



Xwind, LLC

Indianapolis, Indiana

Instructor's Manual

September, 2010

About this Document

This document is intended for flight instructors who will be using the Xwind Crosswind Landing Simulator to train pilots. The flight instructor at the back pressing the buttons should read this document prior to using the simulator for training.

Just knowing how to do a crosswind landing is not the same thing as teaching it. This document can help you become highly effective with the Xwind sim.

Caution!

The Xwind Crosswind Landing Simulator is an industrial machine. Any operation or use beyond the guidelines of Xwind, LLC as directed in this manual can result in equipment damage or serious injury.

Every effort has been made to insure operator and pilot safety and this device is safe for both if operated according to this manual.

Only certified flight instructors should provide flight instruction with this device and only persons authorized to operate this device are allowed to turn power on.

Every pilot sitting in the pilot's seat should be strapped in using the supplied seatbelt BEFORE power is applied. This is not only for restraint during normal motion, but also for restraint in the event of some electrical or mechanical malfunction.

Terms

Here are several terms used in this document:

Pilot – The pilot in the seat of the simulator receiving instruction.

Instructor – The person at the rear of the simulator providing setup and instruction.

Track – The rails on the floor that the simulator rides on.

Platform – The lowest part of the simulators that sits on wheels and moves left and right on the track.

Yaw Tree – Supports the roll axis of the deck. It is the part that yaws.

Deck – Supports the seat and cockpit. It is the part that rolls.

Left, Right – As viewed by the pilot or instructor.

Front, Back – As viewed by the pilot in the seat or instructor standing at the back.

Roll – The left right rotating motion of the cockpit where the pilot is strapped in.

Yaw – The left right twisting motion of the cockpit where the pilot is strapped in.

Drift – The left and right movement of the entire simulator on the track.

Philosophy

The Xwind Crosswind Landing Simulator is designed to place a pilot 6 inches from touchdown in an aircraft cockpit and give them extended periods of time to learn how to automatically react to gusty crosswinds. The number one goal is to instill muscle memory feel on the body and correct automatic reactions to wind and gusts.

This simulation of crosswind landings is not supposed to be easy. It is designed to be challenging in many ways so that the aircraft seems easier.

The cowling is designed to limit visual cues much like an aircraft pitched up to land. It is designed to encourage the pilot to lift their chin and possibly lean forward just a bit to improve their posture and use of their eyes.

The rudder pedals have more throw than a typical C172. This is to help enforce the extended use of the feet so that it will feel easier in the airplane.

The yoke will turn 90 degrees much like a C152. Again, this is to encourage full use of the yoke during a gusty crosswind landing. A pilot will be more willing to use the more limited throw of controls if they get used to using extended control throw.

The control feel will be a bit sluggish. It is designed to represent a standard light single just before touchdown.

In the LAND or touchdown mode, the tail dragger sequence is designed to be very challenging. If a pilot can stay ahead of the tail dragger sequence they will probably be very effective at staying ahead of a standard tricycle gear airplane in a modest crosswind.

So, if a pilot feels overwhelmed by the challenge, it is important to understand that it is designed to be harder than the real thing so that the airplane seems easy.

The goal is to help pilots handle modest crosswinds with skill and confidence and not to land in extremely strong crosswinds.

The Xwind simulator allows pitch input from the pilot but there is no pitch axis of rotation. The pitch axis has been eliminated for several key reasons.

1. The original design target was to produce a low cost trainer to improve crosswind skill. The pitch axis adds tremendous cost with little training value in this regard.
2. This simulator is not designed to teach a pilot to land. That is to be done in the airplane.

3. The entire landing sequence cannot be simulated well without much higher cost in computing and visual feedback.
4. If the cost of the simulator were to double in cost and only do a poor job at landing simulation, the main objective of teaching crosswind skill at an affordable price could be lost.
5. Our testing has shown that the pitch axis is not necessary if a pilot has already learned how to land a real aircraft.

