Downsizing Intelligently: Choosing the Best Canopy Size

By Scott Miller

"What size canopy should I buy?"

Anyone who makes more than a handful of jumps will eventually ask this question. Almost every skydiver transitions to a different size canopy at least once, if not several times. When you ask this question it's important to find the right answer. And if someone asks you this question it's important to give good advice.

Today most of us are flying much smaller canopies than skydivers were ten years ago, and the idea that "smaller is better" has become very popular. Unfortunately, many people choose a smaller canopy for the wrong reasons and end up regretting their decision. Learning a few facts about canopy sizing and understanding some common myths can help you avoid this mistake.

It's difficult to discuss canopy sizing without using the terms "wing loading" and "exit weight." Exit weight is your body weight plus the weight of your clothing, rig, both canopies, and anything else you are wearing when you exit the plane. This is the amount of weight your canopy will have to support. A typical jumper's exit weight will be about 20 to 25 pounds more than his or her body weight.

In this article the weight given for a jumper is his or her exit weight.

Wing loading is equal to your exit weight in pounds divided by your canopy's surface area in square feet. For example, if Joe weighs 180 pounds and flies a 180 square foot canopy his wing loading would be 180 pounds divided by 180 square feet, or 1 pound per square foot. If Joe downsized to a 120 square foot canopy his wing loading would be 1.5 pounds per square foot (180 / 120 = 1.5).

Higher wing loading increases the speed of a canopy. Joe will have a faster forward speed and higher rate of descent under the 120 than he did on his 180. In fact, the smaller canopy will not be capable of flying as slowly as the 180. The 120 may penetrate better into strong winds, but may not glide as far in light winds or when running with the wind.

The smaller canopy will also turn more quickly and lose more altitude in a turn. Joe will need to plan further ahead and will have less time to react if something goes wrong. The smaller canopy might level off or "swoop" farther on landing, but timing the flare will be more difficult and crashing more painful. If Joe knows how to flare well he may have more fun landing the smaller canopy. But if his landings have never been great, or he has trouble adjusting to the new canopy, his landings will almost certainly be worse.

Some of these effects are caused by the size of the canopy itself, not just by the wing loading. Suppose Marco weighs 190 pounds and flies a 190 square foot canopy. The canopy is easy to handle and he lands well even in light winds. Let's say his girlfriend, Sue, has 20 jumps and is ready to buy her own gear. Sue weighs 135 pounds, so Marco tells her she should buy a 135. They would both be loading their canopies at 1 pound per square foot, so a 135 should be just as easy for Sue to fly as Marco's 190 is for him, shouldn't it?

Unfortunately, this isn't going to be true. As canopy designer John LeBlanc explains in his seminar on wing loading, different size canopies will not fly the same when flown at the same wing loading even if they are the exact same type of canopy. One reason is that both canopies will be flying through the same air. Sue may be 30% lighter than Marco, and her canopy 30% smaller, but the air molecules she flies through will not be 30% smaller or closer together.

A smaller canopy usually has shorter lines, which will make it react more quickly than a larger canopy flown at the same wing loading. Sue would find a 135 more responsive, but also less forgiving, than the 190 is for Marco.

Some of these effects may increase or decrease if you change from one design to another. For example, zero-porosity canopies will normally glide farther and flare better than ones made of low-porosity "F-111" type material. You might find a zero-p canopy has a lower rate of descent and is easier to land than a slightly larger F-111 canopy. If the zero-p canopy is more than 20 square feet smaller, though, this may no longer be true.

In order to help customers choose the right canopy, manufacturers publish sizing recommendations for the canopies they build. Unfortunately, these recommendations are often misunderstood and end up being used incorrectly.

The most common recommendation given is maximum exit weight. Suppose the maximum exit weight for a certain canopy is 144 pounds. If a person flying this canopy weighs 144 pounds *or less* then the canopy will perform as the designers intended. If someone heavier jumps the canopy it will be faster, but may not glide as far in all situations or land as well.

Too many people ignore the word "maximum" when looking at maximum exit weight, and believe this is simply the recommended weight. Some will even say you are "under-loading" your canopy if you weigh less than the maximum weight. Technically, a canopy can only be under-loaded if the manufacturer specifies a *minimum* exit weight. If a canopy has a maximum weight of 190 pounds, but no specific minimum weight, there is no reason why a 130-pound person could not jump it. In fact, a novice jumper or someone who is simply conservative may want to be well below the maximum exit weight for his or her canopy.

