ULTRA-REALISTIC FLIGHT SIMULATION

X-PLANE 8

CONTENTS

FAA EFFECT AND USE OF CONTROLS

An excerpt from The U.S. Department of Transportation Federal Aviation Administration Flight Standards Service Copyright 1980

THE EFFECT AND USE OF CONTROLS

This chapter briefly discusses the devices with which the pilot operates the airplane in the air and on the ground, and how those devices are to be used effectively.

To maneuver an airplane, the pilot must control its movement around its lateral, longitudinal, and vertical axes. This is accomplished by the use of the light controls—elevators, ailerons, and rudder—which can be deflected from their neutral position into the flow of air as the airplane moves forward through the air. During flight, the flight controls have a natural "live pressure" due to the force of the airflow around them.

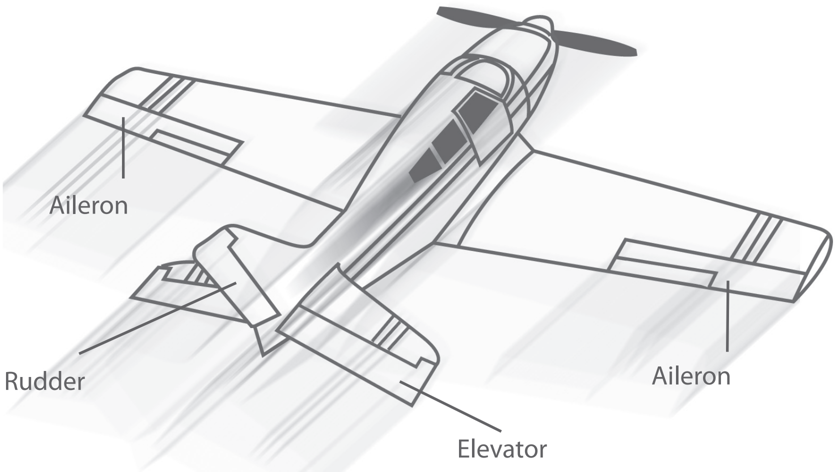
With this in mind, the pilot should think not of moving the flight controls, but of exerting force on them against this live pressure or resistance.

ELEVATORS

The elevators control the movements of the airplane about its lateral axis. They form the rear part of the horizontal stabilizer, and are free to be moved up and down by the pilot, and are connected to a control stick or wheel in the cockpit by means of cables or rods. Applying forward pressure on the control causes the elevator surfaces to move downward. The flow of air striking the deflected elevator surfaces exerts an upward force, pushing the airplane's tail upward and the nose downward. Conversely, exerting back pressure on the control causes the elevator surfaces to move up, exerting a downward force to push the tail downward and the nose upward

In effect, the elevators are the angle-of-attack control. When back pressure is applied on the control, the tail lowers and the nose rises, thus increasing the wing's angle of attack and lift.

Some airplanes have a movable horizontal surface called a "stabilator," which serves the same purpose as the horizontal stabilizer and elevators combined. When the cockpit control is moved, the complete stabilator is moved to raise or lower its leading edge, thus changing its angle of attack and amount of lift. In turn, this changes the wing's angle of attack and amount of lift.



AILERONS

The ailerons control the airplane's movement about its longitudinal axis. There are two ailerons, one at the trailing edge of each wing, near the wingtips. They are moveable surfaces hinged to the wing's rear spar and are linked together by cables or rods so that when one aileron is deflected down, the opposite aileron moves up.

Contrary to popular belief, the lift on the wings is the force that turns the airplane in flight—not the rudder. To obtain the horizontal component of lift required to pull the airplane in the desired direction of turn, the wings must be banked in that direction. When the pilot applies pressure to the left on the control stick or turns the control wheel toward the left, the right aileron surface deflects downward and the left aileron deflects upward. The force exerted by the airflow on the deflected surfaces raises the right wing and lowers the left wing. This happens because the downward deflection of the right aileron changes the wing camber and increases the angle of attack and life on that wing. Simultaneously, the left aileron moves upward and changes the effective camber, resulting in a decreased angle of attack, and less lift. Thus, decreased lift on the left wing and increased lift on the right wing causes the airplane to roll and bank to the left.

Since the downward deflected aileron produces more lift, it also produces more drag, while the opposite aileron has less lift and less drag. This added drag attempts to pull or veer the airplane's nose in the direction of the raised wing; that is, it tries to turn the airplane in the direction opposite to that desired. This undesired veering is referred to as adverse yaw. To demonstrate this in flight, an attempt can be made to turn to the right without using the rudder pedals. As right aileron pressure is applied, the airplane rolls into a right bank and tries to turn to the right. But the adverse yaw, or the drag on the downward deflected left aileron, pulls the airplane's nose to the left. The airplane banks, but is turns hesitantly and sideslips. This is undesirable and corrective action should be taken by applying right rudder pressure.

When right rudder pressure is applied simultaneously with right aileron pressure, it keeps the airplane from yawing opposite to the desired direction of turn. In fact, the rudder must be used because the ailerons were used. Therefore, neither of those controls should be sued separately when making normal turns.

RUDDER

The rudder controls movement of the airplane about its vertical axis. This is the motion called yaw. Like the other primary control surfaces, the rudder is a moveable surface hinged to a fixed surface—in this case to the vertical stabilizer, or fin. Movement of the rudder is controlled by two rudder pedals—left and right. Its action is very much like that of the elevators, except that is moves in the different plane; the rudder deflects from side to side instead of up and down. When the rudder is deflected to one side, it protrudes into the airflow, causing a horizontal force to be exerted in the opposite direction. This pushes the tail of the airplane in that direction and yaws the nose in the desired direction. When rudder is used for steering during ground taxiing, the propeller slipstream provides the force to yaw or turn the airplane in the desired direction.

USE OF FLIGHT CONTROLS

The following will always be true, regardless of the airplane's attitude in relation to the earth:

• When back pressure is applied to the elevator control, the airplane's nose rises in relation to the pilot.

• When forward pressure is applied to the elevator control, the airplane's nose lowers in relation to the pilot.

• When right pressure is applied to the aileron control, the airplane's right wing lowers in relation to the pilot.

• When left pressure is applied to the aileron control, the airplane's left wing lowers in relation to the pilot.

• When pressure is applied to the right rudder pedal, the airplane's nose moves to the right in relation to the pilot.

• When pressure is applied to the left rudder pedal, the airplane's nose moves to the left in relation to the pilot.

The preceding explanations should prevent the beginning pilot from thinking in terms of "up" or "down" in respect to the earth, which is only a relative state to the pilot. It will also make understanding of the functions of the controls much easier, particularly when performing steep banked turns and the more advanced maneuvers. Consequently, the pilot must be able to properly determine the control application required to place the airplane in any attitude or flight condition that is desired.

GENERAL CONTROLS

General Controls

Mouse, for general panel controls

You can drag engine controls, set frequencies, and manipulate any other on-screen controls with the mouse. Note: For aircraft with reverse thrust, such as the Boeing 777, you need to drag the throttle all the way to the bottom of the throttle travel with the mouse and hold the mouse button down for a few seconds at the very bottom of the throttle travel to drop the engines into reverse thrust.

Joystick, mouse, or keyboard, for flight control

The joystick, rudder pedals and throttle-quadrant operate the flight controls of the airplane. If you don't have any such peripherals hooked up, you can use the mouse and keyboard instead. To use the mouse, click in the center of the windshield and you will be able to fly the plane with the mouse that way. Click again in the center of the windshield to stop flying the plane with the mouse. You can use the numeric keypad to fly the plane with the keyboard.

Normally, you will use the joystick to pitch and roll the airplane, the rudder pedals (on the floor) to steer the airplane on the ground, and the throttle to control the power output.

Many people do not have joystick AND rudder pedals AND throttle, so you can get by with the mouse for flight control, no rudders, and the mouse or functions keys (F1/F2) for throttle control.

Keyboard

Keyboard use is not required. Command key equivalents, if any, are listed in the X-Plane menus. There are also command key equivalents for views in the "View" menu so you do not have to memorize the keys... they are surrounded by brackets like this "[W]". Just hit those keys without hitting the shift, option/alt or control keys to select those views.

Tip
Although reducing the realism somewhat, you may want some "damping" if you are new to flight sims or are flying a light helicopter. Do this in the "Hardware and Flight Mode" window in the "Settings" menu. You can reduce joystick sensitivity there, too.

Key List:
The keys given here are the DEFAULT keys, but you can easily change them by editing the "RESOURCES : KEYS : X-Plane.txt" file! Just change the keys in that file and save the file to use your new keys in X-Plane!

SPACE BAR Fail a system selected in the failure mode window
[Enter] Activate ATC if ATC menu not up
[Enter] Accept ATC selection if ATC menu is up
[Enter] Send message to other player in multiplayer flight
[Enter] Close open window if any window is open
[Enter] Choose ATC option if an ATC menu is up
[↑][↓][→][←] Rotate view angle (free-view)
[↑][↓][→][←] Rotate view location (in spot-view)
[.] Reverse thrust
[R] Release payload (jettison)
[Y] Adjust directional gyro
[I][O] Adjust barometric pressure
[H][J] Adjust OBS 1
[N][M] Adjust OBS 2
[P] Pause
[B] Brakes, 2/3 stopping effort, normally used.
[V] Brakes, maximum stopping effort!
[G] Gear
[F] Transponder ident
[K][L] Progress time in 1/2 hour increments

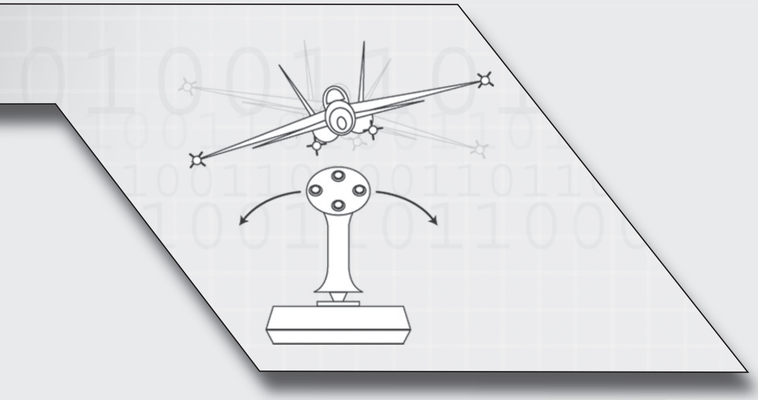
[’] Toggle FADEC on/off for helos
[!] Autopilot disconnect
[‘] Autopilot heading
[~] Autopilot Nav 1
[$] Autopilot Nav 2
[%] Autopilot GPS
[^] Autopilot alt hld
[&] Autopilot vertical speed hold
[*] Autopilot glide slope Nav 1
[(] Autopilot glide slope Nav 2
[)] Autopilot airspeed hold

[Q][W][E][R] Com 1 radio frequency
[T][Y][U][I] Nav 1 radio frequency
[A][S][D][F] Com 2 radio frequency
[G][H][J][K] Nav 2 radio frequency
[O][P][L][:][>][?] ADF frequency
[Z][X][C][V][B][N][M][<] Transponder setting
[1][2] Flaps up or down one
[3][4] Carb heat off or on
[5][6] Speedbrake up or down one (use joystick throttle on gliders)
[7][8] Aileron Trim
[9][0] Rudder Trim
[[][]] Elevator trim
[+][-] Zoom in/out

Function keys control the throttle, prop, and mixture... with one exception: use the BACKSPACE key instead of the F-10 key in Windows. In Windows the F-10 key is reserved by Microsoft for menu-operations.

Controlling X-Plane with a joystick

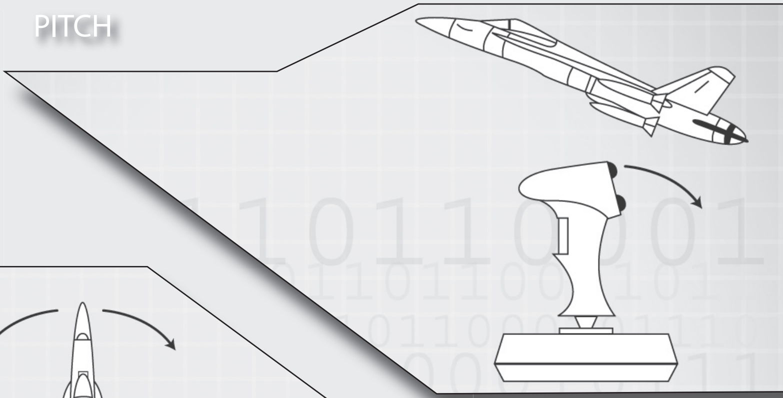
Roll: The stick controls the airplanes pitch and roll.
Roll is movement about the longitudinal axis of the aircraft. To control roll use side to side motion of the stick. Moving the stick left to right will cause the aircraft to roll until the stick is re-centered. The amount of roll is called the angle of bank. Once the aircraft has banked the ports of lift is no longer vertical, but at an angle equal to the bank angle. If the pilot pulls back on the stick while banked some of the lift goes to the left or the right turning the aircraft in the direction of the bank.

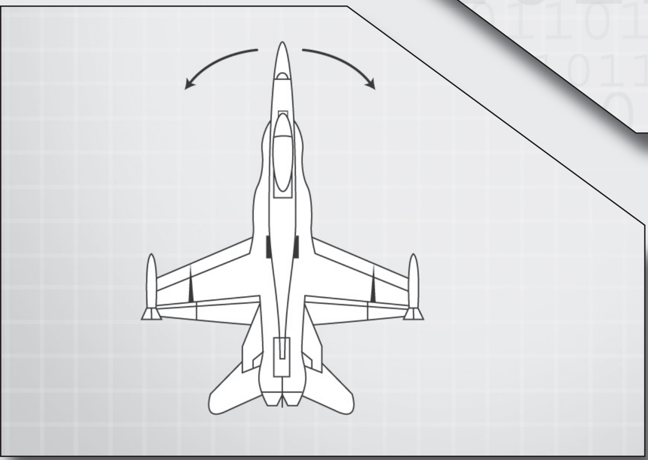


ROLL

Pitch: Pitch is motion about the aircrafts lateral axis. Pitch causes the nose of the aircraft to move up or down relative to the horizon. To control pitch use forward and back stick pressure.

