

# X-Plane 9



# X-Plane for iPad/X-Plane HDEF 4G

## Operation Manual

### Table of Contents

1. Introduction to X-Plane for iPad/X-Plane HDEF 4G.....	5
I. About This Manual.....	5
2. Getting Acquainted with the Simulator.....	6
I. Basic Flight Controls.....	6
II. Using the Menu and View Options.....	7
A. The Head-Up Display in Depth .....	9
B. The Panel View in Depth .....	12
i. The Steam Gauge-Based Panel .....	12
ii. The Glass Cockpit Panel .....	16
III. The Settings Menu .....	18
A. The Map Tab.....	18
B. The Region Tab .....	19
C. The Plane Tab .....	20
D. The Time Tab.....	20
E. The Wxr Tab .....	20
F. The Apollo Tab .....	20
G. The Set Tab.....	21
IV. Updating X-Plane .....	22
3. Aircraft Specifics .....	24
I. General Aviation Aircraft .....	24
II. Airlines .....	24
III. Fighters, Racing Planes, and Other Extreme Aircraft....	25

A. Pre-WWII-Era Planes .....	26
B. WWII-Era Planes .....	26
C. Korean War-Era Planes.....	26
D. Vietnam War-Era Planes .....	26
E. Post-Vietnam War-Era Planes .....	27
i. The F-14 Tomcat.....	27
ii. The F/A-18F Super Hornet.....	28
iii. The F-15 Eagle .....	28
iv. The F-22 Raptor .....	28
v. The SR-71 Blackbird .....	28
vi. The B-1 "Bone" .....	29
vii. The B-2 Spirit .....	29
viii. The B-52 Stratofortress .....	29
ix. The X-15.....	29
F. Approximate Takeoff Speeds .....	30
IV. Helicopters .....	30
V. Gliders .....	31
VI. The Space Shuttle.....	31
4. Taking Off, Flying, and Landing .....	32
I. ...in the Cessna 172.....	32
II. ...in the Cirrus Vision SJ50.....	32
III. ...in the F-22 Raptor.....	33
IV. ...in the Boeing 747.....	34
V. ...in a Glider .....	35
VI. ...in a Helicopter .....	36
A. Notes .....	40

B. Review .....	40	XVIII. Kathmandu, Nepal .....	47
VII. ...in the Space Shuttle .....	40	XIX. Boswell Bay, Alaska .....	47
A. Beginning a Space Shuttle Mission Segment .....	41	XX. Anchorage, Alaska .....	47
B. Launch .....	41	XXI. Edwards Air Force Base, California.....	47
C. ISS Dock .....	41	XXII. Cocoa Beach, Florida .....	48
D. Final Approach .....	42	6. Advanced Features of X-Plane.....	49
E. Full Approach .....	42	I. Flying an Approach Using the Instrument Panel .....	49
F. Re-Entry.....	43	A. Types of NAVAIDs.....	49
5. About the Flight Regions .....	44	B. Navigation Instruments .....	52
I. Innsbruck, Austria.....	44	i. Instruments in the Steam Gauge Panel .....	52
II. Hawaii .....	44	ii. Instruments in the Glass Cockpit Panel.....	54
III. Miami, Florida.....	44	C. Flying the Approach.....	56
IV. Southern California.....	44	II. Using the Autopilot.....	58
V. Santa Catalina Island, California .....	44	A. Aircraft with Autopilots.....	58
VI. Van Nuys, California.....	45	B. Available Autopilot Functions .....	58
VII. San Francisco, California .....	45	i. ROLL and PTCH.....	58
VIII. Big Bear, California .....	45	ii. ATHR .....	59
IX. Grand Canyon.....	45	iii. HDG.....	59
X. Provost, Utah .....	46	iv. HOLD .....	60
XI. Canyons.....	46	III. Taking Off from and Landing on a Carrier .....	60
XII. Southern California Desert.....	46	IV. Combat.....	62
XIII. Desert Sky, California.....	46	A. Combat Basics .....	62
XIV. New York.....	46	B. Using the Gun.....	62
XV. Chicago, Illinois.....	46	C. Using the Missiles.....	62
XVI. Seattle-Tacoma area, Washington .....	47	D. Using the Targeting Reticle .....	62
XVII. Juneau, Alaska .....	47	E. Strategy .....	63

F. Turning Off Enemy Aircraft .....	64
7. The Apollo Add-On .....	65
I. About the Add-On .....	65
II. Purchasing the Add-On .....	65
III. Controls in Apollo .....	66
A. Flight Controls .....	66
B. Vehicle Controls .....	67
IV. Selecting a Mission Segment .....	67
V. Flying in Apollo .....	67
A. Separation .....	67
B. Descent Burn.....	67
C. Powered Descent.....	67
D. Vertical Descent .....	68
E. Rove Around!.....	68
F. Launch .....	68
G. Command Module Dock.....	68
8. Tech Support.....	70
Glossary of Terms .....	71
Flight Dynamics .....	74

# 1. Introduction to X-Plane for iPad/X-Plane HDEF 4G

X-Plane for iPad and X-Plane HDEF 4G are the most complete mobile flight simulators available.

Welcome to the world of airliners, carriers, helicopters, gliders, fighters, and rocket-powered fliers—all in one app, and all optimized to fill the beautiful, high-resolution iPad and iPhone 4 screens.

These simulators are based on the most powerful, versatile, and accurate flight simulator in the world—the same simulator used by companies like NASA, Boeing, and Lockheed Martin. Using this flight model, it's easy to believe you're *actually* soaring through the clouds over California, Alaska, Austria, and more.

The iPad's large screen and powerful processor provide more power than we have seen in any other mobile device to date—with the exception, that is, of the iPhone 4. X-Plane takes advantage of this power on both platforms using scenery terrain data of much higher resolution than is found in the iPhone 3G/iPod Touch versions, and image textures that are *four times as detailed* as the ones found in our other mobile simulators.

In addition to this detail, 3-D buildings have been introduced, dotting the terrain in the appropriate places, and true-to-life airport terminal buildings can be found in Seattle, San Francisco, and Innsbruck, Austria.

New instrument panels grace the cockpits of the aircraft, with knobs, switches, and levers that function just like in a real cockpit. Within the cockpit, you'll hear air traffic control

chatter—just like you would in the real aircraft.

The application comes with forty-five aircraft, ranging from the Cessna 172, to the F-18 Super Hornet, to the ASK 21 glider, to the SR-71 Blackbird, to the UH-60 Black Hawk, to the Boeing 787 Dreamliner. These aircraft can fly across over twenty regions, located in Florida, Alaska, Washington, New York, Nepal, Austria, and more.

Updates to the X-Plane simulators will be released periodically. We'll be making improvements to the graphics, flight model, and interface technology, and releasing them as free updates available through the App Store. We have big plans for the future of the mobile sim!

Thanks the phenomenal new scenery, excellent flight model, and fun new interface, flying X-Plane for iPad/X-Plane HDEF 4G is a truly worthwhile experience. Try it out and see.

## I. About This Manual

This is version 9.622 of the X-Plane for iPad/X-Plane HDEF 4G manual, last updated August 13, 2012.

Throughout the manual are cross-reference links, formatted in bold, dark-gray type, like this. Clicking one of these links will take you to the indicated location of the manual. For instance, clicking this **Getting Acquainted with the Simulator** reference will take you to Chapter 2.

Additionally, clicking on any image will open a full-size version of it located on the X-Plane Wiki.

## 2. Getting Acquainted with the Simulator

Let's go through the basics of using the X-Plane for iPad/X-Plane HDEF 4G application. In chapter 3, **Aircraft Specifics**, beginning on page 24, we will go into the specifics of flying each type of aircraft.

Remember that definitions for any unfamiliar terms may be found in the **Glossary of Terms**, beginning on page 71.

### I. Basic Flight Controls



Figure 2.1: Basic flight controls

Upon opening the simulator for the first time, the user is greeted with the panel seen in **Figure 2.1**. This is the cockpit view in the Cirrus Vision SJ50.

In the bottom right corner of every airplane's panel view is the

**BRAKE** button (labeled 1 in **Figure 2.1**). Tap this button to toggle the brakes on or off. When it is lit up (as in **Figure 2.1**), the brakes are on; when it is unlit, they are off.

On the right side of this panel view is the gear lever (labeled 2 in **Figure 2.1**). Tap and drag it up or down to toggle the gear. When this lever is down, the gear is down, and when it is up, the gear is up.

Next to the gear toggle is the throttle lever, labeled 3 in **Figure 2.1**. Slide this lever all the way to the top of its housing for full throttle, or all the way to the bottom for zero throttle.

In some aircraft (those with thrust reversal capabilities), the throttle slider will default to about 1/3 of the way up from the bottom of its travel. Dragging the slider to the top of the screen will, of course, give the aircraft full (forward) throttle. Dragging it to the bottom, however, will give it full *reverse* thrust, useful in slowing down after touching the ground on a landing. For a list of reverse thrust-capable aircraft, see each app's specific chapter.

The lever next to the throttle, labeled 4 in **Figure 2.1**, controls the flaps. When this is at the top of its housing it commands no flaps, and when it is at the bottom, it commands full flaps.

**Note for X-Plane HDEF 4G users only:** To accommodate the iPhone's smaller screen size, the instrument panel in many of the aircraft scrolls to the right; to see the rightmost edges of the panel, touch *above* the panel and drag your finger to the left. After you've finished adjusting instruments on the far right, you can drag the view back to the right.

To steer the aircraft left, tilt the iPad/iPhone to the left. To steer it right, tilt right. This movement—when the wings dip down or rise up while the fuselage (the main body of the plane) stays



pointed in the same direction—is referred to as roll. To pull the airplane’s nose up, tilt the device back toward you, and to push its nose down, tilt the device down away from you. This movement—when the wings remain at the same attitude, but the fuselage moves—is called pitch. See the **Flight Dynamics** appendix, found on page 74, for a visual representation of this.

In the bottom center of the screen (labeled 5 in **Figure 2.1**) is the rudder control. This pushes the aircraft’s nose left and right, a movement referred to as yaw. Touch the RUD slider and drag it left in order to turn the aircraft to the left, and drag it right to turn the aircraft to the right. Once again, the **Flight Dynamics** section depicts this visually.

Basic procedure for taking off the airplanes (covered in greater depth in the following chapter) is as follows:

1. Turn off the brakes.
2. Drag the flaps about 1/3 of the way down to create some extra lift for takeoff.
3. Slide the throttle all the way up.
4. Tilt the iPad/iPhone left and right to steer down the runway.
5. When the aircraft reaches its takeoff velocity (which is different for every craft—heavier planes need greater speed), tilt the iPad/iPhone back toward you, thus pulling back on the craft’s flight controls.
6. Once the airplane is safely in the air, drag the flaps back up to the top of the screen and toggle the gear up (if applicable).
7. Level the plane off once it is a few feet above the ground so that it can build up speed. This will act as a “cushion” to prevent it from stalling once it begins to climb in earnest.
8. Climb at around a 10 degree incline (more powerful craft can handle higher climb rates) at full throttle until the desired altitude is reached. Note that once the power is set at full, the performance of the plane (in terms of its climb rate and airspeed) is controlled by pitching the nose up and down. If its nose is pitched too high up, its speed will drop until it stalls. This can be thought of as being similar to a car trying to go up a hill—an excessively steep hill will cause the car to go very slowly and its engine to overheat.

**Note:** When your aircraft crashes, go into the Settings menu (per the section “**The Settings Menu**”) and select either a new airport to take off from or a random flight. This will reset the airplane after the crash, giving you a brand new one to fly again.

## II. Using the Menu and View Options

Tapping the center of the screen will cause the various menu icons to appear at the top. There are a total of eight icons, as seen in **Figure 2.2**.



Figure 2.2: The menu and view buttons

The view button labeled 1 in **Figure 2.2** selects the standard external view. Tap this button, then drag your finger around on the screen to adjust the viewing angle. To zoom out, put *two* fingers down far apart on the screen and drag them closer together. To zoom in, put two fingers on the screen close together and drag them apart. This is a nice way of controlling the view that is just not possible with a mouse pointer, since the simulator takes input from *both* fingers at once.

The next view button in the menu (labeled 2 in **Figure 2.2**) is the spot view. Selecting this will give the user a stationary view from which to watch as the aircraft flies by.

Next is the linear spot view, labeled 3 in **Figure 2.2**. In this view, the camera takes a constant-speed trajectory to match the airplane's flight path. This is like the view of a pilot with whom the user is flying formation if that pilot were to turn around and look at the user's airplane. This will look identical to the standard external view until the user's craft changes either speed or direction.

The view button labeled 4 in **Figure 2.2** selects the head-up display (HUD). The HUD is described in detail in section "**The Head-Up Display in Depth**," found below.

The view button labeled 5 in **Figure 2.2** selects the cockpit view, where the aircraft's instrument panel takes up most of the bottom half of the screen. The instrument panel is described in depth in the section "**The Panel View in Depth**," beginning on page 12.

Tapping the button labeled 6 in **Figure 2.2** will cause X-Plane to display the aerodynamic forces acting on the airplane. These are only visible when using an external view (i.e., the first, second, and third view options). The lines seen coming off the aircraft are a visual representation of the forces that X-

Plane is calculating for each piece of the airplane. When in an external view, try maneuvering the plane around a good bit to see the little green bars move in real time. Just as in real life, it is these forces that act on the mass of the plane to accelerate it and move it through space—just as Newton predicted over three hundred years ago. Watch what happens as you add and decrease power, extend and retract the flaps, or slow to a stall (where the wings can no longer produce enough lift to support the weight of the plane). Cool!

The menu button labeled 7 in **Figure 2.2** opens the Settings menu, discussed in the section "**The Settings Menu**" below (on page 18).

The final menu option (labeled 8 in **Figure 2.2**) is the pause button. Upon tapping this button, the replay controls will appear in the center top of the screen, seen in **Figure 2.3**.



Figure 2.3: The replay buttons

The center of these five buttons pauses the replay. The two buttons immediately to the left and right, respectively, rewind and fast-forward the replay at a slower-than-real-time rate. The two outer buttons rewind and fast-forward the replay much faster.

At any point in the replay, you can press the pause button in the right-hand corner of the screen again to begin the simulation from wherever the aircraft is at the moment. That is, you could fly around for awhile, press the pause button, rewind using the replay buttons, and start from the point you began.



## A. The Head-Up Display in Depth

The head-up display, or HUD, allows the user to see a great deal of information regarding the aircraft's operation without sacrificing the view of the outside world.



Figure 2.4: The HUD view

The slider labeled 1 in **Figure 2.4** (which is only available in some aircraft, such as airliners) controls the craft's trim, used to hold the nose at a desired pitch. To hold the nose up, drag the TRIM slider down a bit. To hold the nose down, drag the TRIM slider up a bit. This is ergonomically equivalent to using a real trim wheel, which the pilot rolls up to push the nose down, or down to pull the nose up.

Beneath the trim slider is the THROT slider, labeled 2 in **Figure 2.4**. This is used to control the aircraft's throttle. When at the top of its range of motion, it commands full throttle. When it is at the bottom of its range of motion, it commands zero throttle.

Opposite the trim slider is the speedbrake slider (labeled 3 in **Figure 2.4**). This slider commands a special control surface

only found on some aircraft (such as airliners) which generates drag in order to slow the aircraft down. When this slider is at the top of its range of motion, it commands no added drag, and when at the bottom of its range of motion, it commands the maximum drag added.

Beneath the speedbrake is the flaps slider, labeled 4 in **Figure 2.4**. This slider works just like the flaps lever found in the cockpit view. When at the top of its range of motion, it commands no flaps, and when at the bottom of its range of motion, it commands full flaps.

Note that when dragging these sliders, the box with writing on it (such as FLAPS or THROT) shows where the user has commanded the controls to be, while the other box following it shows where the setting is at the moment. If the user commands a quick, large movement of the controls, it will take the aircraft a second or two to meet that command.

Now, let's discuss the HUD itself.

The ticking tape on the left side of the screen (seen in **Figure 2.5**) scrolls with the craft's airspeed, and the number in the box (highlighted in blue in **Figure 2.5**) displays the craft's actual airspeed in knots. For instance, in **Figure 2.5**, the craft is moving at 1169 knots.

Note that this is the aircraft's *indicated* airspeed, not necessarily its *true* airspeed. This measurement comes from the airspeed indicator (ASI), which, in its simplest form, it is nothing more than a spring which opposes the force of the air blowing in the front of a tube attached to the aircraft. The faster the airplane is moving the stronger the air pressure is that acts to oppose the spring and the larger the indicated speed. However, when there is little air available to "push" on that spring, the instrument will display a low number

regardless of how fast the craft is moving. For instance, in the SR-71 Blackbird, the craft might be zipping along at Mach 1.5, but at an altitude of 70,000 feet, its ASI will show it moving at around 200 knots (around 0.3 Mach at sea level). Even better, in the Space Shuttle, the craft can be moving at around 17,000 miles per hour while its airspeed indicator shows zero (because, of course, there is no air at all in space).



Figure 2.5: The airspeed and wind direction indicators, and the fuel gauge

Directly beneath the ticking airspeed indicator is the aircraft's speed relative to the speed of sound (highlighted in red in **Figure 2.5**). For instance, in **Figure 2.5**, the craft was moving at 1.8 Mach.

To the right of the airspeed indicator is the indicator for wind speed and direction (highlighted in yellow in **Figure 2.5**). The arrow points in the direction that the wind is moving, and the number beneath it displays the wind speed in miles per hour. For instance, in **Figure 2.5**, the wind was moving with the aircraft at 9 miles per hour.

Finally, beneath the airspeed ticker is the fuel gauge, highlighted in orange in **Figure 2.5**. When the triangle-shaped indicator is at the far right, the aircraft's fuel tanks are full. When it is at the far left, as it is in **Figure 2.5**, the fuel tanks are empty, and the aircraft's engines will not be able to run.



Figure 2.6: The altimeter and variometer display

The ticking tape on the right side of the screen (seen in **Figure 2.6**) scrolls the craft's altitude, and the number in the box (highlighted in red in **Figure 2.6**) displays the craft's actual altitude in feet above mean sea level. For instance, in **Figure 2.6**, the craft was at 7,580 feet above sea level. The number directly below the altitude tape (highlighted in blue in **Figure 2.6**) is the craft's climb rate in feet per minute. For example, in **Figure 2.6**, the craft was descending at a rate of 1,400 feet per minute, so the number displayed was -1,400.