The land mode is not designed to teach the full landing sequence. It is designed to teach these 4 key elements of the crosswind landing:

1. Interacting with the roll axis after one main wheel is on the ground and the other main wheel is being lowered to the ground.
2. Rolling and holding the aileron fully into the wind after touchdown.
3. Steering with the feet after the aircraft is on the ground.
4. Catching the aircraft in a stable slip if it suddenly goes back airborne.

Therefore, the Xwind simulator is not to be viewed as teaching the entire landing sequence but teaching the individual transitions that can occur in a crosswind landings:

1. Crab to Slip
2. Slip to Crab
3. Changing Wind Speed and turbulence
4. Flight to Land
5. Land to Flight

Using the pilot switches, a pilot can practice basic control without an instructor present. This is to be used by pilots who are already trained but would like to practice foot/eye coordination.

Components

Here are the major components of the crosswind landing simulator as referenced in this document.

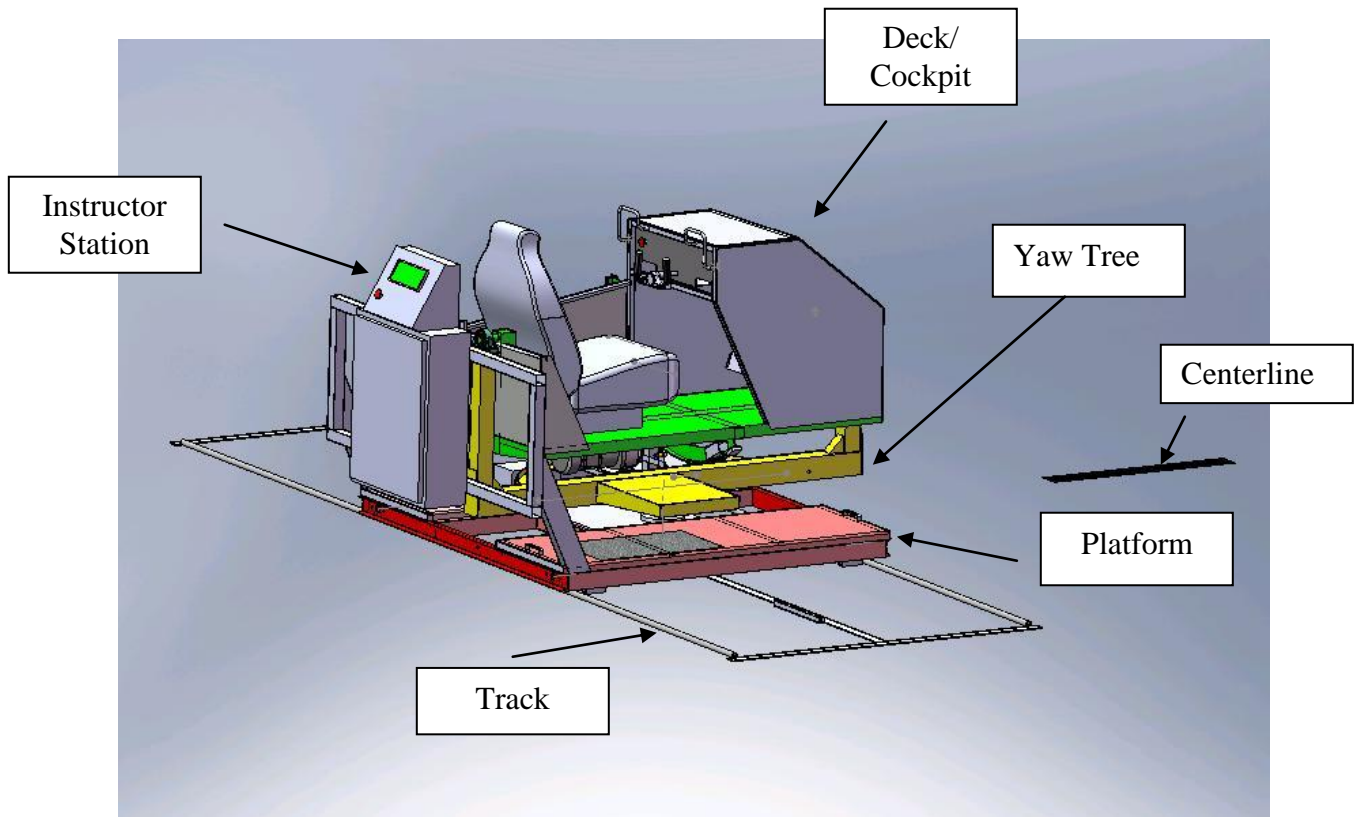


Figure 1
Overall Simulator



Figure 2
Instructor Keypad

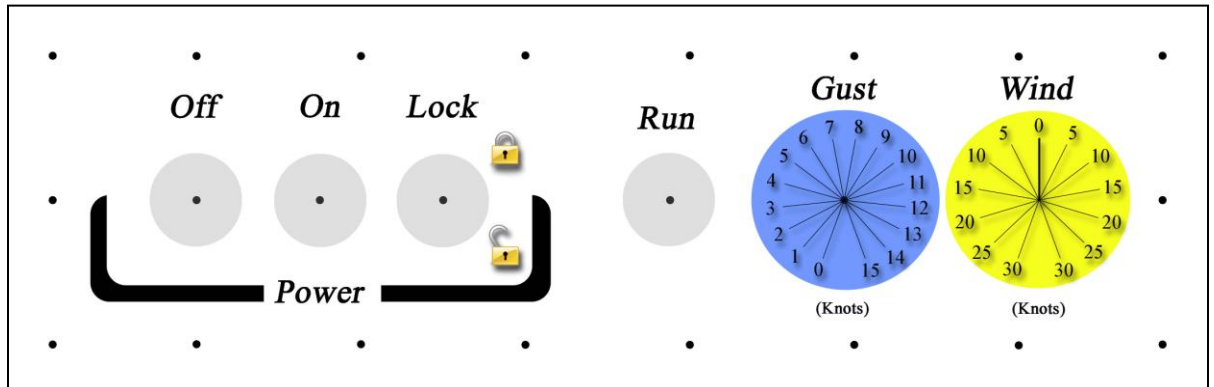


Figure 3
Instructor Switches

Note:

The instructor keypad (figure 2) and instructor switches (figure 3) are both on the instructor station.

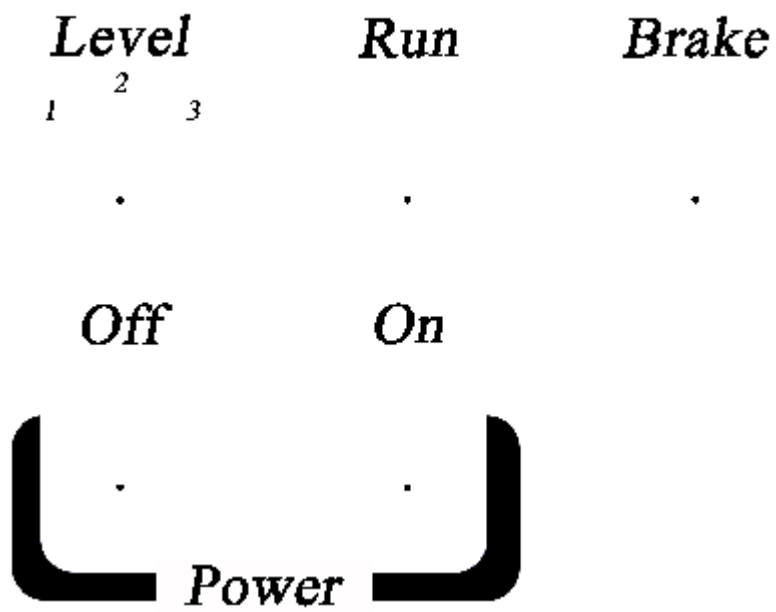


Figure 3a
Pilot Switches

Note: The pilot switches are located on the left side of the dashboard for the pilot.

Power

The simulator must be plugged into a 120VAC, 15 Amp circuit. In Europe, the simulator must be plugged into a 220VAC, 8 Amp circuit.