PITCH





YAW

Yaw: Yaw is the movement of the aircraft right or left about the vertical axis.

FIRST FLIGHT

Your First Flights

- Launch X-Plane from the Start menu (Windows) or by double-clicking on the "X-Plane" icon in the game folder (Mac OS.)
- Wait until you are settled on the runway.
- Hit the '2' key a few (about 2) times to bring in some flaps for takeoff.
- Disengage the brakes. (Click the orange brake button to toggle it.)
- Operate the throttles with the mouse. (The throttles are the light-gray knobs on the lower-right... drag them up all the way to go to full power.)
- Pull the joystick back (or hit the numeric keypad 2 key, or click on the center of the windshield and pull down with the mouse) lightly to rotate and take-off at about 130 knots.
- Upon reaching 3,000 feet or so throttle back a bit.
- Hit the '1' key a few times to retract the flaps.
- Fly the plane for a few minutes with the joystick/mouse/keyboard.
- Select "Quit" from the "File" Menu.

Now you can fly the simulator

- Double-Click on the "Plane-Maker" icon, thus launching Plane-Maker.
- Go to the "File" menu and select "Open".
- Select the Boeing 777 from the "Heavy Metal" folder.
- Select a random window from the "Standard" menu and make any changes you feel Boeing overlooked.
- Select "Save As" from the "File" menu.
- Type in "Modified 777" or similar for your new modified airplane after backspacing over the earlier name and press return.
- Select "Quit" from the "File" Menu.

Now you know how to make your own airplane designs.

- Launch X-Plane.
- Select "Open Aircraft" from the "File" menu.
- Choose the airplane that you just saved in Plane-Maker... yes you might need to navigate around a little bit to find it.
- Fly it. (If you still can!)

Now you are an aircraft designer and test pilot!

OK you have now proven that you can fly, design aircraft, and test-fly your aircraft designs.

You are probably not any GOOD at it, but at least you can do it. A minute to learn, a lifetime to master. The rest of this manual will walk you through everything in much more detail.

INTRO TO X-PLANE

Organization will be as follows: First we will outline what the sim can do, then walk you through each menu, then walk you through the various flight instruments.

Once you are familiar with the menus and instruments, we will walk you through a first flight in a conventional plane, then give you descriptions of how to fly helicopters, the Space Shuttle, theoretical planes on Mars, and other stuff you only find in X-Plane.

First: What X-Plane can do

X-Plane is the world's most comprehensive flight simulator, and the most realistic flight simulator available for personal computers. It is the only consumer-level flight sim on the market that can predict how an airplane will fly based on the GEOMETRY (shape) of that airplane.

While every other sim has a visual model of the aircraft for "eye candy" and a different set of rules to govern the flight, X-Plane takes the shape of the aircraft as defined in Plane-Maker and uses it both to render the airplane visually as well as see how air would interact with that shape to provide the flight model.

This means that in X-Plane, you can enter the design of the aircraft of your dreams, not knowing whether it can really fly or not... and then find out by taking it for a test-flight in X-Plane

In all other sims, you have to enter the performance of your design into the sim, so the sim can blindly spit that performance right back out at you. You learn nothing!

X-Plane is being used by various aircraft manufacturers and designers to evaluate new design ideas on the personal computers before the planes are flown for real... the processing power that is required for this was unthinkable several years ago, but on today's PC's is obtainable at a mass-market price-point, making flight-performance prediction possible for $50.00 that has typically cost hundreds of thousands of dollars for custom-built software.

So what can you fly on X-Plane?
Try props, jets, single- and multi-engine airplanes, as well as gliders, helicopters and VTOLs such as the V-22 Osprey and AV8-B Harrier. X-Plane comes with subsonic and supersonic flight dynamics, and includes 28 aircraft spanning the aviation industry (and history), and several hundred more are freely downloadable from the internet.

What X-Plane can do

X-Plane's scenery includes scenery for the entire continental U.S. Global scenery is available and sold separately. Visit www.graphsim.com to learn more. You can land at any of thousands of airports, as well as test your mettle on aircraft carriers, helipads on building tops, frigates that pitch and roll in the waves, and oil rigs.

Weather is variable from clear skies and high visibility to thunderstorms with controllable wind, wind shear, turbulence, and microbursts! Rain, snow and clouds are available for an instrument flying challenge, and thermals are available for the gliders! Real weather conditions can be downloaded from the internet, allowing you to fly in the actual weather that currently exists for the airports that you are closest to!

X-Plane also has detailed failure-modeling, with 35 systems that can be failed manually or randomly, when you least expect it! You can fail instruments, engines, flight controls, and landing gear at any moment.

While X-Plane is the world's most comprehensive flight sim, the CD also comes with Plane-Maker (to create your own airplanes) World-Maker (to create your own scenery), and Weather Briefer (to get a

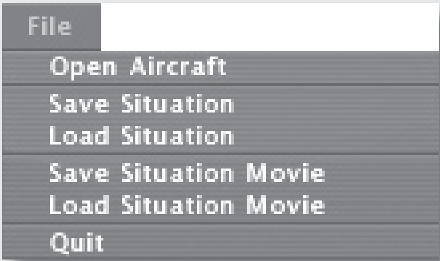
weather briefing before the flight if you use real weather conditions downloaded from the net).

X-Plane is also extremely customizable, allowing you to easily create textures, sounds, and instrument panels for your own airplanes that you design or for the planes that come with the sim.

X-Plane's accuracy (in flight model), scope (in aircraft and terrain coverage), versatility (in aircraft type and weather conditions), add-on programs (in aircraft and scenery editors), user-customizability, downloadable aircraft, and downloadable scenery makes it the ULTIMATE flight simulation experience for BOTH major platforms.

The X-Plane Menus

OK, let's quickly go through each menu in X-Plane to see what this baby can do. Once we have gone through all the menus, we will take a look at the cockpit instrumentation.



File Menu

Open Aircraft

This works just like opening a text file in a word-processor, only you are opening an aircraft to go flying instead! Fun! Just select your favorite airplane, provided it is available on the disk, and go fly it! The aircraft file must be in the "X-Sytem" folder to be selectable!

Load/Save Situation or Movie

Just set up the location, weather, airplane, etc any way you want and save the situation.

You can load that situation again whenever you want. Situations are saved in the "Situations" folder in the "Output" folder. Ditto all that for movies, which are saved in the "Movies" folder in the "Output" folder.

Quit

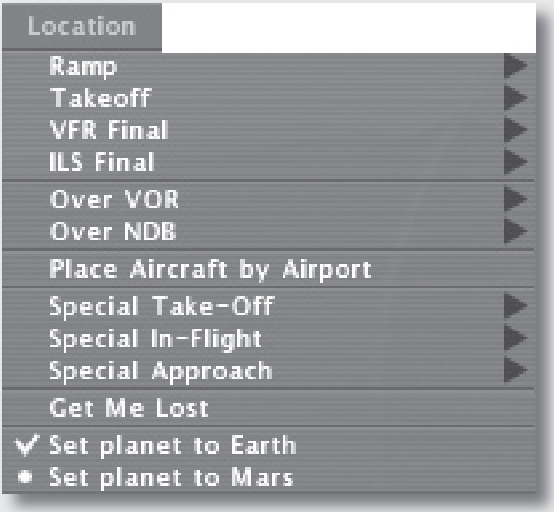
Exit the simulator.

X-Plane remembers the nearest airport, weather, aircraft, etc. for the next time you restart the simulator.

The Location Menu

This starts you off wherever you want.

The "Takeoff" and "Final" menus let you select from every airport in the general vicinity. (About 100 miles or so). If you want to go farther away than that, then you should select location by Airport, where you can enter any of the 20,000 or so airports in the X-Plane database.



The various "Special Approach", etc. menus are more fun than a barrel full of monkeys that have had too much coffee, and then cooped up too long in the barrel, and then released at a fruit-stand. You can buzz forest fires in the B-26 water bomber and jettison the flame-retardant load right over the fires to put them out, try putting an F-4 on an aircraft carrier, try getting an F-4 OFF an aircraft carrier, get towed aloft in your Cirrus glider by a towplane, fly a helicopter (or the V-22!) to a building top, oil rig, or even a frigate pitching and rolling in the waves. You can fly the space shuttle through a complete, realistic re-entry sequence to landing at Edwards...and we haven't even gotten to what you can do on Mars yet! That's just here on Earth!

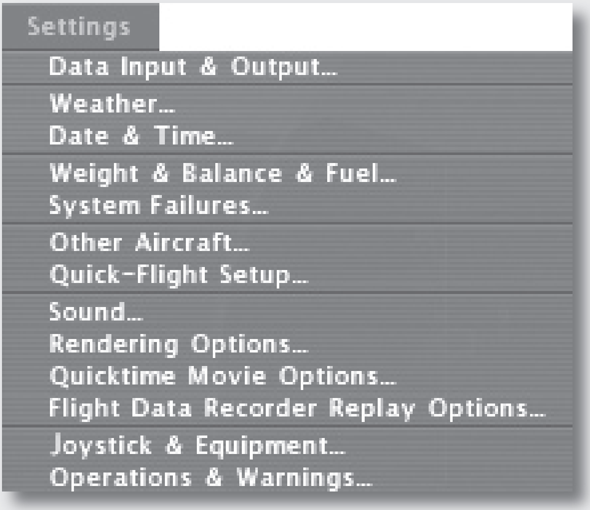
At the bottom of the location menu you can select your planet.. don't be fooled! The laws of physics are the same on Mars as on Earth (but with thinner air and lower gravity) and these variances are known to X-Plane, so the flight on Mars is just as accurate as the flight on Earth!

The Settings Menu

Data Output
This windows is extremely important and you must open it now. This is where you can output all manner of flight data to the cockpit display, a graphical output, a disk file, or even the internet via UDP. Here are some more thorough descriptions:

• Cockpit Display
Do this to send data numerically to the windshield, where it is shown in real time. You can look at things like propulsive efficiency, engine power output, exact prop RPM or mach number, or any number of other things where you want precise flight data. This is commonly used for test-flying your own airplane designs.

• Disk File
The data requested goes to the file "X-Plane.out" in ASCI text format. You can view the data after the flight by opening "X-Plane.out" with any word processor. After that, you may choose to import the data into a spreadsheet or graphics program of your choice for thorough analysis or printing or sharing with others.



- Graphic Display
  The data requested goes to a graphical display where it can be accessed by selecting "Graphic Flight Record" from the "Output" menu. Up to four variable groups may be chosen. This is a good idea for cases where you want to see control deflections over time from an artificial stability system, etc.

- Internet
  Send data to the internet? Huh? It sounds crazy until you consider the possibilities Say you are making your own virtual cockpit with many computers and monitors... or maybe you are making some type of motion platform... or maybe you want data to drive your own visual display system... just put an ethernet card in your computer if you do not already have one, and select the data you wish to be output here... it will be sent out over the ethernet cable by UDP protocol in such a way that there is basically NO FRAME-

RATE HIT AT ALL... now you hook up the other end of the ethernet cable to another computer, and you have yourself a little network, with the second computer getting data from X-Plane on the first computer. Now you may burden that second computer with hardware or software to drive motion platforms, displays, cockpits, or anything else you can think of, and the frame-rate of X-Plane is not hurt at all since it sent the data to the second machine for processing! See X-Plane Internet Output for a full description of the file formats and how to make it work if you are not a UDP or network guru.

Internet Connections

OK, this is where you enter the TCP/IP addresses of all the other computers this computer is talking to for your little "X-Plane network" just mentioned above. This is also where you set up X-Plane to run with many monitors, other players, instructor consoles, etc.

Rendering Options Item

This allows you to set the graphics options for the sim. Set to higher color depths and texture resolutions if your card can handle it, otherwise leave them at the defaults. When in doubt, experiment! With all the video cards and computer and configurations in use today, we are not even going to TRY to tell you what settings to use... you need to experiment for yourself!

If you set the graphical load too high and X-Plane will not restart the next time you try to run the sim because of it, just delete your various X-Plane preferences from the "System: Preferences" folder on Macs, or the "System" folder on Windows machines. View files by name in a list and you will see the various X-Plane preferences at the end of the list alphabetically under "X". You can delete them safely.. X-Plane will just restart to it's default config. when you do.

Joystick Axis Assignment
This is where you decide what each axis on your joystick does. For Macintosh users, this is a standard Input Sprockets interface. For Windows users, be sure to set all unused axis to NONE! See the General Controls section of this manual for a more thorough description of joystick setup.

Set Equipment Options
This is where you decide what each button on your joystick does, and choose any special hardware you have, such as radio stacks, etc.

Test Joystick and Equipment
This is where you can see how your joystick is responding, as well as see if any special hardware selected above is responding. You can also set the joystick damping here. For technically-realistic flying, all the damping should be completely turned off, and the joystick sensitivity cranked to full. Simulators are harder to fly than real airplanes, though, so you may want to add some artificial damping and lower the joystick sensitivity to make the airplane feel more realistic.

Time of Day
Use this to set the time of day for your flights.
Dawn (06:00) and Dusk (17:00) are cool-looking. Evening (19:00) with an overcast cloud layer is recommended for instrument flight (IFR) training. Time will advance in real-time.