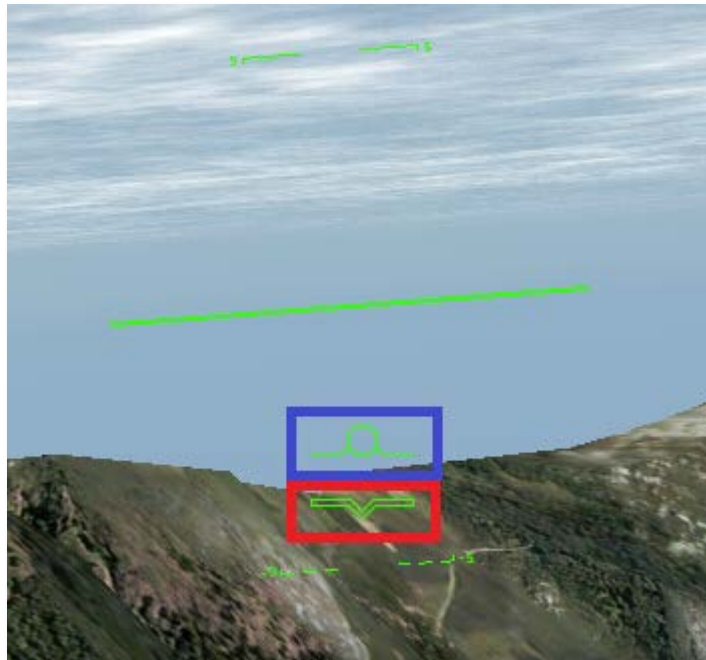


Figure 2.7: The flight path indicator and attitude indicator

In the center of the screen are two horizontal bars. The V-shaped bar (highlighted in red in **Figure 2.7**) indicates the aircraft's attitude—that is, the combination of its pitch and roll.

The bar with a circle in the center of it (highlighted in blue in **Figure 2.7**) is called the flight path indicator. It represents where the plane is actually flying, rather than where it is pointed. For instance, when the craft is taken into a 90 degree stall, the attitude indicator (the V-shaped bar) will stay momentarily at the 90 degree mark even as the flight path indicator drops rapidly. This is due to the fact that the aircraft's vertical velocity slows to zero, then becomes negative, while its nose is still pointing up. Only after the craft falls a bit will its nose be pushed down.

Surrounding those bars are lines marking degrees of pitch. For instance, in **Figure 2.7**, the aircraft was pitched down about 4 degrees (indicated by the V-shaped bar), but it was actually moving down at around 3 degrees (indicated by the bar with a circle in the middle). Its wings were banked ever-so-slightly to the right.

Note that the craft will hold a constant altitude (that is, it will have a climb rate of zero) when the *center* of the velocity vector's circle is at the zero degree mark.



Figure 2.8: The directional gyro

Finally, in the bottom center of the screen is a directional gyro, as seen in **Figure 2.8**, showing which direction the aircraft's nose is pointing.

## B. The Panel View in Depth

In the panel view, the aircraft's instrument gauges (or EFIS, as the case may be), navigation radios, and basic autopilot settings (where available) are accessible. Unlike in other X-Plane Mobile platforms, where flying from this view requires the use of the artificial horizon, in X-Plane for iPad and X-Plane HDEF 4G, users can simply look out the window!

A few different panels are used in the aircraft in the application. Many of the general aviation aircraft, such as the Cessna 172, use a panel equipped with steam gauge flight instruments. More complex (and expensive) aircraft, such as those using jet engines, have an electronic flight instrument system, or EFIS, instead. All of the more specialized panels are based on some combination of these two types; understanding what each gauge and screen does in the two following sections will allow the user to understand any of the panels in the simulator.

### i. The Steam Gauge-Based Panel

The steam gauge panel from the Cessna 172 is shown in **Figure 2.9**.



Figure 2.9: The steam gauge panel

Note that, in the following descriptions, the numbers on the instrument faces correspond with their numbers in the full panel view above. These sets of images work together to give both a detailed look at the instrument itself and a view of where in the panel it lies. Clicking on any of these images will load an image of the full panel on the X-Plane Wiki.

The group of switches labeled 1 in **Figure 2.9** toggle the indicated systems on and off. The switch labeled “BATTERY” controls all the electrical systems, while the switch labeled “LAND LIGHT” controls the landing light, and so on.



Figure 2.10: The airspeed indicator



The gauge seen in **Figure 2.10** is the airspeed indicator (ASI). In its simplest form, this is connected to nothing more than a spring which opposes the force of the air blowing in the front of a tube attached to the aircraft. The faster the airplane is moving the stronger the air pressure is that acts to oppose the spring and the larger the deflection of the needle from which the pilot reads the craft's speed. There are a number of ways that this reading can be thrown off (most obviously by flying at an altitude where there is little to no air), so bear in mind that this is the *indicated* airspeed, not necessarily the *true* airspeed.



Figure 2.11: The attitude indicator

The instrument to the right of the ASI is the attitude indicator (AI), seen in **Figure 2.11**, which displays the aircraft's position in space relative to the horizon. This is accomplished by fixing the case of the instrument to the aircraft and measuring the displacement of the case with reference to a fixed gyroscope inside. This instrument corresponds to the horizontal bars seen in the middle of the HUD view.



Figure 2.12: The altimeter

Next to the attitude indicator is the altimeter, seen in **Figure 2.12**. This displays the aircraft's altitude (in feet above mean sea level) by measuring the expansion or contraction of a fixed amount of air acting on a set of springs. As the airplane climbs or descends, the relative air pressure outside the aircraft changes and the altimeter reports the difference between the outside air pressure and a reference, contained in a set of airtight bellows.



Figure 2.13: The course deviation indicator

To the right of the attitude indicator is the course deviation indicator (CDI), seen in **Figure 2.13**. More information on this instrument can be found in Chapter 6, in the section "**Flying an Approach Using the Instrument Panel**" (beginning on

page 49).



Figure 2.14: The fuel gauges

Beneath the electrical switches are the fuel indicators, seen in **Figure 2.14**. These work just like the fuel gauges in an automobile, aside from the fact that most of the aircraft here have two fuel tanks (one in each wing for the sake of balance).



Figure 2.15: The turn coordinator

To the right of the fuel gauges is the turn coordinator, seen in **Figure 2.15**. This measures the aircraft's rate of turn. The instrument is only accurate when the turn is coordinated—that is, when the airplane is not skidding or slipping through the turn. A skid is the aeronautical equivalent to a car that is understeering, where the front wheels do not have enough traction to overcome the car's momentum and the front of the car is thus plowing through the turn. In a car, this results in a turn radius that is larger than that commanded by the driver. A slip is a bit more difficult to imagine unless one is a pilot already. It results from an aircraft that is banked too steeply for the rate of turn selected. To correct the slip, all the pilot has to

do is increase back pressure on the yoke, pulling the airplane "up" into a tighter turn, such that the turn rate is in equilibrium with the bank angle.

Next to the turn coordinator is a directional gyro, seen in **Figure 2.16**, indicating which direction the aircraft is traveling.



Figure 2.16: The directional gyro

To the right of the directional gyro is the vertical speed indicator (seen in **Figure 2.17**), also called the vertical velocity indicator or variometer. This reports the aircraft's climb or descent rate in feet per minute (fpm). Typically, non-pressurized airplanes will climb comfortably at about 700 fpm (if the plane is capable) and descend at about 500 fpm. Descent rates faster than this cause discomfort on the occupants which is felt in passengers' ears. Pressurized airplanes can climb and descend much more rapidly and still maintain the cabin rate of change at about these levels, since the cabin pressure is not related to the ambient altitude unless the pressurization system fails.





Figure 2.17: The variometer

Next to the variometer is a second CDI (labeled 10 in **Figure 2.9**) which functions identically to the first CDI. Having two CDIs like this allows a pilot to track two NAVAIDs at once. For more information, see the section “**Flying an Approach Using the Instrument Panel**” in Chapter 6 (beginning on page 49).



Figure 2.18: The tachometer

In the top right of the panel is a tachometer, seen in **Figure 2.18**, which indicates the aircraft engine's RPM on a scale from 0 to 100 percent of maximum.



Figure 2.19: The fuel flow indicator

Directly beneath the tachometer is a fuel flow indicator, seen in **Figure 2.19**. Like the tachometer, this measures on a scale from 0 to 100 percent of its maximum rate.

In the top right corner of the panel are the navigation radios, seen in **Figure 2.20**. These are used for navigating using a radio signal (sent by a navigation aid, or NAVAID). Each radio is tuned using the two knobs on the instrument. The knob on the left is used to tune the integer (or "counting number") portion of the frequency. The knob on the right is used to tune the decimal portion of the frequency.



Figure 2.20: The navigation radios

To turn a knob up, touch it and move your finger clockwise around it. To turn it down, touch it and move counter-clockwise around it. For instance, if the frequency read 111.10 and the

user circled clockwise around the *left* knob, the frequency would increase to 112.10. If the user instead circled clockwise around the *right* knob, the frequency would increase to 111.20. More information on instrument navigation is found in the section “Flying an Approach Using the Instrument Panel” of Chapter 6 (beginning on page 49).

## ii. The Glass Cockpit Panel

The “glass cockpit” instrument panels—that is, those that use an electronic flight instrument system (or EFIS)—display the same information as the steam gauges in the previous section, with a few additions.



Figure 2.21: The EFIS panel

Again, note that in the following descriptions, the numbers on the instrument faces correspond with their numbers in the full panel view above. These sets of images work together to give both a detailed look at the instrument itself and a view of where in the panel it lies. Clicking on any of these images will load an image of the full panel on the X-Plane Wiki.

The rows of switches labeled 1 in **Figure 2.21** above are identical to the switches seen in the previous section; they control navigation lights, electrical systems, and so on, and are toggled on and off with a tap.

Beneath the switches are the fuel gauges, labeled 2 in **Figure 2.21**. These, too, are identical to the fuel gauges in the previous section, dropping closer to empty the farther the craft is flown.

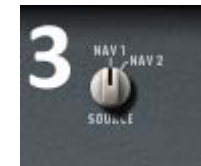


Figure 2.22: The navigation source selection switch

In the top center of the panel is the navigation source selection switch (seen in **Figure 2.22**). This switch selects between navigating using the frequency on the NAV 1 radio and that of the NAV 2 radio; the selected radio's data is sent to the EFIS and moving map display (described below). Tap the switch to change its position.



Figure 2.23: The autopilot controls

In the top right of the panel are the autopilot controls (seen in **Figure 2.23**). For information on these controls, see the section “Using the Autopilot” of Chapter 6, beginning on page 58.

Beneath the autopilot controls are the navigation radios (labeled 5 in **Figure 2.21**), which function just like those found in the steam gauge-based panel from the previous section.



Figure 2.24: The fuel flow gauges

Beneath the navigation radios are two fuel flow indicators, as seen in **Figure 2.24** one for each engine (where available). Each of these functions like the fuel flow indicator in the steam gauge-based panels.

The center of this panel is occupied by two LCD screens. The first, labeled 7 in **Figure 2.21**, is the EFIS. The second, labeled 8 in the figure, is a moving map.

The primary flight display in the EFIS combines the functions of a slew of navigation instruments into one display. Let's look at this display closer.

The scrolling tape on the far left (labeled with a 1 in **Figure 2.25**) is the airspeed indicator. Once again, this is the *indicated* airspeed, not necessarily the *true* airspeed (see the discussion in the section “**The Head-Up Display in Depth**” on page 9 for information on why this is so). Directly below the scrolling tape is the craft's speed relative to the speed of sound, just like in the HUD view. In **Figure 2.25**, the craft had an indicated airspeed of 155 knots, corresponding to 0.24 Mach.

In the center of the EFIS display is the attitude indicator (labeled 2 in **Figure 2.25**). This shows the aircraft's pitch and

roll attitude in space relative to the horizon. As in the HUD view, there are lines above and below the representation of the aircraft that mark degrees of pitch. Additionally, the two purple lines (one horizontal and one vertical) represent the course deviation indicator (CDI) and glideslope indicator. More information on navigation is found in the section “**Flying an Approach Using the Instrument Panel**” of Chapter 6 (beginning on page 49).



Figure 2.25: The primary EFIS display

The scrolling tape on the right (labeled 3 in **Figure 2.25**) is the altimeter. This displays the airplane's altitude in feet above mean sea level. In **Figure 2.25**, the aircraft was at 1,710 feet above mean sea level.

In the bottom of EFIS screen is a modified view of the horizontal situation indicator (or HSI—labeled 4 in **Figure 2.25**). This is a combination of a directional gyro (DG) and the course deviation indicator (CDI). The DG is a gyroscopically driven compass, which makes it much more stable than the older "whisky" compasses (so named because of the whisky alcohol used to stabilize the compass inside the housing). It is the DG portion of the HSI that is marked 4 in **Figure 2.25**. Once again, more information on flying on instruments can be found in the section “**Flying an Approach Using the Instrument Panel**” of Chapter 6 (beginning on page 49).

The right display panel of the EFIS serves as a moving map, as seen in **Figure 2.26**.



Figure 2.26: The secondary EFIS display

The local airport's identifier is shown in blue—in the case of **Figure 2.26**, this is the default field for the Hawaii region, PHOG. The magenta triangles are the localizers which set up the approach for that runway at that airport. More information on using the localizers can be found in the section “**Flying an Approach Using the Instrument Panel**” of Chapter 6 (beginning on page 49).

### III. The Settings Menu

Selecting the second menu button from the left (marked in **Figure 2.27**) will open the Settings menu.



Figure 2.27: The Settings button highlighted

#### A. The Map Tab

The options available on the Map screen are simple: Place the craft in a random location or on whole new random flight (randomizing the weather, time of day, and your location) by tapping the respective buttons. Beneath the **Random Location** button is buttons to set a random location at a predefined altitude (5,000 or 10,000 feet above mean sea level).

The buttons below the randomizing ones place the aircraft either on the runway for the indicated airport or on a final approach to that runway. The map can be dragged using a single finger or zoomed in or out of using two fingers, just like

when using the external aircraft view. Additionally, placing two fingers on the screen and moving them in a circular motion (“swizzling” them) will rotate the map. Tapping the **Center** button will center the map view on your aircraft.

Zoom into the map near a navigational aid (NAVAID) or airport to view detailed information about it such as its ILS or VOR frequency.

Found in the center of the Map screen is a circular compass, as seen in **Figure 2.28**.



Figure 2.28: The compass in the Map tab

The numbers inside the compass denote the degrees

(multiplied by ten) from north. Thus, the 0 mark (for 0 degrees) points north, the 9 mark (for 90 degrees) points east, the 18 mark (for 180 degrees) points south, and the 27 mark (for 270 degrees) points west.

The Map tab is also where you can reset a flight after a crash. Upon crashing, open the settings menu, which will come to the Map tab by default. Tap one of the location buttons (either for an airport or for a random flight) to “fix” your virtual aircraft and start a new flight.

## B. The Region Tab

The Region tab allows the user to select which region to fly from. Swiping a finger across the screen will scroll through the available maps. Upon leaving the Region tab, the last region selected will be loaded.

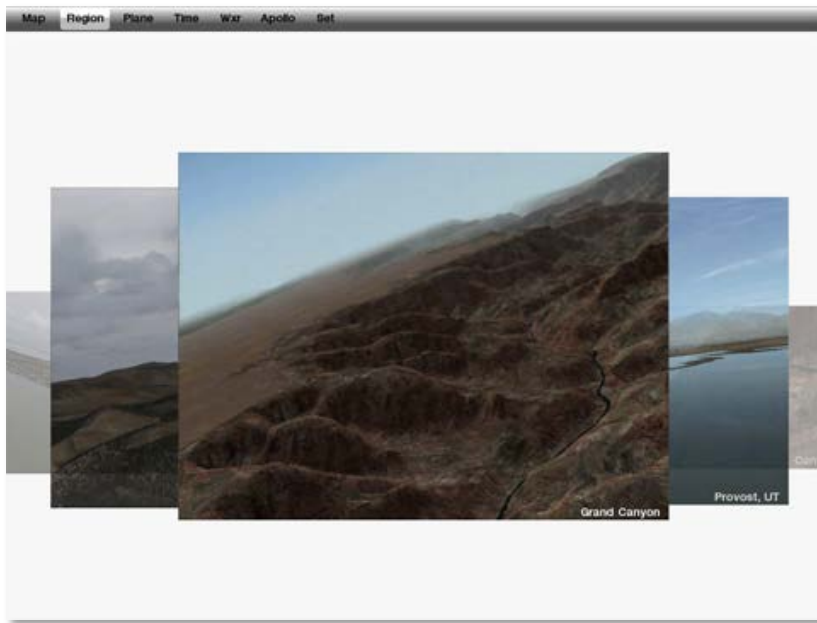


Figure 2.29: Selecting the Grand Canyon region

For instance, if the user tapped the Plane tab when the screen looked like it does in **Figure 2.29**, X-Plane would take a few seconds to load the Grand Canyon region, then display the Plane tab.

### C. The Plane Tab

The Plane tab lets the user pick one of the forty-five different aircraft included in the application. As with the Region tab, the aircraft that is in the center of the screen when the user changes tabs will be loaded. It will be placed on the default runway for the current region. More information can be found in Chapter 3, **Aircraft Specifics**, beginning on page 24.

Beneath the images of the aircraft are the weight and center of gravity settings. Here, the user can move the center of gravity *forward* to give the craft greater stability, or *aft* to make it more maneuverable. Additionally, the weight of the aircraft can be adjusted using the slider—just touch the slider and drag it. Lighter airplanes will of course perform better than heavier ones.

### D. The Time Tab

The Time tab of the Settings window allows the user to set one of four times of day, and thus four corresponding levels of daylight.

### E. The Wxr Tab

The Wxr tab is used to set the weather. This in the upper half of the window are cloud coverage levels (X-Plane renders two cloud layers). Beneath each bank of images is a slider used to adjust the cloud base height. To move a slider, simply tap and drag it.

Beneath the cloud controls are four sliders (moved just like in the Sky tab) which are used to change the visibility, wind speed, turbulence, and wave height. Additionally, the round button is used to set wind direction. To move this, touch near the edge of the circle and drag your finger. Wherever your finger releases is where the wind will come from.

### F. The Apollo Tab

In the Apollo tab, users can purchase the Apollo add-on. This is a sort of app-within-the-app; when running the Apollo



simulator, only the Apollo tab modifies the simulation. See Chapter 7, **The Apollo Add-On**, beginning on page 65 for more information on the Apollo simulator.

## G. The Set Tab

The Set menu allows the user to change the iPad or iPhone's "control calibration." Just hold the device at the desired angle and tap the **Set current pitch and roll as center** button to make the current attitude of the device the point for which input is zero. This lets users fly with the device in their lap when sitting or standing, or held vertical when lying down—kind of convenient!

Also in this window is the **Show instructions in flight if in Cessna 172** button. This is enabled by default and will provide on-screen, step-by-step instructions for taking off, climbing, cruising, approaching the runway, and landing in the Cessna 172, just like in the X-Plane Trainer and X-Plane 9 apps for the iPhone and iPod Touch.

