X-Plane Helicopter

for the iPhone and iPod Touch

X-Plane Helicopter for the iPhone, iPod Touch, and Pre Operation Manual

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1. Introduction to X-Plane Helicopter

X-Plane Helicopter one of the X-Plane Mobile applications for the iPhone, iPod Touch, and Palm Pre. It is the only X-Plane Mobile app in which helicopter flight is modeled. Flying a helicopter is radically different from flying an airplane, so it is more crucial than ever that users of X-Plane Helicopter read the flight instructions included here.

The X-Plane simulators for the iPhone and iPod Touch are each little “slices” of the X-Plane desktop flight simulator that are just the right size to run on the Palm Pre and Apple iPhone and iPod Touch.

The X-Plane Mobile applications use a flight model that is about 95% as accurate as the one used by the desktop simulator—that is, 95% as accurate as the simulator currently being used by companies like Boeing, Lockheed Martin, and NASA. Each of the $10 “slices” comes with four to seven aircraft that can be used to explore the virtual skies of four to six regions of the globe, spanning from America’s West Coast to the capital of Nepal.

Updates to the X-Plane Mobile applications are released periodically. As the graphics, flight model, and interface technology are improved on one X-Plane app, *all* the applications will be updated—for free! We have big plans for the future of the mobile sim!

The goal of the X-Plane Mobile apps is to have most of the fun and power of the full desktop version available in a portable form. Due to these devices’ limited RAM and screen area, this will be broken into a number of little “pieces” of the desktop simulator. By pricing at only $10 (or less), though, we can offer a pretty amazing value for each of these pieces of the X-Plane desktop simulator.

Note: A **Glossary of Terms**, containing definitions for the aviation-specific terms used in the manual is provided beginning on page **20**. We recommend that users consult this for reference as needed.

If you've enjoyed piloting the craft in the X-Plane flight simulators, why not try commanding a Giant Fighting Robot, too? There's even a free Giant Fighting Robots Trainer! These apps, made by the same people who write X-Plane, are some of the most fun (and challenging) games available for the iPhone, iPod Touch, and Pre.

I. About This Manual

This is version 9.65 of the X-Plane Helicopter manual, last updated November 21, 2010.

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 **Features of X-Plane Helicopter** reference will take you to Chapter 2.

2. Features of X-Plane Helicopter

I. Aircraft

Included in X-Plane Helicopter are the following aircraft:

- Robinson R22
- Bell 206
- Sikorsky H-3 Sea King
- Sikorsky S-76C
- Sikorsky UH-60 Black Hawk
- Boeing CH-47 Chinook
- Bell AH-1 “Attack” 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.

II. Regions and Airports

The following regions and their respective airports are available in X-Plane Helicopter.

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 heliport even starts users out from within the canyon!

Santa Catalina Island forms the center of the Catalina region, 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.

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).

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.

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.

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

3. Getting Acquainted with the Simulator

The X-Plane Helicopter interface shares many similarities with the rest of the X-Plane Mobile simulators. A few differences arise, though, out of the unique way in which helicopters are flown.

Remember that definitions for any unfamiliar terms may be found in the **Glossary of Terms**, beginning on page **20**. Additionally, the **Flight Dynamics** section contains a diagram of aircraft flight dynamics (that is, pitch, roll, and yaw).

Note: Due to the uniqueness of their flight and thus the uniqueness of their user interfaces, X-Plane Helicopter, X-Plane Apollo, and Space Shuttle have their own separate manuals. These may be downloaded from the [X-Plane.com website].

I. Basic Flight Controls

Found on the left side of every flight view is a sliding bar labeled COLL (number 1 in **Figure 3.1**). This controls the collective pitch of the main rotor's blades. The blades' pitch is zero (thus generating almost zero lift) when the collective slider is at the top of the screen. This is ergonomically equivalent to the way that, in a real helicopter, the collective is at zero when it is pushed farthest away from the pilot; to increase the collective, the pilot pulls *up* on the collective handle. Note that a discussion of how helicopter flight works, as well as how the collective in particular works, can be found in Chapter 4, **Flight in X-Plane Helicopter**.