Set Weather (Space, Atmosphere, and Water)
Note that you have slider control over the meteorological situation at various altitudes. These triple-sliders outline the limits you set for the weather at various altitudes. The "rate of change" slider controls how fast the weather is changing. The computer's internal weather generator will keep the weather changing until your limits are reached!

You can also fly in actual real-time weather downloaded from the internet! Check out www.X-Plane.com for the current location of the current file.

Conditions for atmosphere, water, and space may also be set. Don't slide on a wet runway, crash a floatplane on a Tsunami, or get distracted by a meteor! (Unless you want to, of course.)

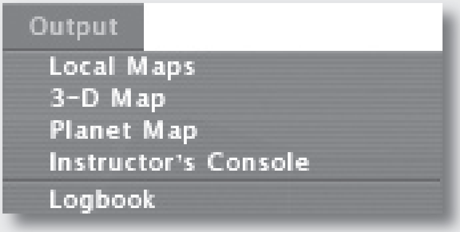
Weights and Fuel
Use the sliders to set the weights and fuel you want to fly. Watch the maximum take-off weight! If you fly over this weight you are asking for trouble!

Realistic, Instrument and Equipment Reliability
• Engine failures will cause immediate lack of power.
• Oil pressure failures will cause the engine to slowly lose power and then seize
• Vacuum system failures are realistic, complete with gyro tumble as the gyros spin down.
• Instrument failures will cause the instruments to stay in the position they were in when the failure occurred.
• Control failures will cause the controls to snap to the center position and stay there, simulating cable failure.

Sound
Sounds are set here. ATC verbal communications are possible if the appropriate speech drivers are installed. The window explains in more detail.

Warnings
This sets how "strict" the sim is. All boxes should be checked "on" for maximum realism. Check them "off" if you want to do free-flight without worrying about aircraft limitations.

Quick-Flight Setup
Quickly set your aircraft, location, time, and even a little weather here.



The Output Menu

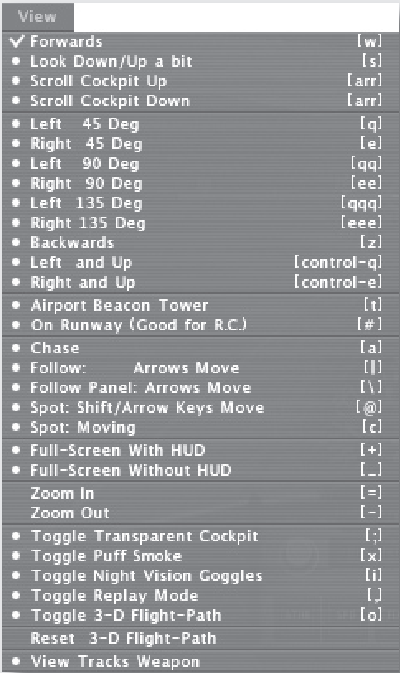
Graphic Flight Record
This is where the graphic data selected from the "Data Output" in the "Settings" menu can be observed. Point the mouse at whatever part of the curve you are interested in (no need to click) and the numerical value of that data appears underneath the labels at the left side of the screen. Clicking on the "starting time" controls at the bottom of the screen controls how many seconds since data selection was made you wish to start viewing.

Low Enroute, Sectional Chart, Weather Radar Map, Textured Map, and 3-D Map
These plot the local area with your flight path plotted in red and black. The weather radar map shows fine details if you have thunderstorms selected in the "Set Weather" window. You may position your aircraft in various maps by setting altitude, speed and direction, then clicking in the map. The 3-D Map requires a pretty fast machine to run smoothly, but is a nice site to see if you have the hardware for it.

Approach Plates for the Local Airports Menu
Plots the approach plate of the selected airport. This chart is used for setting VOR, ILS, and ADF frequencies as well as planning ILS

approaches. Notice the elevation of your airport! Fly an instrument approach and then open these windows to see how your approach looked.

The View Menu



Many view options are available for watching your flight. The letters in brackets are keyboard equivalents. Just hit those keys to get the views.

Enter/Leave Flight Replay Mode offers a video replay of your flight. In the glareshield some VCR-like buttons appear, which can be pressed to wind up or down, start or stop the replay, or study interesting situations (like crashes). If your monitor or videocard has video-out you can output the movie to a VCR. You can change the view of the replay with the usual keys from the "View" menu.

The Special Menu

Output one flight engine cycle
This saves an extended text file to your hard disk with all current simulator data. You can read this file with any word processor. This

option is useful for people with an aeronautical engineering background or the extremely curious. Use this data to check the simulator output, or observe loads or other data pertaining to the aircraft at the moment that you clicked on this menu item.

Instructions

These are brief but self-explanatory. X-Plane uses help-screens when you leave the mouse-pointer over an unclear subject for a few seconds.

Show Mouse-Click Regions

This plots annoying little yellow rectangles where you can click with the mouse... it might be useful for designing custom cockpits, etc. X-

Plane Primary Instruments

Go to the “File” menu and select “Open Aircraft”. Select the Cessna 172 Skyhawk, the most popular plane in the world these days. It is in the “General Aviation” folder in the “Aircraft” folder.

With that plane open, read the following:
Most all aircraft are equipped with the “standard 6” instruments, which give your orientation and velocities in space. They do NOT tell you what piece of real estate you are over (they are NOT navigation instruments) but they tell you what your attitude and speed are, which is what you need to fly the plane. Navigation is secondary to staying right side up!

So what ARE the “standard 6” instruments? Let us tell you:

“Standard-6” Flight Instruments

- Airspeed Indicator
  This tells you your speed through the air. It is the upper-left speedometer-like instrument. Notice the airspeed arcs (the colored arcs on the edge of the instrument). These arcs go to and from certain critical speeds for the airplane,

and here those speeds are:

- Vso:
  The bottom of the white arc is the stall speed with flaps (and gear) down. In other words it is the stall speed in the landing or “dirty” configuration.
- Vs:
  The bottom of the green arc is the stall speed with flaps (and gear) up. This is the so-called “clean” configuration.
- Vfe:
  The top of the white arc is the max. flap extension speed. Don’t extend your flaps above this speed.
- Vno:
  The top of the green arc is the maximum normal operation speed, and the max. speed in rough air.
- Vne:
  The red line is the maximum allowable speed, or the velocity to never exceed. You can lose your wings above this speed.

Artificial Horizon
To the right of the airspeed indicator, this instrument displays the plane’s attitude in the air. Note the “level adjust” knob. Use it on the ground to adjust the “nose-level” or horizontal reference to your liking.

Altimeter
Reading 1,400 feet above sea-level, note it's barometric pressure setting knob. Use it to adjust the altimeter setting. The barometric pressure is preset to 29.92"/1013,2 mbar (hPa), the standard altimeter setting. The altimeter should be adjusted for the local barometric pressure from time to time. Get the barometric pressure by checking ATIS, which can be done by hitting the ENTER key to activate radio communications. Once you get the current barometric pressure setting from ATIS, load that into your altimeter to calibrate it properly. This is needed for it to read correctly since it works be sensing air pressure!

Turn-Slip Indicator
Look at the instrument below the airspeed indicator. That is the turn-slip indicator. The airplane symbol indicates the rate of turn (not bank!) and the ball indicates sideslip. Use your pedals to keep the ball in the center.

Horizontal Situation Indicator
Very important navigational instrument with 2 arrow pointers controlled by the 2 buttons on either side of the instrument... see the next page for further explanation.

Vertical Velocity Indicator
The VVI indicates climb and descent rate in steps of 100's of feet per minute.

Standard Flight Controls

OK so those were the standard flight INSTRUMENTS, which tell you what the plane is doing... now lets go to the standard flight CONTROLS, which you will use to control the plane!

The General Controls section already clued you in on using the joystick and throttle and rudder pedals, or mouse and keyboard for controlling the 4 major flight inputs (pitch and roll, yaw, and throttle), but now it is time to take a look at the engine controls.

Here they are:

Throttle gray handle (left) up is full
Prop blue handle (middle), up is full RPM (not available on Cessna 172)
Mixture red handle (right), up is full rich
Carb heat little square (right), up is full cold
Flaps pull down handle in 4 stages, up is retracted
Trim with arrows on it (right) to trim the plane up/down

The throttle simply controls the power output of the engine… full up is maximum.

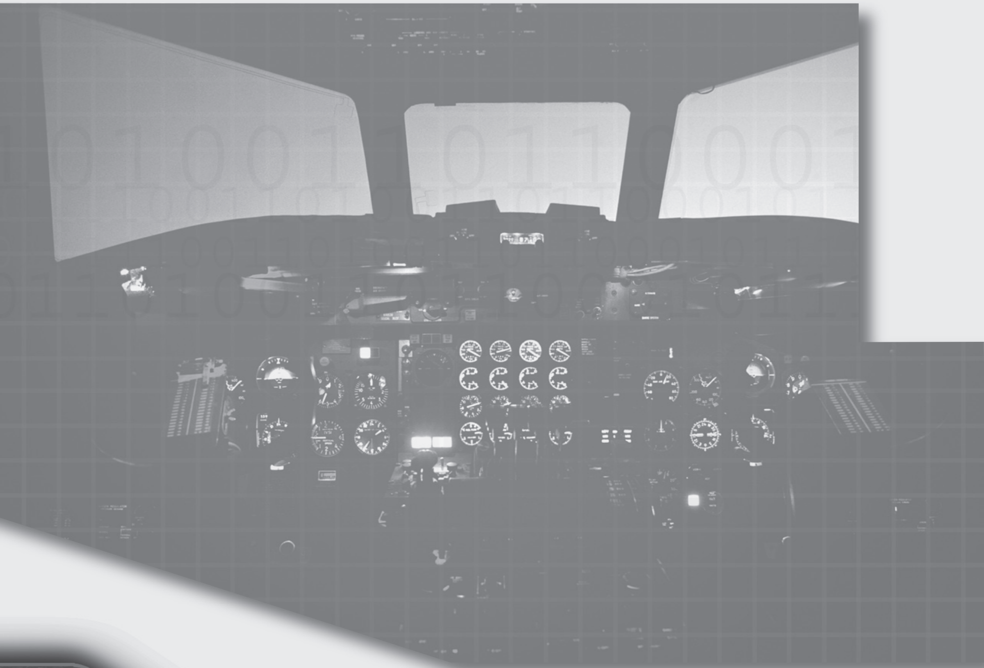
The prop is like a gearshift in a car.. it controls the pitch of the propeller to maintain a constant RPM regardless of the power setting. The Cessna 172 does not have this control because it cannot adjust the pitch of it's prop, but you can open the Mooney in the General Aviation folder to see and use this control.

The mixture controls the ratio of fuel to air inside the combustion chambers of the engine... pull it back a bit to save fuel, but if you pull it back too far the engine will quit!

The carburetor heat is needed when landing a carbureted a plane, or ice may form in the engine air intake and strangle the engine! If this happens then activate the carb heat found in the lower right!

Flaps have a significant effect on both lift and drag. The first bit of flaps (say 10°, or 1 notch) increases the lift (upward force) significantly, yet does not add much drag (braking force). As the flaps are FULLY deployed, however, the lift does not increase that much more, but the DRAG goes up a lot. In short, deploy only a LITTLE flaps to get a LIFT boost (like for take-off) but deploy them FULLY to get maximum lift AND drag (like for landing). Cessnas in particular have very effective flaps for steep approaches and low minimum flight speeds. It is not uncommon to have the airspeed indicator pegged on the lower end of the dial while in flight in a Cessna with the flaps down at minimum speed.

The trim adjusts the speed at which the airplane will sit without any stick input from the pilot. Use the k/l keys or mouse (HOLD THEM DOWN!) to adjust the trim so that you do not have to hold the stick all day long to hold the plane level.



Navigation Instruments

Open the King-Air B200 in the General Aviation folder if you are not already in that plane.

Lets take a look at a popular general-purpose navigation instrument, the Horizontal Situation Indicator, or HSI. The horizontal situation indicator is below the artificial horizon. The gyrocompass part of this instrument is obviously your heading, but notice the yellow arrow (with line) on this instrument. This is the Omni-Bearing Selector (OBS). It is a course deviation indicator for a VOR or ILS.

Put in english, the yellow arrow points to or from the radial that you have selected to fly from a VOR, or ground-reference station. The little knob on the lower-left of the HSI is the OBS selector knob. Use that knob to adjust the radial to the VOR that you want to fly. Click on the left or right part of the OBS selector to decrease / increase the OBS.

Now the next question is, "Ok, so the little yellow knob decide what radial I will be on to or from a VOR, but how do I decide which VOR the HSI is taking me to or from?". To answer that question, you dial the frequency of the VOR you want to fly to or from into one of the two NAV radios you have on board. Most planes have 2 nav radios, with an HSI connected to either or both of them. In the Mooney it is connected to Nav 2... the lower of the 2 Nav frequencies in the radio stack.

So, in summary: Dial the frequency of a VOR you want to fly to (the VOR's are the little hexagons on the maps in the "Output" menu), then twiddle the little yellow knob to select the radial you want to fly to (or from) the VOR, and then fly until the line between the two little yellow pointers is centered and you will be on the radial.

The small orange arrow on the HSI is the heading-select pointer. This is the heading the autopilot will fly when the "heading-select" (HDG SEL) button on the autopilot in the radio stack is pressed.

A simplified version of the HSI is the VOR. This just shows the deflection of the aircraft from the radial you have dialed in, without rotating the little needles as you dial in the OBS (or radial) you want to fly. Note the little round knob on the VOR gauge. This is the OBS selector for the VOR, which is hooked up to Nav 1 in the radio stack. Remember that the frequency on the left of the radio stack is used for communications, the frequency on the right is used for navigation. Click on the left or right part of a OBS selector to decrease/increase the OBS.

The VOR and HSI also have glideslope indicators (horizontal lines) for the ILS. While you keep the little pointers centered to be on course on the radial you have selected to a VOR, you keep the horizontal pointers centered to maintain your VERTICAL course on the ILS as you follow it down to the airport.