Another source of confusion is the fact that two very different canopies may have similar weight recommendations. Let's say there's a canopy named the "Floatie" and another called the "Zippo." The maximum exit weight for a Floatie 150 is 165 pounds, for a wing load of 1.1. A Zippo 97 has the same maximum weight of 165 pounds, for a wing load of 1.7. If a 165-pound jumper has been flying a Floatie 150, and wants to buy a Zippo, should he downsize to a 97? Probably not.

It's important to understand that there is no standard formula for determining a main canopy's weight limit. These numbers are based on the designers' ideas of how their canopies should fly and who will be flying them. In this example the Zippo is probably intended for jumpers who like very fast, responsive canopies and have the skill and experience to fly them. A Zippo 97 may be capable of landing with a wing loading of 1.7, but this will certainly be more difficult than landing a Floatie 150 loaded at 1.1.

Also, different manufacturers have different ideas about wing loading in general. One company may believe canopies need to be loaded heavily to perform correctly while another may feel that high wing loading isn't necessary.

We've already seen that a 97 will have very different flight characteristics from 150. This is still true even if the weight recommendations for the two canopies are the same. Even if our 165-pound friend flies his 150 very well, this will not prepare him for the demands of a 97.

So the question remains: what size canopy should I buy? Only one person can give you the final answer. That person is you.

First, you need to ask yourself why you want a smaller canopy. If you simply want a canopy that is faster than the one you currently fly, that might be a good reason to downsize. Other reasons are not as good.

If you have problems landing and believe a smaller canopy will help, you may want to read the first half of this article again. If you're happy with your current canopy but "everyone else" says you need a smaller one, that also isn't a good reason. Everyone else doesn't have to land your canopy, and a choice that is right for others may not be right for you.

You might choose a smaller canopy just to get better penetration in strong winds. This may not be a bad choice as long as you remember that a smaller canopy will be more difficult to land in light winds. Also, a smaller canopy may give you better penetration but it will not give you the skill and experience needed to land safely in windy conditions.

Some jumpers dream of a smaller canopy the way motorcycle racers dream of more horsepower. Most of us have seen other jumpers swoop through the landing area on smaller canopies, going farther and faster than we do. It's easy to think, "That could be me, if only I had one of those canopies."

It's also easy to forget that most of the best canopy pilots have hundreds, if not thousands, of jumps on larger, more docile canopies. Rickster Powell is a good example. Many people have seen Rickster's extreme landings in the film *Antigravity* by Patrick Passe. He also appears in Passe's newest film, *Crosswind*.

"I'm glad I made a lot of jumps on larger canopies," says Powell. "You're just making it hard for yourself if you downsize to a really small canopy and then try to learn how to swoop,"

Powell, a camera flyer who weighs about 180 pounds in gear, started swooping over 15 years ago on a Spitfire 180. After several hundred jumps on this canopy, he downsized to a PD 170. Then, as zero-p canopies became available, Powell continued downsizing one size at a time as his skills improved.

Joey Jones, who won first place in both the Daytona 5000 and Caribbean Challenge swoop competitions last year, followed a similar path. Jones learned high-performance landings on a Falcon 175, which he used for 800 jumps. Like Powell, Jones made over 1000 jumps on some of his canopies before downsizing. "If you aren't really wringing out your canopy, getting the best performance you can from it, there's no reason to downsize," says Jones.

Before you decide you are "bored" with your current canopy be honest about how much you can still learn with it. Has anything happened recently under canopy that surprised you? Can you consistently land on your feet, even in light winds? What are the accuracy requirements for the license that you currently hold? Did you earn that license with a larger canopy than the one you are jumping now?

If you decide you are ready for a smaller canopy then try it before you buy it. You probably wouldn't buy a car you had never driven or a house you had never seen, so why buy a canopy you have never jumped?

Although some drop zones have demo or rental gear with a variety of canopies, many do not. Some manufacturers have demo programs, though, and can send you a canopy to use for a short period of time. Anyone selling a used main should be willing to let you jump it a few times if you are seriously interested.

