

Crosswind Landing Excellence

By: Brad Whitsitt

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It is possible to land an airplane in a crosswind without using very good technique and still not damage anything. However, this article is about excellence in this maneuver and not just getting by. No matter what hardware you fly, a good understanding of crosswind landing concepts and techniques is important.

Crosswind landing skill is mostly obtained through trial and error. There are plenty of trials. Crosswinds are the number one cause of weather related accidents every year.

Let's jump straight to the essence of crosswind landing excellence.

Visual Field

A very critical part of any landing is the visual field and it is more important for crosswind landings. The pilot must look into the distance near touchdown. However, the majority of the visual work is done with peripheral vision. Here are all of the attributes of the landing that are measured with peripheral vision:

Pitch
Bank
Lateral Position
Altitude
Alignment

Therefore, the more visual information that the pilot can obtain, the better the control. In many airplanes, there is not much of a window left to see the runway environment during a flare for landing. This means that just slightly better posture, can mean the difference between seeing half of the remaining runway or seeing none of it. There can literally be a difference of 300,000 square feet of information lost if the pilot does not take care to insure that good visual posture is maintained.

Don't lay charts in the window and restrict even the smallest amount of visual information. The pilot must have every morsel of visual feedback, especially in a crosswind. Yes, good pilots can learn to land with most of the visual field restricted. But this happens after thousands of hours of flying and not during the formative stages of flying. While learning, this is the most important factor.

If your visual skills are a bit weak, do more to boost your visual field. It may be very helpful.

Body Posture

The visibility out the window (visual field) is very critical to landing and crosswind landing success. Raise the eyes up 1" and increase the visible area over the aircraft nose and around the periphery by hundreds and maybe thousands of square feet.

I recommend raising the chin 1" and leaning forward 1". If you wear bifocals, you will have to achieve a happy balance that still allows you to see into the distance.

Seating

This relates to the visual field again. An extra ½" in height can make a big difference in the visual feedback. After adjusting the seat properly, if a pilot still finds that they wish they could see better, some type of seat help might be a big help.

In addition, many pilots need some assistance from the back. If a pilot must lean back slightly to get the full rudder pedal throw, they are too far away. Think about what leaning back does to the eyes and the visual field. The eyes are lowered and visual field is lost when the pilot leans back to get full rudder throw. Just ½” forward can make things feel very different. The pilot’s comfort with crosswind landing often goes up with the height of the seat.

Shoes

Don’t wear slip-on shoes. The shoes must be tied solid to the feet. The pilot must have good control of the shoes and that will help with good control and feel of the rudder pedals.

Posture of the Feet

During any landing, make sure the feet are lowered so that the toes are being used to press low on the rudder pedals. The goal is to guarantee that there is no danger of touching the brakes when going for full rudder throw.

The heels should be just above the floor and not stuck on the floor during the critical landing moments. However, the toes cannot touch the brakes. Think of jabbing the toes forward to get rudder throw and not just pushing the heel forward. Think “point your nose with your toes”.

Pilots who place the foot too high on the rudder pedal are plagued with two problems: 1) It is hard to get good and fast rudder throw with the middle of the foot. 2) There is risk of touching the brakes which can lead to blown tires and less control.

How to use the Feet

The most important part of a crosswind landing is foot/eye coordination. How many of us get to practice foot/eye coordination? We all get to practice hand/eye stuff from driving to video games but we don’t get to engage the feet rapidly in response to what we see.

Also, in a crosswind landing, the feet should be moving at all times even when that movement is not needed. Let me say that again. The feet should be moving at about the rate of 1 cycle per second all the time, even when the landing is going great. By moving, I mean to alternately depress each pedal by ¼” at the rate of at least 1 cycle per second and faster is better. This keeps the mind and the feet fully in the control loop. If the rudder is pressed and held with the knee locked, the crosswind skill will be weak.

Success in Calm Weather

A pilot who can achieve a consistent good solid flare and gentle touchdown in calm weather will be more likely to land well in a crosswind. Here is why.

A pilot who lands well in calm weather demonstrates good visual skill because the plane cannot be landed consistently with poor visual references. It all demonstrates a willingness to slow the airplane down for a landing near stall speed. Both of these skills are essential for good crosswind landings.

Leaning the body

If a pilot aggressively leans away from the bank of the aircraft during a crosswind landing, it is not likely that those landings will go well. Why? Because they eyes are a very critical part of measuring what is going on during the landing. If the pilot moves the eyes quickly left and right, the visual field is changing and the aircraft is harder to control.