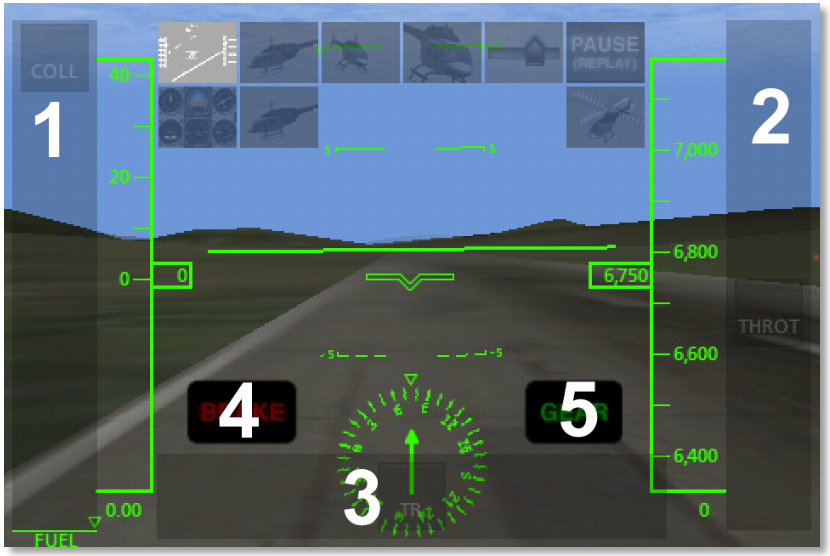


Figure 3.1: Basic flight controls

The scrolling bar on the right side of the screen (number 2 in **Figure 3.1**) displays the throttle. When it is at the top of the screen, the helicopter is putting out full throttle, and when it is at the bottom of the screen, it is putting out zero throttle. Note that this is a *visual display only*—that is, the user cannot tap and drag this to control it. Throttle in helicopters is controlled automatically; for a discussion of why this is so, see Chapter 4, **Flight in X-Plane Helicopter**.

The slider at the bottom of the screen (labeled 3 in **Figure 3.1**) commands the tail rotor. This slider is equivalent to the anti-torque pedals in a real helicopter. When in the center, this does not affect the torque of the craft at all. At full left, it spins the craft left, and at full right, it spins it right.

The button on the bottom left (number 4 in **Figure 3.1**) toggles the brakes on or off. When it is lit red, the brakes are on, and when it is dimmed, the brakes are off. Note that brakes are not available on all helicopters.

The button to the right of the brakes (number 5 in **Figure 3.1**) controls the gear. When this button is lit, the gear is down, and when it is unlit, the gear is up. Of course, this only applies to helicopters with a retractable landing gear.

To steer the aircraft left, tilt the phone or iPod left. To steer it right, tilt right. This movement is referred to as roll. To pull the helicopter's nose up, tilt the device back toward you, and to push its nose down, tilt the device down away from you. This movement is called pitch. To move the helicopter's tail while keeping its nose stationary, use the tail rotor slider. This motion is referred to as yaw.

Note: When your helicopter crashes, go into the settings menu (described in the section "**The Settings Menu**") and select either a new airport to take off from or a random flight. This will reset the craft 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 two rows here; the top row has six buttons, and the bottom row has three, as shown in **Figure 3.2** below.

Figure 3.2: The menu and view options

The menu option labeled 1 in **Figure 3.2** above selects the default cockpit view, which is out the windshield with the head-up display (HUD). The HUD is described in detail in the section "**The Head-Up Display in Depth**," found below.

The menu option labeled 2 in **Figure 3.2** selects the external chase view. Hit that, 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 option from the menu (labeled 3 in **Figure 3.2**) is the spot view. Selecting this will give the user a stationary view from which to watch as the helicopter flies by.

The fourth view in the top row of the menu (labeled 4 in **Figure 3.2**) is the linear spot view, where 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 spot view until the user's craft changes either speed or direction.

The menu option labeled 5 in **Figure 3.2** opens the Settings menu, discussed in the section "**The Settings Menu**" below (on page **10**).

The final menu option in the top row (labeled 6 in **Figure 3.2**) is the pause button. When this is pressed, the replay buttons will appear, as highlighted in red in **Figure 3.3**.

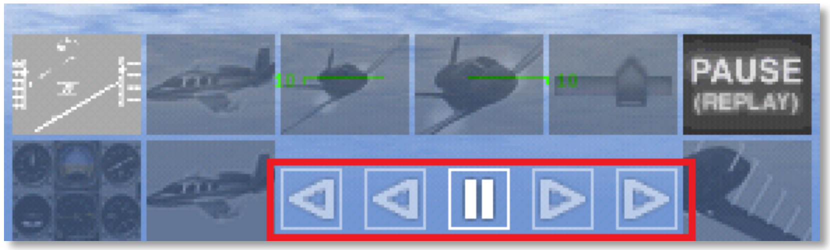


Figure 3.3: The replay buttons

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.