Rout the power cord so that it will not hang up. It is best to run the power cord straight toward the rear of the simulator.

Referencing figure 3 and 3a, power is turned on by:

1. Turning the LOCK switch to the unlock symbol
2. Momentarily pressing the ON switch.
3. Power will turn on if the pathway sensors are clear. If the pathway sensors are not clear or are not aligned properly, the power will not turn on at all.
4. When power turns on, the OFF switch will light up on the instructor station and the cockpit dashboard, and the cooling fan will begin to run.
(Note: For models in Europe, make sure that both emergency stops are pulled out, or power cannot turn on.)

Power is turned off in 4 ways:

1. Momentarily press the OFF switch on the instructor switches.
2. Momentarily press the pilot OFF switch located on the cockpit dashboard.
3. Turn the LOCK switch to the locked symbol.
4. Interrupt a pathway sensor on the left or right of the platform.

Power is secured so that it cannot turn on in 2 ways:

1. Turn the LOCK switch to the locked symbol and remove the key.
2. Unplug the power cord.

Note: Do not turn power off while the simulator is in motion unless there is an emergency. This can limit the life of the drives. If an emergency stop is required, then turn off the simulator regardless of movement.

When power first turns on, the following occurs:

1. All instructor keypad lights should turn on for test.
2. The Run light should turn on for test.
3. After the test period, all lights should go out.
4. During the test period, no jogging or motion should occur.

The LOCK keyswitch key can be removed in both the locked and unlocked position.

Modes

There are three major modes of simulator operation:

1. Pause – Simulator can be jogged by the instructor manually.
2. Instructor Run – Simulator is live and will respond to the pilot and move according to the settings at the instructor keypad and switches.
3. Pilot Run - Simulator is live and will respond to pilot and move according to the scenario switch 1, 2, or 3.

Run mode is entered and the Green run light turns on in 2 ways:

1. Instructor must press the RUN button at the instructor switches.
2. Pilot presses the RUN button at the pilot switches.

The simulator returns to pause mode and the Green run light turns off in 4 ways:

1. Instructor presses the RUN button in the run mode.
2. Pilot presses the RUN button in the run mode on the pilot switches.
3. A fault is detected by the computer.
4. A ground loop occurs in the LAND and TAIL DRAG sequence.

There are no other major modes of operation.

Pilot Switches

The primary purpose of the pilot switches is to allow a pilot the opportunity to practice without an instructor. These should not be used for initial training.

Power control is self explanatory.

The scenarios are set up as follows:

- 1) Variable wind is from one direction only with no turbulence.
- 2) Variable wind is from one direction only with turbulence level 1.
- 3) Variable wind is from left or right with turbulence level 2.

The wind direction for level 1 and 2 alternates direction each time run mode is entered by the pilot.

If run mode is entered from the instructor station, the scenario switch has no effect.

The BRAKE light is used to shown when a brake is being applied. The goal is to help pilots understand that the brake must not be applied.

Jog Functions

Refer to figure 2.

All blue buttons are jog buttons that work only in the pause mode.

The instructor can jog each moving axis of the simulator using the instructor keypad. Each simulator axis will move when the appropriate button is pressed and held. As long as the button is held down, it's associated LED light will light up and the axis will move at a constant slow speed.

The only thing that will stop the axis from moving is the end of travel sensor. At that point, the axis will stop and the red LED light will turn off for that button even if the button is pressed or held.

More than one axis can be jogged at the same time by pressing and holding two buttons at the same time.

The simulator can be brought to the center position for each axis simultaneously by pressing and holding the CENTER ALL button.

Here are some reasons that you may want to jog an individual axis:

1. To test the end of travel limits to be sure that each limit is working.
2. To move the simulator back to a starting position.
3. To place the simulator in a unique starting position so that the pilot must orient and stabilize in a slip for practice.
4. To demonstrate the various movements to a student.

Laser Pointer Functions

Refer to figure 2.

There are two pointers that can be used to help pilots better understand how they are oriented. The YAW and DRIFT LASER buttons are red buttons that control the laser pointers. The YAW LASER is attached to the yaw tree and projects a RED laser beam forward to a target to show how the yaw axis is oriented.