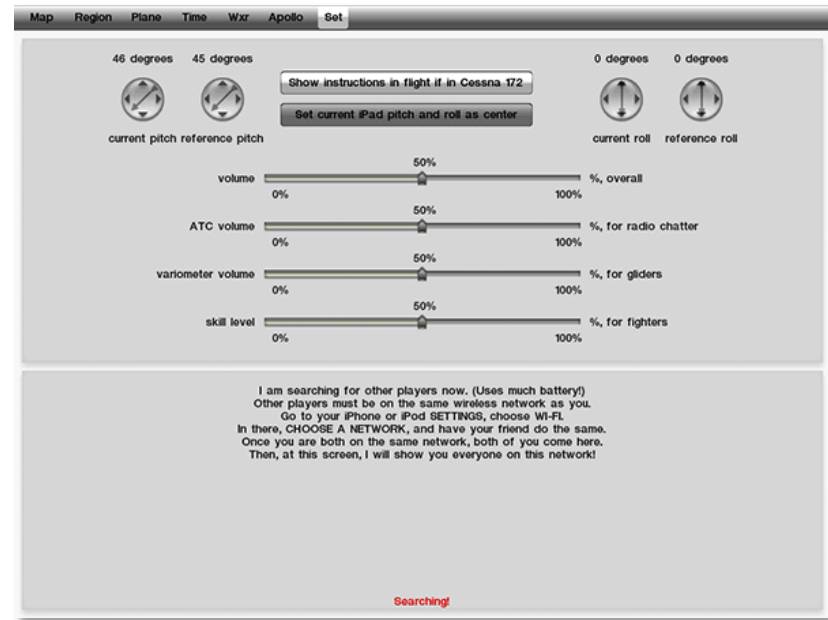


Figure 2.30: The Set tab

Beneath the control settings are three sliders to control volume. The first is the master volume, set by default at 50%. Next is the volume for air traffic control chatter, set by default at 0%. Following that is the variometer volume. Recall from the section on the instrument panel that the variometer is an instrument measuring the rate of ascent or descent of an aircraft. When flying a glider, it is useful to have an audible indication of this. If it is *beeping*, then the glider is in a nice updraft from the air following the terrain. Circling in that area will let the glider ride the climbing air to altitude. When the variometer is emitting a *steady* tone, the craft is in *descending* air.

In addition to the volume sliders, there is a slider to control the skill level of the enemy fighters, which appear automatically when flying some of X-Plane's military fighters.

Finally, at the bottom of this screen is the multi-player configuration. When in the Set tab, X-Plane will search for other devices running the simulator. Both users need to tap the button labeled with the other user's device in order to play with that person. For example, if William and Mary want to fly together on their iPads, William will need to go to the Set tab and tap the **Mary's iPad** button. Likewise, Mary will need to go to the Set tab and tap the **William's iPad** button. Note that the button is selected when it turns a very light gray color. When both users have selected the other, click Done and X-Plane will set both users at the default runway.

Also, note that both users must be on the *same wireless network* in order to play together. This is configured in the device's Wi-Fi setup (found in the device's Settings, as shown in **Figure 2.31**).

In multiplayer mode, hitting the other aircraft will result in damage (sometimes fatal) just like hitting the ground in the simulator. If this occurs, simply open up the Settings menu and take off from an airport again. Note that *both* users must select the *same* airport if they are to fly together; otherwise, X-Plane assumes that the users want to start in different places and meet up somewhere.

Finally, when in multiplayer mode, a pointer will appear (in the shape of a little airplane) near the directional gyro in the HUD view indicating the other user's location. Follow this pointer to join up with the other player in the event that you lose each other.



Figure 2.31: Joining a Wi-Fi network on the iPad

## IV. Updating X-Plane

The easiest way to update X-Plane for iPad/X-Plane HDEF 4G is to go to the App Store (found on the device's "home page") and tap Updates down at the bottom of the screen (selected in **Figure 2.32**).

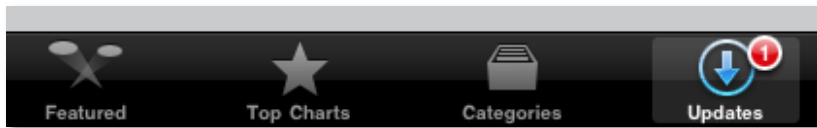


Figure 2.32: Selecting the Updates tab in the App Store

There, just tap the Update All button (highlighted in **Figure 2.33**).



Figure 2.33: Selecting the Update All button in the App Store

The device will prompt for the username and password which were used to purchase the applications, then it will automatically download and install the updates.

### 3. Aircraft Specifics

Note that the takeoff speeds listed in the following sections assume that 1/3 flaps have been pulled in. It is a good idea to add five to ten knots to this number as a "speed cushion" before pulling the aircraft's nose off the ground during takeoff (called "rotating").

**Note:** When your aircraft crashes, go into the Settings menu and select either a new airport to take off from or a random flight. This will reset the airplane after the crash, giving you a brand new one to fly again.

#### I. General Aviation Aircraft

The following general aviation aircraft are included in X-Plane for iPad/X-Plane HDEF 4G:

- Cessna 172
- Columbia 400
- Piper Malibu
- Cirrus Vision
- Piaggio Avanti
- Beechcraft King Air
- Eclipse 500

The Cessna 172 is the most basic of the available craft, while the Columbia 400 is a high performance, turbocharged piston (that is, propeller-based) aircraft. The Piper Malibu is a piston-engined craft with a maximum speed very close to that of the Columbia 400. The Beechcraft King Air is a twin-turboprop craft, and the Cirrus Vision is a next-generation personal jet still being developed. The Eclipse 500 is a six-seater, business-class very light jet (VLJ). Finally, the Piaggio Avanti is a super-efficient Italian turboprop business aircraft.

When flying the Cessna 172, if the **Show instructions in flight if in Cessna 172** button is enabled in the Set menu (which it is by default), the simulator will give on-screen, step-by-step instructions for taking off, flying, and landing the aircraft.

Reverse thrust capabilities are available in the Piaggio Avanti and Beechcraft King Air. As with other reverse thrust-capable aircraft, the throttle slider in these aircraft will sit by default about 1/3 of the way up the screen. Drag it to the bottom of the screen to give the aircraft full backward throttle, or drag it to the top of the screen to give it full forward throttle.

**Table 3.1** lists the approximate minimum takeoff speed for each of the general aviation aircraft.

Aircraft	Approx. Takeoff Speed (knots)
Cessna 172	60
Columbia 400	95
Piper Malibu	90
Cirrus Vision	80
Piaggio Avanti	95
Beechcraft King Air	90
Eclipse 500	85

Table 3.1: Takeoff speeds for general aviation aircraft

#### II. Airliners

The following airliners are included in X-Plane for iPad/X-Plane HDEF 4G:

- Boeing 777
- Boeing 747
- Boeing 737
- Airbus A380

- Boeing 787
- McDonnell Douglas MD-88
- Airbus A320
- Boeing 757
- Aérospatiale-BAC Concorde

The Boeing 777 is the standard for modern airliner design and efficiency, while the 747 is a double-decker, four-engine craft, known as the original “Jumbo Jet.”

The Airbus A380 is the world’s largest airplane (nicknamed the Super Jumbo), complete with two passenger decks and fly-by-wire controls. It was entered in to service as recently as 2007.

The Boeing 787 Dreamliner is a new carbon-fiber, high-bypass, ultra-efficient airliner due to enter service in late 2010.

The McDonnell Douglas MD-88 and the Boeing 737 are twin-engine, medium-range craft that are (relatively) small. The Airbus A320 is slightly larger than the 737 and was designed to challenge both it and Boeing's 727 on the market. With its narrow body and medium size, the Boeing 757 is of a similar design also.

The iconic Aérospatiale-BAC Concorde is one of two supersonic commercial airliners ever flown. Its ability to cruise at Mach 2 at 60,000 feet allowed it to make the trip from New York to London in under three hours. Note that the Concorde has *no flaps or speedbrakes*—when you’re descending for a landing, you’ll have to plan very well to come in at a proper speed.

Reverse thrust capabilities are available in all nine of the airliners listed here. As with other reverse thrust-capable aircraft, the throttle slider in these aircraft will sit by default about 1/3 of the way up the screen. Drag it to the bottom of the

screen to give the aircraft full backward throttle, or drag it to the top of the screen to give it full forward throttle.

**Table 3.2** lists the approximate takeoff speeds for the airliners.

Aircraft	Approx. Takeoff Speed (knots)
Boeing 747	155
Boeing 777	140
Boeing 737	120
Airbus A380	170
Boeing 787	150
McDonnell Douglas MD-88	120
Airbus A320	130
Boeing 757	120
Aérospatiale-BAC Concorde	190

Table 3.2: Takeoff speeds for airliners

### III. Fighters, Racing Planes, and Other Extreme Aircraft

The following are a list of the fighters, racing planes, and other extreme aircraft found in X-Plane for iPad/X-Plane HDEF 4G:

- F4U Corsair
- P-51 Mustang
- F-4 Phantom II
- F-15 Eagle
- F-86 Sabre
- Gee Bee Super Sportster
- F-22 Raptor
- SR-71 Blackbird
- B-1 “The Bone”
- B-2 “The Jet”

- B-52 Stratofortress
- North American X-15
- A6M “Zero”
- MiG-21 Fishbed
- F-14 Tomcat
- F/A-18F Super Hornet
- XB-70 Valkyrie
- C-130 Hercules

### A. Pre-WWII-Era Planes

The Gee Bee Model R Super Sportster was the aircraft racing king of the 1930s. With a top speed of nearly 300 mph, it was untouchable in its time. Be careful, though—its small control surfaces make it a bit of an unruly ride!

### B. WWII-Era Planes

The F4U Corsair is a World War II-era fighter with a top speed of over 350 mph. Because of its taildragger landing gear configuration, it is *very* tricky to land. The pilot must land in a full-stall, nose-high attitude. *Be sure to hold the stick at full aft* (meaning the device is tilted all the way back) on the takeoff roll in this plane in order to hold the tail wheel down for steering authority.

The P-51 Mustang was the premier fighter of the Second World War. It must be taken off and landed with the same technique as the Corsair due to the taildragger landing gear.

The nimble Japanese A6M “Zero” was a favorite opponent of the F4U during the Second World War. Though it is much slower and less powerful than the Corsair, it is a great deal more maneuverable.

Note that both the F4U and P-51 have *very* powerful engines and *very* large propellers. As a result, the torque delivered by the engine and propeller will try to roll the plane to the left. This is most noticeable at very low airspeeds (when taking off, for example), when the aerodynamic forces created by the ailerons to counteract this are at a minimum. Thus, be prepared to roll hard towards the right (by rolling your iPad/iPhone right) as the plane lifts off and the wheels are no longer supporting the weight of the airplane on the ground. As the craft’s airspeed builds you will be able to use less and less right aileron to counteract the torque from the propeller and engine.

### C. Korean War-Era Planes

The F-86 Sabre saw a great deal of action during the Korean War, where it battled the Soviet MiG-15s. In the late 1940s, the Sabre was the fastest jet aircraft in the world, reaching a speed of 570 mph in 1948. It eventually saw speeds as high as 680 mph.

The C-130 is a versatile military transport plane, used across the world as a gunship, airlifter, search-and-rescue craft, and even firefighter. Its six turboprop engines give it a top speed of 320 knots. It holds the record for the longest continuous production run among military aircraft, and the record for the heaviest aircraft to be landed on an aircraft carrier.

### D. Vietnam War-Era Planes

The F-4 Phantom II, the king of the “Jet Age,” held fifteen



world records during the 1960s (listed near the bottom of [this page](http://www.aviation-history.com/mcdonnell/f4.html)<sup>1</sup>), among which were a number of fastest times to altitude, the fastest time across the continental US, and the highest zoom climb. With over thirty-two *thousand* pounds of thrust, four air-to-air guided missiles, and guns if those fail, the F-4 is a force to be reckoned with no matter the application. The fast, agile MiG-21 Fishbed was a strong opponent of the F-4 Phantom II during the Vietnam War. Its light weight and tight turns make it an interesting adversary.

The XB-70 was a prototype bomber designed during the 1950s, able to exceed Mach 3 at 70,000 feet. Like the SR-71, it diffuses the vast amounts of heat produced by friction when flying at Mach 3 by circulating fuel through its outer skin.

This high-speed, high-altitude design worked well for avoiding the threat posed by interceptor aircraft. With the advent of Soviet anti-aircraft missiles in the late 1950s, though, this strategy fell out of favor, replaced by low-altitude aircraft that could only be detected (and fired at!) at much shorter distances.

## E. Post-Vietnam War-Era Planes

### i. The F-14 Tomcat

The F-14 Tomcat was introduced by the US Navy as a replacement for the F-4 Phantom II. In X-Plane for iPad/X-Plane HDEF 4G, it gets pitted against its own replacement—the F/A-18F Super Hornet.

The F-14 uses variable wing sweep to allow the plane to fly at high speeds (its top speed is over Mach 2 at altitude). When

the wing sweep slider is moved *down* (as in **Figure 3.1**), the wings will slowly move to their aft position.

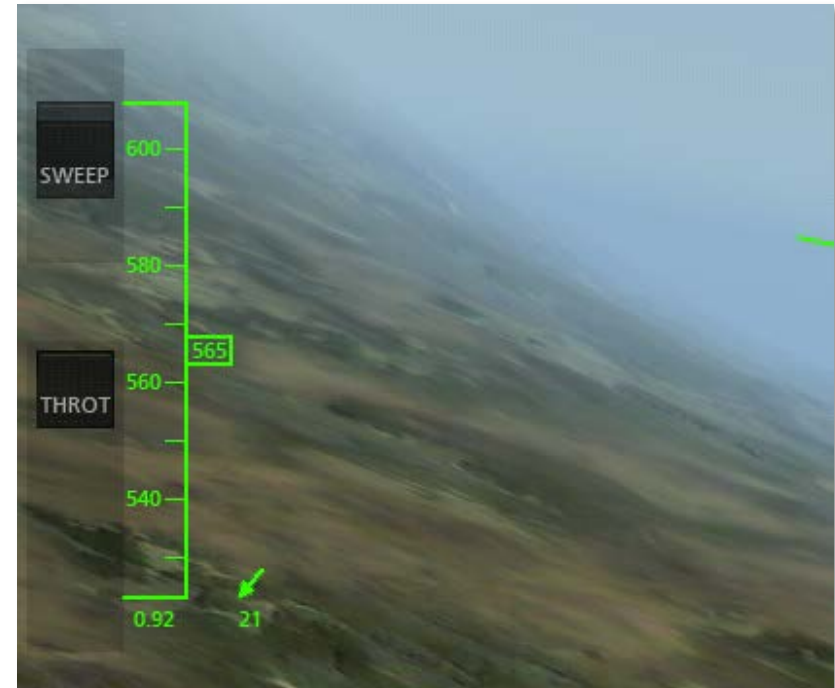


Figure 3.1: Sweeping the wings in the F-14

This causes the center of lift to move aft, forcing the nose down. Thus, the craft must be moving at a very high rate of speed, close to Mach 1 before the wings are swept backwards. Sweep the wings rearward slowly and carefully and let X-Plane automatically add trim to hold the nose up. Move the SWEEP slider a bit (thus moving the wings back a bit) and wait a few seconds as the trim automatically pulls the nose up a bit. When things have stabilized, sweep the wings a bit further and wait for a few more seconds. Do this three or four times to get the wings swept all the way back.

<sup>1</sup> <http://www.aviation-history.com/mcdonnell/f4.html>

## ii. The F/A-18F Super Hornet

The F/A-18F Super Hornet is a larger redesign of the original F/A-18, built originally to replace the Navy's F-14 Tomcats. It is a versatile fighter still in production.

## iii. The F-15 Eagle

The F-15 Eagle is a tactical fighter designed to maintain air superiority for the United States in the years following the Vietnam War. With a maximum speed over Mach 2.5 at altitude, it has proven a very successful design.

## iv. The F-22 Raptor

The F-22 Raptor is by far the most maneuverable and powerful fighter in the sky. Nothing else comes remotely close. One of its more interesting features is its ability to move its thruster up and down to steer the craft, known as thrust vectoring. This lets the plane pitch the nose up and down with full authority even at zero speed, simply by vectoring the thrust—it can even hang (nearly) motionless on its engines. This comes at a cost, though: when the pilot cuts the power, the craft loses that lift and maneuverability.

To see these thrust vectors, select an external view and turn on the visible force vectors (per the section “**Using the Menu and View Options**” of Chapter 2, beginning on page 7). Give the craft full throttle and pull it into a sharp climb or push it into a sharp dive. Then, watch the thrust vectors tilt up or down, respectively, as seen in **Figure 3.2**.

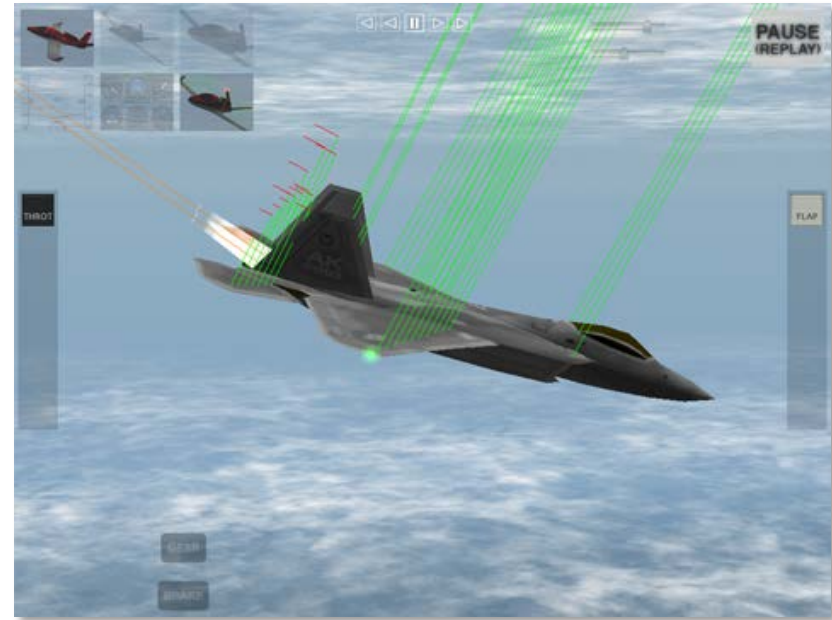


Figure 3.2: The F-22 Raptor's vectored thrust

## v. The SR-71 Blackbird

The SR-71 Blackbird is the fastest jet aircraft in the world, able to exceed Mach 3 and break 70,000 feet. It still holds several world speed records set in the 1970s and 1980s. Many users wonder why it is, then, that the F-22 has a higher acceleration and top speed than the SR-71 at low altitudes. Simply put, each plane is designed for a different mission and operational envelope. The SR-71 was designed as a spy plane and is absolutely untouchable (even 40 years later) in high-altitude, straight and level flight. In 1977, a Russian MiG-25 (Russia's premier interceptor and attack aircraft) made an attempt to intercept an SR-71 at nearly 70,000 feet. The Russian aircraft completely trashed its engines trying to keep up, though it

could momentarily hit Mach 3. The Blackbird simply pulled away. The SR-71 at 50,000 feet or higher will leave any other aircraft in the dust, even the mighty F-22.

Users may notice that even in the SR-71, the craft's indicated airspeed will be very low (on the order of only 100 knots or so). This is expected and is due to the fact that the air at such a high altitude has a very, very low density. Thus, there are very few molecules of air that are getting rammed into the aircraft's instrumentation system, as compared to flying through the very thick air of low altitudes. Once again, the aircraft's gauges display the *indicated* airspeed, not necessarily the *true* airspeed.

Flying the SR-71 is like balancing three checkbooks at once. The pilot must maintain control of the craft's speed, altitude, and flight controls at once in order to reach the craft's maximum speed of Mach 3 at over 70,000 feet.