Remember that VOR's and HSI's that we just discussed also work for ILS's, which are beams that guide you down to the airport with two big differences: ILS's provide vertical guidance as will as horizontal guidance, and ILS's will always keep you on the SAME radial to have the pointer centered, no matter what you dial into the OBS. This is because the course to the runway has been carefully plotted and aligned with the runway, and the FAA does not want you coming at it from just any direction.

Marker Beacon & Audio Selector Panel

Look at the top of the radio stack. The blue, yellow, and white squares are marker beacon indicators. They will flash when you pass over outer, middle, or inner markers during an ILS approach. The buttons to the right are the audio selectors. They select what radios go to the speakers, and are only used for the Nav radios and the ADF in current versions of X-Plane. To hear and test a VOR, dial the VOR frequency into the NAV2 (bottom) radio, then hit the "NAV2" button in the audio selector panel: you should hear the morse code for the VOR if the VOR is in range. The same can be done for a Nav1 VOR on airplanes that have a VOR for Nav1 radio instead of a GPS (global positioning system or satellite navigation), and it can also be used for the ADF.

DME
The next instrument down is the distance-measuring equipment. This instrument gives the distance, speed, and time to a VOR. Like a real DME, this one takes a little while to give an accurate answer. The two buttons to the right of the display select which Nav radio you want to get the distance to. N1 gets the distance to the VOR selected in the top Nav radio, N2 gets the distance to the VOR selected in the bottom Nav radio.

Nav and Com Radios
The next two boxes down are the Nav/Com radios. Com frequencies are on the left, Nav frequencies on the right. Frequencies for Nav 1 are on top, frequencies for Nav 2 on the bottom. You'll be advised by ATC which frequencies to use for communications (press Enter/Return key to activate ATC). Click on the selector knob to change the frequency.

Transponder
The transponder code your plane should send out is given by ATC and must be set in the transponder by turning the knobs. The code can vary during a flight. After setting ("squawking") the code you can cause your plane to light up on radar by pressing the ID button. The blinking reply light indicates ATC's radar is tracking you. Set the ransponder to 1200 if you are not talking to ATC. Click on the selector knob to change each digit.

Autopilot
The three buttons under the "HDNG bar" are as follows:

HDG SEL fly the heading selected by the orange arrow on the HSI. Adjust the orange arrow with a knob on the HSI.
NAV 1 fly the VOR/ILS selected on Nav 1 (or GPS module)
NAV 2 fly the VOR/ILS selected on Nav 2 (HSI left button)

The three buttons under the "ALT bar" are as follows:
ALT HLD hold the altitude selected in the glareshield.
VVI HLD hold the vertical velocity selected in the glareshield.
NAV 2 fly the ILS glideslope selected on Nav 2
Note: a glideslope for the ILS must be available

The button under the "AS bar" is as follows:
AS HLD auto-throttle to maintain the airspeed selected in the glareshield.

GPS - Global Positioning Satellite system
Open the Glasair-II in the "Homebuilts" folder. ("File: Open Aircraft" in X-Plane, then navigate out a level from the "General Aviation: Cessna" folder over to the "Homebuilts: Glasair" folder. Notice that in the Glasair, a GPS replaces the Nav1 radio. The 3 buttons labeled APT, VOR, and NDB select whether you want to fly to an airport, VOR, or NDB. After making the appropriate selection, dial the identifiers with the digit and scroll knobs. As usual, click on the knobs to proceed. Once you have dialed in your destination you can fly to it using the GPS. You get a CDI (course-deflection indicator; the dot between the three | lines), which works just like the horizontal deflection on a VOR to help you fly to your destination. In our above example Lyon Satolas-France is centered and straight on course.

DIGIT moves the cursor across the GPS-selection display
SCROLL when pressed at top or bottom scrolls up or down the list or characters and names

ADF - Automatic Direction Finder

Get back in the Cessna to use an ADF. The needle of the Automatic Direction Finder will simply point at whatever radio station the ADF is tuned to. Notice the three knobs under the ADF indicator. These select the ADF frequency. The ADF compass rose can be slaved to the compass in Plane-Maker. Click on the upper part of the knob to increase the frequency. Click on the lower part to decrease the frequency.

Flight from San Bernardino to Riverside Municipal

OK, we have given you the intro to X-Plane, we have run you through the menus, and we have run you through the instruments. Now it is time for a quick flight!

1. Go to the "Location" menu, "Place Aircraft by Airport" option. Go to San Bernardino, or KSBD, which is the airport ID. That is actually the airport you start at by default, but we are running you through this in case you have moved. In a few seconds you're on runway 06 of San Bernardino, ready for a short instrument flight to KRAL, Riverside Municipal airport - which is about 13 miles west-north-west.

2. Let's take a fun plane. Load the Glasair from the "File:Open Aircraft" menu option. It is in the "Homebuilts" folder, as you recall. Austin Meyer, the author of X-Plane, is building one of these in his garage, though it is highly doubtful he will ever finish it... it takes too much time.

3. Anyway, press Enter/Return and the up-arrow to file your flight plan. Set altitude to 4000 feet and destination to KRAL. Click IFR (top left). Close your flightplan now by clicking the window close-button, top left.

4. Next use the knobs in the instrument bar below the glareshield t set ALT 4000 feet, VVI 1000 feet per minute.

5. Set the GPS to the destination airport (set "KRAL" - read 215°-13 nm).

6. Check the airport map of "Riverside Municipal" in the "Plates" menu. Note the heading of the landing runway and its ILS frequency. You will go for runway 9 with ILS frequency 110.9.

7. Set the HSI needle to 90 (left yellow knob on the directional gyro) and NAV1 to the ILS 110.90.

8. Select "Settings:Weights and Fuel" to adjust the weight of your Glasair. Enter your own weight as the fixed payload, plus the weight of any other people watching over your shoulder while you fly. Enter a half a tank of fuel, or so.

9. Preflight check: Flaps 1 notch, GPS and Nav radios set, ALT and VVI autopilot values set, the engine at idle.

10. Press Enter/Return and select "Pick-up Flightplan". Check and write down the ATC instructions that follow. Set the transponder as instructed and load the tower frequency into the COM radio.

11. Call ATC for take-off permission and note the instructions.

12. Release the brakes (mouse or "b" key), and throttle up to full.
At about 70 knots gently pull the stick to rotate and take off. At a positive climb press the autopilot for VVI SEL and climb to the altitude indicated by Air Traffic Control. If climb to 4000 feet is approved, press ALT SEL, and re-enter the VVI selection if needed.

13. Follow the instructions from ATC, change radio frequency to Departure (if advised) and Riverside's airport. Don't misread ATC.
Ask for a "Say again" when in doubt.

14. Follow the heading instructions from ATC by hand-flying or switching the autopilot to HDNG/HDG SEL and turning the orange bug in the HSI with the orange (second left) knob under the HSI to the compass direction ATC has given.

15. You'll be vectored to the ILS of Riverside in a wide curve.

16. At 13 nm DME from Riverside reduce your airspeed to 120 knots, and set 1 notch flaps. Follow the approach instructions from ATC carefully now.

17. You will be advised to "intercept the localizer for runway 09" - press HDNG NAV1 and ALT NAV1 in the autopilot. The Glasair will turn to the Riverside ILS, flying the ILS until you disengage the autopilot and land.

18. When you visually see the runway deselect the autopilot to fly the Glasair gently to the runway. Glasairs like to fly their approaches at about 80 to 100 knots with partial or full flaps. Gently raise the nose when close to the ground to ease out of your descent and touch down. Power off, hit the brakes, and taxi clear of the runway. Hit enter again to tell the tower that you are clear of the active runway and ready to taxi to the ramp for a cold one. (Iced tea if you will be flying back to San Bernardino today, beer otherwise)

Flying Helicopters

Helo Basics:

Helicopters are so much harder to fly than airplanes that helicopter pilots almost have contempt for fixed-wing pilots. Helos have next to no natural stability (if any at all) and require constant attention to avoid busting their blades.

Ironically, the bigger the helo, the easier it is to fly since it is larger, heavy, slow, and filled with artificial stability systems making it easier to fly! The smaller helos which are light and twitchy are actually the harder ones to fly!

Therefore, for your fist helo flight lesson, we will start you off in the big heavy helo to make it easy for you. Open the UH-60A Blackhawk for your first flights. This is a big heavy helo that has a nice solid feel.

A helicopter is in fact a marginally stable flying machine. The main rotor produces somewhat more lift than the weight of the helo, allowing the machine to take off vertically. To pitch or roll the helicopter the main rotor blades change pitch as they move around the rotor disc. This causes the rotor to put out more thrust on one side than the other, causing the ROTOR DISC to pitch or roll. Once the rotor disc has pitched or rolled, the lift from the disc pulls the helicopter along with it! This change in rotor blade pitch to maneuver is referred to as cyclic pitch. The cyclic pitch is controlled by the "cyclic" stick which is the main control for the helicopter and is equivalent to the stick or yoke of an airplane. To climb or descend, a helo increases or decreases the pitch of the rotor blades overall, not just when the blades are at one part of their path around the disc. This overall change in pitch is referred to as "collective pitch". This "collective" is physically set up like a side-mounted parking brake in a car: you pull it up to go up, you push it down to go down. The collective is somewhat analogous to the throttle in an airplane. But who controls the actual throttle? A computer! The computer in a real helicopter automatically manipulates the throttle to maintain operational RPM. In other words, the RPM will stay the same for the ENTIRE flight (say, 350 rpm) and the computer will vary the throttle to AUTOMATICALLY to hold that 350 rpm, no matter what sort of load you put on rotor system by pulling the collective. There is a catch though: If you force the rotor to a very high collective pitch by pulling up on the collective too much, then the engine might not have enough power to keep a constant rotor speed, even at full throttle! RPM will drop and you are in a rotor-underspeed situation that must be remedied! The cure is simple: lower the collective stick enough that the pitch on the blade lowers to the point that the engine can keep the rotor turning at the right speed.

Thrust-Master or CH-Products throttle quadrants act like the collective when you are flying helos in X-Plane. Throttle full forward is full flat (DOWN), collective. Ease the throttle back towards you to INCREASE the collective. The throttle handle is acting like a collective pitch grip in the helo, and the computer is actually controlling the engine throttle to maintain the correct RPM, which should stay the same for the entire flight.

Your rudder pedals, if you have them, act as anti-torque pedals, which simply increase or decrease the pitch on the tail rotor to yaw the helicopter left or right and counteract the torque of the engine.

The helo cockpit is smaller than that of airplanes. There is a piece of yarn tied to the base of the windshield that serves as a sideslip indicator. The throttle handle serves here as collective pitch grip and should be upward to keep the helo on the ground. Gently drag it down to take-off and learn to hover at low altitudes first. Watch your flight with the replay option in the View menu to see your crashes from the outside.

Flying the Helo:

Ok, let's go for a flight. The throttle slider should be full FORWARD (or full UP on the instrument panel) corresponding to a fully-FLAT collective pitch. In this case, there is next to no lift being generated by the main rotor.

Now, EASE THE THROTTLE BACK TOWARDS YOU, OR EASE THE COLLECTIVE (gray knob) DOWN WITH THE MOUSE. This simulates pulling the collective BACK TOWARDS YOU with the mouse. As the collective increases, the lift from the rotor disc increases. At some point, the helo will rise.

Now, use the cyclic (joystick or yoke) to maneuver the helo. You are changing the cyclic pitch on the blades now, which puts out more lift on one side of the rotor disc than the other, which tilts the rotor disc, which drags the helo around to follow the disc in response.

Use the rudder pedals (or "anti-torque" pedals, in helo terminology) to adjust the pitch of the tail-rotor to yaw the ship around to the left or right. Once you can hold it on a hover under control, push the nose forwards to "lean" forwards and GO somewhere! Pull the nose back to slow or stop for landing.

You can find Aircraft Carriers, Oil Rigs, Frigates, (tossing in the waves) and building tops to land on, all in the location menu. We think that will keep you busy for a while!

Flying to Carriers

Landing on an aircraft carrier seems tricky at first, but gets easier with practice. Head on over to a coastal airport like LAX, get in an F-4 Phantom, and ask for a carrier approach or catshot in the "Location" menu. If the weather is good you can fly your approach visually, otherwise tune an ILS to 108.00 to pick up your ILS signal to the carrier... real carriers use somewhat different frequencies and ILS equipment, but the general result is the same.

At any rate, get set up on or near the carrier in the "Location" menu, "Special Approach" item or navigate to the carrier using the "Textured Map" by looking for a little square with a "C" in the middle. Be sure that "Draw Carriers" is turned on in the "Rendering Options" screen in the "Settings" menu!

If you select Carrier approach you will be aligned with the glideslope. Don't forget hook and gear down! You might also (quickly!) get full flaps down and reduce your weight somewhat by jettisoning your load... carrier approaches are almost always made at minimal weight.

OK, the "Hook", or "arresting gear" is lowered by pushing a little button labeled "Arrest Gear" in the glareshield. The landing gear is the handle with the three red or green lights by it. There is a button labeled "Jettison" to dump your weapons load to lighten up for the approach, and you can hit the '2' key about 5 times to get the flaps all the way down.

Do all that stuff fast... you need to get the F-4 configured quickly since you are begin started off pretty close to the carrier and you are coming in at about 200 knots initially! (Though you will want to slow to more l like 150 knots).

At about 1 mile out you will see the Fresnel lens (or "meatball") on the deck just to the left of the wires. It has a row of green lights with a yellow light in the middle. The Airboss will inform you when to "call the ball" (you need not respond in the sim). You now fly an approach path that keeps the meatball centered. The voice of the Landing Signal Officer warns you of errors in speed, attitude and heading. If the Landing Signal Officer is not happy with your approach he will shout "wave off" at you. Go around and try again. After landing you may select the "carrier cat shot" again or taxi to the left-front catapult to be automatically hooked up for a shot.