The DRIFT LASER is attached to the platform and projects a RED laser beam forward to a target to show how the platform is drifted left or right.

These are push on/push off buttons for both lasers and their state can be changed in pause or run mode. When the associated button's red LED is on, the laser is on.

When both lasers are on and the platform is centered and the yaw tree is centered, both laser dots will be in the center of the target. The red platform laser can only be moved to the center by moving the entire simulator to the center of the track. The yaw laser pointer can be moved to the center with the rudder pedals by changing the yaw axis.

Turbulence Functions

Refer to figure 2.

The TURB 1 and TURB 2 green buttons control turbulence simulation. These buttons are both push on/push off and they function as radio buttons. This means that if TURB 2 is turned on when TURB 1 is on, TURB 1 will turn off when TURB 2 turns on.

With both lights out, there is no turbulence, with TURB 1 on, there is light turbulence. When TURB 2 is on, there is moderate turbulence.

TURB 1 and 2 cannot both be on at the same time.

Turbulence buttons can change state in the run or pause modes.

Rudder Only Function

Refer to figure 2.

One gray button at the bottom controls the rudder only mode. This can be used to allow a pilot to practice foot/eye coordination with no other distractions. The yaw axis responds to wind, gust, and turbulence but roll and yaw are disabled.

When the associated red LED is on, the rudder only mode is enabled.

RUDDER ONLY can be changed in pause or run mode. It is a push on/push off button.

Drift Off Function

Refer to figure 2.

One gray button at the far right controls the drift or platform axis. The drift axis can be turned off so that it will not move at all. This can be used to allow a pilot more time to understand roll and yaw before introducing the platform drift.

When the associated red LED is on, the drift axis will be disabled.

When disabled, the drift axis will not move in pause or run mode.

DRIFT OFF can be changed in pause or run mode. It is a push on/push off button.

Land Function

Refer to figure 2.

When the simulator is in the RUN mode, the LAND button can be pressed and the simulator begins a landing sequence. The purpose of the land sequence is to encourage the pilot to place the flight controls in the proper position while steering with the rudder pedals on the ground.

It is important that a wind be set up with no gust and no turbulence and the student is stabilized in a slip for the event to look normal to the pilot. When in a slip, press the land mode and the following begins to occur.

1. The pilot will feel a bump from the upwind wheel.
2. The roll axis begins to move toward level.
3. The pilot can influence the progress toward level by adding more opposite roll. But, eventually, the deck will reach level.
4. The computer watches for the pilot to keep the yoke fully into the wind after touchdown.
5. The simulator will return to flight by turning land off.
6. If the yoke is not held into the wind, the simulator will return to flight on its on by flipping the pilot downwind.

The land mode will be reset if the simulator is switched to PAUSE. The instructor can return the simulator to flight at any time by pressing the Land button a second time and turning off the land mode light on the land button.

Tail Dragger Function

Refer to figure 2.

In the bottom right of the instructor keypad is a gray button used to tell the simulator how to behave during the land sequence. When this button is on, the simulator will behave like a tail dragger on the ground only in Land mode. It is possible to ground loop the simulator during the land sequence in Tail Dragger mode.

The Tail Drag mode can be changed at any time but will only have influence during the land sequence.

TAIL DRAG can be changed in pause or run mode. It is a push on/push off button.

Fault Function

Refer to figure 2.

In the top right corner of the instructor keypad is a FAULT button. The LED on this button turns on and flashes when there is a fault detected by the simulator computer.

A fault is reset by pressing the fault button. If it can be cleared, the LED will stop flashing and the simulator will return to normal operation in the pause mode. If it cannot be cleared, the fault light will continue to flash.

When the fault light is flashing, the fault type is displayed on the CAL buttons. The fault type is determined by recording which CAL buttons are on and which are OFF. Up to 24 fault types can be detected by the simulator. The purpose of the fault detection is to shut down the simulator if there is a detectable problem rather than allowing it to run and cause some other problem.