## vi. The B-1 "Bone"

The B-1 bomber (known as "The Bone") has almost full-span flaps (that is, the flaps cover nearly the full wingspan), leaving very little room for ailerons. Thus, spoilers must be used for roll control, as well as differentially deflecting all-moving stabilators (the horizontal tail surfaces) to aid in roll control. Despite the huge flaps and multiple roll controls, this huge, ungainly bird still has terribly high stall speeds and a limited roll rate due to its high weight. If pilots can get this plane around the sky and down in one piece, they are doing well!

Use the B-1's SWEEP slider to bring the wings from their low-speed position of full forward to a high-speed position of full aft, just like in the F-14 Tomcat (as described in **The F-14 Tomcat** section on page 27).

## vii. The B-2 Spirit

Next is the B-2 Spirit, otherwise known as the "Stealth Bomber." The B-2, quite uniquely, has no tail. At all. There is no vertical stabilizer, no horizontal stabilizer, and no flaps. Instead, ailerons on the wingtips split open to add drag on the left or right side of the plane to give yaw control.

A fly-by-wire system coupled to multiple flight control surfaces makes this aircraft manageable, and really rather nice to fly. Actually, this aircraft is literally unflyable without the flight control computers, which continually make small inputs to keep the plane flying the way (and direction) the pilot commands.

## viii. The B-52 Stratofortress

The B-52 Stratofortress (informally known as the BUFF—the Big, Ugly, Fat ——) is a huge eight-engined bomber, originally designed during the Cold War to carry nuclear weapons.

This monster of a plane needs about 230 knots (with one-third flaps) to get off the ground, and it has a maximum speed of about 650 miles per hour at 20,000 feet.

## ix. The X-15

The North American X-15 is a rocket-powered speed demon. With a top speed of Mach 6.72 (4520 miles per hour), it is the fastest manned aircraft in the world. To begin flight, this craft is dropped, uniquely, from the B-52 "mothership." Its top speed is over double that of the SR-71 (the world's fastest jet airplane),

and its maximum altitude of over 50 miles qualifies its pilots for astronaut status.

The craft's absurdly high top speed requires a blast shield to be installed over one side of the windshield—without it, the windows would burn up. The X-15 pilots would fly the high speed portion of the mission with the shield on the right side, looking out the left side only. After the craft slowed down (and the left window was sufficiently charred), the pilot would jettison the blast shield and move to the right window in order to land.

When the X-15 is selected from the Settings menu, X-Plane will load up the B-52 to drop it from. Go to the HUD view (if desired) and touch the screen as instructed. Drag the throttle to the top of the screen, take the flaps up, and watch its airspeed "rocket"—that is, until it gains enough altitude, at which point its *indicated* airspeed will drop to maybe 15 knots, while it is *actually* moving at Mach 6.

Be mindful of your fuel when flying the X-15—at full throttle, it takes only a couple minutes to go from a full to an empty tank.

## F. Approximate Takeoff Speeds

**Table 3.3** lists the approximate takeoff speeds for the fighters, racing planes, and “extreme” aircraft.

Aircraft	Approx. Takeoff Speed (knots)
F4U	85
P-51	85
F-4	175
F-15	150
F-86	185
Gee Bee	115
F-22	115
SR-71	145
B-52	230
XB-70	200
C-130	110
B-1	170
B-2	110
X-15	N/A
A6M	70
MiG-21	145
F-14	180
F/A-18F	200

Table 3.3: Takeoff speeds for fighters and other extreme aircraft

## IV. Helicopters

The following helicopters are found in X-Plane for iPad/X-Plane HDEF 4G:

- Robinson R22
- Bell 206
- Sikorsky H-3 Sea King
- Sikorsky S-76C
- Sikorsky UH-60 Black Hawk

- Boeing CH-47 Chinook
- Bell AH-1 Cobra

Four of the helicopters are primarily used by civilians. The R22 is a twin seat, two-bladed, lightweight helicopter used for pilot training. The 206 is a turbine-powered mainstay of many helicopter fleets. The H-3 Sea King is a huge land/sea rescue helicopter. The S-76C is a twin-engined, mid-sized commercial craft.

The other three helicopters are primarily for military use. The UH-60 Black Hawk is a four-bladed, twin-engine massive military cargo and troop mover. The CH-47 Chinook is a twin-engine craft from the 1960s designed for heavy lifting, moving cargo and troops. The AH-1 Cobra is a helicopter gunship, designed in the 1960s to defend American ground troops in the Vietnam War.

## V. Gliders

X-Plane for iPad/X-Plane HDEF 4G contains the following gliders: a Schleicher ASK 21 composite trainer, a high performance Schempp-Hirth Cirrus, and a PZL Bielsko SZD-45 Ogar powered glider.

## VI. The Space Shuttle

The shuttle Orbiter is a reusable spacecraft driven to orbit by solid rocket boosters. Despite the fact that its own three engines (not counting the boosters) put out over 375,000 pounds of thrust *each*, by the time it reenters orbit, the Orbiter is purely an oversized glider—its fuel is spent. It poses quite a challenge to fly by hand back into the atmosphere and safely down to Edwards Air Force Base.

With the shuttle selected, users can sit back and watch the Shuttle's launch and entry into orbit, or take control of the complete re-entry (from nearly 200,000 feet), the full approach to Edwards, or the final approach.

## 4. Taking Off, Flying, and Landing

Let's go over the flight operations of a few representative aircraft. If you aren't sure where to find the controls mentioned here (flaps, throttle, brakes, etc.), see Chapter 2, **Getting Acquainted with the Simulator**, beginning on page 6.

### I. ...in the Cessna 172

The Cessna 172SP is the most straightforward of the aircraft included with X-Plane for iPad/X-Plane HDEF 4G—it's what many student pilots learn to fly in.

To begin takeoff in the 172, touch the FLAP slider and drag it about a third of the way down. This will partially engage the flaps in order to generate more lift, thus getting the airplane off the ground more quickly.

Next, tap the **BRAKES** button to toggle the brakes off. It will go from being lit red (brakes on) to being dim (brakes off).

Then, drag the THROT slider to the top of the screen. This will set the throttle at full.

When the airspeed reaches about 65 knots, pull the nose off the ground and begin climbing. Raise the flaps slider back up to the top of the screen in order to reduce the craft's drag.

To climb most efficiently, raise the nose to the point that the aircraft's speed is 76 knots. At full throttle, this is when the craft's nose is pitched up at about 10 degrees.

After climbing awhile (say, about 2,000 feet), you may want to level off and begin cruising. At this point, move the throttle slider down to about three quarters of its maximum and gently

move the nose down to a pitch of zero

Eventually, you will want to turn back to the runway. To do this, tilt the iPad/iPhone to the left or right and tilt it back slightly (thereby pulling the nose "into" the turn).

Keep turning until the runway is in sight. Ideally, the aircraft will be oriented in line with the runway while it is still far off. This is referred to as the approach to the runway. On the approach, keep the craft's airspeed a little above 90 knots.

As the craft gets closer to the runway, gradually decrease its speed, either by lowering the throttle or by adding flaps. This gradual slowdown should put the plane at a little under 70 knots when it touches down on the runway, with its power at zero and flaps at full. Follow a shallow glide path in to the runway—that is, point the nose down between 3 and 5 degrees. Right before the craft reaches the ground, raise the nose *up* to about 7 degrees for a gentle touchdown.

With the aircraft on the ground, tap the **BRAKES** button to toggle the brakes on.

Now that the flight is complete, open the Settings menu (as described in the section "**The Settings Menu**" of Chapter 2, on page 18) and select a new flight.

### II. ...in the Cirrus Vision SJ50

We will go through the takeoff and flight in the Cirrus Vision SJ50. Flight operations in this jet will be nearly identical to those in other high-end general aviation craft—simply substitute in that aircraft's takeoff speed (found in the chart in Chapter 3's section "**General Aviation Aircraft**" on page 24) for the 80 knots specified here for the Cirrus.



Tap the **BRAKES** button on the lower left of the screen to turn the brakes off. Drag the flaps (controlled with the scroll bar on the right side of the screen in the HUD view) about 1/3 of the way down to get ready to take off. This will partially lower the flaps in order to give the craft more lift, getting it into the air more quickly. Do *not* put the flaps *all* the way down because they would add too much drag. Full flaps are only used when landing.

With the flaps dialed in, drag the throttle (the scroll bar on the left) all the way to the top. This will give the aircraft full power.

Tilt the iPad/iPhone left and right to steer down the runway, holding the device at about a 45 degree pitch (for a neutral elevator). When the craft reaches about 80 knots (indicated by the scrolling tape on the left side of the screen), tilt the device back toward you to raise the nose and get the craft off the ground.

After the craft has risen a few feet, let the nose drop back down a bit to (nearly) level off, but don't settle back to the runway. Let the plane accelerate for a few moments like this (until it reaches, say, 100 knots), then resume climbing. Leveling off in this way will provide a "cushion" of speed for the aircraft so that when it begins to climb in earnest, it will be less likely to slow down toward the stalling speed.

Note that once the power is set at full, the performance of the plane (in terms of its climb rate and airspeed) is controlled by pitching the nose up and down. If the craft's nose is pitched too high up, its speed will drop until it stalls. This can be thought of as being similar to a car trying to go up a hill—an excessively steep hill will cause the car to go very slowly and its engine to overheat. In the Cirrus Vision, a speed of around 130 knots is desirable when climbing.

Tilt the device left and right to steer, and hold the nose about 10 degrees up to climb away from the runway. Hit the **GEAR** button to raise the landing gear, and, once the craft is safely in the air, drag the FLAP slider back up to the top to fully retract the flaps. Continue to hold the nose up about 10 degrees as the plane climbs out. In the climb, both the gear and flaps should be up and power should remain at full. When flying, always keep the plane's speed above about 80 knots as an absolute minimum to avoid stalling. It may be necessary to either add power or lower the nose to maintain this speed.

### III. ...in the F-22 Raptor

Let's go through the basics of takeoff and flight in the F-22 Raptor, an aircraft which will serve as a decent representation of the other fighters (like the F-14 and F-15) as well.

First, tap the **BRAKES** button on the lower left of the screen to turn the brakes off. Because of the excessive amount of power available in the Raptor, flaps are not required to take off. Drag the throttle all the way to the top of its range of motion. This will give the aircraft full power. Tilt the iPad/iPhone left and right to steer down the runway (being careful not to hit the plane in front of you), holding the device at about a 45 degree pitch (for a neutral elevator). When the craft reaches about 120 knots (indicated by the scrolling tape on the *left* side of its HUD), tilt the device back toward you to raise the nose, and away you go.

Keep in mind that this airplane is *excessively* powerful and that it also uses thrust vectoring—that is, it points its exhaust up and down on each engine independently to aid in roll and pitch control. The engines produce more than 35,000 pounds of thrust *each* when in full afterburner. Compare that with the F-

16 which puts out about 24,000 pounds of thrust *total*. Because the Raptor's engines vector the thrust up and down with the flight controls, yanking the stick back rapidly while on the runway will cause the engine's thrust to slam the tail into the ground and the nose will point excessively high upward. Users in the past have commented that this is not possible, that the Raptor can not possibly take off in such a short distance. Of course, the plane has *not* really taken off yet—it's just sliding down the runway dragging its tail on the asphalt. Look at the altimeter to determine when the aircraft is actually in the air and climbing.

Once off the ground, tilt the device left and right to steer. Hit the **GEAR** button to raise the landing gear and make sure the flaps slider is at the top of its range of motion. Hold the nose up about 30 degrees or so as the plane climbs out. In the climb, both the gear and flaps should be up. Given the amazing power this airplane produces, the throttle can be brought back a bit in order to get out of afterburner mode.

Once again, remember that the craft's *indicated* airspeed may be different from its *true* airspeed due to the design of the instrument itself. This becomes especially important at high altitudes, where there is little to no air hitting against the airspeed measuring device on the body of the craft.

#### IV. ...in the Boeing 747

Flying X-Plane's airliners is quite different from flying, say, the Cirrus Vision. The airliners are much, much heavier than the other planes, and thus require a great deal more lift to get off the ground. For pilots who are used to flying light planes, these behemoths will feel very sluggish.

Let's walk through flight in the Boeing 747, a good

representative of the airliners included with X-Plane for iPad/X-Plane HDEF 4G.

To begin, tap the **BRAKES** button to toggle the brakes off. Drag the flaps about one third of the way down. Pulling in the flaps like this will provide some extra lift to get the aircraft off the ground more quickly. Next, drag the throttle slider all the way to the top of its range of motion, giving the craft full throttle.

When the aircraft reaches about 160 knots, gently tilt the device back in order to pull the craft's nose off the ground.

Keep it climbing at a shallow pitch (say, about 5 degrees) for a few seconds in order to get away from the ground, then gently raise the plane's nose up to about 15 degrees. Toggle the gear up, then bring the flaps back to the top of their range of motion. Setting the flaps back to neutral like this will minimize the drag on the craft as it climbs.

Continue climbing until the desired altitude is reached. At that point, level the nose off and bring the throttle down to about three quarters of its maximum.

Use the trim control (currently available only in the HUD view) to hold the desired pitch of the nose. For instance, to hold the nose up, drag the trim control down a bit. To hold the nose down, drag the control up a bit. This is ergonomically equivalent to using a real trim wheel, which the pilot rolls up to push the nose down, or down to pull the nose up.

In order to maintain control of the 747, be sure to always keep its speed above 140 knots as an absolute minimum. Holding a more comfortable speed of 170 or 180 knots is desirable.

Now let's discuss landing the 747. Approaches to the runway

can be easily practiced by selecting the **Final** button from the Map screen (found in the Settings menu—see Chapter 2's “**The Settings Menu**” on page 18). This will set the aircraft lined up with the indicated airport while still a few miles away.

When the desired airport is in sight and the aircraft is lined up with it, it's time to begin the approach in earnest. The key to the approach is to gradually slow the craft down while also gradually descending to the level of the airport.

Ideally, the airplane will have slowed down to just above its stall speed at the point that it touches down. In the 747, this means its speed should be gradually decreasing on the approach so that the instant before it touches down, it is traveling at about 150 knots. In order to slow to this speed, it will be necessary to slowly back the throttle down and pull in full flaps (by dragging the flaps control to the bottom of its range of motion). The speedbrake may also be required—drag it down to decrease the aircraft's speed.

In the descent, pitch the nose downward between 3 and 5 degrees. This will provide a shallow, controlled descent. In the seconds before the aircraft touches down, raise the nose *up* to about 7 degrees. This will cause the *back* wheels to touch down first, yielding a very smooth landing.

Once flying has been mastered using the manual controls, try flying with the autopilot or landing using an ILS, both of which are described in Chapter 6, **Advanced Features of X-Plane**, beginning on page 49.

## V. ...in a Glider

When starting out in one of the two unpowered gliders (the ASK 21 or the Cirrus), the simulator puts the craft on the

runway behind the Cessna towplane. The towplane's engine is running, and it's ready to go. Releasing the glider's brakes (by tapping the **BRAKE** button) commands the towplane to take off, dragging the user's craft with it.

When flying the Schempp-Hirth Cirrus, the gear should be raised once the craft is off the ground. This enables the user to squeeze every last bit of performance from the glider. The other

The towplane, once in flight, will take the glider as high as the user likes, and while being carried up, the glider will have to hold formation behind it as it pulls the glider to altitude. Tapping the **HOOK** button located in the bottom right corner of the screen will release the line between the aircraft, allowing the glider to soar freely.

Notice, of course, that until the **HOOK** button has been pressed, the tow rope connecting the two aircraft is attached to the towplane's tail and the glider's nose. X-Plane models the real physics of this situation, so if the glider pulls left, right, up, or down, it will drag the towplane's tail in that direction. This could result in simply pulling the plane off course, or ultimately in dragging the plane into a stall or spin. If that happens, things will get very complicated very quickly—the towplane (which will likely be crashing) will be dragging the glider with it! The dynamics of the resulting crash are... interesting.

According to [the FAA handbook for gliders](http://www.faa.gov/library/manuals/aircraft/glider_handbook/)<sup>2</sup>, a glider pilot should keep the glider in one of two positions when being towed to altitude. It should either be in a “low tow” position, wherein the glider is just below the wake from the towplane, or it should be in a “high tow” position, just above the wake from the towplane. Hold this position carefully to keep from

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<sup>2</sup>[http://www.faa.gov/library/manuals/aircraft/glider\\_handbook/](http://www.faa.gov/library/manuals/aircraft/glider_handbook/)

dragging the towplane around!

Taking off in the SZD-45 (the powered glider) is like taking off in any other plane—run the throttle all the way up, pull in a little bit of flaps, then pull back at around 50 knots. Then, once the glider reaches altitude (with the flaps up, of course), drag the throttle slider back down to idle and soar like any other glider!

A glider pilot must watch the wind and the slope of the terrain carefully to hold inside the *upward-moving* currents of air, using the lift of the air flowing *up* the mountain slope to hold the craft aloft. With a good 25-knot wind set in the simulator, the user can get a nice, free elevator ride to 10,000 feet when flying along the windward side of a nice, steep mountain. This is called ridge lift.

Unique to the gliders is an instrument called the *total energy variometer*. If it is *beeping*, then the aircraft is in a nice updraft from the air following the terrain. Circling in that area will let the glider ride the climbing air to altitude! When the variometer is emitting a *steady* tone, the craft is in *descending* air—the glider has been blown to the wrong side of the mountain, and a crash will follow soon if the user does not find a way out of that area!

Now, to land the glider, simply circle down to runway level. The trick is to approach the runway with just enough speed to set the craft down safely. Remember, pulling the speedbrakes in can help slow the craft down, but if it doesn't have enough speed to reach the landing strip, the glider has no way of generating thrust. For instance, in **Figure 4.1**, the speedbrakes are fully engaged, and the glider will reach the runway just a hair above its stalling speed.



Figure 4.1: Speedbrakes fully engaged for a glider landing

## VI. ...in a Helicopter

The following is a description of how helicopters are flown in the real world, along with the application of this in X-Plane. As you are about to see, flying a helicopter is very difficult and much more demanding than flying a fixed-wing airplane.

Though all manner of different helicopter layouts can be found in reality, we will discuss only the standard configuration here—a single overhead rotor with a tail rotor in the back, like the Robinson R22 Beta. Here's how it works: first, the main rotor provides the lift needed to support the aircraft, exactly in the same way that an airplane's wing supports its weight, or its propeller pulls it through the air.

Quite unlike an airplane propeller, though, a helicopter's rotor spins at the same RPM in all phases of flight. Whereas an airplane propeller speeds up in order to generate thrust, the

amount of lift generated by a helicopter rotor is controlled by adjusting the pitch of the main rotor blades. This is done using the collective control.

Imagine the one and only operational RPM of a helicopter is 400 RPM. When the craft is sitting on the ground, the rotor is turning 400 RPM, and the pitch of the rotor's blades is about zero. This means that the rotor is giving about *zero* lift. Because the blades have zero pitch, they have very little drag, so it is very easy to move them through the air. In other words, the power required to turn the rotor at its operational RPM is pretty minimal at this point. Now, when the pilot is ready to go flying, he or she begins by pulling *up* on a handle in the cockpit called the collective. When this happens, the blades on the rotor go *up* to a *positive* pitch. All the blades on the main rotor do this together at one time—"collectively."