When trying smaller canopies it's better to downsize only one size at a time, making several jumps on each new size before trying a smaller one. If a canopy feels good and you're happy with the performance, ask yourself if you want or need to go any smaller.

If you try a smaller canopy and have a hard time landing softly, can't land anywhere near your target, or just don't feel comfortable under that canopy, it's almost definitely too small for you right now. Staying with a larger canopy that's easier to handle will be less risky and will help you build better skills in the long run.

If there is absolutely no way to try different mains before you buy one then be conservative. Chose a size that is at least close to one you have jumped. You may end up with a slightly larger canopy than you want, but this is better than being injured under a canopy that is too small. Also, don't buy a container before you decide on a canopy size. Doing so might severely limit your choices.

Skydiving is a high-risk sport. Each of us must decide for ourselves what risks we are willing to take and which ones we wish to avoid. Choosing the right size canopy is an important part of that decision. Finding good information and balancing it with your own good judgment can help you make the right choice.

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Choosing the Right Canopy Part 2: Cells, Shapes, and Skins

By Scott Miller

This is the second of two articles on how to choose a main canopy. Last month we discussed canopy size and wing loading, and looked at factors to consider when downsizing. In this article we will examine differences between various types of canopies.

Today there are many options to consider when choosing a main canopy. The number of cells, overall shape, and type of material used can all affect a canopy's performance characteristics. As with canopy sizing, understanding the facts and avoiding common misconceptions can help you choose a canopy that is best for you.

Seven or Nine

Most skydiving canopies used today are either seven-cell or nine-cell designs. Originally, nine-cell canopies had several advantages over seven-cells. Nine-cells glided farther, and many jumpers preferred the way they landed. Seven-cell canopies were generally more responsive in deep brakes, and performed better when making sinking, accuracy-type approaches. Because they have fewer lines and fewer ribs, seven-cells usually had lower pack volumes. Although seven-cells remained preferable for CRW, accuracy, and as reserves, nine-cell mains quickly became popular with most skydivers.

In the 1990's, a new generation of high performance seven-cells became available, and these canopies soon regained their popularity. Newer seven-cells benefit from improved materials and aerodynamics, and retain the advantages of traditional seven-cells while eliminating some of the disadvantages. Some modern seven-cells glide farther than comparable nine-cells. Most nine-cells will still level off or "swoop" farther when flared, but landings on some seven-cells can easily be just as soft. Seven-cells still tend to pack smaller than nine-cells and are more agile in deep brakes.

Deciding between a seven- or nine-cell canopy today is often just a matter of personal preference. Some people still prefer the way nine-cells perform, while jumpers who occasionally make demonstration or CRW jumps might prefer seven-cells. The mellow opening characteristics of some seven-cells have made them popular with camera and wing-suit flyers.

Material World

Modern skydiving canopies are made from either low-porosity or zero-porosity nylon. Skydivers usually call low-porosity material "F-111," although this is really the brand name for a type of fabric that is no longer manufactured. Most "F-111" canopies being jumped today are actually made from newer types of low-porosity material.

The main problem with low-porosity fabric is that it becomes more porous as it is used, meaning more air can pass through the material. After 300 to 500 jumps an "F-111" type canopy will not flare as well as when it was new, and performance in other areas will also decrease. This change will be less noticeable on large canopies, but may be dramatic on smaller ones.

Zero-porosity fabric has a coating, usually silicone-based, which prevents the porosity from increasing. Canopies made from some types of zero-p may last well over 2,000 jumps. Because it does not let any air through, zero-p fabric allows canopy designers to build more efficient wings capable of better performance.

Unfortunately, zero-p canopies have higher pack volumes than F-111 ones, and can be more difficult to pack. Patience and a good technique may be required just to get a zero-p canopy in the deployment bag, especially when it is new. A correctly sized pilot chute, properly positioned slider, and proper line stows are necessary to reduce the chances of a hard opening. Zero-p does become "softer" and less slippery with use, which makes packing less difficult in time.

In most cases the advantages of zero-p far outweigh the disadvantages. Virtually all main canopies designed in recent years use zero-p. Some companies do offer canopies built with a combination of zero-p and F-111 type fabric. These "hybrid" canopies are designed to perform better and

last longer than ones made completely of F-111, while being easier to pack than canopies made completely of zero-p.