The first view option in the second row (labeled 7 in **Figure 3.2**) displays the aircraft's instrument panel. This view is described in depth in the section "**The Panel View in Depth**," beginning on page **8**. Note that in this view**,** the only menu options available are the HUD view and the pause button. Thus, to access the settings menu or switch to an external view, the user must first return to the HUD view.

The second view option in the second row (labeled 8 in **Figure 3.2**) is the circle view. This is similar to the chase view, labeled 2 in the same figure. However, where the chase view re-orients the camera to track the aircraft, the circle view keeps a fixed heading and orientation as it follows the craft.

The final menu option (labeled 9 in **Figure 3.2**) will cause X-Plane to display the aerodynamic forces acting on the airplane. These are only visible when using an external view. These 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 time and 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!

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.

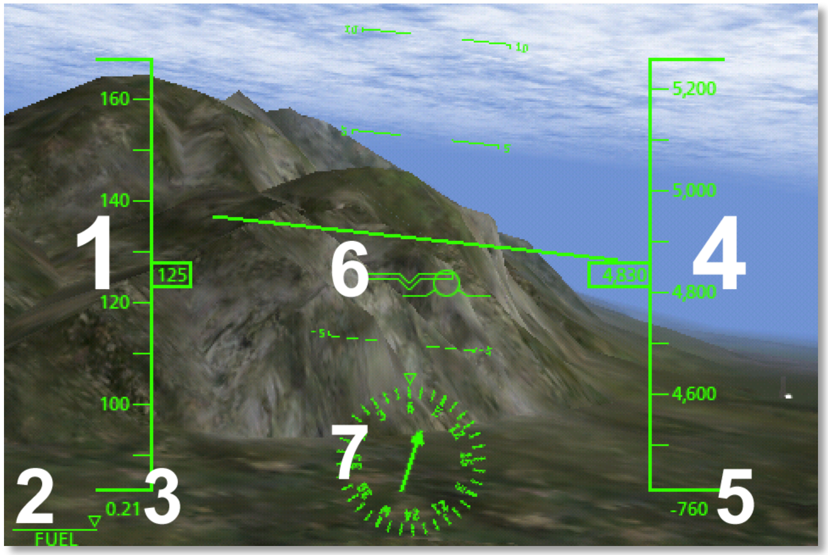


Figure 3.4: The HUD view

The ticking tape on the left side of the screen (numbered 1 in **Figure 3.4**) displays the aircraft's speed in 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 (found in X-Plane Extreme), 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).

In the bottom left of the screen is a fuel gauge, labeled 2 in **Figure 3.4**. When the triangle-shaped indicator is at the far right, as it is in the figure, the helicopter's fuel tanks are full. When it is at the far left, the fuel tanks are empty, and the aircraft's engines will not be able to run.

Directly beneath the ticking airspeed indicator is the aircraft's speed relative to the speed of sound (numbered 3 in **Figure 3.4**). For instance, in **Figure 3.4**, the craft was moving at 0.21 Mach.

The ticking tape on the right side (number 4 in **Figure 3.4**) displays the craft's altitude in feet above mean sea level. For instance, in the figure, the aircraft was at 4830 feet above mean sea level. The number directly below this (labeled 5 in **Figure 3.4**) is the craft's climb rate in feet per minute. For example, in the figure, the craft was descending at a rate of 760 feet per minute, so the number displayed was -760.

In the center of the screen is a horizontal bar (labeled 6 in **Figure 3.4**), which indicates the helicopter's attitude—that is, the combination of its pitch and roll.

Surrounding that bar are lines marking degrees of pitch. For instance, in the figure, the aircraft was pitched down at around 2 degrees (indicated by the V-shaped bar), and its wings were banked slightly to the left.

Finally, in the bottom center of the screen (marked with a 7 in **Figure 3.4**) is a directional gyro, indicating which direction the aircraft's nose is pointing.

B. The Panel View in Depth

In the panel view, the aircraft's instrument gauges and navigation radios are accessible. Flying from this view requires the use of the attitude indicator.

Note: In the panel view**,** the only menu options available are the HUD view and the pause button (both highlighted in red in **Figure 3.5**). Thus, to access the settings menu or switch to an external view, the user must first return to the HUD view.

