopies make is to "reach out to break their fall" while they're flaring; this of course turns the canopy in the direction they are reaching. Most people decide that this is due to a side gust just as they're landing. I remember one jumper at Brown who, amazingly enough, experienced a side gust seconds before he landed (and always from the right) 40-50 times in a row!

Learning to flare turn will help eliminate this problem.

To flare turn, start with a normal flare, then flare _slightly_ more with one toggle. The canopy will turn. Bring the other toggle down to match it, and the canopy will straighten out. It's a dynamic process; rather than put the toggles at a certain position, you have to speed up one toggle for a second, then speed up the other to match it, before you level them and finish the flare. If you balloon upwards, then don't flare as quickly. If you drop to the ground, bring both toggles down more aggressively when they are 'split.' One thing that helps people is to think about where your canopy is rather than what it's doing. Use the toggles to put it off to one side for a moment, then use them to put it back over your head.

Note that if you combine a flare turn with a flat turn, you can pull off nearly a 180 degree turn at just above 50 feet. Also note that knowing how to do flat and flare turns doesn't mean you can always turn at 50 feet and get away with it – sometimes it's better to accept a downwind landing than make a turn at a dangerously low altitude. But if you do have to turn low (say, you're on course for the electrified fence around the pit bull farm) a flat/flare turn will let you either turn and land normally or turn and minimize the damage caused by landing in a turn.

Skill 3: Land crosswind and in no wind

These are straightforward. No wind landings are pretty easy; the only issue is that your perception of speed and altitude will be off. Since you seem to be moving faster over the ground when there's no wind (which you are) it can seem like a good idea to add just a little brake to 'slow you down' before you land. Resist that urge! Keep that speed in your canopy; you can turn the speed into a good flare only if you start the flare with decent (i.e. full flight) speed.

Crosswind landings can be a little trickier because of that strong tendency to want to "reach out to break your fall." Counter this by flaring with your hands in towards the center of your body. You may have to PLF on these landings, since you'll have some decent forward speed and have some sideways motion from the wind. If you want to get fancy, try a flare turn after you start your flare on the crosswind landing – you can easily pull off a standup landing if you get turned enough before you put your feet down. If these work well you may want to try a downwind landing. The benefit to doing that is it will prepare you to accept a downwind landing in the future; you won't be tempted to turn too low to avoid it. Choose an ideal day for this one, with a slippery landing area (wet grass is perfect) low winds and a clear landing area. Prepare to PLF, and think about "laying it down" on your thigh as you land to start sliding. You can slide across grass at 30mph without getting hurt, but planting your feet and cart-wheeling at those speeds can be very dangerous.

Essential Manoeuvre: Heading Changes in the Landing Surf

- Set up a final approach approximately 45 degrees off the windline
- Achieve zero descent rate within 5 feet of the ground
- Roll and Yaw the canopy into the wind
- Recover the bank angle to zero without overcorrection about the roll axis
- Complete the flare for a soft, stand-up landing.

Special Considerations:

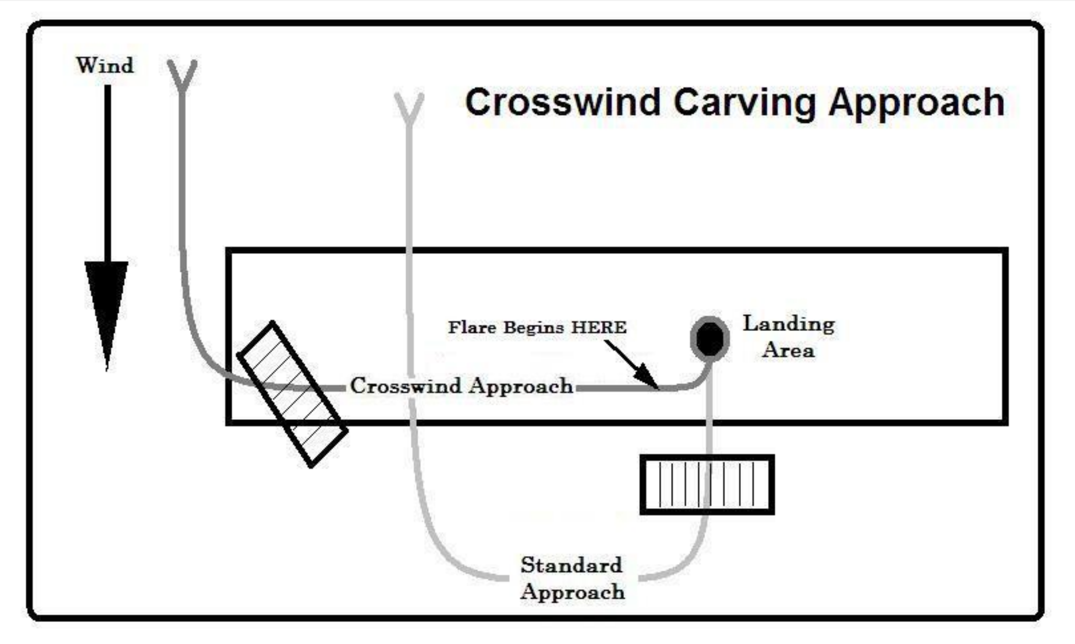
Airspeed is necessary for the performance of a level flight turn. It is not necessary, however, to accelerate the parachute beyond full flight glide in order to perform the manoeuvre.

It is essential that this manoeuvre be rehearsed numerous times at altitude prior to attempting it close to the ground. Roll axis wobble due to overcorrection can result in hard landings, and practice is the only way to become comfortable with the roll axis instability experienced at a high angle of attack.

Why?

Controlling the heading throughout the landing process is essential for safe canopy flight. The increased airspeed and groundspeed exhibited by smaller parachutes causes longer landing surfs as well as a longer period of time in this phase of the landing. This increases the risks of colliding with obstructions on the ground as well as other canopy traffic. The skill of controlling the parachute's heading while maintaining level flight is therefore even more important on parachutes with higher wing loading, and for pilots working on advanced approach techniques.

In the event that the landing area is narrow and off the wind line, the ability to make a crosswind approach allows the pilot to reduce the risk of hitting an obstacle on the ground by overshooting the landing site. Making a heading change back into the wind during the landing flare reduces groundspeed substantially, as well as the distance covered across the ground.



Essential Manoeuvre: Crosswind Landings

- Set pattern and final approach 45 to 90 degrees off the windline
- Complete Level-Off within touching distance from the ground
- Complete the landing flare for minimum groundspeed landing
- Slide or PLF landing should be performed, rather than attempting to run.

