HIGH SPEED CANOPY FLYING

During the early nineties advances in materials, design and construction techniques allowed canopy manufacturers to produce a new generation of canopies with previously unheard of durability and speed. Initially these designs were used only by the most advanced skydivers, but in recent years they have become more common among average recreational jumpers. Speed and energy definitely enhance fun potential - but they also greatly increase risk. Unfortunately flying technique, instruction and skydiving customs have not kept up with fast canopies and the sport is paying for it with a big increase in injuries and deaths in which these parachutes are a factor.

Two fundamental truths underlie the risks of fast canopies. One is that kinetic energy increases geometrically with speed. In other words, doubling speed results in a four fold increase in energy. The second is that speed is, essentially, the relationship of distance and time. Doubling speed cuts time or distance in half, leaving a pilot with less time and space in which to consider his options. The bottom line is that using a faster canopy leaves little room for error, while at the same time greatly increasing the penalty for mistakes.

That said, it should still be possible to fly fast parachutes safely. The key is in developing techniques that minimize traffic conflicts and the potential to collide with the ground, obstacles or spectators. Look back at the section in Chapter Three. The sections on obtaining vertical separation are particularly important to anyone planning high speed landings. By minimizing the number of people you share the landing with you minimize your hazards. Furthermore, study the regular jumpers for their tendencies. If you know the flying style of the people you share the sky with it becomes relatively easy to predict their behaviour.
The next step is to control the landing area. By this I mean that while still high, you have identified all possible traffic, determined landing direction and considered obstacles and escape routes. I like to do a long crosswind approach since it allows a clear view of the intended landing area and if the crosswind is done over an open area, I can abort the approach to the primary landing area with ease. Never do "S turns" or spirals on the approach if you are sharing the air with other canopies because every turn you make increases the chance of a collision. Unless you are alone, the most predictable and safe pattern is the one airplane pilots use at every airport - downwind, ninety degree turn to crosswind, then ninety degree turn to final.

The Final Turn

Beginning with the first jump course every skydiver is drilled on the concept that a turn close to the ground is one of the leading causes of injury in our sport. Whether such a turn is intentional or not, contact with the ground before the canopy has resumed normal flight often results in serious injury or death. There are essentially two causes of these premature landings. One is an unintentional emergency maneuver, often to avoid a far lesser threat such as a downwind landing. The other is intentionally induced turns.

There is no doubt that the increased speed provided by a turn just prior to landing provides thrilling performance. Since many skydivers seek this particular thrill, they need to be extremely familiar with the effects of

turns and the implications of poor judgment. However, even skydivers with no interest in so called "hook turns" still need to know what is involved in order to avoid the consequences of a panic turn. Many of the so-called "hook turn" injuries and fatalities are from unintentional turns. It is also important to distinguish, as we will below, between the out of control hook turn and a controlled high performance landing.
The only safe path to stylish landings is to work your way up slowly, know where to stop, and always be willing to abandon the high performance approach for a more conventional one. For this, of course, you need a canopy that gives this option! One should also recognize that performance is as much a function of piloting as of equipment. Instead of increasing the thrill of canopy flight by moving to a faster design, skydivers should strive to get the maximum performance out of their existing canopy and only move on after they have mastered all aspects of flight on a conservative canopy.

The entry level high performance approach is to use a normal, high toggle turn to put yourself on a straight ahead approach on final, at a comfortable height off the ground. Keeping your toggles securely around your hands, grab your front risers and pull them down about four inches. It will be just like a normal approach, but let the risers up slowly a few feet higher than you would usually flare. Then flare smoothly and slowly at your normal altitude. Initially you will probably initiate and end front riser input too high. Only four or five seconds are needed to reach top speed, so starting too high will wear you out but is otherwise harmless. Ending a little high doesn't do much good either, since your speed bleeds off rapidly. But the important point is that ending high doesn't hurt you either. Ending low will.