The visual glideslope indicator with "meatball" indicates the following:

- If the center light is above the row of green lights, you are high.
- If the center light is below the green lights, you are low or swimming!
- If the center light is right in the middle, between the green lights, you're on glideslope like you should be.

The trick to the carrier landing is:

- Keeping the plane aligned laterally with the extended centerline of the deck. (Do this with heading, of course)

- Keeping the airspeed low enough that the nose is aimed a bit up from the horizontal, at a nice positive angle of attack. (Do this with pitch)

- Keeping the velocity vector of the HUD pointed right at the touchdown zone on the deck. (Do this with pitch and throttle).

- Keeping the meatball centered. (Do this with throttle)

- Keeping all the these parameters centered until you crash into the deck. There is no technique to landing on a carrier other than keeping these parameters perfectly centered until you impact the deck and let the arresting gear take care of the rest.

We are assuming, of course, that you actually catch the arresting gear. Sometimes you won't! In that eventuality, you actually need to go to full throttle right BEFORE touchdown so that the engines are spooled up for the "bolter" or go-around in the event you miss the wires! Of course, you do not know in advance if you will miss the wires, so you should go to full power right before every touchdown so you will be able to "touch and go" off the edge of the deck and bring it around for another pass. It is a good workout to go round and round with the arresting gear up, doing bolter after bolter around the traffic pattern!

Trans-Atmospheric Flight Operations

The Space Shuttle gets stuff into orbit with some reliability, but is awfully expensive to operate for obvious reasons. They have to refurbish the solid rocket boosters every flight, they need a new external fuel tank every flight, the orbiter requires significant maintenance every flight, and the fuel consumption is, shall we say, "significant". (The fuel pumps alone use more horsepower than the total power output of the "Queen Mary"... when you use more power than the total output of the queen mary just to pump the fuel out of the tank, you know you are burning fuel).

The National Aerospace Plane, or "NASP" is an X-Plane (number 30, or "X-30") conceived to be the next generation of orbital delivery vehicle. It will take off with jet engines like an airplane, then switch to rocket engines at high altitude where the jet engines quit putting out an thrust. The rocket engines will take the plane into orbit, where payload can be deployed. The plane will then fly a re-entry into the atmosphere, and fire up the jet engines again for a normal landing.

Flying the NASP takes practice, but this will get you started. Open up the NASP in the "X-Planes" folder and fill it up with fuel ("Settings: Weights and Fuel"). Go to LAX or some other huge runway and blast off in full afterburner. Throttle back to 100% no burner and climb to 30,000 feet or so. Hit the burner again when the engine thrust starts feeling sort of weak. At about 45,000 feet, or as far as you can climb with the engines, shut them down. (Yank the red fuel levers back). Hit the JATO (Jet-Assisted Take-Off) button to simulate the rocket engines that will punch you into space. The JATO is simply a solid-fuel rocket motor. The real NASP will use liquid fuel, but that is a technicality.

During the rocket assisted climb, gradually level the nose so that the artificial horizon is horizontal at about the time you reach 300,000 feet. X-Plane's atmosphere goes up to about 250,000 feet, so you will be "in space" at 300,000 feet. If you climb into space at 45 degrees upside down, you will never get a decent re-entry, so gradually level the nose as to level out at 300,000 feet. Watch the artificial horizon carefully. You must level off in the top of a gentle curve at a reasonable altitude to have a chance of making a survivable re-entry.

At this moment, your indicated airspeed will be zero, but of course this is because there is no air to push against the pitot tube. Your actual speed is extreme, and can be output from the data output window. 18,000 mph is orbital velocity. You will have noticed during the climb that the indicated airspeed was going down as you entered thinner air and the airspeed indicator encountered less air pressure, but the true airspeed was always increasing.

Once in space, keep the space-bird pointed straight ahead until the rocket burns out. Use stick and rudder to always keep the nose pointed right at the flight path velocity vector (the small green moving box) on the HUD. This keeps the nose pointed in the direction you are going. You will need this during re-entry! Once your rocket burns out (4 minutes is up, you can't climb further and your engine thrust from the "Data Output" window is 0) it is time for the re-entry. Hit the "Jettison" button in the glareshield to jettison the satellite you just carried into orbit. Ease the plane into the atmosphere at a shallow angle! Don't go diving straight down at the planet or you will break and burn up like a meteor for sure! The Space Shuttle skips along in the upper atmosphere to gradually bleed off airspeed, and you must do the same. 18,000 miles per hour at sea level would tear any aircraft ever made apart in a micro-second! While you keep the nose up a bit and skip across, gradually descending down into the atmosphere and decelerating, look for an airport on your EFIS display and fly to it for landing. You can do it!

Flying the Space Shuttle

Read this chapter before attempting Space Shuttle landings in X-Plane if you want to live!

What do you think the first rule of flying a glider is?

Think about it.

The first rule of flying a glider is: "Never come up short."

When you are bringing a powered plane in for landing, if you think you are not quite going to make it to the runway, it is no big deal.. just a add a bit of power to cover the extra distance! Need a little more speed maybe? Again no problem: Just add power.

Gliders play by a different set of rules, though: There is no engine to provide power, so when setting up your landing, you must always have enough altitude and speed to be able to coast to the airport, because if you guess low by even one foot, you will hit the ground short of the runway, crashing. You must NEVER be low on speed or altitude, because if you EVER are, you have NO WAY of getting it back: a crash is assured. (the exception is thermals, or rising currents of air, which can give efficient gliders enough boost to get the job done, but thermals will typically provide less than 500 feet per minute of vertical speed... not enough to even keep a lightweight Cessna in the air!)

Now with the Space Shuttle, it is certainly true beyond doubt that it has engines. Three liquid-fuel rockets putting out 375,000 pounds of thrust EACH, to be exact. (To put this in perspective, a fully-loaded Boeing 737 tips that scales around 130,000 pounds or so, so EACH ENGINE of the orbiter could punch the Boeing straight up three times the acceleration of gravity indefinitely.. and that is not even considering the solid rocket boosters attached to the Shuttle's fuel tank that provide MILLIONS of pounds of thrust!)

I think this safely establishes that the Space Shuttle has engines.

The problem is FUEL. The orbiter exhausts everything it's got getting up INTO orbit, and there is nothing left for the trip down: Thus the ship is a glider all the way from orbit to touch-down on Earth. With the final bit of fuel that is left after the mission, the orbiter fires its smaller de-orbit engines to slow it down to a bit over 15,000 miles per hour (I love saying that... SLOWING DOWN TO A BIT OVER 15,000 MILES PER HOUR) and begins it's descent into the atmosphere.

Now we have to remember the cardinal rule of gliding: ALWAYS AIM LONG (PAST your landing point, not short), BECAUSE IF YOU EVER AIM SHORT YOU ARE DEAD SINCE YOU CAN NEVER MAKE UP LOST SPEED OR ALTITUDE WITH NO ENGINES. Aim LONG since you can always dissipate the extra speed and altitude with turns or speedbrakes if you wind up being too HIGH, but you are SCREWED if you come up SHORT.

Following this rule, the orbiter intentionally flies it's glide from orbit

EXTRA HIGH TO BE ON THE SAFE SIDE.

But there is one problem: If the orbiter flies it's entire approach too high, won't it glide right past Edwards? No.

And here is why: For most of the re-entry, the shuttle flies with the nose WWWAAYYY up for EXTRA drag, and making steep turns to intentionally dissipate the extra energy. The nose-up attitude and steep turns are very inefficient, causing the shuttle to slow down and come down to earth in a steeper glide-angle... and if it ever looks like the orbiter might not quite be able to make it to the landing zone, they simply lower the nose to be more efficient and level it out in roll to quit flying the steep turns... the orbiter then glides better, and they can stretch the glide to Edwards for sure. The extra speed and altitude is the ace up their sleeve, but the drawback is they have to constantly bleed the energy off through steep turns (up to 70 degrees bank angle!) and draggy nose up (up to 40 degrees!) to keep from overshooting the field!!!

OK, I will now walk you through the re-entry process from the beginning, as it is done in the real shuttle, and all of this carries over perfectly to the shuttle landing in X-Plane, which you will fly after reading this chapter.

After de-orbit burn, the shuttle heads for the atmosphere at 400,000 feet, 17,000 miles per hour, and 5,300 miles away from Edwards. (Yes, you are landing in the Mojave desert and you are starting your landing approach West of Hawaii). Not a bad pattern entry, huh? In reality, the autopilot flies the entire 30-minute re-entry, and the astronauts do not take over the controls of the shuttle until the final 2 minutes of the glide. The astronauts COULD fly the entire re-entry by hand, but it is officially discouraged by NASA. Something about the gruesome death of hurtling through the upper atmosphere at Mach-20 on fire if the pilot messes up, I think. In the history of Shuttle missions (the 100th mission has just come to a close as I write this), the real space shuttle has been hand-flown for the entire re-entry only ONCE, by an ex-marine pilot, as I understand it, who was ready for the ultimate risk and challenge. Oh yes, did I mention you will be hand-flying the entire mission in X-Plane as well?

I have not gotten around to writing an autopilot for the Space Shuttle in X-Plane yet... I will have to do that some day... maybe after I sort my sock drawer...

Anyway, you start in X-Plane around 400,000+ feet, in space, coming down to eat air like a bag of bricks at Mach-20. Your control will be limited in space (you are operating off of small reaction jets on the Orbiter, set up as "Puffers" in Plane-Maker), but once the shuttle hits atmosphere, there will be some air for the flight controls to get a grip on and you will actually start to be able to fly the thing. You will first hit air at about 400,000 feet, but it will be so thin it will have almost no effect at all. Your airspeed indicator will read around ZERO. Kind of odd since you are actually doing over 15,000, huh? Not really. The airspeed indicator works just like the wings of the orbiter: based on HOW MUCH AIR IS HITTING IT! And in space, that ain't much! It will build gradually as you descend. The odd thing is that even though you are actually SLOWING DOWN, the airspeed indicator will RISE as you descend into thicker air that puts more pressure on the airspeed indicator! You LIKE this oddity of the airspeed indicator, though, since the air is also putting more pressure on the WINGS, so the airspeed indicator is really measuring how much force the WINGS can put out for you, which is really what you are interested in!

bottom line: the airspeed indicator indicates your true airspeed times the square root of the air density, so it indicates lower in thin air, but the wings put out less lift in thin air as well, so the airspeed indicator works very well to tell you how much lift you can get out of the wings. (Word to the wise: If the airspeed indicator is putting out MORE than about 250 knots, your wings can have plenty of lift to carry you.. if the airspeed indicator is indicating LESS than about 250 knots, then the wings do not have enough air hitting them to lift you, and you are still more or less coasting in the thin upper atmosphere where the air is too thin to do much for you.)

So as the airspeed indicator on the HUD gradually starts to indicate a value (as you descend into thicker air), you know it means you are starting to ease down into the atmosphere at 15,000 mph like a sunburned baby trying to ease into a boiling-hot jacuzzi: VERY CAREFULLY AND SLOWLY. Remember, if you were going 15,000 mph in the thick air of sea level, you would break up into a million tiny pieces in a microsecond... the only reason you can survive 15,000 mph up here is the air is so thin it has almost no impact on the ship. (And again, the airspeed indicator tells you how much the air is really impacting the Orbiter... 250 is a "comfortable" amount). The trick is for you to be going a lot slower than 15,000 mph by the time you get down to the thick air of sea level. And be at Edwards Air Force Base. And that is what the re-entry is for... dissipating speed as you descend so that you are never going too fast for the thickness of the air that you are in... you only descend into the thicker air once you have lost some speed in the thinner air up higher... the whole thing is a smooth process where you never ram the ship into thick heavy air at too high a speed.

Now as you begin to feel the out tinges of the earth's atmosphere, you will notice a slight ability to fly the ship as you get some air over the wings and speed on the HUD.. now look at the picture of the orbiter on the right-hand EFIS display... the Atlantis already has this display retrofitted over it's old steam gauges (the EFISs from the Atlantis are modeled very accurately in X-Plane.. astronauts could use it for familiarization for sure). You see yourself and the path down to Edwards. Your goal is to stay on the center path. If you get above it, you are too fast or too high... you might overshoot! If you get below it, you are too slow or too low: You might not make it! (Remember ,the line is drawn with a large margin for error, so if you stay on the line, you have plenty of extra energy... getting BELOW the line a LITTLE will only tap into your speed/altitude reserve... getting BELOW the line a LOT will keep you from making it to Edwards) You must stay right near the center green line. The green line represents the desired SPEED for the early part of the re-entry, the desired TOTAL ENERGY for the middle part of the re-entry, and the ALTITUDE for the final phase of the re-entry. Don't blame me, that is the way NASA set it up. If you are too FAST OR HIGH (above the center line) then it is time to dissipate some energy: put the thing in a steep bank, pull that nose up and hang on!

The REAL orbiter will be about 40 degrees nose up, in a 70 degree bank to try to lose energy, going 14,000 mph, glowing red hot, hurtling through the upper atmosphere on autopilot leaving a 10-mile long trail of ionized gas behind it while the astronauts just watch.

So how was YOUR day?