Special Considerations

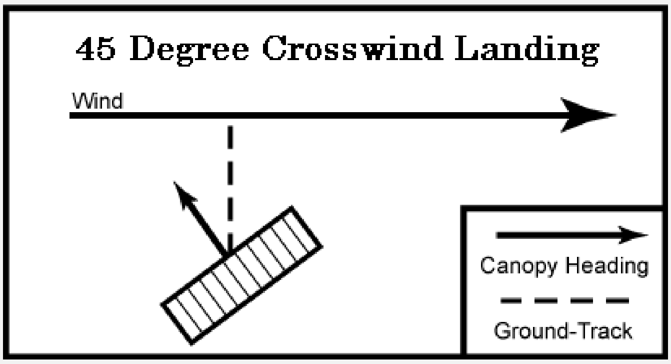
Attempting to run out a crosswind landing significantly increases the risk of injury. The jumper must place the heels on the ground first facing the direction of motion, and then gradually ease back onto the butt toward the completion of the landing. It is also important to continue the flare while sliding for the lowest possible groundspeed.

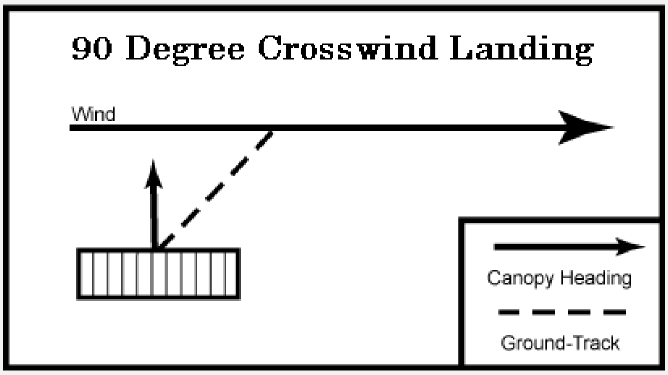
Do not attempt the crosswind landing exercise above 10 miles per hour ground wind velocity. In the event that the jumper is forced to perform a crosswind landing in high winds, it is advisable to carve the canopy into the wind during the landing flare as much as possible, without touching down with significant bank angle.

Crosswind landings must always be performed away from the normal landing area so as to avoid creating a traffic hazard. Further, the site chosen for this manoeuvre should be clear of rocks or other obstacles, and should be level terrain.

Heading changes may be necessary on any landing, and looking forward toward the direction of flight is crucial.

***Do not attempt to land more than 90 degree off the windline while practicing thisexercise.**





Why?

If a pilot is not accustomed to landing with high groundspeed, they will be more likely to attempt to make a dangerous low turn to face into the wind. If, however, they have practiced landing crosswind, they will be prepared for the additional challenges with this type of approach.

Skill 4: Land reliably within a 10 metre long runway

This is essentially the PRO requirement. This is critical because your accuracy skills are what will keep you from having to turn low. It's very comforting to know that you can land in any 50ish foot clearing if you find yourself having to land out; it's especially important as you get to smaller canopies that need longer and longer runways to land well. Your only option may be a section of road, and you may have to hit the beginning of the road dead-on to have enough room to slow down.

Essential Manoeuvre: Accuracy Landings

- 30 **Stand-Up Landings** within 10 meters of the target centre, consisting of:
- (10) No wind/light wind accuracy
- (10) 5-10 mph
- (10) 10-18 mph
- Full Flight Approach
- Braked Approach (5-10 mph wind, no turbulence).

The ability to land precisely in a planned location is essential for safe parachuting. This allows the pilot to negotiate constrained landing areas in the event of an off-field landing, eliminating the need for last minute corrections due to a faulty approach. Such missed approaches in tight landing areas often result in accidents.

Replication of the approach in varied conditions is also an important part of the demonstration of this skill, and is required for the fulfillment of this skill category.

Landing hard on target is not the goal of this exercise. Therefore it is also part of the requirement to land softly without the need for a PLF. This requires a more advanced understanding of the parachute so that the descent rate can be negated prior to landing. A “Flared Landing” requires accommodation of the horizontal “float”, so the target of the approach must be downwind of the actual landing point.

Depending on the size of the landing area, a full speed approach may or may not be appropriate. Therefore it is necessary to demonstrate the ability to make steeper brakes approaches as well. Such a method becomes crucial for small landing areas.

Skill 5: Land on slight uphills and downhills

When landing away from the DZ, often the ground isn't perfectly flat; sometimes you can't tell this until you're at 20 feet. To prepare for this, find a place in your LZ that's not perfectly flat, scope it out, and plan on landing there. There's not

too much magic concerning landing on a slope. You flare more aggressively to land going uphill, less aggressively to land going downhill.

Obviously not all DZ's have slopes. If you don't have a good slope on your DZ somewhere, you may have to put this one off until you're at a DZ that does have one. Beaches are a good place to practice this, since they have pretty predictable slopes down to the water, and overrunning the landing just means you get wet.

Skill 6: Land with rear risers

Knowing how to land with rear risers can help you deal with a canopy problem like a broken or stuck brake line, and can help you make a better land/cutaway decision when you do have such a problem.

Again, this is best practiced up high. Leave your hands in the toggles and reach up as high as you can making sure you grab the rear risers symmetrically between your thumb and forefinger. That way, if things go awry you can drop the risers and flare without the risk of dropping a toggle. See how far you can pull the rear risers before the canopy stalls. It will stall much earlier with rear risers; memorize where that happens so you don't do it near the ground. Now try pushing the rear risers apart and see if you can stall the canopy. It is recommended to push the rear risers apart rather than pull them down to lessen the chance of stalling.

When you try it for real, choose an ideal day – steady moderate winds, soft ground, clear pattern. Be sure to try this for the first time on a largish canopy (one of the reasons you should do these things before downsizing). Start the flare at a normal flare altitude, and prepare to PLF. You may get the sort of lift you're used to, but you probably won't slow down as much before you're near that stall point. Make sure your feet are on the ground (sliding preferably) before you get there.

When trying for the first few times, you may want to start the flare with rear risers. Then, once the canopy is leveled out, release the risers while transitioning smoothly to finish the flare with the toggles (which are still around your hands). That way you get your vertical speed to zero, which is the critical part of a safe slide-in landing, and can still stop the canopy without hitting the ground going too fast.

These are skills you should learn before you downsize. If you can't do some of them yet? Get some coaching. It makes a lot more sense to learn them on your larger canopy, before you start jumping a smaller canopy that scares you. Once you can do them all, then try the smaller canopy. And if someday someone cuts you off under the smaller canopy, you'll have the reactions you learned under the larger canopy. Even if you haven't completely adapted those manoeuvres to the smaller canopy yet, those reactions will more likely than not save your life.