There are a few things to watch out for as you begin learning high performance approaches. One is that riser input definitely increases speed. It also increases forward penetration and once you drop the risers your canopy will tend to float. Expect to overshoot your target, so leave some outs! If you have to run out your landings on calm days, either you are flaring too low or your steering lines are out of tune - toggles too low on the lines. Fix this before trying the front riser approach.
Finally, whether you choose riser blocks or dive loops, be sure your toggles remain securely in your hands when you grab or release the risers! This should be practiced up high to get the feel of it.
At this point in your progress it is a good idea to have an expert canopy pilot watch a few landings, perhaps with a video camera, and critique your technique. An experienced eye can tell you if you are using too much front riser, if your toggles need to be re-set, if you are flaring unevenly, and other important details.

Once you are to the point where you never under or over shoot your landing or have to alter your approach because of traffic not accounted for early enough, you may want to use a slight front riser turn onto your final approach. Be an honest judge of your performance: if you use variables such as changing winds, traffic, or other conditions to excuse a botched approach, you have not mastered the first two steps: traffic management and control of the landing area environment. Using excuses indicates an unwillingness to take responsibility for inexperience or poor judgment, a mental state that has no business in the world of high speed canopies. The increased speed created by high performance canopy flying is a great hazard to others in the landing area, and therefore carries a heavy weight of responsibility. Under a fast canopy there are no excuses!

Progress by making shallow front riser turns of about 30 to 45 degrees onto your final approach, then transition to both front risers until flare time. A turning front riser approach is a step beyond a straight approach, and probably the most commonly used high performance approach. As with a straight approach, a good front riser turn requires a smooth entry and exit from the manoeuvre. The initiation of the turn may be steep, but the second half should have a gradual reduction in front riser input. In this situation, the initial steep descent creates speed that is translated into lift as the parachute flattens out. The transition from riser input to toggles should be almost imperceptible.

If at any time you are having to use rapid, aggressive toggle movement to avoid hitting the ground, you are far too low in your turn. "Stabbing" the toggles down is a definite indication of poor control. The best landings involve both a gradual entry and exit from front risers, followed by a smooth, slow flare. A well landed canopy builds speed gradually and practically flares itself as front risers are smoothly released, leaving the pilot to slowly bring the toggles down to keep the canopy planing as it bleeds off speed. Not only does stabbing the toggles indicate the pilot was about to hit the ground hard, it deteriorates the overall landing. Why? Because toggles are also brakes. The less you use them, the further and faster you will be able to swoop. The longest, fastest canopy swoopers always use the least amount of toggle input!

Because of the lack of formal training for high performance landings, many skydivers have developed bad flying habits that put them in dangerous or inefficient situations without conferring any speed and performance benefits. For example, if too much front riser is pulled down, you deform the airfoil and reduce its efficiency. This will become obvious when you realize pulling the front risers down only affects the front area of the canopy. Seen from the side a canopy with too much front riser input appears to have a step in it, which means a perfectly good canopy has been deformed to the point where it no longer flies well. The classic manifestation of the trashed foil is a canopy that appears to be bucking, or lurching down a flight of stairs. In some situations (and only with some canopies!) this is actually useful, such as initial descent into a tight area like a clearing in the woods or a stadium. For landings, however, deep front risers need to be released early since they create lots of downward speed but not much lift.

Another common mistake in front riser approaches is to enter and exit the front riser maneuver suddenly. A sudden change of the surface configuration can disrupt the smoothness of the flow and cause a dramatic loss of lift! Suddenly dropping the front risers and then rapidly braking with toggles is a very inefficient way to flare, since both actions handicap the airfoil’s lifting ability. Instead, a good front riser landing involves a gentle entry into front risers (never let go of your toggles!) that gradually steepens until the canopy achieves its fastest speed without major distortion of the wing. When the risers are smoothly let up, the canopy slows down and the pilot swings forward - the flare has begun before the toggles are even used. Then, the pilot maintains the high angle of attack by using toggle input to keep the flare going.
In any discussion of high performance landings the subject of riser verses toggle turns will come up. After years of watching a variety of techniques, I have concluded that front riser turns are far superior to toggle turns from a safety stand point. The reason is an extremely simple one. For a toggle turn to produce any speed to swoop with, it must be done

as low as possible! Otherwise, it is just another high turn and all of the speed bleeds off well before the flare. A front riser turn, on the other hand, can intentionally be initiated too high, and then steepened or supplemented with the other front riser as needed. Therefore, a swooper using a front riser approach can always start at a conservative height while a toggle turn onto final compels the skydiver to turn as low as possible.