Additionally, the pilot who leans away from the bank indicates that they don't like what is going on. Mentally, the pilots must be willing to engage with the aircraft and the situation. If the pilots hates the bank and strives to not bank, good crosswind skill is not likely. Go with the aircraft.

Hands vs. Feet

I have observed many pilots trying to use the hands alone to control an aircraft in a crosswind landing. Pilots tend to be aggressive with the hands and weak with the feet. Learn to turn that around. Be aggressive with the feet and gentle with the hands. If the pilot will aggressively make sure the nose of the aircraft is pointed at the far end of the runway during a gusty crosswind landing, everything else becomes easier.

“Point your nose with your toes”. This is the most important thing a pilot can do during crosswind landings. This should be done with an aggressive mental attitude.

If the nose is twitching away from the desired point, the pilot should be stomping on the pedals to get things back to where they should be.

After touchdown

Do not touch the brakes. Continue to keep the feet low and aggressively point the nose at the far end of the runway. If the pilot immediately jumps for the brakes, there can be loss

of control at a very critical time. Let the plane slow down before beginning to lift the toes for the brakes.

Don't land, fly!

The pilot should be thinking 80% fly and 20% land during a crosswind landing. The real goal is to correctly keep the aircraft flying near the runway and not plant it with force on the runway.

To explain this further, maintain the slip over the centerline and touch the upwind wheel. If the aircraft will stay on the upwind wheel, keep doing that. The airplane is happy and the pilot has great control when in the slip, even with one wheel on the runway. Do not set the airplane on all wheels until it will not stay on one wheel. This means that the pilot will have fed in full aileron to maintain the bank during the slip before the airplane settles onto the downwind wheel.

Also, if conditions are gusty, the airspeed could jump up above flying speed. The aircraft should then be flying and not forced to stay on the ground. Be prepared to go back to flight in the slip at all times.

So, embrace the idea of flying and try to get away from being in a rush to force the aircraft on the ground. Once on the ground, there must be enough wheel friction to steer. If the aircraft is too fast, there may not be enough friction to steer and the aircraft is not in a slip to be controlled by flying. Therefore, the pilot can't fly it or drive it. Not good.

Mental Attitude

The pilot must adopt an assertive/aggressive mental attitude during landing. In nearly all other phases of flight, the pilot is being gentle with flight controls. But, during a gusty crosswind landing, the pilot must not be gentle with the flight controls.

Repeat this phrase when preparing for a crosswind landing – “I will stomp my rudder pedals to the floor when needed to immediately force my airplane to point the right direction.”

Flight Control Function

If the airplane is not pointing where it should in a crosswind landing, the pilot must step on the rudder pedal and then release some of the rudder pressure once the nose is in the right place. It is a two step process. It is very hard to step on the rudder with one single pressure and arrive at the correct place with the nose of the aircraft. There are two problems that are encountered. 1) it is impossible to predict the exact rudder pressure needed and 2), it takes too long to wait for the nose of the aircraft to settle where the new rudder pressure will leave it. Therefore, the best way to get the quickest response from

the rudder system is to stomp the pedal to the floor and then release some of the rudder pressure once the nose arrives in the correct location. I use the word stomp because many pilots are reluctant to do any more than gently press 25% of the pedal throw.

Crosswind Component

Always estimate crosswind component. This allows the pilot to learn from every landing. Memorize these numbers:

Wind 30 degrees off the nose, crosswind is $\frac{1}{2}$ of wind speed.

Wind 45 degrees off the nose, crosswind is $\frac{3}{4}$ of wind speed.

Interpolate everything from there.

Crab

When an airplane is approaching the runway in a crab, this is normal flight for the airplane. This means that the crosswind is not hitting the side of the airplane and no special flight controls are needed to make the aircraft stay in the crab. This is wings level, normal flight. When the aircraft is trimmed well and stable, the flight controls can be released and the nose will point to the right or left of ground track depending on wind and the aircraft will still travel toward the runway.

Slip

A slip is always cross controlled... right rudder and left aileron or left rudder and right aileron. The aircraft must be forced to stay in the slip. If controls are released, the aircraft will leave the slip. A slip is higher drag than normal flight. So, airspeed may decay.

Use a steeper approach when a slip is required. This makes it easier to keep the airspeed up.

A side slip is required to land well in a crosswind.