6.2 Parachute Downsizing Criterion

As a guide to canopy downsizing, APF has produced the following chart and its explanatory notes, as well as descriptions of essential in-flight manoeuvres. The explanations are reproduced below are based on content downloadable from Brian Germain's web pages at: http://www.bigairsportz.com/article.php

Canopy Downsizing Chart

DOWNSIZING CHART 2017	EXIT WEIGHT (kg) = Parachutist plus all equipment														
NUMBER OF JUMPS	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120
1	190	190	210	210	220	220	220	230	230	240	250	260	260	260	260
20	170	170	190	190	190	190	200	210	210	220	230	240	240	240	240
50	170	170	170	170	170	170	190	190	190	200	210	220	220	220	220
100	150	150	160	160	170	170	190	190	190	200	210	210	220	220	220
200	150	150	150	150	150	150	170	170	170	190	190	190	210	210	210
300	135	135	150	150	150	150	170	170	170	180	190	190	190	190	190
400	135	135	135	135	150	150	160	170	170	170	180	190	190	190	190
500	120	120	135	135	135	135	150	150	150	170	170	170	190	190	190

(a) Notes and Explanations

- The chart is based on "Total Exit Weight" = Jumper + all equipment.
- The number of jumps already achieved are shown down the left column, with the corresponding canopy minimum square-footage shown for each weight. Jumpers are welcome to use a larger canopy than specified in the chart.
- The parachute sizes pertain to the **smallest parachute** of the dual parachute system (main or reserve).
- Size must be **increased** as necessary to reflect "Relevant Variables"

Due to individual differences in natural ability, judgment and demonstrated in-air awareness, there must be allowances for variability with the recommended size. To fit every canopy pilot into a finite formula is not reflective of the true nature of the situation.

Although some canopy pilots are ready to downsize beyond the recommended limitations of this chart, these are the limits specified by an APF Canopy Pilot expert committee. Most parachute manufacturers prescribe a Maximum Wingloading for a given parachute design, implementation of these limitations requires further elaboration.

(b) Relevant Variables

Density Altitude Compensation:
Surface area should be increased to reflect increases in density altitude [see section 2.7 of this Guide]. Increase the recommended size by roughly 10 square feet for each increment of 2,000 feet above sea level. This adjustment is subject to adaptation based on the proficiency exhibited with regards to the "Essential Manoeuvres" [see Parts 3, 5 and 6.1 of this Guide.]

Currency:
Add approximately 15 square feet for less than 100 jumps per year (i.e. 120 becomes 135)
Add approximately 30 square feet for less than 50 jumps per year (i.e. 120 becomes 150).

Canopy Design:
Add one size for fully Elliptical canopies.

- F.E.C. = More than 20% wing taper
- Fully elliptical canopies are not permitted for jumpers with less than 300 jumps;
- Prior to transitioning from a non-elliptical planform, all jumpers should make at least 100 on a non-elliptical parachute of the same wing-loading, or as dictated by the Canopy Transition Course [coach or] Instructor.

(c) Rounding Sizes

The parachute sizes prescribed by the Chart do not always coincide with the sizes marketed by a given manufacturer. Given this, jumpers should use the size closest to the prescribed number if the number is not a standard size. If the canopy is elliptical or radical in design in some other way, this may or may not suggest increasing the size further. This is a judgment call of the Canopy Transition Course Instructor, and should be based on the skills demonstrated by that canopy pilot. The best course of action is usually to err on the side of safety.

(d) Rounding Weight

Use the weight and size to the right of your numbers. If your weight is above the number on the chart, round up to next the higher number.

(e) Skipping Sizes and Planform Type

It is not advisable to change planform type and or size simultaneously in the transition process. Skipping sizes or changing planform type is a judgment call of the Canopy Transition Course Instructor based on the skills demonstrated by that canopy pilot, and the best course of action is to err on the side of safety.

(f) Beyond 500 Jumps

After a canopy pilot has exceeded 500 jumps, the only limitation on wingloading, size and planform is to be based on the **Specific Canopy Manufacturer's Recommendations** for that design and of the Safety and Training Advisor or equivalent instructional staff.

(g) Probationary Period

The initial jumps on a new canopy are a probationary period. This is an opportunity for the pilot to focus complete attention on the flight characteristics of the new canopy. Therefore, the first 5 jumps on a smaller or more agile parachute should be made solo, opening no less than 5000 feet AGL.

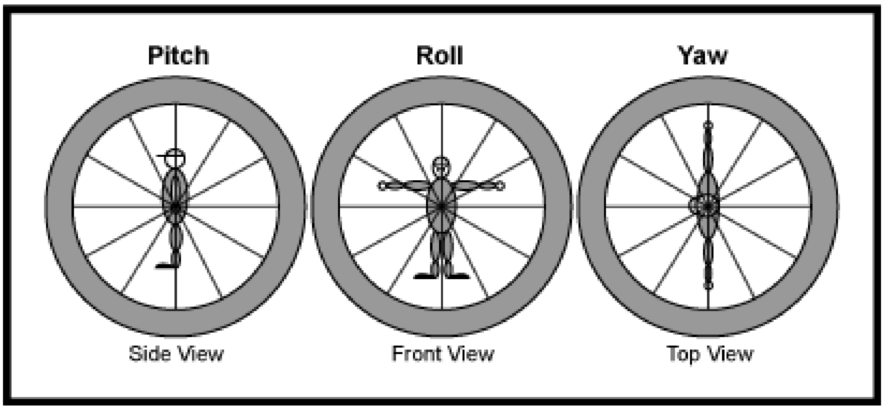
(h) Frame of Reference

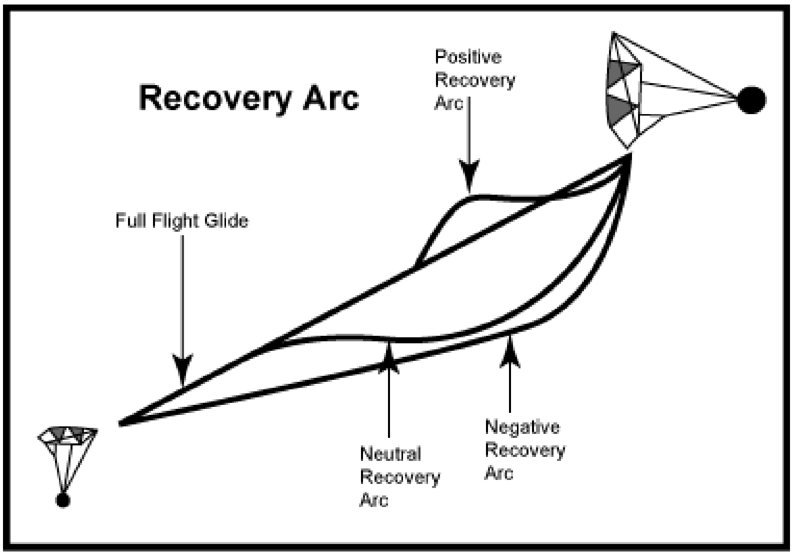
Depending on the jumpers previous experience, currency and individual ability, the canopy transition course instructor may chose to allow accelerated downsizing.

