Canyon Turn
"Emergency Canyon Turn" the maneuver

A common solution for many aviation's perils is the decision and ability to turn around. Turning the airplane is one of the first lessons in flight. Steep turns with an eye on altitude loss are taught from the beginning. If we could prevent pilots from flying into worsening visibilities and weather we would half the accident rates. Practically speaking this means two things. Making the decision to turn around and doing it while you maintain control of the flight situation. In the mountains the one hundred eighty degree turn is not a maneuver but a strategy. Probably the most important rule in mountain and canyon flying is being in a position to turn around. The negative corollary to this golden rule is that when you are in so tight a spot that you can't turn around with complete safety, you're already in deep trouble; you've already made the worst mistake you can make in the backcountry.

Remember there is always risk. Your job is to minimize the risk as much as is possible and manage the situation so it is comfortable for you and your passengers. Repeated and seemingly perfect flights in perfect conditions reinforce the notion that we have things under control. Mistakenly we think our time and experience are the reasons we are in control. We grow to depend on this control and we are lulled into more risk than we realize. Nowhere is this more obvious than by our obvious dependence on engine performance. The repeated reliability of a properly maintained airplane and engine can lull us into dangerous situations. But in more sober moments we know the facts. Things break. Engines lose power unexpectedly. Weather changes before our eyes. Downdrafts happen. We get lost. These are situations that demand immediate and mostly correct reactions on your part. The strategy of the turnaround is your best defense in almost every case. Taken to one more level we can say in the mountains you need the quiet determination to constantly consider your turn around options, even in the best of conditions.

The narrow canyon situations you will face are amplifications of the ground reference maneuvers you practiced as a student pilot. But here we have some real life distractions. First of all the turn is to some degree an emergency situation. You are recovering from some kind of mental error. You might be confused about your position and your navigation. We call that lost. You might be concerned about your altitude to cross a ridge. The weather or the air might be the reason you are turning around. Perhaps you're seeing some indication of impending airframe or engine problem. The issues are complicated by your terrain separation. You might be very close to the tops of trees. Your perceptions of speed this close to the ground will be spooky. Your senses will be at risk. Often there is no horizon and vertigo can betray your abilities. You have to hold it together. Is there room to turn around here? How can I maximize the space I have to turn around? When shall I start the turn? What will I do when I get turned around?

Most mountain pilots will tell you the best defense is altitude. Climb if you can. Two thousand feet of clearance over any terrain is a very comfortable insurance. It takes the fear away. Unfortunately you cannot always afford this option. You might be in a transition to landing or takeoff. The visibilities might be comfortable and acceptable until you begin to climb. You might be climb limited by density altitude and performance. Your expectations of performance can also be completely negated by unseen currents of air and turbulence. For this discussion and in terms of our ideal strategy of turnaround we have to admit that we often cannot, or choose not, to climb. This could be a reason you may be flying below the canyon's rim. It's not because we're trying to teach you to be a daredevil. We're trying to teach techniques in controlled circumstances so that you are not forced to deal with this danger for the first time in deteriorating mountain situations.

After altitude, available space is the key concept. How much space do you need to turn your airplane around? The term radius is commonly used when referring to the actual distance that you will require to get turned around. Radius is a function of speed. The faster you are traveling over the ground the more space you will need to turn around. It follows then that our first effort will be to slow down so our needed radius is smaller. We will be exploring speeds in your airplane and you will be prepared with a specific speed we call "Canyon Speed" it is that configuration on your "Aircraft Performance Card". It will be slower than cruise and probably close to a white arc speed so you can add flaps at any time. A lot of your comfort and safety in the mountains will be a result of your knowledge of exactly how much space you need to turn around. This is an experiment in every airplane you fly. The value of an occasional turn in a questionable but safe space is the best personal instructional device you can learn. Knowledge of your needed radius is a comfort that will simplify the more difficult decisions that await you.

A very common reflex in an experimental mountain turn is a strange throwback to the steep turns in the practical test standards for the pilot license. You will feel the need to maintain altitude. Aerodynamic principals decree that when you bank an aircraft you effectively make the wing smaller and your airfoil has less lift available for the same weight. This means you will loose altitude unless you apply backpressure. It seems like staying at the same altitude would be a good thing but let's look a little closer.