Anyway, you will do steep turns to dissipate energy as needed to keep the orbiter from going above the center green line. Look at the little blue pointer on the far left-hand side of that right-hand display. That indicates how high the nose is supposed to be. The green pointer is where the nose is now. Get that nose up. The pointers just to the right indicate the desired and current deceleration... you will not fly those, though. Look at the little pointer up top on the horizontal scale. That is the computer's estimation of how much bank angle you probably need to stay on the center green line. Follow the computer's recommendation or your own intuition for how much bank to fly, but keep that nose up for sure to keep you in the upper atmosphere and fly STEEP BANKS to dissipate the extra speed and altitude. You might be tempted to just push the nose down if you are high. Don't. You will drop down into the thick air and come to an abrupt stop from the tremendous drag, and then you will never make it to Edwards. You will wind up swimming in the Pacific somewhere around Hawaii. Now, as you make your steep turns, you will be pulled gradually off course. Switch your turn direction from time to time to stay on course... turn left a while, then right, then back to the left again. That is what they do in the real Orbiter... you are slalom-skiing through the upper atmosphere at Mach-20. Not too shabby. Watch Edwards on your center EFIS display. You want to go there. Hit the "@" key to see yourself on a flyby. Fast enough for you? Hit the "w" key to get back in the cockpit. Caps lock off! Caps lock off!

As you approach Edwards, right on your center green line on the right-hand display, you will notice there is sort of a circle or something out past Edwards. This is your Heading Alignment Cylinder, or H.A.C. You will fly PAST Edwards at about 80,000 feet or so, fly AROUND THE OUTSIDE OF THE H.A.C. like you are running around a dining-room table or something, and then after you come around you will be pointed right at Edwards. And if you are on the green line still, your altitude will be just right for landing as well. This is usually where they turn off the autopilot and hand-fly the real Shuttle.

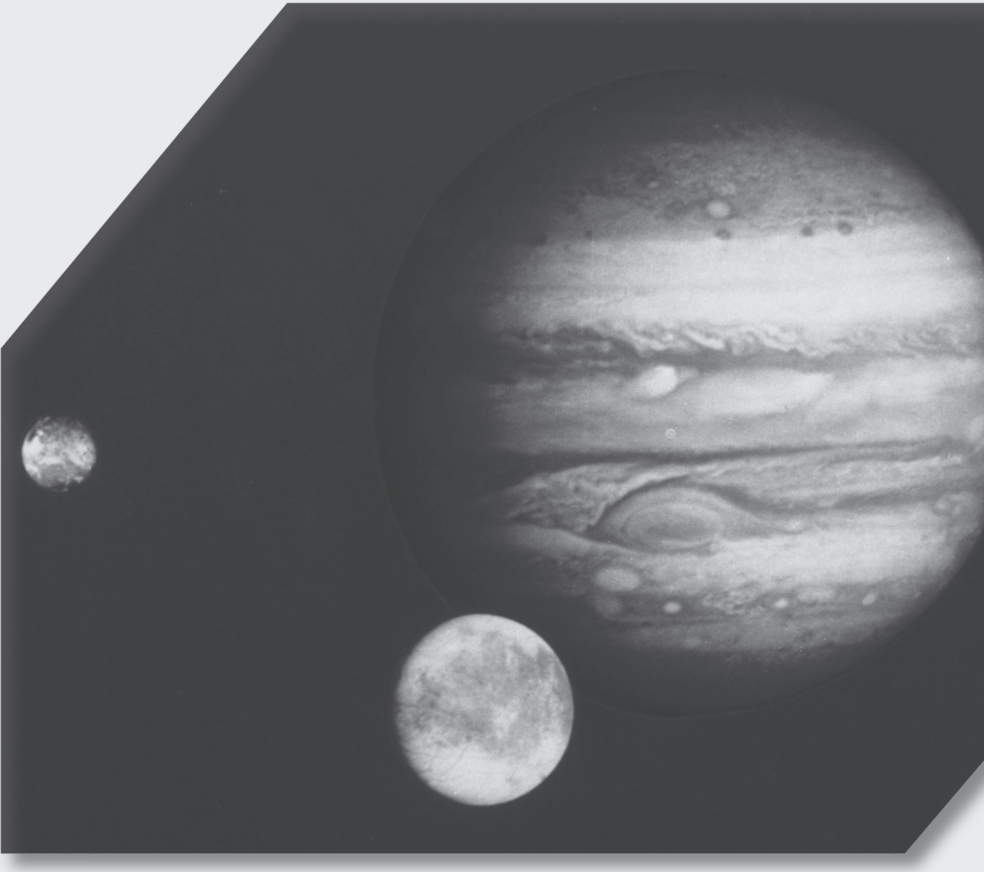
Now you are doing about 250 or 300 knots, coming down at about 15,000 feet per minute or so... about 125 miles per hour of descent rate. Do I really need to tell you what will happen if you hit the ground with that 125 miles per hour descent rate? Do not aim for the runway or you will wind up smeared along it in a thin buttery paste. Aim for the flashing glideslope lights 2 miles SHORT of the runway that I (and NASA) have thoughtfully provided for you. If they are all red, you are too low. (oops) If they are all white, you are too high (hit your speed-brakes, key "6" or use the mouse). If the lights are half red and half white, you are right on your glideslope. (about 20 degrees... airliners fly their approach at 125 knots, 3 degrees descent angle.. we use 250 knots, 20 degrees descent angle... not too unusual when you consider pattern-entry started West of Hawaii, actually).

OK so you are at 250 knots, on the green line, lined up with the runway, looking at half red, half white glideslope lights with the flashing strobes by them. Hold that approach configuration until the you are pretty close to the ground (3-degree glideslope to the runway), then level the descent and get your gear down. ("g"-key or mouse) Get the nose up for a flare as you approach, and touch down smoothly. Now lower the nose. Now hit the parachute and even the brakes if you want and let it roll out.

Now do it 100 times in a row without a single hitch and you are as good as NASA.

austin

PS: Special thanks to Sandy Padilla for providing most Shuttle re-entry information!



Flying on Mars

NASA has very exact data on the atmospheric pressure, density, and temperature on Mars.
NASA has very exact data on the gravity of Mars.
NASA has rough topographic maps for the entire planet of Mars, and very detailed data for some areas.

The laws of physics, which are programmed into X-Plane, are the exactly the same on Earth as on Mars. X-Plane needs atmospheric pressure, density, temperature, gravity, and topographic maps to deliver an engineering-accurate flight simulation.

Enter a new level of flight simulation. X-Plane can simulate Mars.

The following is an e-mail sent by Austin Meyer, author of X-Plane, to the X-Plane community, at 4:35 AM, February 24, 2000:

I DID POSSIBLY THE MOST EXCITING THING I HAVE EVER DONE TONIGHT. (OK, technically I finished it THIS MORNING). As some of you may know, I have been gathering data on Martian atmosphere, gravity, surface "texture", and topography for X-Plane from various NASA sites (http://ltpwww.gsfc.nasa.gov/tharsis/mola.html, for example)

I do NOT yet have the TOPOGRAPHY for Mars, but I DO have everything else, and I have gotten it all entered into X-Plane and designed two planes to fly on Mars as well, and have been experimenting with deign and flight on Mars for the last 6 hours or so. (Could I be the first human to fly a real-time flight simulation of Mars? I have seen many "movies" of "flying" over Mars terrain, but NONE have been hooked to an actual realistic FLIGHT MODEL... has NASA done a REAL-TIME simulation of Mars flight in a PILOTED aircraft? Has ANYONE?) Well, I have for the last 6 hours, AND IT IS FRIGGIN FASCINATING.

First of all, the atmosphere is ONE PERCENT as thick on Mars as it is on earth... INDICATED airspeed is proportional to the square root of the air density, so the INDICATED airspeed is ONE TENTH the true airspeed.

The result: If you take off with 60 knots on the airspeed indicator, your REAL speed is SIX HUNDRED KNOTS! (about Mach 1) Take it from me, Mach-1 takeoffs are quite a thing to behold, when the plane will barely leave the runway at that speed.

While there is almost no AIR for you, you do have the (sort of) advantage of only about ONE THIRD the GRAVITY, so it is three time easier to get airborne!

Result: A take-off in a well-designed airplane can occur at a "mere" 400 knots or so, indicating all of 40 knots on the airspeed indicator!

Sound easy? IT ISN'T, BECAUSE WHILE YOUR GRAVITY (WEIGHT) IS ONLY ONE-THIRD OF EARTH'S, YOUR INERTIA IS STILL THERE IN FULL FORCE! So you are flying with only 1/3 the total lift of what you are used to having to stay in the air, which seems fine UNTIL IT COMES TIME TO TRY TO TURN OR FLARE!!!!! THEN you see that while the lift for STAYING airborne is only 1/3 of Earth's, the INERTIA, and thus the lift needed to CHANGE DIRECTION (this includes the landing flare!) IS STILL THERE IN FULL FORCE! The problem is, you DON'T HAVE THAT KIND OF LIFT, SINCE THE AIR IS SO THIN!

Bottom line: All airplanes on Mars are AIRBORNE TITANICS:
Ripping blissfully along, unaware of their impending doom due to their inability to TURN against their tremendous inertia.

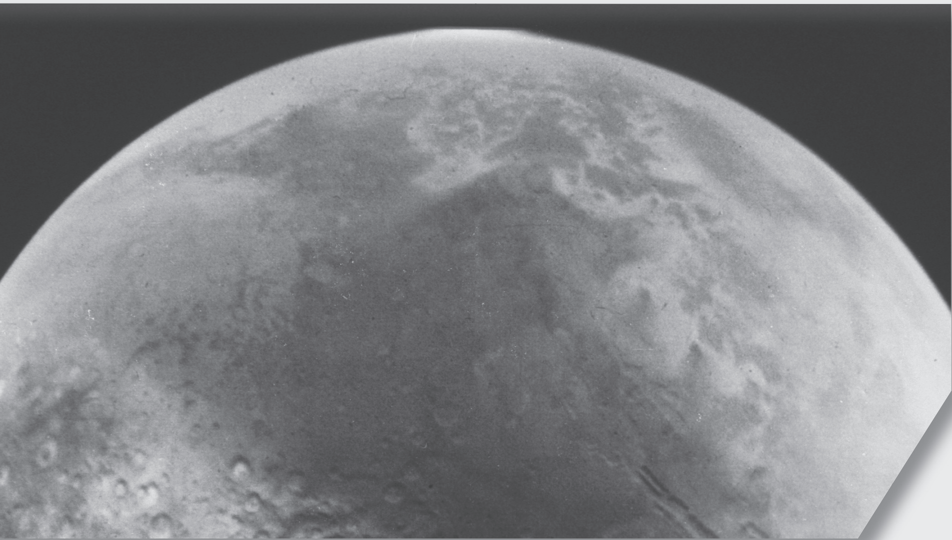
Landings are impossible without arresting gear. If you can work the flare out right (it IS possible with advance planning) then you will touch down doing about 400 mph. Now how do you stop?

• PARACHUTE? NOPE!!!! 400 mph is only 40 mph worth of drag due to the thin air. You will run off the end of the runway going 100 mph with the chute only "seeing" 10 mph: USELESS for slowing down.

• BRAKES? NOPE!!! You only have one-third gravity, so only 1/3 of your weight on the wheels. NO TRACTION!

• REVERSE THRUST? NOPE!!!! With only 1% atmosphere, jet or prop engines can put out basically no thrust... just barely enough to keep the airplane in flight at mach-0.85.. the jet plane needs a JATO to take off!

So how do you stop? I finally went with ARRESTING GEAR. I know of no other way to avoid blasting off the end of the runway at 200 knots with the chute uselessly deployed and brakes uselessly locked.



Speaking of which, CRASHES are interesting. No air drag to slow the tumbling planes down, and little gravity to drag them to a stop against the ground! Crashes look like "the Agony of Defeat" from the Olympics where the guy on the downhill ski-jump bites it near the top of the ramp and tumbles on and on and on, powerless to stop an accident that started hundreds of yards earlier! (though on mars, at 400 mph, your plane will tumble across the plains for MILES!)

CRUISING ALONG OVER MARS is SPECTACULAR, with the scary red-orange Martian sky, new Martian rocky-red terrain textures, VISIBLY thinner air (due to modified lighting in OpenGL, modified fog in OpenGL, and visibility of stars).. you really can tell you are halfway between air and space! Returning to Earth, you feel like you are flying in soupy water! Yuk!

So what sort of planes can fly on Mars? Not anything from Earth, that's for sure. Not enough lift or thrust. A Cessna or Boeing will just sit there on the ground without even moving. Put them in the air and they drop like beveled bricks with no wings. Both of my Mars-plane concepts are much like the U-2 Spyplane (designed to operate at around 100,000 ft, in similar density air) one with a HUGE high-bypass jet engine built AROUND THE FUSELAGE, and another with a smaller rocket engine in the tail, like the X-15. The rocket plane has a lower-thrust engine, with plenty of fuel, for about 30 minutes of flight or so... the JET plane can fly for hours!

My designs are realistic (again, based on the U-2, with reduced weight for the lower structural needs (lower gravity) and modern (composite) materials). The rocket-plane is pretty much guaranteed feasible (known technology across the board) but the jet-powered one I am not sure about since Mars has so little OXYGEN in the atmosphere it may be impossible to keep a turbofan engine running. (My Mars jet-plane has twice the average fuel-consumption, though, to simulate injection of liquid oxygen or nitrous oxide). Bottom line, I now know it IS possible to build and fly a piloted plane on Mars and I now know what it would be like. (though I used a 10,000 ft runway with arresting wires... none of those on Mars now I admit).

INTRO TO PLANE-MAKER

About Plane-Maker:

X-Plane comes with a handful of airplanes ranging from the Cessna 172 to the Space Shuttle…that should be enough to keep you busy for a while.

In the event it is not, you can use Plane-Maker to design your own airplanes. You will enter the DIMENSIONS of your aircraft in Plane-Maker, and X-Plane will then try to figure out how your airplane will fly.

This is totally different from every single other flight simulator in the entire world, in which you tell the simulator how the airplane will fly, and it spits the results right back out at you, thereby teaching you absolutely nothing.

Once you have designed your airplane in Plane-Maker, you can save it to your hard disk (anywhere in the X-System folder will do) and then take it flying in X-Plane. You can also upload your planes to the internet, download other people's planes, etc.