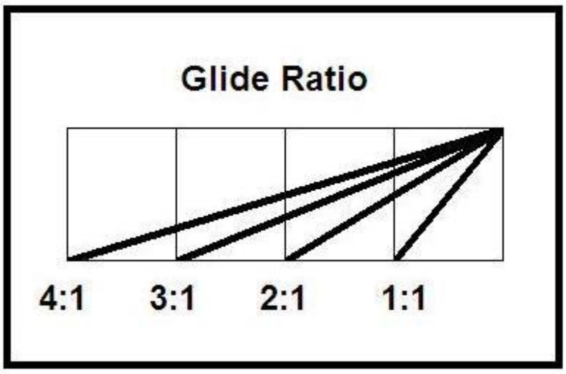
(i) Non-Linear Nature of Parachute Performance

Due to effects relating to the balance of drag between the suspended weight and the parachute, the same canopy design of varied sizes will perform differently with the same wing-loading.

Larger wings tend to have more **Roll Axis Stability**, shortened **Recovery Arc** and superior **True Glide Ratio***.





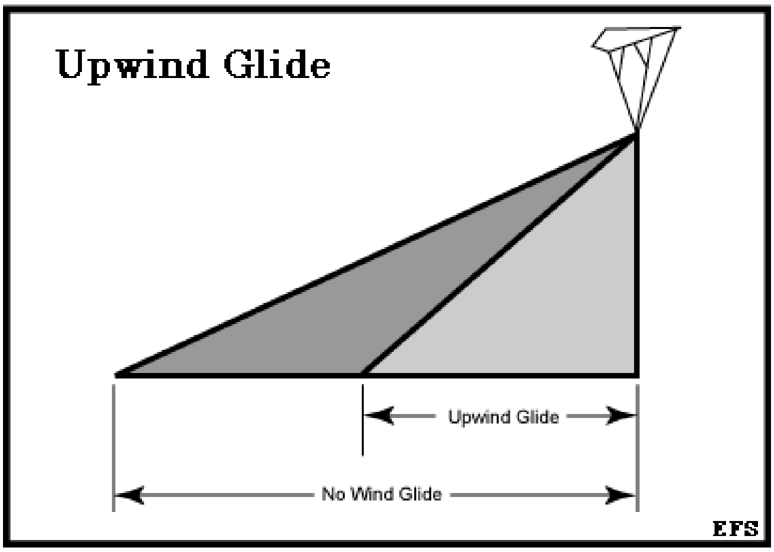


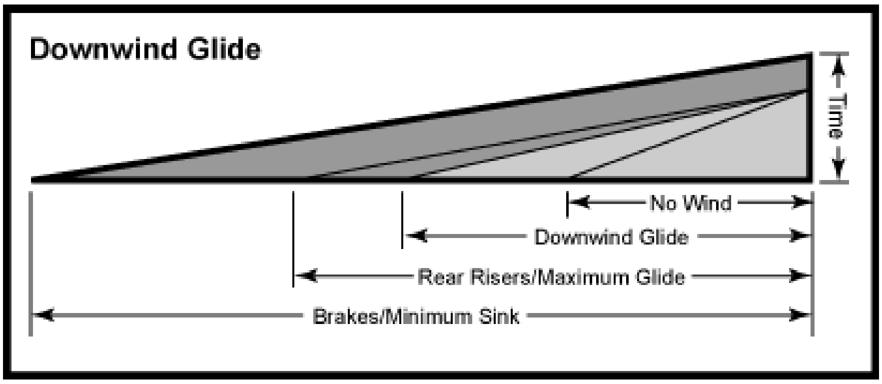
While a 170 square foot canopy may perform in a docile manner at 1.0 lbs per square foot, a 107 of the same design will be much more responsive at the same 1.0 wing-loading. Therefore, the

Chart skews the data in a non-linear nature, suggesting a more gradual downsizing progression for lighter pilots and a more aggressive paradigm for the heavier jumpers.

(j) Relative Glide Ratio and Wing-loading

Although **Upwind Relative Glide Ratio** is further enhanced with increased wing-loading, **Downwind Relative Glide** is more a function of descent rate than airspeed. Therefore, the best way to enhance Downwind Relative Glide is in the deep brake mode on a small canopy, or through the use of a larger parachute.





Smaller parachutes have several advantages when flying in high wind conditions, as well as in turbulent air. Further, heavily loaded canopies tend to perform more like fixed-wing aircraft, enhancing the extrapolative learning process. Nevertheless, downsizing prior to attaining the necessary skills and judgment is unwise and potentially very dangerous. Therefore, the preceding set of performance standards establish a baseline for a canopy pilot as they prepare to downsize. Without demonstrating these survival skills prior to switching to a smaller canopy, the increased airspeed, descent rate and roll axis instability are a set-up for failure.

6.3 Choosing your canopy

You may be a novice looking for your first canopy, or an experienced pilot looking for a different canopy.

Every manufacturer has different recommendations for canopy types and experience levels, so do your research. This is best done with the guidance of an experienced canopy pilot and possibly a Rigger.

You should also seek advice from a few other good sources to ensure a range of opinions. Ideally this should be un-biased advice, knowing that retailers of equipment will tend to only recommend their brand(s).

Here are some manufacturers' resources to help you with your choice:

www.performancedesigns.com/flight-characteristics

www.nzaerosports.com/

www.flyaerodyne.com/products.asp

www.parachutesystems.com

www.precision.aero/products.htm

www.zodiacaerospace.com/en/products-services/aerosafety/parachute-protection/personal-parachute-systems/sport-parachutes/main-canopy

www.fluidwings.com/#!products/c22fl

PART 7: TWO CANOPIES OUT

7.1 Introduction

The following text is reproduced from the original "Dual Square Report" produced February 4, 1997 by the Technical Committee of the Parachute Industry Association for their 1997 Symposium in Houston, Texas.