Contrary to what some people believe, zero-p material does not necessarily make a canopy faster. A zero-p canopy can easily have the same full glide speed as a canopy the same size made from F-111. In fact, the zero-p canopy may have a lower rate of descent and be capable of flying more slowly in brakes.

Why, then, do people believe zero-p canopies are faster? This is probably due to the fact that many people compare smaller zero-p canopies to larger F-111 ones. If you jump a 210 square foot F-111 main and decide to try a zero-p 170, the 170 will certainly seem faster. It will be faster because of its size, though, not the material.

Although few skydivers today buy F-111 mains, a used one might still be a good choice for someone on a tight budget buying a first rig. Since an F-111 main may not flare as well as a zero-p one you will probably need a slightly larger canopy if you choose this option. Few brand new F-111 mains are being sold these days, so it is becoming more difficult to find used ones in good condition. It's especially important to have a used F-111 canopy thoroughly checked by a rigger and to jump it a few times before you buy it.

Shaping Up

Planform is the shape of a wing when viewed from directly above or below. Figure 1 shows basic examples of three planform types found on ram-air canopies: rectangular; tapered or "semi-elliptical;" and highly tapered or "elliptical." At one time virtually all ram-air skydiving canopies were rectangular, but most main canopies designed in recent years have at least some amount of taper.

The terms "semi-elliptical" and "elliptical" can be a little misleading. Rather than describing the actual shape of a canopy, these terms are often used to indicate how responsive a canopy is meant to be.

Canopies described as "tapered" or "semi-elliptical" are generally more responsive than rectangular ones. They often have lighter toggle pressure and turn more easily. Although large rectangular canopies can be a bit sluggish, especially when lightly loaded, some larger tapered canopies feel surprisingly agile. These canopies are ideal for jumpers who want a larger, more forgiving canopy that is still fun to fly. Small tapered canopies can be extremely responsive.

"Elliptical" canopies are usually much more responsive than other types. They turn faster and generally require less input to start a turn. An elliptical canopy, particularly a smaller one, may react to harness inputs in ways a rectangular canopy will not. You may be able to make a surprisingly fast turn just by shifting your weight.

Elliptical canopies can be exciting to fly but can also be unforgiving in some ways. For example, many skydivers unintentionally shift their weight or pull their toggles unevenly when they flare, causing the canopy to turn slightly as they land. On an elliptical canopy this can result in a rather spectacular wipeout.

Because elliptical canopies are more responsive in flight, they are also more responsive while they are opening. To avoid problems such as off-heading openings and line twists you may need to pack more carefully and pay more attention to your body position during deployment. People with hundreds or even thousands of jumps on less responsive canopies have needed to make a few adjustments and get rid of some bad habits once they started jumping elliptical canopies.

Because they can be less forgiving in some ways, elliptical canopies have generally been viewed as "hot rods" only suitable for more experienced, aggressive canopy pilots. Some people believe that elliptical canopies are faster than rectangular ones. This is a misconception, however, similar to the idea that zero-p canopies are faster than F-111 ones. An elliptical canopy may turn faster than a rectangular one of the same size but might still fly at about the same forward speed.

It's important to remember that a canopy's size also determines how responsive it is, and how unforgiving it may be. Many people who jump larger elliptical canopies experience few if any of the problems encountered on small ones.

It is a good idea to gain some experience before flying an elliptical canopy, but you don't necessarily need to be a hot shot. If other canopies aren't quite as responsive as you would like, and you are thinking about downsizing, you may first want to try an elliptical canopy the same size as your current canopy. An elliptical may provide the handling you want without the risks involved in jumping a smaller canopy.

Things That Make You Go Zoom

Some of today's higher-performance canopies have special features designed to increase performance. Two of the most popular ones are "cross-braces" and "airlocks."

Bill Coe of Performance Designs developed cross-braces in the late 1980's. Cross-braces are extra diagonal ribs that keep the canopy more rigid, allowing thinner airfoils and fewer lines to be used.