Several things happen when we apply elevator pressure in a turn. We slow our airspeed slightly. The airplane gets heavier. We lose more lift. We pull gravitational forces that affect us physiologically, primarily the blood pumping in our bodies. Often our response is pulling harder, slowing more, pulling more G's. We face the risk of getting closer to a stall when we're physically most susceptible of ignoring or overlooking the clues of an imminent stall. All this could be acceptable unless you consider the proximity to the changing terrain. Accidents in steep turns in canyons are usually not the wing over, full stall spin events. Loss of lift is a constantly degrading event. Impact with trees and rocks happens before we lose complete control of the airplane. In other words most turning accidents end with a mushy path into the trees as you run out of altitude, speed and space in the turn.

The answer as we see it is not to load the wing in the turn. What does it mean to you when we say do not load the wing? Wing load is actually an aerodynamic expression of lift. It is a theoretical description of a wing. If you're the kind of pilot whose eyes glaze over when physics and the aerodynamics of the wing are discussed you might as well skim down and pick up the text where there are no numbers and spooky words like aspect ratio and induced drag. If on the other hand you are one of those curious people who like math and physics theory please tread carefully for the next few paragraphs. In an attempt to explain some facts of flight it might seem we have pole vaulted to a few conclusions. Accept our tongue in cheek analysis that this theory isn't really necessary to know anyway.

Lift is a function of many aerodynamic principles. The important effect we want to talk about is wing loading but we have to talk a little about all of it first. Let's look at some numbers on a simple single engine trainer. With a wing span of 33 feet and an average chord of 4.8 ft scientists come up with some useful numbers. Planform or total wing area is a simple multiplication of 33 by 4.8, in this case 160 square feet of wing. The relationship between the span and the chord give us aspect ratio; 33 divided by 4.8, in this case 6.9. Are you still with me? One more number might be useful. Wing Load of this airplane is the average weight of 1680 pounds divided by the wing area of 160 square feet gives us a wing loading of 10.5 pounds per square foot.

What do all these numbers mean? Aspect ratio is average span to average chord. Or the ratio of wing span squared to wing area. Aerodynamicists use the number to determine the flight characteristics of an airplane. Sailplanes and gliders typically have 30:1 aspect ratios. The Cessna 150 has an aspect ration of about 7:1. An F-16 has a 3:1 aspect ratio. A Frisbee has an aspect ratio of 1.3(1 point 3):1. You should be able to tell from the examples that all these aircraft fly differently. High aspect ratios mean slower aircraft with good slow flying characteristics, defined stalls and more easily managed sink rates at high angles of attack. Low aspect ratios mean faster aircraft with less defined stall characteristics and dramatic sink rates at high angle of attack.

Wing loading is the average weight of the entire airplane supported by each sq foot of wing, expressed in pounds per square foot. For designers, wing loading is also a useful number to determine aircraft performance and handling characteristics. Low wing loads are commonly found in trainers and simple flying airplanes. High wing loads are faster, trickier but sometimes more useful airplanes. For example a 1700 pound Cessna 150 with 160 sq feet of wing has a wing load of 10.6. A 3500 pound C-182 with 205 sq foot of wing has a wing load number of 17. If you're interested in an airplane that flies short and slow you want low wing loads and high aspect ratios.. If speed and altitude are important characteristics you want in an airplane and you can accept trickier slow flying and handling characteristics, you will design with higher wing loads and lower aspect ratios.

Wing loading and lift are also important in determining stall speeds. In this vein, the FAA regulations for aircraft manufacturers require safe maximum landing speeds for light single engine aircraft. Generally this is about 61 and above. This speed limits maximum wing load from 25 pounds per square foot to 15 pounds per square foot. 15 would be a wing load number on an aircraft with no flaps. You might be interested in some aircraft wing load numbers.

Aircraft Wing Load Numbers

Piper cub 6.8
Citabria 10
C-150 10.5
Pitts 13
C-182 17.8
C206 20.8
DC-3 25
P-51 Mustang 48
F-16 76.