The heading numbering has been added for consistency within this Guide, and two of the Conclusions contain amended or additional text (highlighted).

The photos included in this Part have been inserted as an aid to recognition and understanding of the reader and were not part of the original Report.

Note: You should also refer to the APF's DVD, "Cutaway!" as an excellent training resource that covers how to deal with these two-canopies-out malfunctions.

7.2 About the 'Dual Square Report'

In early 1992 the U.S. Army Parachute Team, in conjunction with PIA, conducted a series of test jumps on the flight characteristics of two square parachutes (main and reserve) in flight at the same time. The study was undertaken in an effort to evaluate the ram-air canopy as main and reserve for student use. The army was interested, also, because some of their troops use square main/square reserve equipment.

The Army had planned to make about 50 jumps but were only able to do about 10. The canopies used were 288 sq ft Mantas with Raven III (249 sq ft) and Raven IV (282 sq ft) reserves. On the jumps conducted, the reserve was deployed manually while under a fully inflated and flying main.

In late 1992 and into 1993, Scott Smith made an additional 21 jumps using Crickets (147 sq ft), Fury (220 sq ft), and Sharpchuter (244 sq ft). The jumps were performed along the same lines as the Army tests with basically the same results and conclusions.

Both studies, while encouraging, were felt to be inconclusive by the PIA technical committee. Chairman of the committee, Sandy Reid, said that "In order to do a complete study, other canopy combinations need to be jumped such as: large main/small reserve, large reserve/ small main, and small main/small reserve." "In addition, we need to consider factors such as line lengths, zero porosity (ZP) fabric, and wing loading."

In 1994 Performance Designs Inc. proposed to the technical committee a series of test jumps designed to fulfill these unanswered questions. While realising it would be an impossible task to test every conceivable canopy combination and situation, the tests were an effort to get a good cross section of possibilities.

Both the Army Parachute Team and Scott Smith came up with conclusions that still stand true. Our test jumps allowed us to verify much of what they submitted and give additional input.

The following is the report on those test jumps:

7.3 Dual Square Test Equipment

The equipment used in the dual square test jumps was extensively thought through and planned. Every jump was conducted using a three or four parachute system. When deploying a canopy while under its fully deployed mate, the appropriate container and pack tray were used as well as normal riser lengths, and deployment systems. This was done to gather the most accurate data possible.

Note: During the 12 intentional cutaways from a biplane, the reserve was deployed using a hand deploy pilot chute with a main d-bag modified as a free bag. This was done to save on the loss of expensive spring loaded pilot chutes and free bags. The cutaway was being evaluated in these scenario's, not the deployment.

In all except the simultaneous/near simultaneous tests jumps both the main and reserve were on risers that had the capability to be cutaway. A chest mounted back up reserve was worn that was not capable of being cut away.

During the simultaneous/near simultaneous deployments a special system was assembled that would house 4 canopies. Two would be deployed from their normal locations. One of these could be cut away separately, or they could both be cutaway together. The third parachute if needed could also be cutaway, and the fourth was on risers that could not be cutaway.

Great care was used to assemble this equipment in such a manner that the sequence of deployment and breakaway would be in as much a normal sequence as possible.

7.4 Common Results of a Dual Square Deployment

The most likely canopy configuration from a simultaneous or near simultaneous deployment is a ***biplane*** with the main canopy in front and the reserve in the rear.

A biplane *is both canopies flying in the same direction with one behind the other. Excluding extremes, the shorter rear canopy's leading edge rests against the steering lines below the trailing edge of the taller front canopy.*

The next most common configuration is a **side-by-side** with the main risers behind the reserve risers.

A ***side-by-side*** *is both canopies flying side by side in the same direction. They are usually touching end cell to end cell, or the end cell of the shorter canopy resting against the outside lines of the taller canopy.*

Another fairly common configuration would be a fully inflated canopy (either main or reserve) with a ***trailing pilot chute, p.c. and bag, or trailing uninflated second canopy*** behind the jumper. This scenario if left unattended would sometimes remain as it is, or result in one of the other configurations.

A less frequently occurring configuration is a ***downplane***.

A downplane *is both canopies flying away from each other and toward the ground.*

Another infrequent configuration is an ***entanglement*** of the two canopies.

Note: Some people have always believed that you must choose a reserve that is smaller than the main. While this is probably a safe thing to do it is not an entirely accurate gauge. For example: a PD-143R has shorter lines than a Stiletto-135. This combination flew well in a biplane with the main in front. 7 cell canopies typically have shorter lines than equally sized 9 cells.

Conclusion: Use great care to choose proper equipment. Choose a reserve that is similar in size to the main canopy.

7.5 The Biplane

From looking at the simultaneous/near simultaneous deployment results, as well as numerous reports from the field, the biplane with the taller main canopy in front and the shorter reserve in the rear, is the most common result of both canopies deploying. This personal biplane seems to be stable and easy to control.