In this chapter we will walk through the aircraft design-entry process. For engineers, this should be easy. For pilots not as well versed in the fundamentals of aircraft design, fear not! We will explain things for all audiences as we go.

(see the "Plane-Maker Instructions.txt" file with the copy of X-Plane for the latest info!)

Terminology:

You will have to enter the locations of various parts of the aircraft (of course), so the first thing you should do is pick a reference point (such as the top center of the firewall, for example, or the back of the

spinner) to take all of you measurements from.
Plane-Maker will ask for the following dimensions for each part:

longitudinal arm (abbreviated "long arm"), which is the distance the item is behind the reference point (use negative numbers for items forward of the reference point).

vertical arm (abbreviated "vert arm"), which is how far the item is above the reference point (use negative numbers for items below the reference point).

lateral arm (abbreviated "lat arm"), which is how far the item is to either side of the reference point. (All aircraft are assumed to be symmetrical, so most lateral arms are positive, indicating simply the distance from the fuselage centerline. In other cases, the lateral arm is positive-right. You will be able to figure out which convention to use based on the situation).

Again, you may use any reference point you wish, just be sure to use the same reference point for all of the items on each aircraft design!

OK let's go. We will go through every function of Plane-Maker now:

1: Launch "Plane-Maker".
2: Go to the "File" menu and select "Open",
3: Select an airplane, like the Mooney in the "General Aviation" folder, that you wish to modify. (Don't worry, none of the changes you make will be saved unless you decide to save in the "File" menu.. and even then you can save under a different filename and thereby not mess up your Mooney!)

As we go through this tour, change any of the design data you want to customize the airplane that you just opened. You then can fly the modified design when you are done.
You can save all the aircraft design you like on your hard disk, naming

them anything you like, and open them up later in X-Plane just like word-processor files!

Plane-Maker Menus

Here We go...

OK, with the airplane of your choice opened, we will go through each window in Plane-Maker... you will fill data into each of these windows to design your own plane, if you want to. Just leave the mouse still for a second over any number to get a description of that number in plain english... with the on-line help explaining each number individually, this manual will speak in general terms only, not duplicating your reading by covering each individual number unless it warrants special attention.

Now, go through each item in each menu, looking at the values there and reading the description here, entering values for your dream plane if desired.

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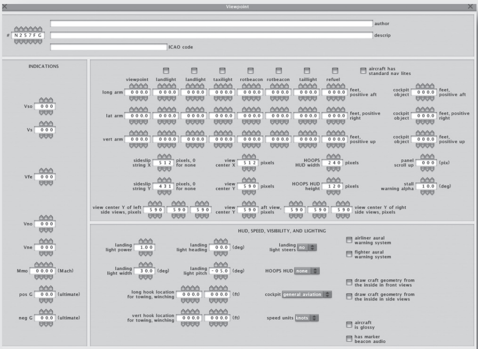
Viewpoint

This window is for entering general pilot's viewpoint info. The left-most box contains the airspeed-indicator markings. These speeds are not used to determine airplane performance in any way, but are ONLY for airspeed indicator markings! Make test flights to determine spe-



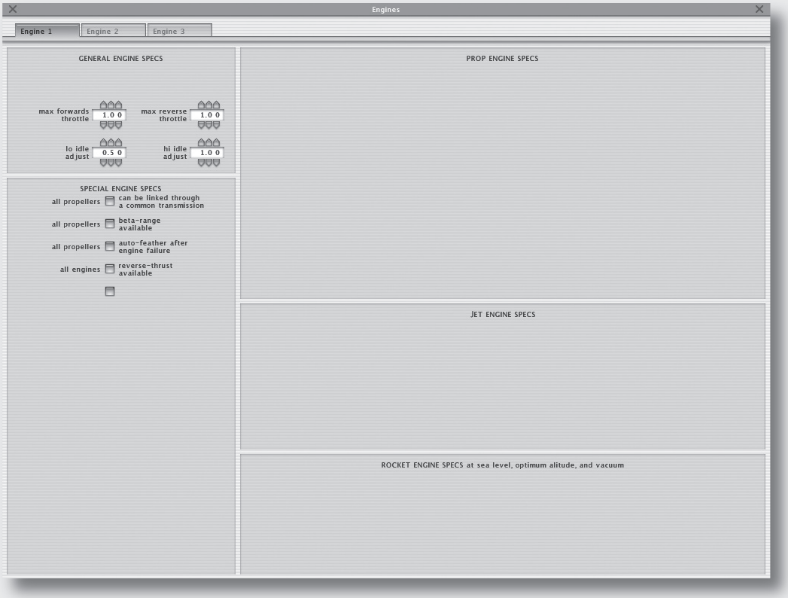
cific speeds for your design if needed. Be sure to set Vne high enough, because X-Plane will break the airplane up if you exceed Vne!

Here is a quick review of the V-speeds in case you need them:

- Vso stall speed flaps down ("dirty" approach configuration)
- Vs stall speed flaps up ("clean" configuration)
- Vfe maximum flap extension speed (don't get them torn off)
- Vno maximum rough-air speed or "normal operation"
- Vne maximum allowable speed or "never exceed"
- Mmo maximum allowable mach number (if required) The pilot's eye viewpoint is also entered here. This is simply the location of the pilot's viewpoint while flying. Also enter the location of the various landing lights, nav lights, etc.

Use the long arm / lat arm / vert arm convention explained in the previous section.

Panel
Enter the instruments you want and the locations of those instruments on the panel by simply pointing and clicking. The interface is self-explanatory…simply choose instruments from the list and drag them into place... very easy!
DRAG INSTRUMENTS ALL THE WAY OFF THE SCREEN TO DELETE THEM.



Force-Feedback

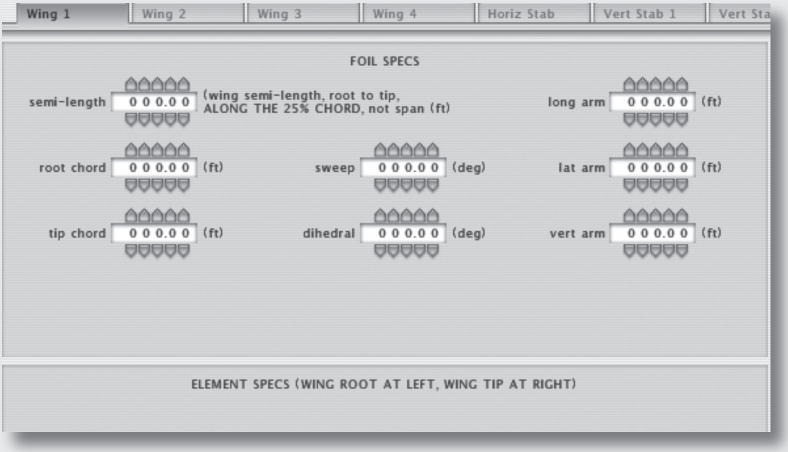
Force-feedback joysticks are joysticks with motors in them that actually move the stick in your hands. X-Plane does not support force-feedback joysticks now, but this may be added later. Parameters that are relevant to force-feedback are entered here.

Engines Specs 1 & 2

One tricky area is the number of engines. (!) For prop airplanes, enter the number of propellers here. If you have multiple engines going to one propeller, just enter the number of engines as ONE (per propeller), and enter the power of all the engines added together as their (total) engine power (directed to that propeller).

Another tricky area is the "Design Point" (RPM, advance, and associated speed). The design point is the speed and RPM that prop is designed for. It is probably close to the climb or cruise speed and their associated RPM's, but this up to you!

Prop Pitch Limits: When you fill data in the design-point boxes, Plane-Maker will guess at the pitch-limits automatically. You may override Plane-Maker's guesses, though, by entering data here. As soon as you change the design point, however, Plane-Maker will put in it's own best guess again! Be sure to enter zero if you have a fixed-pitch prop.



Wings, Horizontal Stabilizer, Vertical Stabilizers, and Pylons

These are all the wings that contribute lift, drag, and pitch-moment in X-Plane. (Yes, even engine pylons can produce lift! They are therefore treated as airfoils in X-Plane, just like the wings and stabilizers are!)

Note: For any surface (like wing numbers 2 and 3, vertical stabilizer number 2, or whatever) that your design does not have, enter zero for the wing semi-length. This will tell X-Plane that your aircraft is not equipped with that particular part.

Semi-Length, Root Chord, and Tip Chord: The "semi-length" is the length of the wing from the root to the tip, measured along the so-called 25% chord.
This is the length of the wing from its root to its tip, as measured along an imaginary line that is 25% of the way back from the leading edge of the wing to the trailing edge. Note: This is NOT really the span, since the span is shortened on SWEPT wings!

Also note that the wing root is usually thought of as being inside the fuselage, at the aircraft's centerline. There are exceptions to this rule, but we usually put the wing root here, since air pressure from the wings carries over the fuselage to a large extent. As far as the air is concerned, the wings really do go all the way to the centerline of the fuselage!

Enter the root chord ("width" of the root) and tip chord ("width" of tip). Remember that the chord is the distance from the leading edge to the trailing edge of the wing.

The sweep is the sweep of the 25% chord. Aft (backward) sweep is positive. Forward sweep is fine, just enter it as negative. The Mooney wing has a slight forward wing sweep. Enter the dihedral (angle of each wing above the horizontal plane). Positive (wingtip-up) dihedral is entered as positive. Negative dihedral, or "anhedral" is fine as well. Just enter it negative. For variable sweep wings this value is the MINIMUM sweep value!

Wing sweep makes sense above about 70% of the speed of sound or so, where there is a large drag penalty associated with trying to meet the air head-on. Dihedral helps with stability in roll... if the wings have some healthy dihedral then the plane will tend to roll wings-level (eventually) if you take your hands off the stick... the drawback is that if you ever get into a SIDESLIP situation due to losing an engine on one side or something like that, the plane will try hard to roll into the sideslip because of the dihedral effect. (Sweeping the wings actually causes the plane to act somewhat like it has dihedral, even if it really doesn't!)

Has drag-rudders trailing that wing element:
The Northrop B-2, among other flying wings, has things that look just like ailerons on the wing tips. The difference is, they split open rather that going up and down. This produces drag, which acts like a rudder for the flying wing. You can try that with your flying wing designs here. (Just remember to enter a horizontal stabilizer area of zero for your flying wing designs!)

Note to flying-wing designers: You can have the "ailerons" on the trailing edge of the outboard part of the wing deflect in unison to act as elevators. You will use the "deflect ailerons with elevators" option in the "Special Controls" menu coming up soon. Just select the part of the wing that has elevons as having ailerons on this screen.

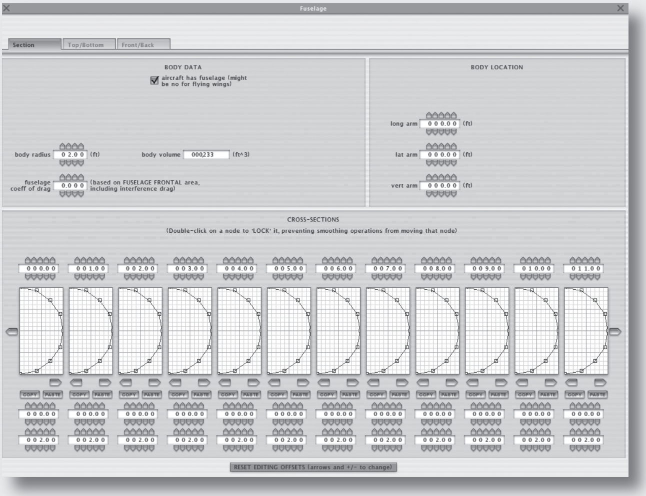
Horizontal stabilizers type:

(a) Select "stabilizer" if you want the stabilizer fixed, with an elevator on the back (like on most Cessnas), or

(b) a "stabilator", if you want the whole surface to move with joystick deflection (like on most airliners).

If you want to fly a canard airplane, no problem! Just enter a long arm for the horizontal stab that is in front of the wing. X-Plane will see that you have put the stabilizer in front of the wing and automatically deduce that you are flying a canard. It will then reverse the elevator or stabilator deflections from a conventional plane to give the correct response.

X-Plane will automatically cast downwash from the canard onto the part of the aft wing that is behind the canard. If you are flying a conventional design, X-Plane will cast downwash from the wing onto the stabilizer or stabilator. See the file "X-Plane.out" after flying your design to see what X-Plane is doing with downwash on your design, if you want. Do this by opening "X-Plane.out" with your favorite word processor.



Fuselage, Nacelles, Fuel Tanks, and Wheel Fairings
These are the bodies that create mostly just DRAG in X-Plane (they the fuselage can create some small amount of lift).

Most of the contents in these windows is self-explanatory, but the fuselage coefficient of drag may require some explanation:
The fuselage drag coefficient must include the drag due to fuselage/wing interference, fuselage/stabilizer interference, and any other drag that is not accounted for by the wings, stabilizers, and landing gear. If

you do not have firm data on what the coefficient of drag is, you can make a guess along the following guidelines:

- Use 0.05 for a super-sleek machine (like the Lancair 360).
- Use 0.10 is a decent guess for a reasonably "clean" airplane.
- Try 0.15 for a somewhat "dirty" design.

Remember, this is the coefficient of drag of the fuselage and miscellaneous appendages, including interference drag, based on the frontal area of the fuselage.

If you want to get this data more scientifically, and you already have a coefficient of drag for your entire aircraft which is based on the wing area, just subtract out the drag associated with the wing, horizontal stabilizer, and vertical stabilizer to get the drag of the fuselage.