Of course, they are then putting out a lot of lift, since they have a positive pitch. Equally apparent is the fact that they are harder to drag through the air now, since they are doing a lot more work. Since it is a lot harder to turn the blades, they start to slow down—if this were allowed to happen, it would be *catastrophic*, since the craft can't fly when its rotor isn't turning! To compensate for this, the helicopter's feedback sensors will increase the throttle as much as necessary in order to maintain the desired 400 RPM in the rotor. In X-Plane, the effect of this throttle governor can be seen in the slider on the right side of the screen while in the HUD view, as highlighted in **Figure 4.2**.



Figure 4.2: The throttle indicator in a helicopter

So, increasing the collective pitch of the main rotor will increase the lift generated by it, thus pulling the helicopter off the ground. However, because of the main rotor's inertia and its increasing drag as its pitch increases, the force required from the engine to spin the rotor also increases. When the throttle governor increases power to meet this need, the torque delivered from the main rotor blades to the fuselage of the helicopter will change. This torque (and the fact that it is continually changing) must be compensated for in order to keep the craft flying straight.

This compensation comes in the form of the tail rotor, controlled with the foot pedals in a real helicopter. The pilot must continually be making small changes with his or her feet (changing the pitch of the tail rotor blades just like the collective control does to the main rotor blades) in order to



correct for the torque of the main rotor. This torque itself is continually changing depending on the amount of power delivered to the main rotor by the engine.



Figure 4.3: The TR slider

X-Plane will try to stabilize the tail rotor automatically. However, in most cases, it is a good idea to manually control it using the TR slider, found at the bottom of the screen (see **Figure 4.3**). Remember, move this left to turn the helicopter left, and move it right to turn right. This will need to be moved back and forth as the collective pitch of the main rotor is changed (which changes the power delivered by the engine and the energy absorbed by the rotor).

Incidentally, the tail rotor is geared to the main rotor so that they always turn in unison. If the main rotor loses 10% RPM, the tail rotor loses 10% RPM. The tail rotor, like the main rotor,

cannot change its speed to adjust its thrust. Like the main rotor, it must adjust its pitch, and it is the tail rotor's pitch that is being controlled with the anti-torque pedals (that is, the TR slider in X-Plane for iPad/X-Plane HDEF 4G).

Once the craft is in the air and the *collective pitch* of the main rotor is being adjusted (in X-Plane for iPad/X-Plane HDEF 4G, using the sliding control on the left side of the screen), the helicopter pilot in the real world will use the cyclic control (the joystick) to tilt the craft left, right, down, or up. In X-Plane, this is controlled by tilting the device left, right, fore, and aft.

The cyclic control works like this: If the cyclic is moved to the *right* (corresponding to the device being tilted to the right), then the rotor blade will *increase* its pitch when it is in the *front* of the craft, and *decrease* its pitch when it is *behind* the craft. In other words, the rotor blade will change its pitch through a full cycle every time it runs around the helicopter once, continually going to a higher or lower pitch. If we use the example from before, this means that the rotor would change its pitch from one condition to the other, and back again, 400 times per minute (7 times per second), because the rotor is turning at 400 RPM. Pretty impressive, especially considering that the craft manages to stay together under these conditions! The fact that moving the stick sends the blade pitch through one *cycle* every rotation of the rotor blades is why we call the control stick the *cyclic*.

Let's talk more about the cyclic. When the stick is moved to the right, the rotor increases pitch when it is in the part of its travel that is in *front* of the helicopter. Surprising, right? One might have assumed that if we wanted to turn *right*, we would increase lift on the *left* side of the helicopter, thereby lifting the left and causing the helicopter to roll right. This isn't how it works, though, due to the fact that gyroscopic forces are applied 90 degrees along the direction of rotation of the



gyroscope, which is why the lift must be changed *in front* of the helicopter to enact a change on the *left* of the machine.

Here's an *amazing* experiment that you can try on your own to see how this works. Sit on a free spinning (low friction) bar stool with a bicycle wheel in your hands. Have a friend spin the tire as quickly as possible while you hold the wheel stationary with one hand on each side of the axle. Now, after your friend backs away a bit slowly rotate the axle about the lateral (fore and aft) and roll axes and you will be surprised at how you can control your spinning motion on the stool by making controlled movements with the bicycle wheel. Cool!

Here's something else that is surprising—the helicopter's rotor doesn't directly pull the aircraft to change its flight path. To turn right, the helicopter must increase the lift on the front of the rotor, which causes the left side of the rotor to come up (tilt to the right). But the rotor doesn't force the helicopter to roll to the right; only the angle of the rotor itself is changed. The resulting change in the *direction of lift* is what actually changes the flight path of the helicopter. Once the rotor (and thus the helicopter's thrust vector) is tilted to the *right*, it will drag the craft off to the right. In fact, the thrust vector from the main rotor can be broken down into two components, vertical lift (which supports the weight of the helicopter) and horizontal lift (which causes the helicopter to accelerate to the right).

We said that the helicopter's rotor doesn't directly pull the craft to change its flight path. This is because the rotor on many helicopters is totally free-teetering; it has a completely "loose and floppy" connection to the craft. It cannot conduct any force (left, right, fore, and aft) to the body of the helicopter. Maneuvering is only achieved by the rotor tilting left, right, fore, and aft, dragging the top of the craft underneath it in that direction. The helicopter body is dragged along under the rotor like livestock by a nose ring, blindly following wherever the

rotor leads.

To summarize, this is the sequence for getting a helicopter to fly (in the real world, as well as in X-Plane):

1. While on the ground, the collective handle is *flat on the ground*. This means the rotor pitch is flat, with minimum drag and zero lift. In X-Plane, a *flat collective corresponds to the collective control (found on the left side of the screen) being at the top of its range of motion*. The automatic throttle in the helicopter is obsessively watching the rotor's RPM, adjusting the throttle as needed to hold exactly the design RPM (which varies from helicopter to helicopter). On the ground, with the collective pitch flat, there is little drag on the blades, so the power required to hold this speed is pretty low.
2. When the user decides to take off, s/he does so by *raising the collective up* by pulling it up from the floor of the helicopter. In X-Plane, this is done *by easing the sliding bar collective control down toward the bottom of the screen*. This increases the blade pitch on the main rotor and therefore increases its lift, but it also increases the *drag* on the rotor a lot. The rotor RPM begins to fall below its operational speed, but the auto-throttle senses this and loads in however much engine power it has to in order to keep the rotor moving at exactly the required RPM.
3. *More* collective is pulled in until the blades are creating enough lift to raise the aircraft from the ground. The auto-throttle continues adding power to keep the rotor turning at its operational RPM no matter how much the collective is raised or lowered.
4. The tail rotor is actively controlled to keep the helicopter

from spinning due to torque and gyroscopic effects. Any change made by the pilot or nature will require input in the other two controls. Thus, the pilot must continually be making small adjustments to the cyclic (the control stick—controlled with the device's tilt), collective (the lever to adjust main rotor pitch—controlled with the COLL slider) and anti-torque pedals (to adjust tail rotor pitch—controlled with the TR slider) to account for changes based on moving any of these controls.

Use the above information to hover perfectly. Once that is mastered, push the nose down to tilt the rotor forwards. The lift from the rotor acting above the center of gravity of the aircraft will lower the nose of the helicopter, and the forward component of lift from the rotor will drag the craft forward as it flies along.

## A. Notes

Remember that in this application the throttle is automatically controlled for the helicopter. It is shown only as a visual indicator of how hard the engine is working. Be careful not to command more lift from the main rotor (with the collective control) than the engine is capable of providing or the rotor RPM will decay and the craft's flight will quickly deteriorate.

Note that the collective is dragged *down* to *increase* its pitch. This is ergonomically similar to the collective in real helicopters, where pilots pull the collective handle towards them to increase the collective. Thus, in X-Plane, the collective control is dragged *towards* the user (that is, *down* on the screen) to increase it.

## B. Review

To review, helicopter flight in X-Plane follows these steps:

1. The collective slider, found on the left side of the screen, is dragged down gently in order to increase the pitch of the main rotor. This increases the lift generated by the rotor. As this is done, the throttle, shown on the left side of the screen, will *automatically* increase. This is caused by the throttle governor automatically increasing the engine power to maintain the desired rotor RPM as the rotor load is increased (caused by increasing the rotor's pitch). This is how the real helicopters work, and thus how they are simulated in X-Plane.
2. The TR slider (controlling the tail rotor) is dragged left to turn the helicopter left (or to counter rightward torque). It is dragged right to turn the helicopter right (or to counter leftward torque).
3. The iPad/iPhone is tilted left, right, forward, and back to move the craft in each respective direction. This corresponds to input from the stick (the cyclic control) in a real helicopter. Remember that what is actually happening with the cyclic is that the rotor is being made to roll and pitch around the helicopter, thereby changing the thrust vector. This thrust is what causes the helicopter to accelerate either forward, rightward, rearward or leftward.

## VII. ...in the Space Shuttle

Flying the Space Shuttle is quite different from flying the other aircraft in X-Plane. In the real world, almost all of the Shuttle's flight is controlled by its computers—it is “hands off” for the

astronauts. This is the case for the Launch mission in X-Plane for iPad/X-Plane HDEF 4G. However, in X-Plane, unlike in almost every mission in the real world, you can pilot the Shuttle down by hand for the full re-entry. This makes for a great challenge, and it's a lot of fun!

## A. Beginning a Space Shuttle Mission Segment

To begin a mission segment in the Space Shuttle, select it in the Plane tab of the Settings menu (per the section “**The Plane Tab**” of Chapter 2, on page 20). With the Orbiter selected, the Map tab of the settings menu will be replaced by the screen seen below:



Tap the desired mission segment, then tap the **Go!** Button to begin the simulation.

## B. Launch

The first mission segment is the launch phase. Here, the user can simply watch as the launch is run. Displayed throughout the launch are the Shuttle's speed, altitude, time into flight, and time until orbit. The simulator will accurately recreate how long it takes for the Shuttle to reach orbit (eight and a half minutes) and the maneuvers that it goes through on the way

there. This kind of visualization isn't normally possible—after all, the Shuttle is out of range of the cameras within about two minutes of launch, so we never see the whole flight to orbit. In Space Shuttle, though, the entire path to orbit is faithfully reproduced, so users can see what really happens, as fast as it really happens.

It is fascinating to watch the indicated air speed (found in the HUD view—see Chapter 2's “**Using the Menu and View Options**” on page 7 on how to select this) slowly fall to zero knots as the Shuttle climbs into space and the air pressure drops to nothing. Also, watch the take off from the HUD view and note how the shuttle only climbs vertically for the first 40 seconds or so, after which it begins to tip over on its back. The shuttle then climbs *inverted* for the next 300 seconds or so (nearly five minutes), until the spacecraft rolls upright at about 330 seconds after liftoff.

The simulator also puts into perspective the duration of the main engine burn after the solid rocket boosters burn out and are jettisoned. This shows visually why the external fuel tank (the orange-colored center cylinder) is so gigantic in comparison to the Shuttle.

## C. ISS Dock

In this segment of the mission, the user will dock the Space Shuttle with the International Space Station orbiting the earth.

To do this, the user must monitor quite a few controls at once. First, the Shuttle's pitch and roll (controlled using the device's tilt) as well as its yaw (controlled using the YAW slider at the bottom of the screen) must be used to properly align the shuttle with the docking hatch in three dimensions.

While keeping the pitch, roll, and yaw on target, the user must carefully use the throttle control (found on the left side of the screen) to bring the Shuttle in. This slider goes from full forward (at the top of its range of motion) to full backward (at the bottom of its range of motion), and releasing it will reset it back to zero thrust (in the center of the screen). Be sure to have the craft's velocity under 1 meter per second when it meets up with the ISS.

Finally, while keeping the pitch, roll, yaw, and throttle where they need to be, use the translational thrusters (the control in the box on the right side of the screen) to align the body of the Shuttle with the space station. The orange circle in the center of the screen and the moving orange dot show where the translational thrusters need to push the craft. Simply drag the thruster control in the direction of the circle relative to the dot to properly align the Shuttle. For instance, if the circle is above the dot, drag the translational thruster control up, and if the circle is to the right of the dot, drag the thruster control right, etc. When the Shuttle is right on target, the orange dot will be *inside* the orange circle.

Keep all of these controls where they need to be and docking will be a breeze.

## D. Final Approach

The final approach is the easiest of the mission segments. The Shuttle will be placed on an eight mile final approach to Edwards, and the user will have to glide down to the runway as in any glider (this one just happens to have a pretty poor glide ratio). The speedbrake (the slider in the upper right of the HUD view, labeled SBRK) will likely be required to get the craft's descent profile just right. The Shuttle should be slowed to about 250 knots as it approaches the runway, and it should

be descending on about a 20 degree glide path until the VASI lights beside the runway turn from white to red. At that point, raise the nose (this is called the "pre-flare") and follow that shallow 3 degree glide path in for the final bit of the approach for touchdown. Don't forget to lower the brakes at the last second!

If the approach is flown correctly, the pilot will

- follow a 20 degree angle down,
- adjust the speedbrakes to slow to 250 knots,
- raise the nose as the lights beside the runway start to turn red,
- lower the landing gear,
- follow a path in that keeps two of the lights beside the runway white and two of them red (if more are red, the craft is too low, and if more are white, it's too high),
- touch down in a nose-high attitude,
- lower the nose,
- hit the brakes, and
- be stopped well before the end of the runway.

That is, at least, how the pros do it.

## E. Full Approach

The full approach provides a greater challenge than the final. It starts the aircraft off at 83,000 feet and moving at Mach 2.5, 40 miles downrange of landing. This approach is a bit trickier: The pilot will need to raise or lower the nose to hold the desired angle of attack (thus keeping a proper drag profile) while slaloming back and forth to get rid of surplus energy. The Shuttle will be slaloming back and forth through the stratosphere at Mach 2, trying to dissipate just the right amount of energy to arrive over Edwards at the right speed and altitude to land.

Onscreen instruction is given during the flight in the cockpit view to help guide the user through it. This is the orange text marked in **Figure 4.4**.



Figure 4.4: The onscreen instruction for re-entry

As the approach progresses, the little yellow shuttle in the far right EFIS screen will glide down the green line to Edwards. If the craft gets *below* that line, it has too little energy (meaning it is either too low or too slow). Pull the nose up and level the wings in order to conserve energy in the thick air of low altitude. If the craft gets *above* the green line, it has too much speed or altitude. Bring out the speedbrakes (found in the center right of the HUD screen) and slalom left and right (like a skier) to lose the extra energy. This is what the real Space Shuttle does to dissipate energy. If the user can manage this, he or she is flying very much like the real Orbiter pilots would.

## F. Re-Entry

Once the full approach has been mastered, try the "Final Re-Entry" option from the Missions screen. This will start the aircraft 600 miles downrange at 200,000 feet, moving at Mach 10. This is a true challenge.

Worth noting is the fact that the Shuttle starts out 600 miles away, 40 miles straight up, and moving at Mach 10. By the end of the re-entry, it will be sitting on a runway that is only a couple hundred feet wide and a few thousand feet long. Even more remarkable, this is done without a bit of power from the craft's engines—it gets there on nothing but inertia, drag, and careful flight. The cockpit displays (coupled with the orange help text at the top of the panel) do indeed make it possible!

## 5. About the Flight Regions

X-Plane for iPad/X-Plane HDEF 4G includes more than twenty flight regions, ranging from the deserts of California to the snowy mountains of Nepal. Let's look at these regions in depth.

### I. Innsbruck, Austria

The Innsbruck region has some of the most highly detailed scenery found in the simulator. Note the accurately reproduced airport terminal buildings and the super-high-definition textures, as seen in **Figure 5.1**.

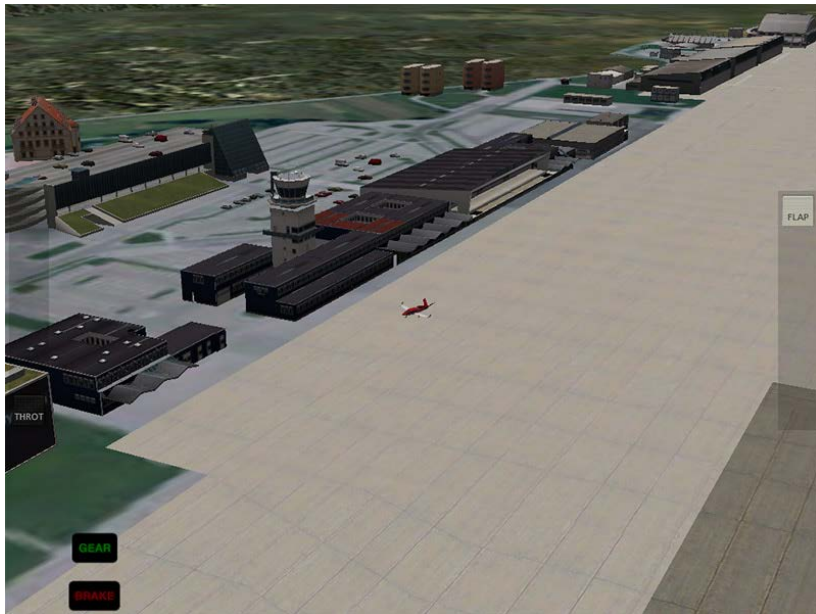


Figure 5.1: The LOWI terminal

Innsbruck includes Innsbruck Airport (LOWI).

### II. Hawaii

The Hawaii region includes nearly the whole of the Maui and Lanai islands. Its main airports are Kahului Airport (PHOG) and Lanai Airport (PHNY). With the close combination of flats, gently sloping mountains, jagged peaks, and the ocean, Hawaii makes a beautiful place to fly.

This region has an aircraft carrier situated in the south for use with carrier-capable fighters.

### III. Miami, Florida

The Miami region spans from Tavernier in the south, to North Miami Beach in the northeast, to Marco Island in the northwest. It encompasses all of Everglades National Park, and includes an aircraft carrier in the west.

### IV. Southern California

The Southern California region spans the coast of California from Imperial Beach in the south to Barstow in the northeast to Edwards Air Force Base in the northwest. It includes San Bernardino International (KSBD), San Diego International (KSAN), and Ontario International (KONT) airports, as well as an aircraft carrier (located near the center of the map).

### V. Santa Catalina Island, California

Santa Catalina Island forms the center of this map, with Long Beach and Los Angeles in the north. Prominent airports



include Catalina Airport (KAVX) and Los Angeles International Airport, as well as an aircraft carrier located just north of Catalina Island.

## VI. Van Nuys, California

The Van Nuys region extends from Mojave in the northeast to Thousand Oaks in the southwest. Prominent airports include Van Nuys Airport (KVNYY) and Bob Hope Airport (KBUR) in Burbank.

## VII. San Francisco, California



Figure 5.2: The KSFO terminal

The San Francisco region spans from San Rafael in the

northwest, to Concord in the northeast, to Santa Cruz in the south. Note the very high level of detail at San Francisco International Airport (KSFO)—runway lights, terminal buildings, and the network of taxiways are all accurately modeled, as seen in **Figure 5.2**.

Additionally, there is an aircraft carrier located off the west coast near the center of the map.

## VIII. Big Bear, California

The Big Bear region extends from Big Bear City Airport (L35) in the south up to Barstow, California in the north, and includes Twentynine Palms Airport (KNXP).