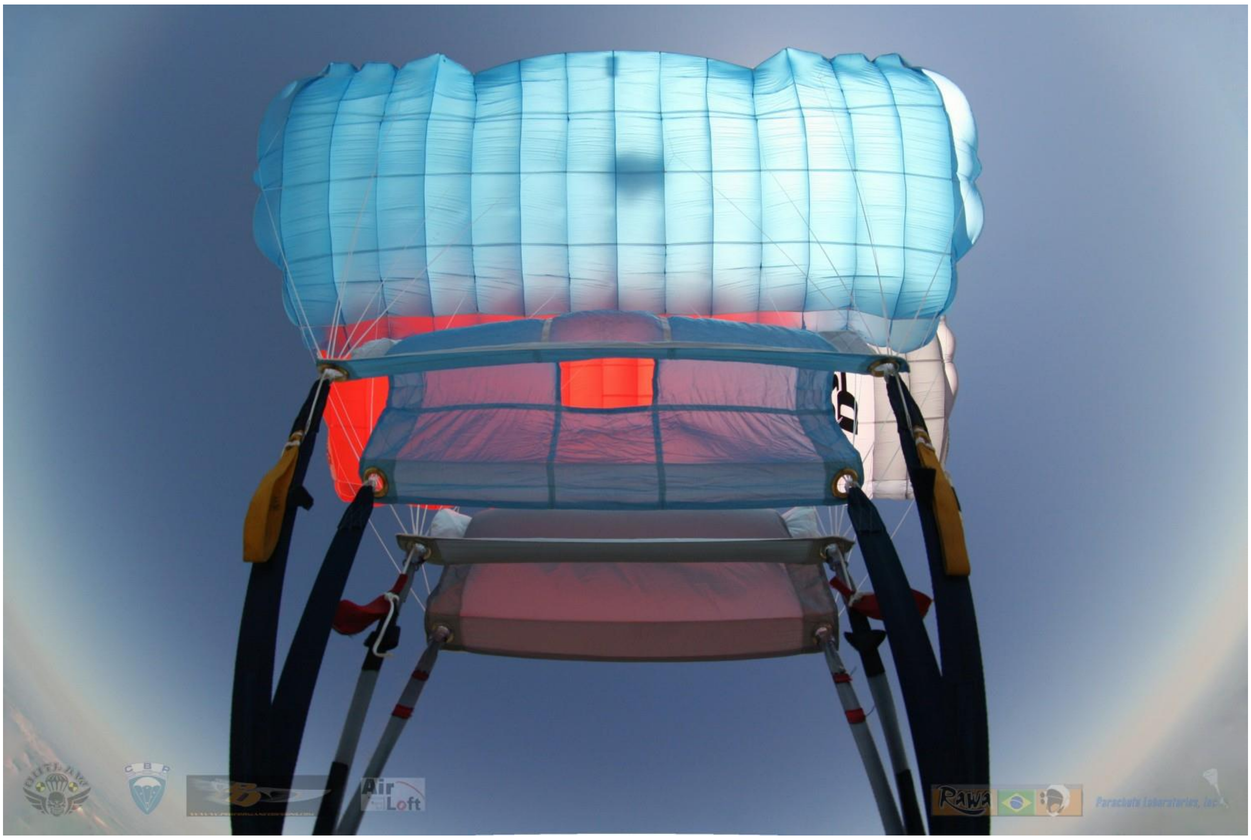


Photo by Performance Designs

Several combinations of canopies were used in the test jumps with some being greatly mismatched. Canopies with a difference of 100 sq ft or more could cause results out of the norm. We consider this type of combination to be extreme and not advisable.

The most commonly preferred method of flying the personal biplane is to leave the brakes stowed on both canopies and fly the rear canopy using smooth, gentle rear riser inputs. A few canopy combinations were reported to be slightly more solid with the brakes released on both canopies, but the majority seemed to be most solid with brakes set on the rear canopy.

With the canopies in a compatible biplane it did not seem necessary or wise to attempt to move the configuration into a side by side to cut away the main canopy. In moving one canopy or the other to a side by side it always seemed necessary to maintain outside input to one canopy or the other, or both, to keep them in that configuration. They seemed to always want to return to a biplane. Cutting away while the canopies are returning to a biplane could be dangerous.

In addition, while manoeuvring canopies back and forth between side-by-sides and biplanes there were times when the two canopies tried to foul with each other or did in fact foul with each other. It does not make any sense to take a docile, manoeuvrable, and landable biplane configuration and try to change it.

Landing a personal biplane proved to be easy with large canopies, small canopies, heavily loaded canopies, and lightly loaded canopies. Flaring the front canopy seemed to be the preferred method of landing. However, it must be noted that flaring the front canopy, or both, did not produce a significant effect in the landing. The canopy would pitch in attitude, but it did not plane out or slow in descent rate much if at all. The descent rate on all canopy combinations was very slow, even in full flight.

Recognising the student and novice jumpers' propensity to flare high, combined with the non-effectiveness of a dual square flare, leads us to believe that not flaring at all is the best way to land a dual square.

Conclusion: If a biplane is present and the jumper has directional control, leave the brakes stowed on *both canopies* and fly the biplane using gentle *rear riser* input on the *rear* canopy. Do not flare either canopy for landing. Be prepared to do a *PLR*.

If the toggles have been released on one canopy, then the biplane can be steered using gentle inputs using those toggles. If no brakes have been released, then steer with gentle inputs using the rear risers of the rear parachute.

***Note**: Text here in italics is different or additional to the original Report conclusion, based on more recent best practice.*

7.6 The Side-by-Side

The personal side-by-side was the result of the taller of the two canopies deploying behind the shorter of the two. Whether this was the result of mismatched canopies where the reserve was the taller and deployed second, or the taller main canopy deployed second, the result was always the same during our tests, except for the downplanes that are noted later.

Photo by Performance Designs

The reference to ***taller*** and ***shorter*** canopies is to indicate which canopy, when two are inflated together, is longer from the common connecting point on the harness to the very top skin of the canopies.

Line length alone doesn't seem to be an exact indicator as to which canopy is taller due to differences from manufacturers, harness/container sizes, and personal preferences in riser lengths. Different canopies will also have a variance in leading edge heights. At this time there doesn't seem to be an all-inclusive formula readily available for determining heights when suspended from a common point on the harness under a fully inflated canopy.

What seems consistent at this time is:

- If the top of the ***leading edge*** of the rear canopy is below the ***trailing edge*** of the front canopy the likely result will be a biplane.
- If the top of the ***leading edge*** of the rear canopy is at or above the ***trailing edge*** of the front canopy the likely result will be a side by side.

For the most part side-by-sides formed in this manner seemed to be a configuration that was easy to fly with gentle toggle input from the dominant (usually the larger) canopy. It is not recommended to fly this configuration with all four toggles. On one such test jump a flare was tried with all four toggles which immediately turned the two canopies into a nose to nose fighting match. This was not a desirable result.

In addition, flaring with the outside toggle of each canopy will turn the dual square into a downplane. This also is not a desirable result.

The side by side seemed to be more susceptible to instability than the biplane when faced with mismatched sizing and shape. Sometimes with mismatched sizes, the larger canopy wanted to out fly the smaller canopy. The result would be a twisted-up, partial biplane with the smaller canopy partially in back. The stability of the mismatched combination is marginal in this twisted-up partial biplane, and requires very cautious control input.

Cutting away from a side-by-side that does not want to return to a biplane seems to be a safe action as long as no equipment problems exist, and the canopies are not entangled. It must be noted that RSLs were not used in any of these tests. Great caution must be used when cutting away in that scenario due to the varied styles and applications of RSLs.

The jumpers also did not feel comfortable landing heavily loaded side by sides, especially when a highly elliptical canopy is involved.

Both the personal biplane and the personal side-by-side seemed fairly docile and easy to control. The biplane especially so. It should be emphasised that while this is certainly true, complacency should not take place in this situation. During all these test jumps the canopies were really put through the works and at times were caused to foul with one another. It should be noted that strong or erratic control input could cause undesirable results.