The implication of this goes further because of the way a canopy comes out of a turn. A front riser turn accelerates the canopy, while a toggle turn slows the canopy down. The difference is most noticeable at the end of the turn. Following a front riser manoeuvre, the canopy slows down to its normal speed and wants to come back over the pilot. After a toggle turn, the canopy must speed up, then there is a considerable delay before the pilot swings back under it. A toggle turn may create a bigger pendulum action for the suspended weight because the canopy can slow down much faster than the person under it, whereas in a riser turn the canopy accelerates only slightly faster than the pilot. In a toggle turn, the pilot must swing back under the parachute and the parachute must regain lost speed before it is controllable and generating maximum lift. A front riser turn is easily abandoned at any point, with full control of the canopy retained. Once a toggle turn is in effect, there is no escape.
A dramatic toggle turn also causes the wing loading of the canopy to change considerably - normal in flight, low as the canopy slows down and the weight reaches the height of its swing, then heavy as the weight swings back under the canopy. Whether or not these dynamic changes in wing loading make the canopy more vulnerable to turbulence than the fairly steady loading of a riser turn is open to debate.

An additional hazard with toggle turns can occur at very high wing loadings - perhaps 1.4 or higher, depending on the canopy. In a sharp enough turn, the pilot can swing out so far that as he swings back under the canopy, the induced weight overloads the canopy. In this situation the wing is essentially in a high speed stall - what pilots would call an accelerated stall. At this point the pilot has no control and even flaring may be useless. In fact, flaring might reduce lift even further. In any case, remember the apparent wind. If you are looking straight at the ground, flaring will only change your impact point.

However, this is not a blanket endorsement of front riser turns. There is a phenomenon that can take place in a high speed turn that can lead to complete collapse of the canopy, and in theory a canopy in a sudden front riser turn may be the most susceptible. Canopy collapse takes place when the apparent wind striking a canopy undergoes a sudden change, whether the cause be a change in angle of attack, angle of incidence, or some other factor - wake turbulence off another canopy, for example - causes the canopy to be "back winded," a term from sailing. When a foil is back winded, it means the apparent wind is striking the lifting surface of the foil instead of the leading edge. In the case of a canopy, this can drive the air out of the cells and collapse the canopy. Canopies at particular risk are small, highly loaded canopies with a relatively flat trim angle and a relatively aft centre of lift. Proponents of toggle turns argue that a front riser turn is more likely than a toggle turn to produce a canopy collapse, due to the changing angle of incidence. In the real world, the few catastrophic canopy collapses on record seem to be more a factor of design than of handling. There does not seen to be a correlation between front riser input and canopy collapse - at least none that I know of.

In summary, while both front riser turns and toggle turns create an increased descent rate and corresponding increase in speed, for intentional manoeuvres a front riser turn is usually more desirable in that it offers more escapes in the event of a lapse of judgment or a sudden change in the environment.