When to Begin to Slip

During the approach to the runway, the pilot can initiate the side-slip at any desired point. Here is how it usually works. The more experience a pilot has, the closer to the ground the slip is started. When flying larger equipment the slip is always done very close to the ground because:

- The airplane does not fly well in a slip.
- Passengers do not like to slip.
- The wind and slip effort will be much larger at 500 feet than it will at the ground.

However, when pilots are learning, that extra time to set up and stabilize is necessary. No matter if the slip begins right at the ground, I strongly believe that a pilot must know how to slip in order to have the highest level of effectiveness in tough crosswind condition. Many will say that the aircraft can be kicked at the last second. This is true when a pilot has plenty of experience. With high experience, the slip should be initiated in the last few feet. However, never use this as an excuse to avoid learning to slip effectively.

Induced Roll

When an airplane is flying in level flight and the rudder is pressed with no aileron, the airplane will roll toward the foot being depressed. If this continues, the airplane will roll inverted until it is pointing at the earth in a dive.

It is helpful to realize that when landing in a crosswind, the rudder is being depressed in the same way to point the nose at the far end of the runway. This causes the airplane to roll toward the foot being depressed. The foot being depressed is always the downwind foot. This means that the airplane is trying real hard to roll downwind and it has nothing to do with the wind. Considerable opposite aileron is required just to keep the airplane from rolling downwind and this is all caused by the rudder deflection.

Adverse Yaw

When battling gusty crosswinds, the ailerons may be deflected rapidly to maintain or adjust the bank angle being used to stay over the centerline. This change of aileron at slow speed can cause yawing. This is called adverse yaw. The aircraft can yaw in a direction opposite the way the yoke is being turned. It does not matter why the aircraft yaws. Use the feet to make sure the nose continues to point in the right place.

Land on the Upwind Wheel

This may seem obvious, but many pilots fail to achieve this goal. The aircraft must touch down on the upwind wheel. Don't think of landing on the upwind wheel, think of touching the upwind wheel while the aircraft continues to fly down the runway. This is a much more controlled way to land in a crosswind.

Rudder for Alignment

As stated, the main goal in crosswind landing is to “point your nose with your toes” at the far end of the runway. If this is done well, everything else is easier. Control of alignment is very direct. This nose will move when the rudder is changed.

Bank for Lateral Position

The lateral or left/right position of the aircraft over the centerline is controlled by aircraft bank angle not yoke position. Aircraft bank angle is the magic element being controlled. The pilot must see the bank angle with peripheral vision and then see how it is working with peripheral vision and then adjust the bank angle as needed. Bank angle adjustment is a two step process, change the yoke, wait to see the bank in the new position and let some of the yoke change out.

Aileron does not control lateral position. Aileron controls bank angle which then controls lateral position. This sounds like a play on words. However, it is actually a very critical point of understanding. If an aircraft is left of the centerline and the pilot wants to go back to center, turning the yoke right and holding it there until the aircraft reaches center would be disastrous. Turning the yoke right until a new appropriate bank is reached and releasing some of the yoke until the bank takes affect, is the right way to do it.

Learn to read bank angle. It actually does not matter where the yoke is as long as the bank angle is being controlled properly. The maximum bank angle for any kind of normal crosswind in a C172 will not exceed 10 degrees. The pilot's entire area of work after pointing the nose properly is to stay within this 10 degree window in most cases.

Centerline

The centerline is for the pilot, not the airplane. The pilot's eyes should always be over the centerline. In most small planes, the nose wheel will only be 12” to the right of the center if the pilot is exactly over the center.

A pilot over the centerline will be able to see drift left or right much faster than a pilot over open runway with no marks.

Also, there is no good reason to compensate into the wind just in case the plane get's blown downwind. There are plenty of crosswind accidents resulting from the aircraft departing the upwind side of the runway. Always stay over the centerline. This allows the pilot to determine if all is well or if the landing should be aborted.

When to Abort

Here are two guidelines to keep a pilot safe. Go around if either of these is true or both are true.

- 1) The nose of the aircraft cannot be pointed at the far end of the runway. "Can't point your nose with your toes."
- 2) The aircraft will not progress back toward the centerline.

If the aircraft is in the air (last 10 feet) or on the ground (after touchdown) and either of these two or both problems exist, go around.

Crosswind Landing - a Unique Maneuver

Crosswind landings are unique because it requires skill that we don't use much in the aircraft. Here is a comparison between most of flying and the crosswind landing.