If a fault occurs, the two digits of the fault number are sequenced through the CAL buttons. The first digit is displayed when CAL 5 is off for about 1.5 seconds. The second digit is displayed when CAL 5 is on for about 1.5 seconds.

If you experience a fault use the table below to determine what type of fault has occurred. This may be helpful in talking to the manufacturer about a possible solution. “X” represents an LED on for that button. Blank means that the LED is off for that button.

Fault Table

Fault #	Description	First Digit					Second Digit				
		CAL Button					CAL Button				
		1	2	3	4	5	1	2	3	4	5
1	Computer Error									x	x
2	Computer Error								x		x
3	Computer Error								x	x	x
4	Computer Error							x			x
5	Computer Error							x		x	x
6	Computer Error							x	x		x
7	Computer Error							x	x	x	x
8	Roll Drive Fault						x				x
9	Yaw Drive Fault						x			x	x
10	Platform Drive Fault				x						x
11	Roll Drive Did not Run				x					x	x
12	Yaw Drive Did not Run				x				x		x
13	Platform Drive Did not Run				x				x	x	X
14	Both Roll Limits On				x			x			X
15	Both Yaw Limits On				x			x		x	X
16	Both Drift Limits On				x			x	x		X
17	Roll Forward Limit On at Wrong Time				x			x	x	x	X
18	Yaw Forward Limit On at Wrong Time				x		x				X
19	Roll Reverse Limit On at Wrong Time				x		x			x	X
20	Yaw Reverse Limit On at Wrong Time			x							X
21	Roll Sensor Fail			x						x	x
22	Yaw Sensor Fail			x					x		x
23	Yoke Sensor Fail			x					x	x	x
24	Rudder Sensor Fail			x				x			x
25	Not Used			x				x		x	x

Calibrate Function

Refer to figure 2.

It is possible to calibrate each axis of movement. However, you must have access to the owner's manual in order to calibrate any axis. Pressing the CAL buttons will have no effect unless you know the access code.

Wind

Refer to figure 3.

The wind value used by the simulator is determined by the wind dial at the instructor switches. Wind is blowing from the right when the pointer on the wind dial is pointed to the right and likewise for the left. The wind value is set in knots and refers to the crosswind component. So, it can be assumed that all wind is 90 degrees off the nose from the direction selected.

The wind can be set up to 30 knots from the left or right. When the dial is centered, there is no wind affecting the simulator.

The wind can be changed at any time in pause or run mode. It has an immediate effect in run mode or will take effect when the run mode is entered.

The rate that the wind dial is changed is the rate that the wind will be increasing or decreasing for the simulation. This feature can be used to manually vary the wind in random ways.

Gust

Refer to figure 3.

The gust value used by simulator is determined by the gust dial at the instructor switches. The gust setting acts in addition to the wind setting. If the wind is set from the left at 10 and gust is set to 10. The wind will be from the left at 10 gusting to 20.

The computer randomly adds and removes the entire gust amount. So, the pilot will see a step change in the wind up to the gust amount.

Gust values can be changed at any time. They only take effect at the instant that the computer decides to add the gust to the wind.

For Flight Instructors Only

The Xwind simulator is a highly effective tool in the hands of a qualified instructor. The Xwind simulator is not a perfect reproduction of the landing environment. It is however, an excellent representation of the forces on the body and visual cues that are very difficult to learn and manage in an airplane. As the instructor, you can help produce a competent and safe pilot that will come back

for more training from you when they experience how well you can help them with this challenging aspect of flight.

You must be willing to learn more about crosswind landings and how to teach them in order to be effective with this simulator. If you simply place your student in the seat and crank the wind up to 20 Knots and throw in gust and turbulence, they will not gain much. If you take the time to help the student build up each skill in a sequential way, you will be amazed at the results and your student will love the confidence they gain with this very difficult maneuver.

You will need to develop your skill at analyzing the pilot's performance in order to help them break down why they struggle with some aspects of the crosswind landing.