Now you're asking yourself so what? What do all these numbers have to do with flying my airplane in the backcountry? Bear with us and consider our buddy Bernoulli's take on induced drag. The total pressure of an airstream is the sum of static and dynamic pressures. Air accelerates around a wing. Faster over the top than the bottom because of the airfoil shape and angle. The dynamic pressure on top of the wing is slightly lower than the static pressure on the bottom. Lift is the imbalance of static and dynamic pressures. It is the component of this force perpendicular to the free airstream. A certain amount of downwash is imparted to the airstream flowing across the wing causing the force to be tilted slightly aft. This force is the lift. The horizontal component of this force is called induced drag, the penalty we pay for the lift. The total lift generated by a wing is determined by wing surface area, including aspect ratio and wing load and the speed it moves through the airstream. The engineers call this relationship the coefficient of lift. The induced drag part of the equation is where we start to see problems. Induced drag increases dramatically when wing load increases. In fact, induced drag also decreases as aspect ratio increases for a given airplane, wing loading, and airspeed.

Or you could say induced drag increases as aspect ratio decreases for a given wing load and airspeed if you really want to get confused. The reason this is important is that stall speed is proportional to the square root of the wing load. Stall speed increases with an increase of wing load. Increasing wing load also means more speed, time and distance to complete a maneuver.

There are only two ways to increase the wing loading of an airplane that is beyond the design and flying stage. You can increase the weight of the airplane by putting things into it before you takeoff, or you can create weight centrifugally by pulling backpressure in a steep turn. In both cases, you are loading the wing. This excess backpressure is a complicated mistake but completely understandable if you consider the heat of the moment, rocks and trees in your windscreen, simple unfamiliarity with your airplane turn radius, and all the John Wayne flying movies you have watched in your life.

So now you should know what 'loading the wing' means. It means you're increasing the G load. Don't do that. If this means you have to give up a little altitude in the turn, so be it. You cannot stall a wing in a steep bank unless you are loading the wing, pulling back on the stick. Loading explains why stall speed increases 100 percent in a 4G turn. Loading the wing even slightly to 2G's raises the stall speed by 40%. Don't load the wing in a turn. We will show you techniques for remarkably tight turns, at relatively slow speeds that never get close to stall. If you don't understand that this works because we intend to sacrifice a few hundred feet of altitude, go back and play around with the physics. This is a practical aerodynamic principal that is very important in mountain flying.

We call this phase of mountain flight preparation the *emergency canyon turn*. Perhaps you've heard of the chandelle. The chandelle is a popularly held turning technique that involves climbing while you turn. For our purposes we have already discussed limiting your ability to climb so we have evolved a new turning maneuver moniker, the Lynn-del. It is named tongue in cheek, in honor of a remarkable mountain flight instructor named Lynn Clark. How do you do it? First of all remember you should be with a flight instructor who is versed in this maneuver so this description will not be your only chance to learn it. It is possible though, three years from now you will be rummaging around for a written account of the *emergency canyon turn*.

We will do this in controlled conditions. This exercise will be repeated a few times so you understand exactly what is taking place. We will use fixed points of reference, such as a ridge top, an out cropping of prominent rocks or could be in a narrow enough canyon to get your attention. This method will help you recognize the benefits of the emergency turn so you can simplify it in your own mind. One of the best results will be a safe visual display of your airplane's turn radius. You will feel competent enough about your ability to make this turn so you might not hesitate quite so long in making the decision to turn. That is our goal.

“Emergency Canyon Turn” the maneuver

<u>This maneuver will be completed no lower than 1500 feet AGL</u>

We will find a point of reference that we both identify.
We will configure the airplane for what we call “canyon speed”.
It will be a speed slightly less than cruise speed, probably a white arc speed.
“Canyon speed” will be found on your “Aircraft Performance Card”.

It will seem we are doing three things at once. Since no one can do three things at once, be assured there will be time to do them one at a time.

Start of maneuver:
We will fly abeam our point of reference at “canyon speed” once abeam.

1) We will apply power at the beginning of the turn.
2) We will go as quickly as the airframe limitations allow to a full flap wing configuration.
3) We will roll into an immediate steep turn, between 30 and 60 degrees. Typically, 45 degrees or as needed.

The important part happens next. ***Do not load the wing***. Let the nose of the aircraft drop below the horizon. You will expect and accept a loss of altitude of 50 feet to 100 feet.

Completion of maneuver:

1) Approximately halfway around the turn you will retract full flaps to the best lift drag position, usually half flaps.
2) From that point you will begin to roll out
3) Reduce power and then recover the altitude you lost in the turn.

You are now going in an opposite direction of your troubles and ready to face your next problem. This is an amazing exercise in pilot and aircraft ability. It will lead to confidence and comfort in the hostile canyon environment we will be working.