Description	Enroute	Crosswind Landing
Assertive/Aggressive with Flight Controls	No	Yes
Cross Controlled Flight	No	Yes
Strong Rudder Skill	No	Yes
Seldom used part of flight	No	Yes
Hard to practice	No	Yes
Higher Risk	No	Yes
Unusual Forces on the Body	No	Yes

In most crosswind landings there is 5 seconds of effort that is key to success. If the pilot can fly and get to the airport, there is not much of a problem. The issue is really the last few feet, keeping the airplane aligned and keeping lateral position under control. Many pilots have very limited experience in this area with crosswinds that exceed 15 knots in a standard GA airplane. So, taking the number of crosswind component landings in excess of 15 knots and multiplying by 5 may yield an actual experience level of only 25 seconds for a new private pilot. It may yield only a few minutes of experience for someone with 500 hours. It is very hard to be highly skilled as something when experience is so limited.

Unlike many other areas of flight, crosswind landings are often not tested or demonstrated. A pilot can work through many checkrides without demonstrating this challenging skill. Many checkrides occur on calm days and good weather. It is fascinating to think that such an important maneuver with such little practice may not ever be demonstrated for evaluation. We all know that it would be hard to require that demonstration. But, just consider that a pilot can be rated in many ways and never show that they can handle a gusty crosswind.

Even aircraft checkout flights for rental at the local airport are usually done in good weather and crosswinds are not required to go forth and rent. Again, it would be hard to require that demonstration. I'm just pointing out that we don't really know if a pilot can handle strong crosswinds or not.

All of this begs the question. When are we required to demonstrate this very tough skill? It usually comes finally at the end of a long trip when we are tired and we are going to try to get down in some tough conditions.

Imagine how poor our golf skills would be if we had only hit 20 balls in our career and now we are up for a very challenging shot over water that needs to be very accurate to stay out of trouble. This is the nature of tough crosswind landings. Some people are naturals at hitting the golf ball and most are not so good, like me.

Big vs. Small Aircraft

A large aircraft may touchdown at 100 knots. If the crosswind is 20 knots, that is 20% of forward speed. If a small aircraft touches down at 40 knots, that same 20 Knot wind is 50% of forward speed. A small airplane pilot must work harder than the large airplane pilots regarding that crosswind condition.

It is also true that as the light sport category of aircraft continues to grow, pilots have even more work to do in that slower aircraft if they try to land in high winds. Light wing loading and slower flying speed means that crosswind skill will need to be high in order to land in modest crosswinds.

Don't Bank Downwind

This is helpful when approaching in a crosswind. If the pilot points the nose at the far end of the runway, the aircraft will drift downwind when the wings are level. There is no reason to bank downwind. It just makes the problem harder.

On the Runway, if Sliding Downwind, you Should be Flying

If the aircraft is on the ground and all three wheels are sliding downwind, it indicates that the aircraft is moving too fast. The aircraft should not be on the ground at all and should be encouraged to go back to flight in the slip. If the crosswind component is reasonable, let's say under 20 knots, wheels sliding downwind indicate that the airplane is moving too fast, it should be flying and not driving on the ground.

Aileron on the Ground

The aileron should be turned fully into the wind when the plane is on the runway. Many ask when the aileron should be turned into the wind. This is the wrong question to ask. The aileron should be turned into the wind during the landing to try to keep the downwind wheel off of the ground. When the aileron is at full deflection and the plane slows enough, the downwind wheel will set down on the runway and the aileron will be fully deflected. So, don't land and then fully deflect the aileron, fully deflect the aileron and then finish the landing.

The full aileron into the wind on the ground helps insure that the airplane does not flip downwind. It also prepares the airplane to go back to flight in the slip if the wind should gust above flying speed.

Get to the Ground and Stay Near the Ground

This helps to take some of the fear out of landing in a crosswind. If the aircraft can get near the runway and stay near the runway without ballooning upward, it is not possible to hurt much. If the plane falls 1 foot, no problem. However, the airplane cannot drop 10 feet. It can ease a pilot's mind if the aircraft can be hurried down to the runway and forced to stay near the runway while flying and bleeding off energy. If a gust drops the airplane on the runway, there will be no harm.

Just touch the upwind wheel during touchdown while still flying

The goal is not to plant the airplane but to touch the upwind wheel while flying. This difference in thinking can really change how crosswind landings are executed.

Night and Low Visibility

Since all landings and especially crosswind landings required plenty of visual cues, be careful about trying to land in strong and gusty crosswinds at night. It can make things much harder when it is dark. It is harder to see the frame of the aircraft and compare it with the horizon with the peripheral vision at night or in other visibility limiting conditions.