Conclusion: If a side-by-side is present and the *canopies are more than an arm's length apart, disconnect any RSL, if time/altitude permits, and cut away the main canopy.*

If the canopies are touching, then keep them together by steering using the inside rear risers of each parachute. i.e. to steer left, use the left rear riser of the right-hand parachute.

Do not flare either canopy for landing. Be prepared to do a PLR.

If the canopies do not seem controllable, and are not entangled with each other, disconnect any RSL, if time/altitude permits, and cut away the main canopy.

***Note**: Text here in italics differs from or is additional to the original Report conclusion, based on more recent best practice.*

7.7 The Downplane

The personal downplane was a rare but valid and possible result of a dual square deployment. It always involved line twists due to a tumbling bag on deployment of the main canopy when it was the second canopy deployed. While we did see an occasional flip in a reserve bag, it happened when the deploying lines reached the locking stows. The result in that case would be one, or maybe one half twist, which would untwist as the canopy inflated.

In most cases what started out as a downplane would quickly evolve into a side-by-side with no input from the jumper.

In the cases where the downplane did not recover on its own and the jumper did not feel like it was recoverable, there is question as to whether working the controls of the reserve canopy could have brought the downplane into a side-by-side configuration. The fact remains that this side-by-side would very likely result in a canopy with line twists remaining. This is probably not a configuration that one would want to land, and might still call for a cutaway.

The fact also remains that the reason a person is probably in this position to begin with is that their AAD fired. If their AAD fired, they are already low. If they are already low, there isn't much time to be playing around trying to undue things when that time could be used cutting away and sorting out the best place to land.

Being in a dual square situation calls for quick evaluation and quick action. A downplane plummets out of the sky at a high rate of speed. The best thing to do in a downplane situation is to disconnect any RSL and cutaway the main canopy.

Conclusion: If a downplane is present, disconnect any RSL, if time /altitude permits, and cutaway the main canopy.

7.8 Trailing Equipment

In some cases, the jumper found himself under one fully inflated parachute with a partially deployed second parachute trailing behind.

It was found to be easy to pull in a trailing pilot chute, or even a pilot chute, bag, and lines. Great caution must be used however in doing this. If the canopy should get out into the airstream it could inflate or partially inflate quite rapidly and get out of control. **We do not recommend trying to pull in an inflated or partially inflated canopy.**

Even a bagged canopy is dangerous to carry around due to the possibility of it getting away from the jumper and inflating. This happened on one jump just as the test jumper was making a turn into final for landing. The result was a late developing personal downplane that caused bodily injury.

It might be wise when possible to cut away any canopy that is going to be pulled in and carried to the ground. The very act of trying to pull in a partially deployed parachute can aid in its deployment with undesirable results.

Conclusion: If the main canopy deploys and the reserve is in a stage of deployment it might be best to aid the deployment of the reserve by shaking the risers. Then be prepared to take action on the resulting configuration.

If the reserve opens and the main is in a stage of deployment, it might be best to remove the RSL and cut away the main.

7.9 Main/Reserve Entanglement

We did have one simultaneous deployment that resulted in a spinning entanglement. The reserve deployed directly into the deploying main, trapping the main slider which choked off the main canopy's inflation. The test jumper tried pulling risers, but due to the spinning situation elected not to stay with it past 6 or 7 revolutions and cut away both canopies.

We felt after evaluating the situation that if the jumper had cut away the main canopy only there was a chance it would have cleared. This is however, only speculation.

Conclusion: If a main/reserve entanglement should occur, do everything possible to clear the two canopies by pulling on risers and/or toggles. Be cautious about immediately cutting away the main canopy as this may accentuate the problem.

7.10 Final conclusions of the Dual Square Study

Conclusion 1: Avoid

The best way to handle any Dual Square Scenario is to avoid the situation. Use appropriate and available altitude reporting devices to help maintain good altitude awareness. Follow safety regulations on proper opening altitudes. Ensure that AAD's are properly maintained and used. Use properly maintained equipment and gear checks.

Conclusion 2: Choose proper equipment

Use great care to choose proper equipment. Choose canopies that are not drastically different in size. A general rule of thumb is to choose a reserve that is similar in size to the main canopy.

Conclusion 3: Biplane

If a biplane is present and the jumper has directional control, leave the brakes stowed on the rear canopy and fly the biplane using gentle toggle input on the front canopy. Do not flare either canopy for landing, and be prepared to do a PLF.

* If the toggles have been released on one canopy, then the biplane can be steered using gentle inputs using those toggles. If no brakes have been released, then steer with gentle inputs using the rear risers of the rear parachute.

* This is additional to the original Report conclusion, based on more recent best practice.

Conclusion 4: Side by side

If a side by side is present and the jumper has directional control, fly the side-by-side using smooth, gentle toggle input of the larger/dominant canopy. Do not flare either canopy for landing, and be prepared to do a PLF. If the canopies do not seem controllable, and they are not entangled with each other, disconnect any RSL, if time/altitude permits and cut away the main canopy.

Note: This conclusion differs from or is additional to the original Report conclusion, based on more recent best practice.

Conclusion 5: Downplane

If a downplane is present, disconnect any RSL, if time /altitude permits, and cutaway the main canopy.

Conclusion 6: One out, the other in a stage of deployment

If the main canopy deploys and the reserve is in a stage of deployment it might be best to aid the deployment of the reserve by shaking the risers. Then be prepared to take action on the resulting configuration.

If the reserve opens and the main is in a stage of deployment, it might be best to remove the RSL and cut away the main.

Conclusion 7: Entanglement

If a main/reserve entanglement should occur, do everything possible to clear the two canopies by pulling on risers and/or toggles. Be cautious about immediately cutting away the main canopy as this may accentuate the problem.

Conclusion 8: Additional safety devices – New emergency procedures

Additional safety devices, such as AAD's and RSLs, may cause standard emergency procedures to change. Analyse the release recommendations and be sure they coincide with your equipment manufacturer’s guidelines. Practice these new emergency procedures prior to every jump.

7.11 Final Note about the Study

During the study we were besieged with requests from DZ owner operators and press wanting information on the tests. Indeed, at the onset of the study we intended to release information as we went along.

Yet it did not take long to realise this might not be a good idea. As we were preparing the equipment for the tests we reread the information that had been printed regarding the Army's tests.

There was one glaring error that bothered us. In the Army's summary, they reported a split decision between releasing the RSL and cutting away, or landing the side by side. A publication reported the army as saying, “If the two canopies form a side-by-side, jettison the main.”