Turns over 90 degrees carry an unacceptable degree of risk to other skydivers unless they are very carefully executed within an established pattern. It becomes very difficult to monitor traffic once you stray from the customary downwind, crosswind, final pattern. Equally important, it is difficult for traffic to monitor you! Downwind legs over the landing area followed by low 180s not only create tremendous changes in vertical and horizontal speeds but interfere with the traffic patterns already established by others. An additional consideration is that a turn over 90 degrees does not confer significant increases in speed but greatly increases the potential for mistakes, not just on the part of the person doing the hook turn. Some of the other parachutes on approach could be piloted by people who may not be able to avoid unusual wake turbulence or who might do their own low turn unintentionally in order to avoid the undisciplined canopy pilot. The same ethics apply to people on the ground. The wuffo being swooped could be deaf or unaware of how parachutes fly, and no skydiver likes to hear the whistle of wind through microline behind their back and wonder if they are the next innocent victim.
Referring again to practical tests with an airspeed indicator and variometer, modern canopies at 1.4 wing loadings typically fly at about 30 mph straight and level, toggles up. They can hit speeds of up to 50 mph coming out of a turn, and may be going 20 mph with the brakes still set for deployment. In descent rate modern canopies usually peg my variometer at its peak reading of 1600 feet per minute of descent, giving us a minimum downward component of 18 miles per hour. Since this instrument limit is hit long before the manoeuvre is completed, we can assume downward speeds of 20 to 30 mph are routine when deep in a turn. Older, lightly loaded designs are significantly slower. Thus, it is the combination of a fast canopy, high wing loading and a turning manoeuvre that creates the greatest energy.

Besides the amount of kinetic energy delivered by fast canopies, there is the time factor. I prefer to use feet per second instead of miles per hour, since skydivers work in feet and seconds, not miles and hours. Twenty miles per hour is roughly 30 feet per second. Thirty miles per hour is roughly 45 feet per second, and fifty miles per hour is about 75 feet per second. Regardless of how fast the canopy flies, human reaction time is about one quarter of a second to merely recognize a problem. In a complex emergency situation, we can assume that an alert individual will require a quarter second to recognize a problem and no less than the remainder of a second to implement a response.

A second is more than enough time to resolve a simple emergency - pulling your hand away from a hot stove, for example - but is it enough time to recognize, assess and resolve a potential canopy collision? I think not, since the pilot must not only avoid the collision but do it in such a way that he does not create an equally serious secondary emergency, such as a different collision.

Imagine an illustration that shows two canopies on a collision course at ninety …….degrees to one another. Imagine situation a), where the canopies are one second from a collision when they are 42.4 feet apart. If we speed the canopies up, that one second remains constant as the distance expands. Imagine situation C, the canopies are one second from collision when they are just over one hundred feet apart.

Now imagine that these scenarios are transpiring not on a blank sheet of paper but in a crowded sky fifty feet above the ground. Add a couple buildings and some power lines to the landing area to dramatically curtail the options. The point? We must assume a single second is not enough time to adequately respond to this complex emergency. That means to have any kind of safety margin - let's say three seconds - the canopy pilots in situation C must know the position, current direction and the intent of every canopy within three hundred feet.

In a similar situation, let's substitute a running child (12 feet per second) for one of the canopies. If the child darts out in front of the swooper (canopy C) with only 40 feet of horizontal separation, we have a dead child on our hands.

Using the same scenarios and assuming a collision at the end, let's look at the kinetic energy involved. For simplicity we will assume that the skydivers involved both weigh 170 pounds. Using mass times velocity squared to determine the energy going into the collision, we find each skydiver in a) enters the game with 153,000 foot-pounds of energy, for a total collision force of 306,000. Moving to scene c) we come up with 956,250 per skydiver and 1,912,500 total points in the collision. Substitute a seventy pound child at 12 feet per second for one of the canopies, and you find the child enters collision a) with a mere 10,080 points versus the skydiver with 153,000. In c) the difference is even more spectacular: 10,080 vs. 956,250.

Thus we see that speed, more than any other factor, drives up risk by increasing collision forces and reducing the time and space in which we act. An interesting corollary develops with fast canopies; piloting them to a safe landing can demand so much focus that other important factors might be neglected. For example, if you need to devote all of your concentration to your canopy handling in order to land well, you have nothing left for traffic management. Conversely, if a traffic problem suddenly arises you may not have enough attention left to land your own parachute well. In a crowded landing area with canopies of varying speeds you need to devote quite a bit of concentration to the other canopies. If your own parachute demands all of your attention, you cannot safely land around others.