For years, crosswind landing skill has been taught by providing a beginning pilot with the basic ideas, practice some crosswind landings, and send them to their checkride. On the checkride, pilots are seldom required to demonstrate solid crosswind skill. Pilots can acquire many ratings and never demonstrate crosswind competence. If a pilot gets the wrong start, they may fly for years with very little crosswind skill.

Also, in the aviation industry, we assume that a pilot who has flown for 5 years knows how to handle crosswinds. The fact is that many pilots struggle greatly with crosswinds and they would like to have a way to improve skill without looking bad in the process. Your ability to encourage pilots to work on their skill without pretending to be perfect, will help you earn considerable money for your insights.

Pilots are often afraid that they are going to look bad or demonstrate just how weak they are at crosswind landings. If you want to generate more business, it is important that you constantly work to set aside any expectations of how effective a pilot is supposed to be and start at the beginning no matter what.

At Xwind, we have found through experience that these key items can help you be much more effective:

1. Go over all terms – Many pilots do not know what adverse yaw is and how it can affect a crosswind landing. Give them a chance to review all of the issues. Most pilots do not know that a wind 30 degrees off the nose yields a crosswind component that is 50% of the wind speed. Provide time to discuss. When we have trained a more experienced pilot and assumed that they knew what they were supposed to do, we were less effective because we did not give them time to talk over the technical aspects.
2. Start slow – make sure a pilot has time to get used to the simulator. Many pilots have not pressed the rudder pedals to the floor in years. Let them

feel those issues before they are pressed to do more. If a pilot cannot stabilize in a forward slip with no wind, do not move on to more complex concepts.

3. Insure success – Make sure that you provide positive feedback for the smallest areas of success. Give pilots plenty of time to improve skill on small items and do not overload them too fast. Most pilots just wish they were better at this. A pilot with a deeply engrained bad habit will probably continue to revert back to that bad habit each time a bigger challenge is introduced. It is very important to laugh with them as long as they clearly see that the technique was wrong.
4. Recognize apprehension – Pilots that are very apprehensive about crosswinds in the airplane will bring this to the simulator. It may take an hour or more for them to relax. As an instructor, you should encourage them to relax constantly. You will get much better results and truly help them get better in the airplane. Pilots will probably not come for training if they have it all nailed down. The pilots that are really worried will come and they must go slow to improve or you will simply confirm that they can't do it. Some anxious pilots have required 6 hours of simulator time on different days just to get the concepts to work in the simulator.
5. Pause Often - The Xwind simulator is hard work for a pilot in the seat. The more a pilot struggles, the more they need to stop, rest, and discuss their struggles. A great way to allow rest time is to pause and discuss other crosswind landing tips in this manual or talk about other flying concepts.

When you pause, it is helpful to walk around to the right side and make eye contact with the pilot during discussion

6. From Rough to Smooth -

As instructors, we sometimes expect our students to be smooth in their flying. We know that we got smoother over time and we want our students to be the best, so we may insist that they are smooth from the start. However, especially with crosswinds, it is very important to encourage a pilot to be assertive and even rough with the controls so that they can learn when they have control and then they can get smoother.

As instructors, we always tell our students to be gentle with the flight controls. So, they operate this way for 97% of their flying. Yet, in a crosswind, when they need full rudder deflection in order to maintain directional control, they have little skill and little knowledge and very little practice. You must encourage them to be rough, especially with the rudder pedals and less with the Yoke. A student's idea of rough will be about 20% of what you believe is rough. So, you will need to help them to learn to fully engage the controls without fear.

This may be different from how you teach crosswind and it may be different from how you perform them. But, trust me, if you can help them to get rough and gain control, they can easily get smoother over time.

There are 3 reasons that many pilots are ineffective with crosswinds:

1. Incorrect technical knowledge... For example, some may not know that bank angle must be controlled in order to control drift.
2. Very little experience... If they added together 5 seconds for every crosswind landing over 10 knots, they may only have 60 seconds of experience where it counts.
3. Very weak rudder skills... They may have very little foot/eye coordination and very little experience in posturing the feet for action and using the full throw of the rudder pedals quickly.