Even still, we did release some information to another publication because we thought it was safe to do so, and felt it was important. We released the statement: “Intentional cutaways from biplanes showed that the main had the possibility of entangling with the reserve 11 out of 11 times, with 1 actual entanglement resulting in a cutaway of the reserve.” What was written: “All of these (11 jumps) showed at least a probability of canopy entanglement, or a brief entanglement that cleared.”

We were told at times that the public has a right to know what we are finding, and that the information could save a life. We realise that information put out in a timely manner could save a life. We also realise that information which is incomplete, misquoted, or taken out of context can cause the loss of life.

We feel that it was an appropriate decision to wait until all the tests were complete and the information carefully researched before releasing the results in a proper format.

Performance Designs, Inc. would like to thank all those individuals and organisations who helped make these test jumps possible, with special thanks to:

- Precision Aerodynamics, Inc. – canopies and cutaway rig. Jump Shack - cutaway rig. Skydive Deland – who dropped us at 5 – 10,000 ft. and then took extra time going the rest of the way to altitude so as not to drop other skydivers on top of our group.
- Rickster Powell, Brian Rogers, Gus Wing, and Scott Miller - Cameramen.
- John LeBlanc, Joe Stanley, Rusty Vest - Test jumpers.
- Wayne Downey – Equipment strategist

PART 8: A FINAL WORD

During the year prior to publishing this new guide, in Australia we had landings where personal canopy piloting resulted in one fatality and at least two members with life-threatening injuries. These two involved much trauma and were so serious that they are very lucky to have survived.

The instructors and canopy piloting experts have been frustrated by their own limited impact on low-time jumpers taking high risks – hook-turning too close to the ground, downsizing too quickly, and swooping before they build the necessary skills and experience.

Canopy pilots, like the one performing in this competition photo, have **thousands** of jumps, not 100 or 200. Similarly, those at the DZ doing the amazing swoops also have amassed a lot of jumps to get to the level of skill they hold – they're past the intermediate CP stage that spans about 200 to 700 jumps.

To help instil the necessary risk management thinking in the young and/or inexperienced canopy pilot, our experts believe it necessary to expose them to the carnage of bad decisions and serious consequences of high-risk behaviour. Think High School students about to be let loose on the roads attending sessions run by Emergency Services, Hospital Spinal Units and ICUs; being presented with a mangled person telling their horrible story; or a parent telling of the loss of their child. These are designed to demonstrate the shocking reality of combining inexperience with bad decisions and an it-won't-happen-to-me attitude.

In parachuting, we all go through developmental stages as we build capability, from student to novice to intermediate, and then advance in one of the many wonderful disciplines in our more and more diverse sport. While some jumpers will develop particular expertise in canopy piloting, every skydive has a canopy flight stage and a landing stage. This guide is to help you safely build your capability to fly your canopy and better enjoy its capabilities, and walk away uninjured after each landing having had fun!

Remember, the jump isn't over until after you are safely back in the packing area.

APPENDIX A: GLOSSARY OF CANOPY PILOTING TERMS

TERM	DEFINITION / INTERPRETATION
Aerofoil	The shape of a canopy.
Base leg	Phase of the landing pattern that takes you across the wind line. Also known as cross wind leg.
Brake	To apply brake by pulling down a on both steering toggles.
Cross Wind Leg	Phase of the landing pattern that takes you across the wind line. Also known as the base leg.
Downwind leg	First leg (phase) of your landing pattern.
Elliptical	A canopy shape designed to give more performance.
Final leg	Final phase of your landing pattern which should be made facing into wind. Also known as into wind leg.
Full drive	When a parachutist has both steering toggles all the way up (arms fully extended upwards) the canopy is on full drive. Also known as full flight, full speed
Flare	Technique used for landing a canopy.
Flat turn	A steering toggle input which, if executed correctly, causes the canopy to turn with a minimum amount of bank and altitude loss.
F 111	Material used in the construction of parachutes. Normally made of a fabric called Ripstop nylon. Ripstop nylon is designed to allow a minimal amount of air to pass through it when inflated. The amount of air that is allowed to pass through the material is known as porosity. Canopies generally become more porous as they get older
Half brakes	By pulling down approximately halfway on both steering toggles at the same time, we apply half brakes. This causes the canopy to fly at half its (full drive) speed.
Holding Area	An area that is upwind of the intended landing area from which you can easily make it onto the intended landing area.
Hook turn	A sharp toggle turn that pendulum swings the pilot out close to a horizontal angle, so that as they swing back under that canopy, they generate extra airspeed. If performed closer to the ground without spot-on technique and judgment, can lead to serious injury or death.
HP	high performance
Into wind leg	Final phase of your landing pattern which should be made facing into wind. Also known as final leg or finals.
LZ	landing zone
Quarter brakes	When both steering toggles are pulled down a quarter of their full length of travel (about 6 to 10 inches) the canopy will be said to be on quarter brakes and will fly at 3-quarters of its (full drive) speed.
S-Turn(s)	Flat turns (see above) that are used to lose altitude.
Semi-elliptical	See elliptical canopy above, but not as radical in shape.
Set-up point	A point where you intend to be located at a particular altitude (so as to begin the next stage of your approach).
Traffic	Other canopies in the air
Zero porosity material (ZP)	A material used in the construction of canopies. Fabric which starts out as F111 (see F111 above) and is given a coating which greatly reduces its porosity.

Downsizing Criteria

WHAT TO CONSIDER WHEN YOU WANT TO DOWNSIZE

- Competence, not jump numbers
- Currency and time in the sport
- Long term goals in the sport
- Change one size at a time or
- If changing planform (square to elliptical or to crossbraced) then same or similar size

DOWNSIZING CHECKLIST

The following in-air and landing exercises should be done to the satisfaction of the DZSO on your current canopy before considering changing size or type of canopy.

IN-AIR EXERCISES (TO BE PRACTICED ABOVE 2000Ft)

- Slow flight
- Stall and stall recovery using brakes
- Rear riser turns
- Flat turns
- Flare turns
- Harness turns
- Hook turn recovery

LANDING EXERCISES

- Land in nil wind
- Land in light crosswind
- Land on a slope (uphill and downhill)
- Full glide landing approach
- Demonstrate consistent accuracy in different wind conditions
- Are you confident to land off DZ?

OTHER FACTORS TO CONSIDER BEFORE DOWNSIZING

Have a plan for canopy progression (short term and long term)

Attend a canopy course

CI or DZSO approval

T: 07 3457 0100
www.apf.com.au

AUSTRALIAN PARACHUTE FEDERATION