Today, cross-braces are used on a few ultra-high performance elliptical canopies. These canopies are generally faster, and create more lift on landing, than non cross-braced canopies of the same size. Because they are only available in smaller sizes and require a good amount of skill to be flown safely, they are only recommended for pilots who already have experience jumping small elliptical canopies.

Airlocks, patented by Brian Germain in the mid 1990's, are fabric valves sewn into the openings at the nose of a canopy. They allow air to enter the cells but make it difficult for the air to escape. Like cross-braces, airlocks make a canopy more rigid and improve performance. Airlocked canopies are available in a wider range of sizes than cross-braced ones.

Because airlocks help a canopy stay pressurized, these canopies have a reputation for being very stable in turbulence. Although some jumpers have gone as far as calling them "turbulence-proof," Germain and others caution against this kind of overconfidence.

"Airlocks are intended to give you a greater margin of safety under normal jumping conditions," says Germain, "but if you get caught in a strong downdraft, even if your canopy stays fully inflated, you're still going down." Turbulence can affect any canopy, just as it can affect a rigid-winged aircraft. If the wind or turbulence becomes so strong that you wouldn't jump with a non-airlocked canopy then you shouldn't jump in those conditions with an airlocked canopy, either.

Although airlocks and cross-braces improve performance in some areas they are only part of the picture. You certainly shouldn't feel "left behind" if you prefer the overall performance and handling of a more conventional canopy.

Keeping Perspective

Although we have looked at some general differences between types of canopies, there are many other factors that influence performance. The number of cells, planform, and fabric type may give you a basic idea of how a certain canopy will fly, but this information merely serves as a starting point.

Canopy designers also use different airfoils, trims, and other design elements to make their canopies perform a certain way. Two canopies that appear basically similar may have very different characteristics. Also, canopy size and wing loading are just as important as the design of a canopy. You can only make an accurate comparison between different types of canopies if they are similar in size and flown at the same wing loading.

Whether you are considering a differently sized canopy, a different type than the one you currently jump, or both, it certainly helps to hear opinions and advice from people that you trust. However, it's important to trust your own feelings as well. Two different people may have very different opinions of the exact same canopy.

Jumping a canopy is the surest way to know if that particular size and type of canopy is the right one for you. If you consider the big picture rather than relying on a few limited pieces of information then you are more likely to buy a canopy that will make you happy in the long run.

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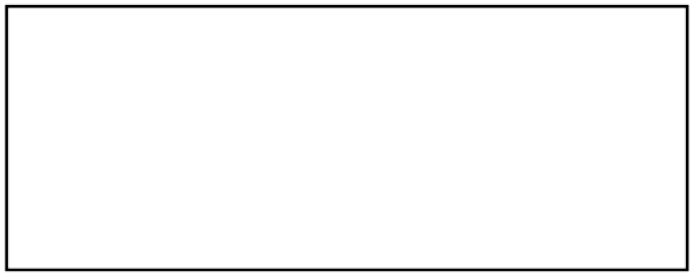

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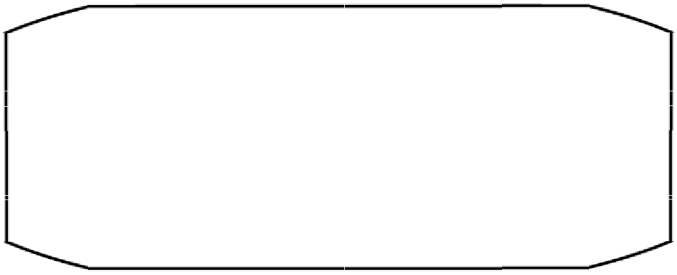

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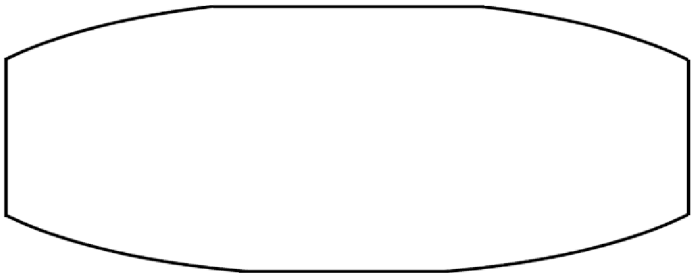

Highly Tapered or "Elliptical"

Figure 1 - planform examples