Figure 3.5: The "standard six" gauges

The first instrument in the top row (labeled 1 in **Figure 3.5**) is the airspeed indicator. 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 helicopter 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 craft's *indicated* airspeed, not necessarily its *true* airspeed.

The second instrument in the top row (labeled 2 in **Figure 3.5**) is the attitude indicator, 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.

The third instrument in the top row (labeled 3 in **Figure 3.5**) is the altimeter. 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.

The first instrument in the bottom row (labeled 4 in **Figure 3.5**) is the turn coordinator. This measures the aircraft's rate of turn. The instrument is only accurate when the turn is coordinated—that is, when the helicopter 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 helicopter "up" into a tighter turn, such that the turn rate is in equilibrium with the bank angle.

The second instrument in the second row (labeled 5 in **Figure 3.5**) is the horizontal situation indicator (HSI), which also serves as a compass.

The final instrument in the second row (labeled 6 in **Figure 3.5**) is the vertical speed indicator, also called the vertical velocity indicator or variometer. This reports the aircraft's climb or descent rate in feet per minute.

Scrolling down in the panel (by dragging your finger up the screen) will show the navigation radios, as in **Figure 3.6**.

Figure 3.6: The navigation radios

The **BRAKES** button here (labeled 1 in **Figure 3.6**) functions just like the one in the HUD view—when it is lit up red, the brakes are on, and when it is dimmed, the brakes are off. To the right of this button in the helicopters with retractable landing gear is the **GEAR** button. When it is lit, the gear is down, and when it is dimmed, the gear is up.

The NAV 1 radio (labeled 2 in **Figure 3.6**) is used for navigation using a VOR. It is tuned using the two knobs on the instrument. The first knob (labeled 3 in **Figure 3.6**) is used to tune the integer (or "counting number") portion of the frequency. The second knob (labeled 4 in **Figure 3.6**) is used to tune the decimal portion of the frequency.

To turn a knob up, tap directly above it, and to turn it down, tap directly below it. For instance, if the frequency read 109.20 and the user clicked above the *left* knob, the frequency would increase to 110.20. If the user instead tapped above the *right* knob, the frequency would increase to 109.30.

To the right of the NAV 1 radio is the HSI source selection switch (labeled 5 in **Figure 3.6**). This selects between navigating using the frequency on the NAV 1 radio and that of the NAV 2 radio; tap the switch to change its position.

To the right of the HSI source selector is the NAV 2 radio (labeled 6 in **Figure 3.6**). This is functionally identical to the NAV 1 radio.

III. The Settings Menu

Selecting the fifth menu option from the left (highlighted in **Figure 3.7** below) will open the Settings menu.

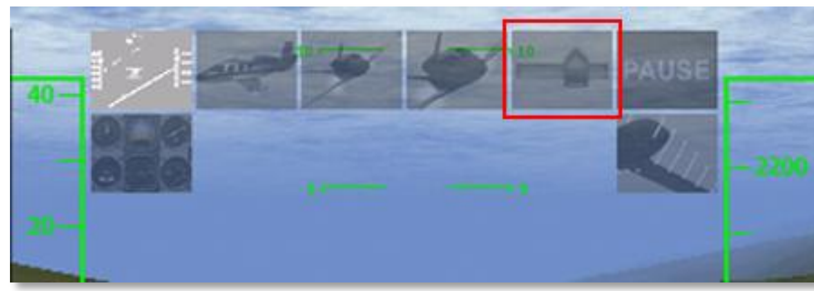


Figure 3.7: The Settings menu button

The Settings menu has nine tabs across the top, each of which shows a different set of options when selected. Tap one of the tabs to change the settings there, and tap the **Fly** button in the upper left to go back to the simulation.

A. Map

The options available on the Map screen are simple: Place the craft in a random location or on whole new random flight by pressing the respective buttons. The buttons in the lower half of the screen place the aircraft either on the runway for the indicated airport (the **Takeoff** buttons) or on a final approach to that runway (the **Final** buttons). The map can be dragged using a single finger or zoomed in or out 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 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.

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 helicopter and start a new flight.

B. Region

The Region menu allows the user to select which region to fly from. Tap a region to load it. The regions available in X-Plane Helicopter are discussed in Chapter 2, in the section "**Regions and Airports**."

C. Plane

The Plane tab lets the user pick one of the seven different helicopters included in the app. Tap an aircraft to load it (it will be placed on the default runway for the current region). The specific craft available in X-Plane Helicopter are discussed in the **Aircraft** section of Chapter 2.