## IX. Grand Canyon

The Grand Canyon map covers hundreds of square miles of Grand Canyon National Park in Arizona. It includes four fictional airports from which to explore the spectacular canyons of the area. The OZ\_V mini-heliport (seen from a distance in **Figure 5.3**) even starts users out from within the canyon!

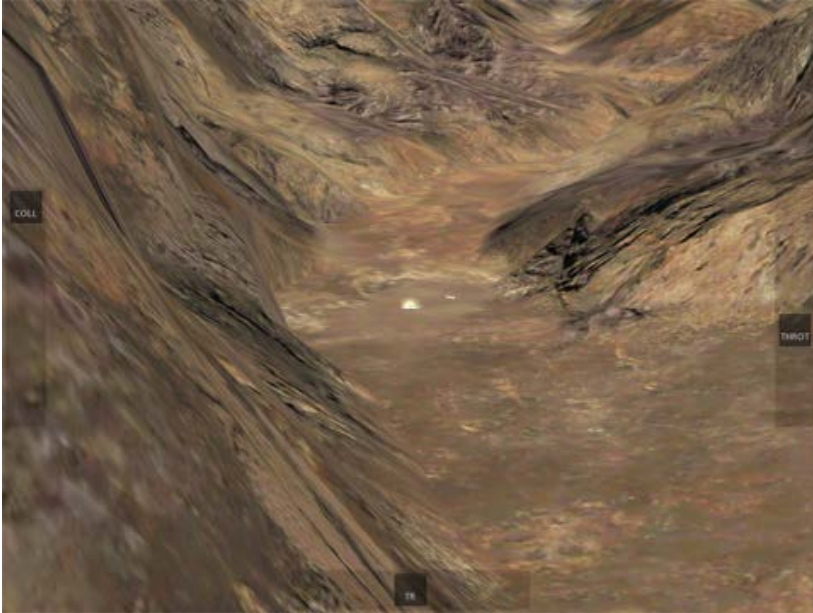


Figure 5.3: The OZ\_V helipad, seen at a distance

## X. Provost, Utah

The Provost region is bordered by Salt Lake City International Airport in the northwest, with the Strawberry Reservoir and Uinta National Forest in its southeastern corner.

## XI. Canyons

The fictitious Canyons region is filled with five airports and lots and lots of canyons. You're virtually guaranteed to have some mountain peaks in view any time you tap the **Random Location** button in the Map screen.

## XII. Southern California Desert

The Southern California Desert region spans about 60 miles from Palm Springs in the northeast to Ramona in the southwest and includes Palm Springs International Airport (KPSP).

## XIII. Desert Sky, California

The Desert Sky region encompasses much of the Salton Sea, and it is virtually right next door to the Southern California Desert map.

## XIV. New York

The New York region contains nearly all of New York City in the northeast and reaches down past Trenton, New Jersey in the southwest. Prominent airports include La Guardia Airport, John F. Kennedy International Airport, and Trenton Mercer Airport (KTTN), though there are over a hundred total airports in the region.

New York also features an aircraft carrier near the center of the map.

## XV. Chicago, Illinois

The Chicago region reaches from Kankakee, Illinois in the south to Milwaukee, Wisconsin in the north along the Lake Michigan shore. Prominent airports include Kenosha Regional Airport (KENW), Chicago Executive Airport (KPWK), Chicago O'Hare International Airport (KORD), and Chicago Midway International Airport (KMDW).

## **XVI. Seattle-Tacoma area, Washington**

The Seattle-Tacoma region stretches from Everett, Washington in the northeast down to Olympia, Washington in the southwest. It contains Seattle-Tacoma International Airport (KSEA), Bremerton National Airport (KPWT), and McChord Air Force Base (KTCM).

Note especially the detail in the Seattle-Tacoma Int'l terminal, as seen in **Figure 5.4**.



Figure 5.4: The KSEA Terminal

## **XVII. Juneau, Alaska**

The Juneau region centers on Juneau International Airport (PAJN). With lots of frigid water and snowy mountains, it makes for a beautiful flight.

## **XVIII. Kathmandu, Nepal**

The Kathmandu region centers around Tribhuvan International Airport (VNKT), located in the mountains of Nepal.

## **XIX. Boswell Bay, Alaska**

The Boswell Bay region features prominently Boswell Bay and a large portion of Prince William Sound, located in southeastern Alaska. It also includes an aircraft carrier near the center of the map.

## **XX. Anchorage, Alaska**

Anchorage lies about a hundred miles to the west of Boswell Bay. The map features Ted Stevens Anchorage International Airport (PANC), as well as an aircraft carrier.

## **XXI. Edwards Air Force Base, California**

The Edwards AFB region spans from Sequoia National Forest in the northwest all the way down to San Bernardino in the southeast. It includes Van Nuys Airport (KVNY) in the southwest, as well as Ontario International Airport (KONT) and, of course, Edwards Air Force Base (KEDW).

## **XXII. Cocoa Beach, Florida**

The Cocoa Beach region (and specifically the Kennedy Space Center in Cape Canaveral), is the site of the Space Shuttle launch. The region's default airport is Space Coast Regional (KTIX), the nearest commercial airport to the Kennedy Space Center. The most prominent airport, the NASA Shuttle Landing Facility (KTTT), lies to the northeast of it. Additionally, a carrier is included off the west coast of Cape Canaveral.

## 6. Advanced Features of X-Plane

**Note:** This chapter assumes prior familiarity with the workings of the view options and the Settings menu, as well as with the standard flight instruments. All of this is described in Chapter 2, **Getting Acquainted with the Simulator**, beginning on page 6.

### I. Flying an Approach Using the Instrument Panel

Nearly all of the aircraft in X-Plane for iPad/X-Plane HDEF 4G have basic navigation radios and instruments built into them, and all of these are used in more or less the same way. We will go through an example for flying an ILS approach (that is, an approach using an instrument landing system) in the Southern California region, but similar steps can be used for any airport.

Note that instrument navigation is not for the faint of heart. X-Plane is as realistic a flight simulator as possible, and navigation is no exception. This section is by no means a complete guide to airplane navigation (there are plenty of 400-page books available that claim that), but it will go into quite a bit of detail. We will discuss a great deal of side information needed to fly *all* approaches, but we will always come back and relate it to flying the example approach into San Bernardino International (again, found in the Southern California region).

To fly an instrument approach, users will first need to know the local navigational aid (NAVAID) frequencies. To find this, tap the center of the screen to make the various menu options appear, then open the Settings menu.

The map in the window that appears shows the ILS, LOC,

VOR, and VORTAC frequencies for the area. Zoom in and out of the map by placing two fingers on the screen and dragging them farther apart (to zoom in) or closer together (to zoom out). To pan the map, place one finger on the map and drag it, and to rotate it, place two fingers onto the map and twist them in a circular motion.

Let's discuss the specifics of each of these types of navigational aids (NAVAIDs).

### A. Types of NAVAIDs

The earliest type of navigation modeled in X-Plane for iPad/X-Plane HDEF 4G is based on VOR signals (that is, signals from a very high frequency omnidirectional range transmitter). VOR transmitters work by sending a series of 360 discrete little carrier tones on a main frequency. Each of these carriers is oriented along a different radial from the station, one of 360 just like on a compass rose. Thus, when one is flying along and tunes in the main VOR frequency, one then fine tunes the navigation display to tell which of the 360 radials the aircraft is flying and also whether the transmitter station is in front of or behind the plane.

In X-Plane for iPad/X-Plane HDEF 4G, a VOR beacon is labeled as in **Figure 6.1**.



Figure 6.1: A VOR beacon

A specific type of VOR, a VOR-DME, combines the lateral guidance (that is, guidance left and right) of a VOR with the distance guidance of a DME (distance measuring equipment). In X-Plane, this is labeled as in **Figure 6.2**.



Figure 6.2: A VOR-DME beacon

Another type of VOR beacon, a VORTAC, is also found throughout the X-Plane maps. This is a transmitter that combines both VOR and TACAN features. TACAN (or tactical air navigation) provides special information to military pilots similar to a civilian VOR. However, for our purposes, this is functionally identical to a VOR-DME.

A VORTAC in X-Plane is labeled as in **Figure 6.3**.



Figure 6.3: A VORTAC beacon

A LOC (or localizer) transmitter provides guidance to the centerline of a runway. It works by sending out two signals on the same channel, one of which modulates at 90 Hz and the other of which modulates at 150 Hz. One of these signals is sent out slightly to the left of the runway, while the other sent out slightly to the right of it. If an aircraft is picking up more of the tone modulated at 150 Hz, it is off to the left. If it is picking up more of the tone modulated at 90 Hz, it is off to the right. The course deviation indicator (or CDI) in the instrument panel then indicates this so that the pilot can correct it. When both tones are being received in equal amounts, the craft is lined up with the physical centerline of the runway.

In X-Plane, a LOC transmitter is marked as in **Figure 6.4**.





Figure 6.4: A LOC beacon

An ILS (or instrument landing system) combines the functionality of a localizer, which provides lateral guidance, with a glideslope transmitter, which provides vertical guidance to the runway. The glideslope beacon functions similarly to the localizer, sending out two tones that have the same frequency, but different modulations. The difference is that the glideslope tells the plane that it is either too high or too low for its distance from the runway. The pilot uses this information to push the craft's nose up or down as needed. The ILS will allow a pilot to fly on instruments only to a point that is a half mile from the end of the runway at 200 feet (depending on the category of the ILS) above the ground. If the runway cannot be clearly seen at that point the pilot is prevented from executing a normal landing. If this happens, the pilot in real life is required to fly a "missed approach" and climb back to altitude in order to try again or go somewhere else.

In X-Plane, an ILS transmitter is marked as in **Figure 6.5**.



Figure 6.5: An ILS beacon

For our example approach, we'll be flying into San Bernardino International Airport (KSBD, found in the Southern California region). Zooming into the map screen near this airport shows that the ILS signal is coming from runway 06 (as seen in **Figure 6.6**). Not coincidentally, there is a button here in the map screen to put the aircraft on a final approach to this runway. Per **Figure 6.6**, the frequency we need to tune for KSBD's runway 06 ILS is 109.30.



Figure 6.6: KSBD's ILS information

## B. Navigation Instruments

Before we begin the approach, let's review the instruments used in navigation. This section assumes familiarity with the panel view as described in the section "**The Panel View in Depth**" of Chapter 2, beginning on page 12.

### i. Instruments in the Steam Gauge Panel

**Figure 6.7** shows the panel view in the Cessna 172. The course deviation indicator (or CDI—the most important instrument in navigating approaches like this) is seen in **Figure 6.8**.



Figure 6.7: The steam-gauge panel in the Cessna 172

The vertical line in the CDI displays the aircraft's lateral position relative to the tuned signal, and the horizontal line represents its position relative to the transmitted glidepath (where available).



Figure 6.8: The steam-gauge CDI

To navigate using any of the previously listed NAVAIDs (VOR, LOC, ILS, etc.), that NAVAID's frequency must first be tuned in to one of the navigation radios. The two knobs on each radio are used to tune them. The knob on the left is used to tune the

integer (or "counting number") portion of the frequency. The knob on the right is used to tune the decimal portion of the frequency.

For instance, let's pretend we want to fly the ILS into San Bernardino International airport using the radio in **Figure 6.9**.



Figure 6.9: A NAV radio set to 110.10 Hz

We found in the “**Types of NAVAIDs**” section that the KSBD ILS is transmitting at 109.30 Hz.

To tune the radio in **Figure 6.9** down to 109.30 Hz, first touch the left knob and slowly move your finger counter-clockwise until the radio reads 109.10. From here, touch the right knob and move your finger clockwise around it, bringing the frequency up to the required 109.30. At this point, we are all set to fly San Bernardino International's ILS.

Note that it doesn't matter which NAV radio is used, so long as you follow the proper radio when flying. In aircraft with a source select switch, the CDI will be driven with the signal from the radio indicated by the switch. For instance, if the source select switch was set as in **Figure 6.10**, the NAV 1 radio would drive the CDI. In aircraft without a source select switch, the NAV 1 radio drives the top CDI, while the NAV 2 radio drives the bottom CDI; following the right radio is a matter of following the right CDI.



Figure 6.10: The navigation source selection switch

With the navigation radio set, the CDI will begin to move once you're on an approach to the right airport. For our approach to KSBD, the simulator can automatically set this up when you tap the KSBD 06 **Final** button found on the Map screen.

For instance, in **Figure 6.11**, the vertical bar of the CDI instrument is a bit to the right of center. This indicates that the *aircraft* has moved to the *left* of the localizer course (recall that the localizer portion of the ILS is responsible for guiding the craft left and right). To get back on course, the aircraft needs to turn right—in other words, it needs to follow the line on the CDI.



Figure 6.11: A CDI deflected slightly right

Also note the horizontal bar in the instrument. This is the glideslope indicator. In **Figure 6.11**, it is a bit above the center of its range. In order to stay on the glideslope, the aircraft will need to pull its nose up just a bit—in other words, it needs to

follow the glideslope indicator. When the horizontal line is in the center of the instrument, the craft is right on course.

## ii. Instruments in the Glass Cockpit Panel



Figure 6.12: The EFIS-based panel

**Figure 6.12** shows the relevant portion of the panel found in the Cirrus Vision. Recall that the LCD panel on the left, the primary flight display, indicates the craft's pitch and roll attitude. In addition, it combines in functionality from the horizontal situation indicator, or HSI. For our purposes, the HSI serves the same function as the CDI in the steam gauge panel; it simply displays the information differently. Let's look at this screen closer.

The course deviation indicator (CDI) portion of the HSI is represented by the vertical purple line in **Figure 6.13**. It is in the center of the artificial horizon, meaning that the aircraft is lined up almost perfectly with the physical centerline of the runway. The glideslope indicator portion of the HSI is

represented by the horizontal purple line. In **Figure 6.13**, this is lined up almost perfectly with the aircraft's attitude indicator. Follow these purple lines just like the white lines in the steam gauge CDI. If the horizontal line is above the craft attitude indicator, pull up to meet it, and if the vertical line is to the left of the artificial horizon center, turn left to meet it, and so on.



Figure 6.13: The primary flight display of the EFIS

Below the attitude indicator is the directional gyro. This, like the CDI and glideslope indicator, is normally a part of the HSI.

The directional gyro works like a compass in that it indicates the aircraft's heading. For instance, in **Figure 6.13**, the craft has a heading of 058 (notice that the arrow is pointing just a little to the left of the six, representing a heading of 060).

If we looked at a navigational chart for San Bernardino



International Airport (or use an airport database like [AirNav](#)), we would see that runway 06 that we're flying into has a magnetic heading of 057. This means that, according to **Figure 6.13**, we are pointed one degree to the right of the runway.

Now let's look at the moving map.



Figure 6.14: The moving map display

In **Figure 6.14**, the omni-bearing selector, which serves the same function as the OBS in the mechanical CDI instrument,

is marked with a 1. In this case, it will rotate the green CDI found in the moving map to line up with whatever heading the pilot specifies—for our example approach to San Bernardino International, we would want it pointing a little to the left of the 6 found at the top of the map (for a heading of 057).

To the right of that is the navigation source select switch (marked with a 2 in **Figure 6.14**), which switches between using the NAV 1 and NAV 2 radios. Data from the radio selected here gets sent to the EFIS. Tap this switch to change its position.

To the right of the source select switch is the zoom dial for the moving map, marked with a 3 in **Figure 6.14**. To move this, touch it and move your finger in a circle around it. Turn it clockwise to zoom out, and counter-clockwise to zoom in.

In **Figure 6.14**, the panel's moving map is marked with a 4. The green bar on this map indicates the aircraft's lateral position relative to the localizer's transmitted path. When the broken center portion of the bar is moved to the left, the aircraft needs to turn left in order to stay on the path, and when it is moved to the right, the craft needs to turn right.

Important to note are the light blue airports indicated in this map (for example, KSB, CL95, and 74CA in **Figure 6.14**). The locations of these airports are shown relative to the aircraft, which is represented as the white triangle in the center of the map.

Localizers are represented on the moving map as purple triangles for pilots to fly down. Recall from prior in this chapter that a localizer provides the lateral (left and right) guidance in an instrument landing system (ILS).

When flying a localizer, the pilot starts at the widest part of

these purple triangles. The center line of the triangle is the desired course and the right and left edges correspond to full scale right and left deflections of the course deviation indicator. This means that the triangle's edges represent the width that one could fly to either side of the CDI's center line and still get accurate guidance. The path comes to a point at the end of the approach (corresponding to the end of the runway). Consequently, it gets much more difficult to stay on course at the end of the approach because a very small deviation off course will give the pilot a full scale deflection on the CDI. So, pilots fly into the fat part of the arrow and, hopefully, right down the center line, keeping the CDI centered the whole time by making progressively smaller and smaller corrections left and right to keep the needle centered.

As the navigation radios work identically in all the instrument panels, we will not describe them again here (see **Instruments in the Steam Gauge Panel** for a description).

### C. Flying the Approach

Now that we've discussed the different types of NAVAIDs in X-Plane, as well as how to use the navigation instruments in all the aircraft, let's begin flying the actual approach.

For our example instrument approach, we'll be flying into San Bernardino International Airport (KSBD), which is found in the northern half of the Southern California region. According to the map (shown in **Figure 6.15**), KSBD has an ILS navigation system. This means that an instrument approach to the airport can take advantage of both horizontal (left and right) and vertical (up and down) guidance, thanks to the ILS's localizer and glideslope beacon, respectively. The map shows that the ILS frequency for runway 06 is 109.30.

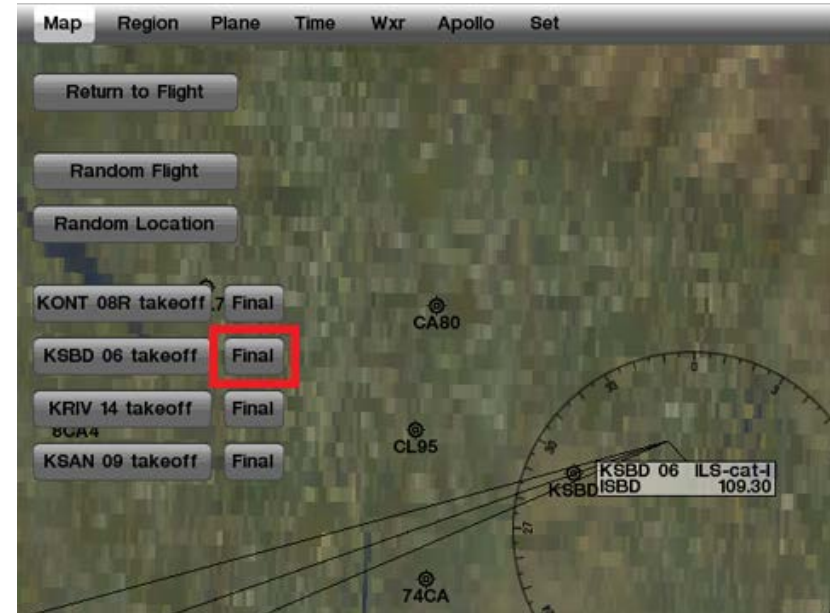


Figure 6.15: The button for the final approach to KSBD

For simplicity's sake, rather than taking off from one airport and flying to San Bernardino, press the **Final** button for KSBD runway 06 (marked with a red box in **Figure 6.15**).