Contaminated Runway

It will not work well to land in a crosswind on ice. At some point, friction with the runway is required in order to steer. This does not mean that it cannot be done. When a pilot is bored because of such superior crosswind skill, that is when landing on an icy runway can be tested, and not before.

Approach Fast, Land Slow

When conditions are gusty, it helps to carry extra speed during the approach. A common error is to then land the aircraft at a higher speed. This usually leads to trouble. It is good to approach fast but the aircraft must still slow down to land. Keep flying near the ground and be patient.

Another helpful tip is to aim earlier if the approach speed is higher. Aim at the grass in front of the runway. This gives the airplane more time to slow down after the faster approach.

Steeper is Better

During gusty approaches, the aircraft will handle much better in a dive toward the runway rather than hanging on the prop to try to get to the runway. Fly down through the turbulence instead of bumping along at treetop level. It will keep the aircraft safer and the ride will be better.

Multiple Runways and Controlled Fields

At airports with multiple runways, pilots can fail to gain much crosswind experience. It can be hard to interface with the rest of traffic and it is easy to always land on the favorable runway. This can mean that pilots from fields with multiple crossing runways may lack crosswind practice especially at fields with a control tower.

Light Sport Aircraft

Light sport aircraft have light wing loading and may have pilots aboard with less flight training. Do not underestimate the challenge in landing a light sport aircraft in gusty crosswinds. The pilot of a light sport aircraft will have more work to do in a 10 knot crosswind than an MD 80 pilot will in a 20 knot crosswind.

Different Methods?

There is always talk about different methods for landing in a crosswind. We hear it called the wing low method vs. the crab method, etc. If a pilot is skilled enough to kick the aircraft at the last second and land consistently in gusty crosswinds, that pilot already understands crosswind landings. If a pilot believes that they can learn to kick the aircraft just right instead of learning to land in a crosswind, they may never be very effective with crosswind landings.

It is my humble opinion that a pilot must know how to slip an aircraft effectively in order to be highly effective with crosswind landings. Here is why.

If a pilot only knows the concept of kicking at the last second, the airplane may not stay on the ground after it touches. That pilot is faced with trouble or going around. Also, if a gust takes the plane back above flying speed after it is on the ground, the aircraft should be flying. The “kick only” pilot has no option but to try to stay on the ground or to go around. Staying on the ground can be trouble.

The more experience a pilot has, the lower to the ground they will begin to slip. Even if the slip begins right at the ground, the pilot should still be thinking slip and fly not kick and plant. Again, an experienced pilot can make a quick kick look really good. But, I would suggest that they are most likely a very knowledgeable pilot and did not skip learning to slip an aircraft.

When I flew a Citation, I did not slip very long because it is uncomfortable for the passengers. But when landing with a 30 knot direct crosswind at Midway in Chicago, I was definitely slipping the aircraft during the last 6 inches of descent. So, it looked like a kick, but I was most definitely thinking slip to help me maintain good control.

In many ways, I don't really believe there are two methods of landing in a crosswind. There is really only one, the slip. The real question is when does the slip begin? The pilot trying to learn may begin to slip after turning final. The experienced pilot will not slip until in the flare. But an effective pilot will be thinking slip at the point of touchdown in a crosswind.

When I say effective pilot, I mean a pilot who is gentle with the equipment and can consistently land in gusty crosswinds without any doubt about the outcome.

Also, landing an airliner can be a little different than landing a small plane. Some large aircraft are designed to land in a crab. However, many will argue that those same large planes should be landed with a gentle slip and it is much easier on the hardware. I'm not attempting to address landing an airliner here. But, I know many experienced captains who will say that a pilot should have great crosswind skill to be excellent at landing an airliner and not just drop the machine in a crosswind.

Conclusion

This document is about excellence in crosswind skill and not just getting the aircraft on the ground. Excellence can mean the difference between a safe landing and a blown tire. It can mean the difference between a collapsed gear and a nice rollout. It can mean the difference between tires with flat spots and lower operating cost.

So, I'm challenging you to strive for excellence in your crosswind landings.

Check out the Xwind crosswind landing trainer in different cities around the country. With Xwind, a pilot can practice foot/eye coordination and dealing with hundreds of gusty crosswinds in complete safety while feeling all of the forces on the body. No matter what your skill level, this machine will make you better and provide insights that you never imagined.

Thanks for your time.

Brad Whitsitt CFI/II, MEI, ATP
President
Xwind, LLC
xwindsim.com
brad@xwindsim.com
(317) 501-0733