D. Weight

The Weight menu is interesting. Here, the user can drag the center of gravity *forward* to give the craft greater stability, or *aft* to make it more maneuverable. The weight of the aircraft can be adjusted the same way, using the slider—just tap it and drag. Lighter helicopters will of course perform better than heavier ones.

E. Time

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.

F. Sky

The Sky tab is used to set one of five cloud conditions. You can also change the cloud base height and the visibility. To move a slider, simply tap and drag it.

G. Wxr

The Wxr tab allows the user to set the weather. It has four sliders (moved just like in the rest of the app) which are used to change the wind speed, turbulence, storm cell prevalence, and wave height. Additionally, the round button on the right side is used to set wind direction. To move this, tap near the edge of the circle and drag your finger around the circle. Wherever your finger releases is where the wind will come from.

H. Set

The Set menu allows the user to change the phone or iPod's "control calibration." Just hold the device at the desired angle and tap the **Set current phone pitch and roll as center** button to make the current attitude of the phone or iPod 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!

Additionally, at the bottom of this screen is the sound slider, set by default at 50%.

I. Multi

The Multi tab is used to set up multiplayer flights. When it is selected, 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, William will need to go to the Multi tab and tap the **Mary's iPod** button, and Mary will need to go to the Multi tab and tap the **William's iPhone** 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 iPhone/iPod's Wi-Fi setup (found in the device's Settings, as shown in **Figure 3.8**).

Figure 3.8: The iPhone and iPod Touch Wi-Fi setup

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 indicating the other user's location. Follow this pointer to join up with the other player in the event that you lose each other.

IV. Updating the X-Plane Apps

The easiest way to update the mobile X-Plane applications is to go to the App Store (found on the device's "home page") and tap Updates down at the bottom of the screen. There, simply select Update All (as marked in **Figure 3.9**).

Figure 3.9: The Update tab of the App Store

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

4. Flight in X-Plane 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.

Note that unfamiliar terms may be found in the **Glossary of Terms**, beginning on page **20** of this manual.

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 aircraft modeled in X-Plane Helicopter. 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 Helicopter, the effect of this throttle governor can be seen in the slider on the right side of the screen, as highlighted in **Figure 4.1**.

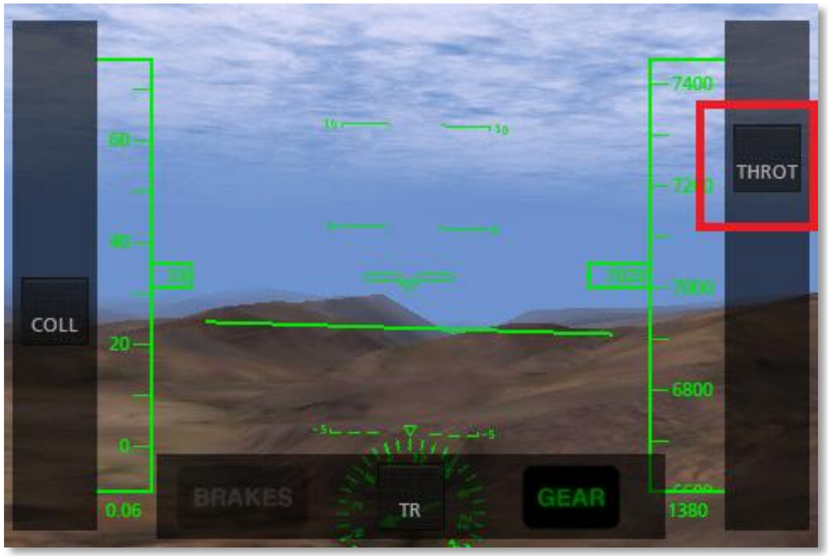


Figure 4.1: The throttle indicator, dependent on the collective control

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 just like the collective control does to the main rotor) 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.

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 4.2**). 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 (thus changing 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 Helicopter).