Now that we're on the approach, select the instrument panel view. Tune one of the navigation radios to the desired ILS frequency (in this case, 109.30). Make sure that the radio that was tuned is also selected with the navigation source selector switch. For instance, if the NAV 1 radio is tuned to 109.30, the source selector also needs to be pointing to NAV 1.

In the real world, we would look at a approach plate to determine what heading we should be flying to get to the runway. As not everyone has a set of California approach plates, the [AirNav database](#) can be consulted for the heading. Scrolling down on that web page to the Runway Information



section reveals that Runway 06 has a magnetic heading of 057. Additionally, the page lists the runway's elevation as 1084.6 feet above sea level. This information will be important when we get close to the runway, for obvious reasons!

At this point, the vertical bar in the CDI will begin to wander left or right to indicate which direction the craft needs to move in order to point down the centerline of the runway. Aim *toward* the deflection to intercept the localizer course; when the CDI wanders right, point the aircraft's nose right, and so on.



Figure 6.16: An EFIS CDI to follow

Additionally, the glideslope indicator (the horizontal bar in the CDI or EFIS) will begin to move. If its needles are *above* the center of the instrument then the craft needs to fly *up*, and if they are *below* the center of the instrument, it needs to fly

*down* to intercept the glideslope. The goal is to keep the localizer bar in the CDI centered to stay on the localizer, and the glideslope bar centered to stay on the glideslope.

For example, in **Figure 6.16**, the CDI is deflected a little to the right (indicating the craft needs to turn to the right) and the glideslope indicators are a bit high (indicating that the aircraft needs to raise its nose a bit).

In **Figure 6.17**, the CDI is deflected to the right (indicating the aircraft needs to bank to the right) and the glideslope indicator is high (indicating the craft needs to raise its nose).



Figure 6.17: A mechanical CDI to follow

Follow the guidance of the localizer and glideslope until the craft reaches an altitude of about 300 feet above the runway. Remember from when we looked up the runway information on AirNav that its elevation is 1084.6 feet; therefore, our key altitude will be 1385 feet. When the aircraft's altimeter reads 1385, we should switch to visual navigation to land.

At this point, if everything was done correctly, the runway will be right in front of the aircraft. If the landing itself was managed properly, the aircraft will be at its stalling speed plus 30% with the gear and flaps down (remember that gear, flaps, and throttle are still visible in the panel view) as it comes in for

a landing. In the Cirrus Vision, this is about 90 knots. In the Cessna 172, it's about 65 knots, and in the Boeing 747, it's about 140 knots.

## II. Using the Autopilot

The autopilot is one of the most asked about features in X-Plane—indeed, in real world planes, too. The fact is that many real aircraft owners never take the time to learn to use their autopilots. The basic autopilot functions available in X-Plane for iPad/X-Plane HDEF 4G, however, are really not too difficult to understand once the user has taken the time to learn about them.

In a real aircraft, there are three levels of autopilot functionality:

- Off, with no autopilot functions active,
- On, where the autopilot servos take over the flight controls and fly the airplane, and
- Flight Director, where the autopilot displays a set of "wings" on the attitude indicator to show the pilot where to fly

If the pilot follows the flight director wings perfectly, the airplane will behave just like when it has the autopilot servos on. If the pilot does not follow the wings, it will be as if the autopilot were off completely.

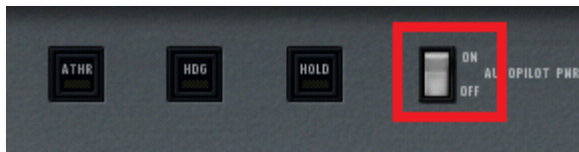


Figure 6.18: The autopilot switch

X-Plane for iPad/X-Plane HDEF 4G does not have this flight director mode. Therefore, whenever the autopilot is switched on (using the switch at the top of the panel view, highlighted in **Figure 6.18**), it will automatically take control of the flight controls.

### A. Aircraft with Autopilots

The following aircraft have autopilot functions:

- Columbia 400
- Cirrus SJ50 Vision
- Eclipse 500
- Boeing 747
- Boeing 777
- Airbus A380
- Boeing 787
- Boeing 737
- Airbus A320
- Boeing 757
- B-2 Spirit

### B. Available Autopilot Functions

The following autopilot functions are available in the aircraft listed above.

#### i. ROLL and PTCH

The first autopilot functions, **ROLL** and **PTCH**, are the roll and pitch hold modes, respectively. When the autopilot is switched on, these two are turned on automatically. They will hold the current roll and pitch attitudes of the aircraft. For example, if the craft has its nose pitched down ten degrees and is in a five

degree left bank when the autopilot is switched on, ROLL and PTCH modes will hold this ten degree down, five degree left attitude. These modes are shown in **Figure 6.19**.



Figure 6.19: Roll and pitch modes activated

## ii. ATHR

The next autopilot function is the auto-throttle mode. When the **ATHR** button is pressed, the autopilot will attempt to maintain the craft's current airspeed by increasing or decreasing the throttle. It will not, however, attempt to control the craft's speed using any other method, such as pitching the nose up or down or adding or subtracting flaps. Therefore, the auto-throttle will be able to put the throttle anywhere between its maximum or minimum, but it will not be able to maintain an excessively high or low airspeed (such as one obtained by pitching the nose excessively low or high).

The **ATHR** is turned on (as indicated by its button being lit yellow) in **Figure 6.20**.

In **Figure 6.20**, the auto-throttle is set to hold 150 knots. Note that it is not uncommon for the auto-throttle to stay a few knots above or below the set speed like this.



Figure 6.20: Auto-throttle mode activated

With the **ATHR** button pressed, the other autopilot functions can be disengaged by turning the autopilot power switch to off. This allows the pilot to pitch and roll the craft freely while the auto-throttle maintains the same speed.

Also, note that when auto-throttle mode is engaged, it will start the throttle at its minimum, then slowly bring the throttle up to the point where it holds the selected airspeed. This results in a drop of around ten knots when the **ATHR** button is first pressed, but this drop in speed is not permanent.

## iii. HDG

The next autopilot function is the heading hold mode. Pressing the **HDG** button will set the autopilot to follow the heading currently displayed on the directional gyro (recall that the directional gyro is the partial circle found at the bottom of the

left EFIS display). It will follow this heading by rolling the aircraft left and right. For this reason, when the **HDG** button is pressed, heading hold mode will replace roll hold mode.

For instance, in **Figure 6.21**, the **HDG** button was pressed when the craft was pointed at heading 043. Since a heading of 0 is due north, and a heading of 090 is due east, the autopilot will be flying the aircraft northeast.



Figure 6.21: Heading hold mode activated

#### iv. HOLD

The final autopilot function is the altitude hold mode. Pressing the **HOLD** button will cause the autopilot to hold the current altitude by pitching the nose up or down. This mode automatically replaces pitch hold mode.

For instance, in **Figure 6.22**, the **HOLD** button was pressed when the craft was at an altitude of 7,200 feet, so the autopilot will continue to maintain this altitude.



Figure 6.22: Altitude hold mode activated

### III. Taking Off from and Landing on a Carrier

Carrier operations are another challenging and fun feature of X-Plane for iPad and X-Plane HDEF 4G.

To take off from a carrier, a few things must be done in quick succession. First, the throttle slider must be dragged to the top of its range of motion. The flaps must be pulled down about half way, and the **BRAKE** button must be tapped to disengage the brakes and activate the catapult propelling the craft off the deck. From there, simply guide the craft down the flight deck and, once clear, pull the nose up sharply and bring the gear up.

(Note that information on the location of these controls on the screen can be found in Chapter 2's "**Basic Flight Controls**," on page 6.)

Landing on the carrier is a bit more difficult. First, note that the ADF (the arrow in the middle of the directional gyro, which is

highlighted in **Figure 6.23**) always points the way back to the carrier. This is invaluable in setting up an approach to the carrier.



Figure 6.23: The ADF, pointing toward the carrier

To set up an approach to the WWII carrier used with the F4U (whose landing deck goes straight down the flight deck), a pilot should fly either a 90 or 45 degree intercept (depending on the aircraft's distance) in order to get behind the ship. If the ship is traveling north, and the aircraft is coming from the east with the ship to its north (as in **Figure 6.24**), the pilot will continue on his or her intercept trajectory until the ADF needle is pointing either 45 or 90 degrees to the right, at which point he or she will turn in toward the landing deck.

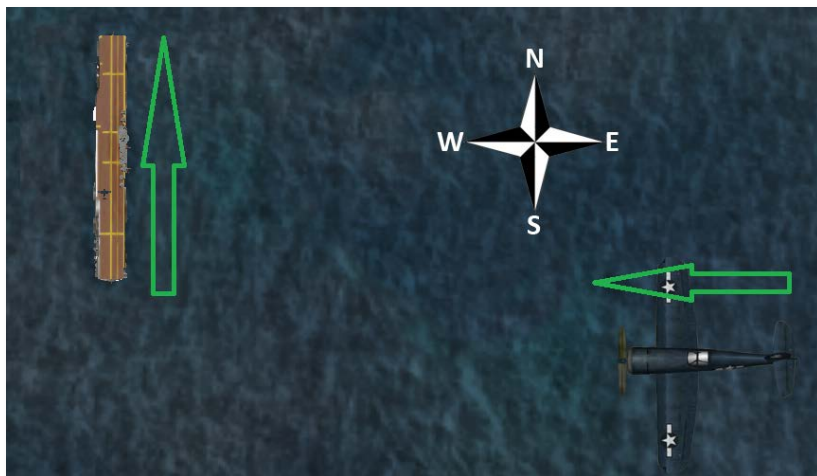


Figure 6.24: Approaching a carrier at a 90° angle

If the carrier is instead the John F. Kennedy-class ship used with the F-4, F-14, and F-18, the landing runway is angled 30 degrees to the port (left) side—it is not straight down the flight deck like in the older carriers. This change was made to prevent the all-too-common overruns that occurred in WWII when a landing plane crashed into the stacked line of planes at the far end of the carrier. A pilot landing on such a carrier must correct for this angling. Using the previous example, the pilot would instead wait until the ADF was pointing either 15 or 60 degrees to the right before turning in for a landing.

When approaching the flight deck to land, a glidepath of about 3.5 degrees is standard. At this time, the tail hook should be lowered by tapping the **HOOK** button, turning it green. This will allow the tail of the aircraft to catch the arresting wires on the deck. These wires will accelerate the craft from well over 100 knots down to zero in little more than a second.

Unlike in a conventional landing, there should be no “flare” before touching down on the carrier. Whereas, say, an airliner would raise its nose up just before touching the runway (thereby ensuring a smooth landing), a carrier approach should maintain a constant glideslope until the craft hits the deck.

Also, rather counter-intuitively, a real fighter pilot must slam the throttle to full the instant that the aircraft touches the deck. This is because, even when the pilot has done everything right, the craft's tail hook can bounce over the arresting wires in what is called a “bolter.” When this happens, the pilot must be ready to get off the deck safely and come around for another try. Don't worry—even when the throttle revs up like this, the arresting wires will still pull the craft down to zero velocity.



To see how the pros do it, check out the following links:

[Video: Carrier Landing—F-4J Phantom II in the Mediterranean Sea](#)<sup>3</sup>

[Video: F-14 Carrier Landing](#)<sup>4</sup>

[Walkthrough: How to land a jet plane on an aircraft carrier](#)<sup>5</sup>

## IV. Combat

### A. Combat Basics

Of course, taking off and landing on the carrier are only means to an end. The real goal is the dogfight—shooting down the enemy. Each aircraft's weapons can be fired with the FIRE button (labeled 1 in **Figure 6.25**). Above and to the left of this button is the **GUN** button (labeled 2 in **Figure 6.25**), and beside this button is a number indicating the number of rounds left. In the MiG, F-4, F-14, and F-18, there is also an **AIM9** button (labeled 3 in **Figure 6.25**) beneath the **GUN** button. Tapping this will switch from the guns to the guided missiles, and tapping the **GUN** button will switch back.



Figure 6.25: Weapon controls

<sup>3</sup> <http://www.youtube.com/watch?v=PDMtkwMA75A>

<sup>4</sup>

[http://www.metacafe.com/watch/303345/carrier\\_landing\\_home\\_video](http://www.metacafe.com/watch/303345/carrier_landing_home_video)

<sup>5</sup>

<http://everything2.com/title/How+to+land+a+jet+plane+on+an+aircraft+carrier>

### B. Using the Gun

When firing a gun, be sure to lead opponents (called deflection shooting)—fire at where they will be, not where they are. Mastering so-called “high deflection shooting” can make the difference between ending a fight quickly and losing it entirely. Whereas the surest shot will always come when a pilot is right on an enemy's tail, a high deflection shot comes from beside or in front of the enemy. In most cases, a pilot has only a split second in which the enemy will cross his or her path of fire, so timing is critical.

### C. Using the Missiles

When firing the AIM-9 missiles, they will more or less lock on to an enemy automatically, even when fired from a good distance. While this makes it relatively easy to score a kill on an enemy, that enemy is equipped with the same missiles, so be prepared to jink (rapidly deflect the flight controls into turns in different directions) when the return fire comes.

### D. Using the Targeting Reticle

The targeting reticle always follows the enemy's aircraft. If the enemy is visible on screen (as in **Figure 6.26**), it will appear as a thin green box around the opponent's craft.





Figure 6.26: The targeting reticle with an enemy on-screen

If, however, the enemy is not visible on screen, the reticle will be “dragged” to the edge of the screen and will appear as a thick green bar on the edge of the screen. For instance, in **Figure 6.27**, the opponent is on the pilot's right side (the green bar is near the center on the right side of the screen).

The reticle breaks down, though, when the opponent's aircraft is very close to the user's, or when it is directly on the user's tail. In this case, the reticle will bounce around from full left deflection to full right deflection. This is simply a limitation associated with trying to point in three dimensions using a two dimensional display.

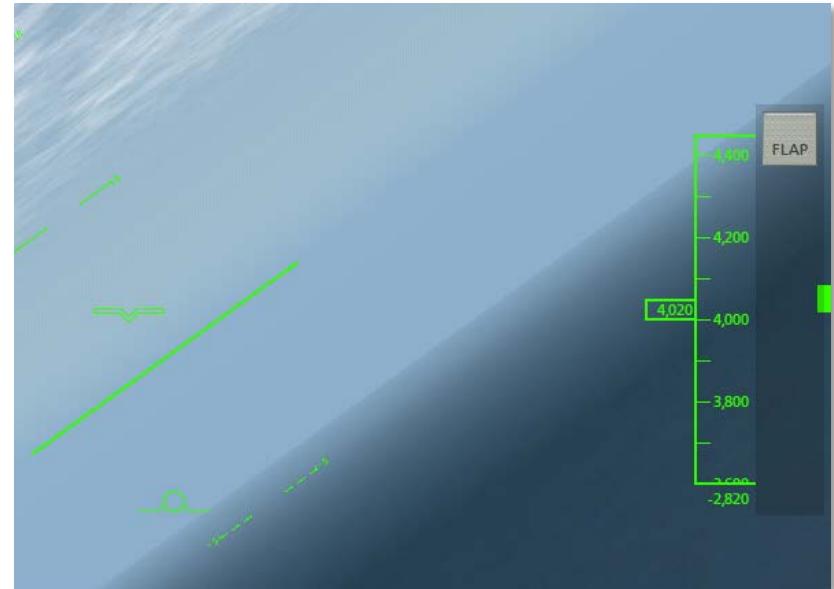


Figure 6.27: The targeting reticle with an enemy off-screen

## E. Strategy

The key to winning a dogfight lies in creating a situation where your aircraft's strengths are emphasized and an opponent's weaknesses are exploited. This means trying to force a tight, up-close battle when flying a more maneuverable fighter than the enemy, or aiming for dive-bombs and other tactics requiring speed and weight when flying a faster, larger craft.

Additionally, do not underestimate the value of quick combat maneuvers, such as:

- corkscrews—rolling your craft left or right while continuously varying its pitch
- feints—rolling to one side as though to go into a banked turn (i.e., a turn with the craft on its side, while

pulling back on the controls in order to pull “in” to the turn), but pushing the nose forward instead

- barrel rolls—often described as “a cross between a roll and a loop” (see **Figure 6.28**, released into the public domain by its creator [MioUzaki](#)).

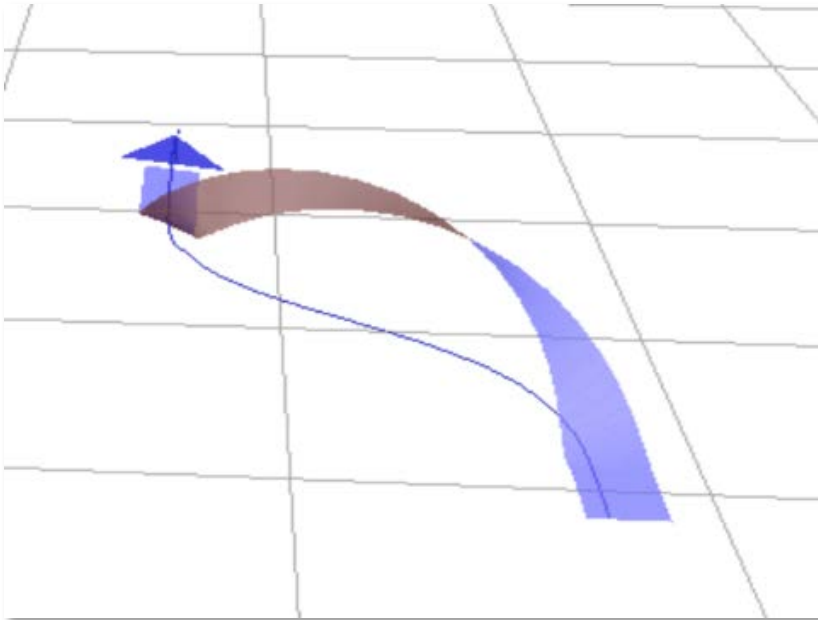


Figure 6.28: A barrel roll

For more information on combat tactics, see [the Dicta Boelcke](#)<sup>6</sup>, a list of tactics developed by WWI ace Oswald Boelcke.

## F. Turning Off Enemy Aircraft

To disable combat when flying a fighter in X-Plane for iPad and X-Plane HDEF 4G, you can do one of two things:

- Switch to a different flight region (such as Innsbruck, Austria), since some regions do not provide enemy aircraft at all, or
- Turn the enemy aircraft’s skill level down to 0% in the Set menu, so that the enemy will not fire on you (although the enemy aircraft will still be there).

To switch to a different flight region, simply tap the Settings button in the upper right of the screen, move to the Region tab, and flip through the available options. That region will be loaded when you go back to the Map tab to return to the flight.

To turn down the enemy’s skill level, open the Settings (by tapping the button in the upper right of the screen), go to the Set tab. Drag the **skill level** slider all the way down to zero. Then, return to the Map tab to return to your flight.

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<sup>6</sup> [http://en.wikipedia.org/wiki/Dicta\\_Boelcke](http://en.wikipedia.org/wiki/Dicta_Boelcke)

## 7. The Apollo Add-On

### I. About the Add-On

The X-Plane Apollo add-on is a realistic simulation of the lunar landing and docking operations of the Apollo 11 mission. In fact, it is the most complete, realistic simulation of a lunar landing available for the iPad or iPhone 4, with a wide range of missions to try.