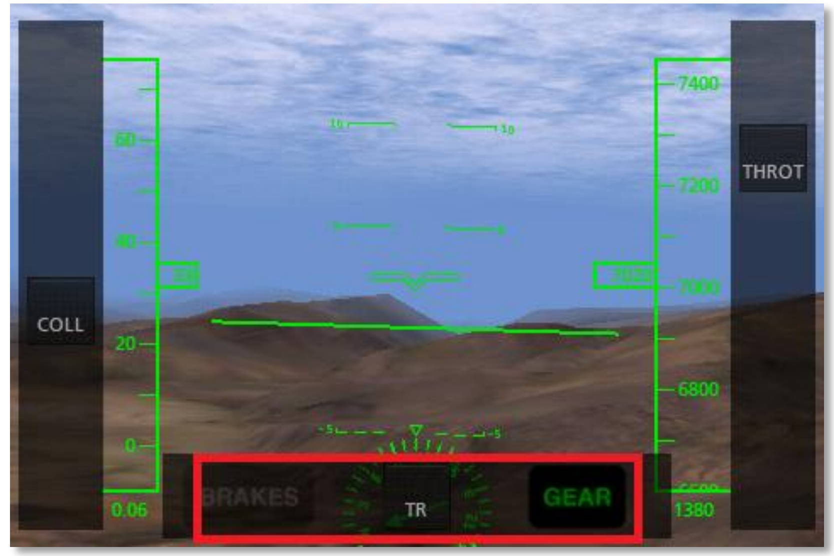


Figure 4.2: The tail rotor control

Once the craft is in the air and the *collective pitch* of the main rotor is being adjusted (in X-Plane Helicopter, 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 Helicopter, this is controlled by tilting the phone or iPod 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 Helicopter, *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 Helicopter, 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 phone or iPod'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 slier) 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.

I. 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 Helicopter, the collective control is dragged *towards* the user (that is, *down* on the screen) to increase it.

II. Review

To review, flight in X-Plane Helicopter 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 phone/iPod 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.

5. Tech Support

The only technical issues that X-Plane customer support has yet encountered with the X-Plane Mobile applications is caused by the hardware exceeding its RAM allocation.

Many users leave their iPod or iPhone on for literally months at a time (the hardware appears to be off when in fact it is 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 iPhone/iPod, 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 issues described above happen very infrequently, and in all cases are fixable by restarting.

For additional assistance, please e-mail 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 instrument (found in the OBI or HSI) displays which direction the aircraft needs to turn in order to intercept the VOR 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 mechanical gauges of a standard panel. In X-Plane Mobile, such displays are found 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.

HSI: Horizontal Situation Indicator. This instrument is found in the jet-engined craft in X-Plane, in the left side of the panel. It serves the same function as an OBI—that is, it indicates course deviation.

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 useable from about 50 miles away.

Pitch: Movement of the aircraft's nose up or down (see the image in the "**Flight Dynamics**" section of the manual on page **22**).

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 **22**.

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 mobile devices do not simulate rudder pedals (as they have only two axes for input 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.

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 the X-Plane Mobile applications, this is done by following the instructions in the "**Updating the X-Plane Apps**" section of Chapter 2, beginning on page **12**. 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.

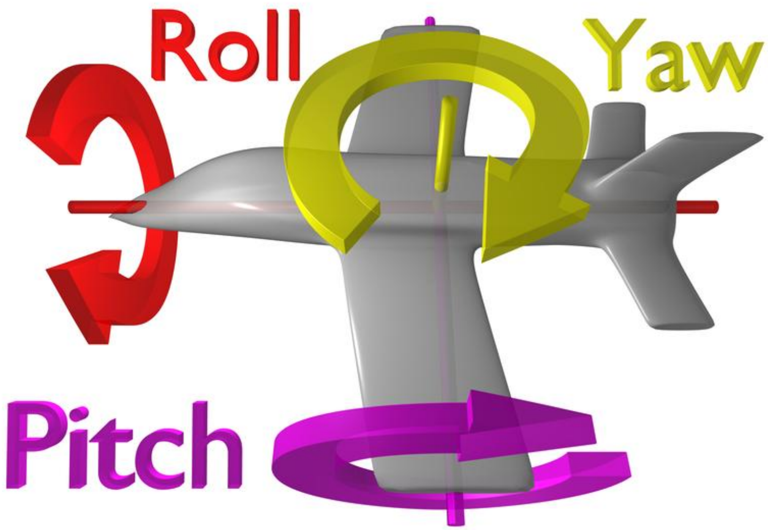
VFR: Visual Flight Rules. Flying done using a combination of the pilot's view of the outside world and the aircraft's instruments. Environmental conditions permitting such flight (such as a sunny day with 10 mile visibility) are referred to as VFR conditions.

VOR navigation: Very High Frequency Omnidirectional Range navigation; this is navigation based on radio signals sent out by a VOR beacon. Airplanes (such as the propeller-based craft in X-Plane) often track these signals using an Horizontal Situation Indicator, or HSI.

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 **22**.

Flight Dynamics

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



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