Users can start off docked with the command module in a lunar orbit, and then separate from the command module to start the journey down to the lunar surface. After that, the lander must go through a full de-orbit burn and orbital transfer, going from lunar orbit down to the touch-down phase of the flight. All of this, of course, happens in *real time* with the actual weight, thrust, fuel capacity, and fuel burn of the *real* Apollo 11 lander.

Following the de-orbit burn and orbit transfer, users enter the most challenging phase of the flight—the *powered descent*. During this phase of the mission, users must keep their *tail* pointed in the direction of flight, running *full thrust* to slow the craft from orbital speed to a standstill. This phase of the flight is actually where pilots spend most of their time.

After the powered descent comes the vertical descent and landing. This is accompanied by the sounds taken from the *real* lander, right down to the radio call-outs made by mission control as Neil and Buzz worked their way down in 1969.

Once users have aced the landing, they can cruise around on the moon in the rover! This is a realistic simulation of the 4-wheel drive (with a separate motor for each wheel), surprisingly speedy rover that was used for the Apollo 15, 16, and 17 missions—this is a lot of fun to drive in the 1/6<sup>th</sup> gravity

conditions on the moon! No wonder the astronauts drove it 17 miles in one day.

After roving around in the off-off-off-road simulator, users can launch the lander back up toward the command module (waiting in orbit) and dock with it.

Additionally, a huge number of historic pictures are included in the app, spanning from images of the control room back on Earth to the launch to the touch down on the moon and everything in between.

### II. Purchasing the Add-On

Prior to purchasing the Apollo add-on, whenever users open the Apollo tab in the settings menu and try to launch one of the mission segments, X-Plane will display the message seen in **Figure 7.1**.

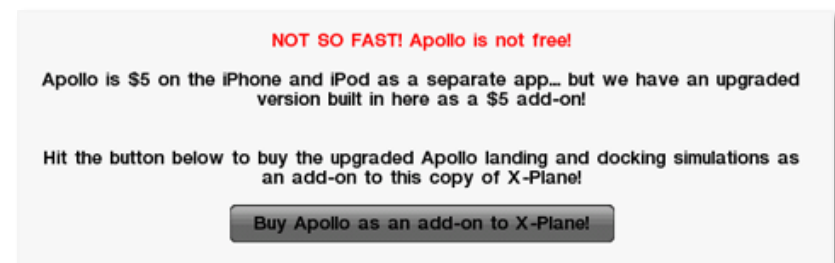


Figure 7.1: Message to purchase the Apollo add-on

Tap the **Buy Apollo as an add-on to X-Plane!** button to purchase the upgrade.

There is sometimes an issue with the Apollo add-on where, after having purchased and downloaded the add-on, the simulator will need to re-download it. This is caused by the

application having its configuration settings reset. When this happens, users will see the same message about purchasing the add-on when they try to launch an Apollo mission that they saw *before* they purchased it (as seen in **Figure 7.1**).

If this happens, tap the **Buy Apollo** button again. The device will request the password (use the account that originally purchased the add-on), and will then display the message seen in **Figure 7.2**. **You will *not* be charged a second time for the add-on.**

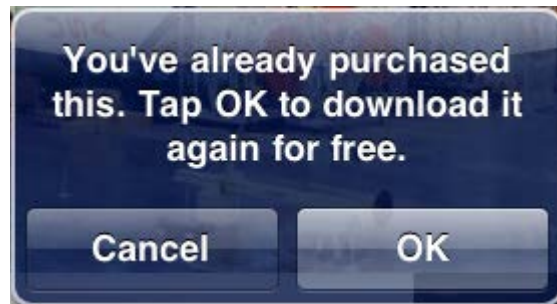


Figure 7.2: Re-download the add-on for free

### III. Controls in Apollo

Controls in the Apollo add-on fall into one of three categories—a mission segment either has:

- a) no control (i.e., the user watches, as in the separation, descent burn, and launch mission segments),
- b) flight controls (as in the powered descent, vertical descent, and command module docking mission segments),
- c) or vehicle controls (as in the lunar rover mission segment).

#### A. Flight Controls

Flight controls in Apollo are as follows.



Figure 7.3: Flight controls in Apollo

First, there is the throttle control (labeled 1 in **Figure 7.3**). For the descent phases of the mission, this goes from zero to full forward, corresponding to the bottom and top of the screen, respectively. For the command module docking, though, it goes from full backward to full forward, with zero thrust found in the center of its range.

Next is the yaw control (labeled 2 in **Figure 7.3**). When in the center, it does not affect the craft's motion. When dragged left, it pushes the lander's nose to the left, and when dragged right, it pushes the nose right.

The translational thrusters (whose control is labeled 3 in

**Figure 7.3)** serve to push the lander's entire body up, down, left, or right. Drag this control in the direction that the craft should move.

Finally, the lander's pitch and roll are controlled as in other X-Plane aircraft—tilt the device forward to pitch the nose down, tilt it back to pitch the nose up, and tilt it left or right to roll the craft in the corresponding direction.

## B. Vehicle Controls

Controlling the lunar rover is quite intuitive. Simply tilt the device forward to accelerate, tilt it back to brake, and tilt it left or right to turn in that direction.

## IV. Selecting a Mission Segment

Each mission segment can be selected by entering the Settings menu (using the same button as ever in the upper left of the screen), tapping the desired mission segment, and tapping the **Go!** button.

## V. Flying in Apollo

### A. Separation

This is the segment of the mission that the application will enter when first starting up. All the user has to do is hit the **SEPARATE** button, and the path to touching down on the moon has begun!

### B. Descent Burn

Following the separation from the command module is the descent burn, a 30 second firing of the engines that starts the lander toward the surface of the moon.

After beginning this portion of the mission, the rockets will automatically ignite for thirty seconds. At the end of that, the craft will be approximately 345,000 feet above the surface of the moon. Users can either choose to wait as the lander slowly makes its way down, or they can go back into the menu and select Powered Descent to skip over the wait. If users choose to wait through the unpowered portion of the descent, the sim will automatically enter the powered phase at about 45,000 feet.

### C. Powered Descent

The objective of the powered descent phase is to slow from an orbital horizontal speed of about 3,600 miles per hour (relative to the surface of the moon) to a horizontal speed appropriate for landing—zero. This is achieved by pointing the lander's tail in the direction of the craft's motion and holding full power.

During this phase, be sure to keep the throttle slider all the way up. Use the white circle (found in the center of the screen) and the white dot to line the craft up with its direction of motion. For instance, when the white dot is above the circle, pitch the craft down so that the circle will move to meet the dot. When the dot is to the right of the circle, roll left to meet it.

Once the craft's orbital velocity has been burned off, it enters the vertical descent portion of the mission.

## D. Vertical Descent

The vertical descent phase is where the craft descends the last 4,000 or so feet down to the surface of the moon. During this time, the lander's fore-aft and left-right velocities should be zero—that is, it should have no motion relative to the surface except its descent.

The goal here is to touch down very, very gently, with no ground speed at all and a level attitude for the lander. Use the tilt of the device to control pitch and roll, use the YAW slider to control motion left and right, and use the translational thrusters (labeled TRANS) to change left-right and fore-aft velocity. For instance, if, in the upper center of the screen, the simulator is indicating a *positive* fore-aft speed, drag the TRANS control *down* and hold it there a few seconds. If the sim is indicating a *negative* left-right speed, drag the TRANS control *right*, and so on.

In addition to all this, users must contend with the limited amount of fuel remaining. Use it wisely!

Upon touching down, the simulator will score the landing based on angular tilt, descent rate, ground speed, and the terrain hilliness.

## E. Rove Around!

In this portion of the mission, the user is put behind the wheels of a lunar rover like the ones used for the last three Apollo missions. Tilt the device forward to accelerate, back to brake, and left or right to steer.

See the [Lunar Rover Wikipedia page](http://en.wikipedia.org/wiki/Lunar_rover#Media)<sup>7</sup> for a video of the real rover!

## F. Launch

For the launch stage of the mission, all the user has to do is press the **Launch** button. This starts the craft on its way into orbit, eventually climbing 65 miles above the moon's surface.

## G. Command Module Dock

When docking with the command module, the goal is to be perfectly aligned with the docking hatch with very little velocity when the lander touches the command module. This is achieved by closely monitoring:

- a) the throttle control, to ensure that the craft is only barely moving forward when it docks,
- b) the yaw control, to ensure that the lander is aligned with the command module,
- c) the pitch and roll controls, to ensure that the lander is aligned properly when it docks, and
- d) the translational thrusters, to ensure that the craft's hatch meets up with the command module's hatch.

Note that the translational thruster control (labeled TRANS) adds thrust to cause movement in the direction that it is dragged (for example, if it is dragged left, it will add thrust from the right side in order to push the craft left). Note also that the throttle control likely only needs little bursts of thrust—tap somewhere in the middle of the sliders range, and it will briefly power the thruster, then stop.

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<sup>7</sup>[http://en.wikipedia.org/wiki/Lunar\\_rover#Media](http://en.wikipedia.org/wiki/Lunar_rover#Media)



After docking, the simulator will give a score based on the angular tilt, position, closure rate, and lateral speed of the craft at the time of docking.

## 8. Tech Support

The most common technical issue that X-Plane customer support encounters with the X-Plane for iPad and X-Plane HDEF 4G applications is caused by the hardware exceeding its RAM allocation.

Many users leave their iPad or iPhone on for weeks or months at a time, as the hardware appears to be off when it is in fact in standby mode. In some cases, this can cause too much “garbage” to be stored in the RAM. The X-Plane app is so demanding on the hardware that it comes within 2% of crashing *every device every time* it is launched. If the “garbage” isn’t cleaned out of the RAM periodically by restarting the device, it is possible that X-Plane will exceed the available RAM, causing a crash or a loss of flight control (where the aircraft doesn’t respond to the tilting of the device).

To perform a reboot of the iPad and iPhone, hold the top power button down for three seconds, then use your finger to slide the power switch on the screen to off. Leave the unit off for two to three minutes before turning it back on.

The issue described above happens very infrequently, and in all cases is fixable by restarting.

Additionally, there is sometimes an issue with the Apollo add-on where, after having purchased and downloaded the add-on, the simulator will need to re-download it. This is caused by the application having its configuration settings reset. When this happens, users will see the same message about purchasing the add-on when they try to launch an Apollo mission (as seen in **Figure 8.1**) that they saw *before* they purchased it.

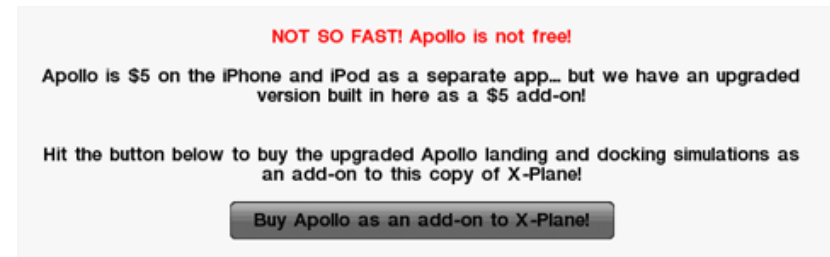


Figure 8.1: Message to purchase the Apollo add-on

If this happens, tap the **Buy Apollo** button again. The device will request the password (use the account that originally purchased the add-on), and will then display the message seen in **Figure 8.2**. You will *not* be charged a second time for the add-on.

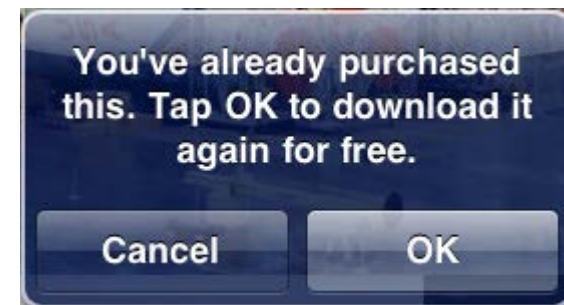


Figure 8.2: Re-download the add-on for free

In all cases seen so far, this fixes the issue.

For additional assistance, please e-mail [info@x-plane.com](mailto:info@x-plane.com) or call 913-269-0976 (Central Standard Time).

## Glossary of Terms

**Altitude:** An aircraft's altitude is its height above sea level.

**CDI:** Course Deviation Indicator. This refers either to the instrument used for navigating a VOR or ILS course, or more specifically to the horizontal bar found in this instrument which displays the aircraft's lateral position relative to the VOR or ILS course.

**DME:** Distance Measuring Equipment. An instrument used in navigation which measures distance using the delay between the sending and receiving of a radio signal. Aircraft use this to determine their distance from a fixed NAVAID.

**Drag:** The aerodynamic force (created by a fluid such as air flowing around an object) that slows the object's motion.

**EFIS:** Electronic Flight Instrument System. A flight instrument system (found in an aircraft's panel) with electronic displays rather than the steam gauges of a standard panel. In X-Plane for iPad/X-Plane HDEF 4G, such displays are found mostly in jet-engined aircraft.

**Glideslope:** The angle at which an aircraft approaches (or needs to approach) a runway; often used when discussing navigation by instruments.

**Heading:** An aircraft's heading is the direction that its nose is pointing.

**IFR:** Instrument Flight Rules. The procedure for flying an aircraft based solely on the craft's instrument panel. Environmental conditions requiring such flight (such as the poor visibility on a rainy day) are referred to as IFR conditions. This is contrasted with VFR conditions (those operating under

visual flight rules).

**ILS:** Instrument Landing System. A ground-based system for guiding approaching aircraft into the runway via radio signals.

**Indicated airspeed:** The presumed airspeed of a craft as determined by measuring the pressure acting on a little tube attached to the craft which points into the wind. This differs from true airspeed in situations where the air has very little density (for example, at 80,000 feet in an SR-71 Blackbird or in orbit in the Space Shuttle).

**Lift:** The aerodynamic force (created by a fluid such as air flowing around an object) that pushes an object upward.

**Localizer:** A localizer is part of an instrument landing system (ILS). It serves as a guide to the centerline of the runway.

**Mach speed:** The speed of sound through the air. Mach's number actually describes the speed of sound through any fluid (that is, liquid or gas). In application to aeronautics, though, it is implied that the fluid is air. Note that this number is dependent on a number of factors, such as temperature, humidity, and pressure. Generally, "Mach 1" is cited as 768 miles per hour (the speed of sound at sea level in dry air at 68° Fahrenheit).

**NAVAID:** A navigation aid transmitter (in X-Plane, either a VOR or ILS) which is used as a reference when flying. These are often found near or on an airport. Pilots often fly from NAVAID to NAVAID on long flights, as a VOR is usable from about 50 miles away.

**OBI:** Omni-Bearing Indicator. This instrument is found for the most part in X-Plane's general aviation aircraft. It consists of two moving bars (called the course deviation indicator, or CDI)

which points the way to whatever VOR frequency is tuned in the navigation radio. The instrument is set using the Omni-Bearing Selector (or OBS), the knob in its lower left corner.

**Pitch:** Movement of the aircraft's nose up or down. See the image in the **Flight Dynamics** section of the manual on page 74.

**Roll:** Movement of the aircraft's body along the line formed by its body; in an airplane, this is easily seen as the dip or rise of the wings. See the image in the **Flight Dynamics** section of the manual on page 74.

**Rotor:** The rotating part of a helicopter that generates the craft's lift; similar in appearance to an oversized airplane propeller, though different in its operation.

**RPM:** Rotations per minute; a way of measuring the speed of a rotor or propeller. In a helicopter, the RPM of both the main rotor and the tail rotor are held constant.

**Rudder pedals:** Foot pedals in an airplane used to steer the plane down the runway and to control its yaw motion in flight (that is, the wagging of its tail left or right). Because the iPad and iPhone do not simulate rudder pedals (as it takes input from only two axes rather than three), X-Plane will automatically control the rudder pedals in an attempt to stabilize the craft's yaw motion.

**Speed:** The change in the position of an object over time; unlike velocity, speed does not take into account the direction of the object's movement.

**Speedbrake:** Also called airbrake, this is a flight control surface designed to generate drag in order to slow an aircraft down.

**Thrust vector:** The direction in which the engine or rotor's thrust is going; for a helicopter sitting on a helipad with its controls at neutral, this is straight down.

**Thrust vectoring:** The ability of helicopters and some other aircraft (such as the Harrier or the F-22) to change the direction of the thrust from its engines/rotors.

**Update:** To update a piece of software is to convert it to a newer version. In X-Plane for iPad/X-Plane HDEF 4G, this is done by following the instructions in Chapter 2's "**Updating X-Plane**" (beginning on page 22). This should be done every couple months or so in order to take advantage of new features in the simulator.

**Velocity:** The combination of an object's speed and the direction of its movement; for example, an aircraft might have a vertical velocity of 500 feet per minute (meaning it moves upward at a rate of 500 feet per minute) or a vertical velocity of -500 feet per minute (meaning it moves downward at 500 feet per minute).

**Vertical speed/vertical velocity:** The rate at which the aircraft is gaining or losing altitude, typically given in feet per minute.

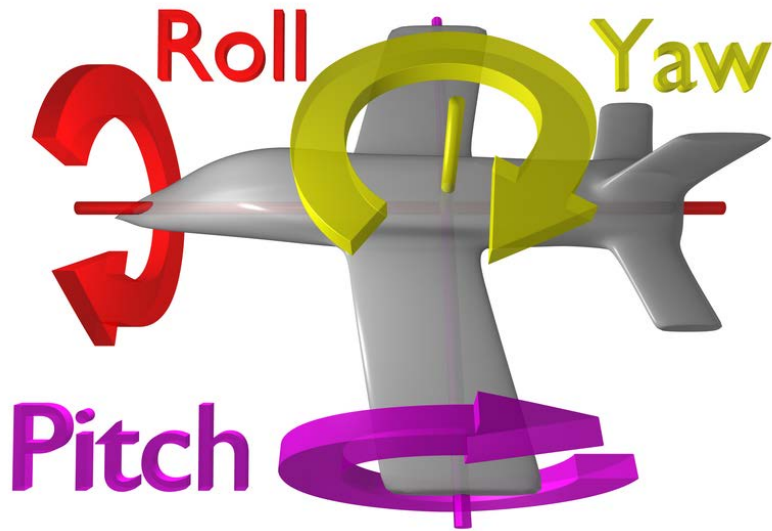
**VFR:** Visual Flight Rules. Flying done using a combination of the pilot's view of the outside world and the aircraft's instruments. Environmental conditions permitting such flight (such as a sunny day with 10 mile visibility) are referred to as VFR conditions.

**VOR navigation:** Very High Frequency Omnidirectional Range navigation; this is navigation based on radio signals sent out by a VOR beacon. Light airplanes often track these signals using an Omni-Bearing Indicator, or OBI.

**Yaw:** Movement of the aircraft's body left or right, most easily pictured as a wagging of the aircraft's tail. See the image in the **Flight Dynamics** section of the manual on page **74**.

## Flight Dynamics

The image below illustrates the pitch, roll, and yaw axes of an airplane (which also apply to helicopters).



Thanks to Wikipedia contributor [ZeroOne](#) for releasing this image under the Creative Commons Attribution 3.0 Unported license.