This requires an example:
Assume the coefficient of drag (at zero-lift) of your airplane is 0.015, based on a wing area of 150 square feet, with a fuselage frontal area of 10 square feet. Let us further assume that your wings, horizontal stabilizer, and vertical stabilizer have a coefficient of drag of 0.005 at zero lift. (In "Part-Maker" you may verify these numbers).

Follow this process to find the coefficient of drag of the fuselage, including interference drag, based on fuselage frontal area:

- Find wing area = 150
- Find horizontal stabilizer area = 30
- Find vertical stabilizer area = 30
- Add those to get total airfoil area (150+30+30) = 210
- Divide total airfoil area by wing area (210/150) = 1.4
- Multiply this by the airfoil coefficient of drag (1.4 x 0.005) = 0.007
- Subtract this from the total coefficient of drag (0.0150.007) = 0.008
- Find the ratio of wing area to fuselage area (150/10) = 15.0
- Multiply this by the coefficient of drag (15 x 0.008) = 0.12

The final number is the fuselage coefficient of drag (including interference drag) based on fuselage frontal area. Now enter this into "Plane-Maker". Fun, quick, and easy!

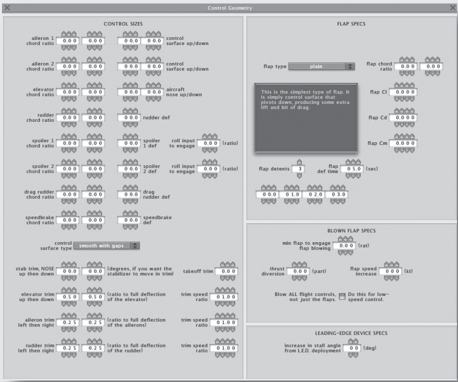
Section Cuts:

Drag the little squares around with the mouse to define the fuselage geometry. Close the window and look at the airplane on the main screen to see the results of your handiwork. X-Plane will determine aerodynamic and mass properties of your airplane based on the fuselage geometry, so enter this data accurately!

The frontal area will be used for drag, and the side and top area will be used for lift and sideforce. The weight of the airplane will be distributed across the airplane as well to determine it's angular moments of inertia.

Control Geometry

Set control surface sizes and deflections here. For the controls that you don't use (for example roll spoiler in a plane without roll spoilers) just enter zero.



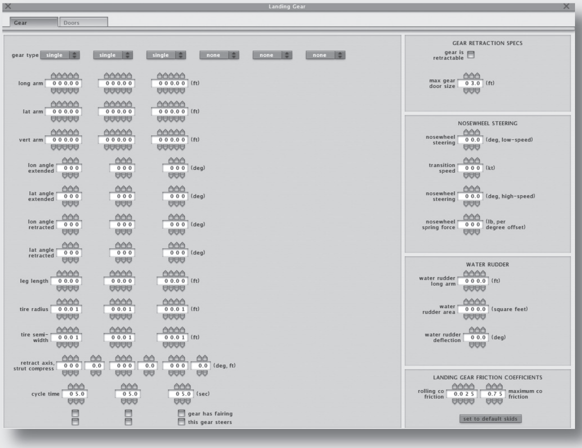
The "chord ratio" is the fraction of the distance from the leading edge to the trailing edge that the surface takes up. It is the part of the total wing chord taken up by the control surface. Almost all controls will be in the 15% to 25% range, depending on the control response required. If you have no blueprint or picture on hand it requires some testing to find the optimum values.

Weight & Balance

Center of gravity location

Enter the longitudinal and vertical centers of gravity. The longitudinal center of gravity may be close to or just behind the longitudinal location of the wing that you entered in the "Wing" section. The vertical center you can more-or-less guess... it's in the fuselage of the airplane somewhere. Scoot it up a bit if you are flying a plane like the Lake Amphibian which has the engine way up over the fuselage. Scoot it down a bit for airliners which have large engines hanging below the plane.

Enter the weights of the airplane as well. Empty weight is the weight with no fuel, water, or other payload aboard. Maximum weight is the maximum weight you are allowed to fly at. The fuel load is simply the maximum fuel you can put in the machine, the water load (used for forest-fire bombers) is the jettisonable load that you carry. There will be a water-dump button next to the anti-ice button in the cockpit if your aircraft carries water. Dumping he water over a forest fire puts the fire out.

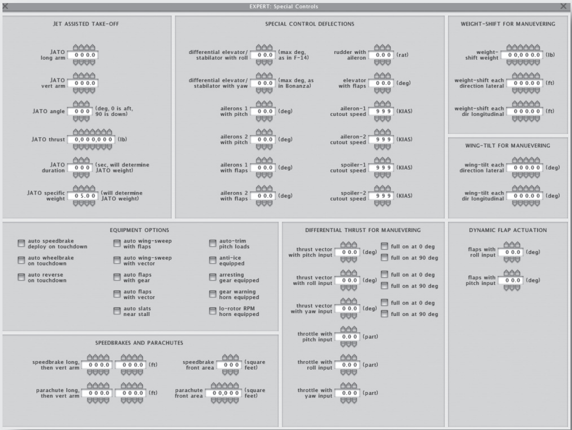


Landing Gear

Use this to set the landing gear tire contact point (with the ground) locations. Remember this data is WITH THE GEAR DEFLECTED UNDER THE GROSS WEIGHT OF THE AIRCRAFT

Nosewheel steering

This is how many degrees the nose wheel turns with full joystick or rudder-pedal deflection at various speeds. 2.0 degrees might work well for you at high speeds, and much more for lower speeds. (Remember that in a real airplane, the nose wheel may end up being turned more than this by differential braking... a pilot would only do this at low speed, though! Remember also that while the nosewheel steering on an airliner may only be a few degrees from rudder-pedal travel, he has a little "steering wheel" off to the side that can steer the nosewheel through almost 90 degrees! Bottom line: Enter a large number for low-speed use to simulate the steering tiller in airliners or differential braking in a light plane, and enter a smaller number at higher speeds to simulate nosewheel steering to being only hooked up to the rudder pedals).



The Expert Design Menu

Airfoils

This is where you select the airfoils for the airplane that you made in Part-Maker. (Though X-Plane comes with a handful of airfoils so you never really have to make any new ones). FIND THE AIRFOILS IN THE "RESOURCES:AIRFOILS" FOLDER.

Variable-Sweep Wings:

Enter whether or not the wing has variable sweep (like the F-14 and B-1). In this case the wing sweep will vary from the degrees of sweep already assigned to the wing in the regular "Wing" window to the amount you enter here in the wing sweep box. Control the sweep during flight by moving the wing-sweep control in the cockpit. Aerodynamic effects of both wing sweep and moving of the center of lift fore or aft are simulate by X-Plane.

Special Controls

There is a ton of cool stuff in here... let's go through the tricky stuff:

JATO
Jet Assisted Take Off is a takeoff where a solid-rocket fuel booster is strapped onto a C-130 or the like to boost the airplane into the air in hurry, making extremely short-field takeoff possible. Just enter the location, thrust direction (0 is straight back, 90 straight down), thrust force, and duration. A properly-mounted JATO will have it's thrust line go through a point close behind the airplane's center of gravity.

Stabilator/Elevator Differential Roll Deflection
F-22's deflect their stabilators in opposite directions to help roll. Question: How will a Piper Arrow roll if you do the same thing? Answer: The stabilators are so short you won't get much response. They can complement the ailerons, but not replace them. This feature also works on elevator deflection if you are flying an airplane with stabilizer rather than a stabilator.

Aileron With Elevator
The "aileron with elevator" coupling may seem strange, but flying wings might use the same control surface for both pitch and roll. If the "aileron with elevator" coupling is set to 0.5 x the control geometry value of the aileron (ie. 20°), then pulling full back on the stick will deflect the ailerons up halfway, causing the flying wing to pitch up. (Remember the flying wing has a swept wing, so raising the ailerons is like raising the elevator on a conventional plane: it pushes the back of the plane down, raising the nose). This poses an interesting idea for conventional airplanes: What if pulling back on the stick pushed the tail down (regular elevator) and the main wings up (with aileron-droop)? This would increase pitch response and help lift the airplane! This is something you might try on the Cessna 172. Note that a positive numbers pull the aileron upward when the elevator goes up, and negative numbers will push the aileron down. Test this phenomenon while viewing the airplane from the outside with the "|" key to see the controls move.

Arresting-Gear Equipped
Arresting gear is used for carrier landings. If you shoot a carrier approach remember to lower your arresting gear! Use the little button in the glareshield's auxiliary instrument bar.

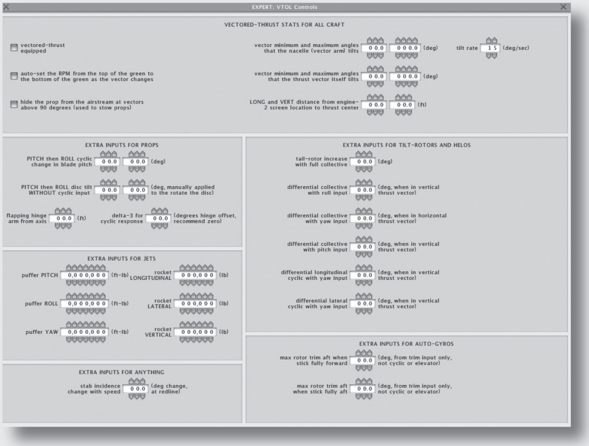
Aural Warning Equipped
Aural warning system equipment warns you of being too low, coming down to fast, not lowering your landing gear, etc.

Automatic Deployment
Automatic deployment of slats, brakes, and speed brakes (like airliners have) can be had. You can also select automatic wing sweep with flap retraction. This is used by the Beech Starship. As the flaps retract, the canard sweeps aft to keep the plane in balance. This option only works with airplanes that have variable-sweep wings or variable-sweep horizontal stabilizers.

Speedbrake Frontal Area
Enter the frontal area of the speedbrakes when fully deployed here. This doesn't include speedbrakes, or spoilers, that are mounted on the wing. This option only applies to speedbrakes that are mounted on the fuselage (or maybe other places) that do not affect the lift of the airplane, but only the drag.

VTOL Controls

Designing a VTOL (Vertical Take-Off and Landing) aircraft is fun but challenging. Enter "yes" or "no" in the selection box to indicate whether you want your aircraft to vector thrust for hovering or not.



The tilt-rotor VTOL (Vertical Take-Off & Landing) aircraft can obtain its flight control in the same way a helicopter does: by adjusting what is known as the "cyclic pitch" of the rotor blades. This is a process whereby the pitch of the blades varies depending on where the blade is on its trip around the hub. This creates a lift asymmetry that will pitch or roll the aircraft. In this window you enter the degrees of pitch that a blade is increased or decreased with full joystick pitch and roll deflections.

Another way to obtain control of a VTOL aircraft is to do it the same way the AV-8B Harrier does: "puffers". The British like to talk about how they invented the idea, and can't figure out why we Yankees didn't come up with it sooner. The concept is simple.

Bleed air is taken from the compressor and then sent out through little jets on the tail and wing tips to steer the airplane around when in hover. "X-Plane" takes the simplest possible approach to simulating this: you just enter the pitch, roll, and yaw moments associated with full joystick deflections. (Remember if you don't know what the maximum moment is, just multiply the force exerted by the puffer times the distance from the puffer to the center of gravity of the airplane to get the moment). If you don't know how much force you need, try some values to see if they give you comfortable authority. That is what the simulator is for!

Note on propeller-equipped VTOL aircraft: The control that you are used to seeing as a throttle acts instead as a collective pitch, with the computer controlling the throttle to maintain some rpm. This is how a helicopter is typically managed. The collective pitch travel and redline rpm are set in the usual places for prop pitch and rpm in Plane-Maker.

Artificial Stability

Unstable airplanes don't want to point in the same direction they are going. Once they start to point away from the direction they are traveling, they continue to move away from the flight path!

No human is able to fly such an aircraft for long, so a computer is implemented in these aircraft to keep the airplane from ever diverging from the desired heading and attitude. This computer system is called an artificial stability system, sometimes referred to as "fly-by-wire" because there are no direct control linkages between the pilot and control surfaces.

The F-16 and airplanes that are basically just neutrally stable in hover (like the V-22 Osprey), have this control system. This system looks at the control input from the pilot, then determines what the pilot wants the airplane to do and based on this, looks where the airplane is actually going, moving the control surface to obtain the desired result.

You will probably need an artificial stability system in your plane if it is unstable or is a VTOL design. If it is a VTOL design, you may wish to have the system turn off at conventional flight speeds, and only phase in as you slow down to hover. This is because there is little or no inherent stability in hover. (As first-time helicopter pilots learning to hover can attest!) You enter the speed below which the artificial stability system is completely engaged (say 60 knots) and the speed above which the artificial stability system is completely out of the loop (say 180 knots). The system will automatically phase gradually from one extreme to the other at intermediate speeds. If you are flying an unstable aircraft and always want the system to remain on, just enter a phase-in and phase-out speed of 999 knots. The system will always be on below 999 knots INDICATED airspeed. Remember that your TRUE airspeed may be much higher than this at high altitudes, while your INDICATED airspeed is still under 99 knots, thanks to the thin air that causes the pressure on the airplane to be lower, and thus the indicated airspeed to be lower as well.

The fly-by-wire, or artificial stability system, used by "X-Plane" is simple yet effective: You enter what pitch and roll rates you want the artificial stability system to shoot for with full joystick deflections. Look at some examples in the your airplane files. Output the control deflections to the graphical output display in X-Plane (Settings:Set Data Output) to see how your controls are responding to flight inputs.

Background Menu and Special Menus

The items in these menus are mostly self-explanatory One tricky area is the "Output Texture Map Starting Points", though... Once you have done your airplane, choose this item to have Plane-Maker create a "template" bitmap image for you to make your own "paint" or "skin" for the airplane. This will be explained by Plane-Maker when you select that menu item.

INTRO TO WORLD-MAKER

X-Plane comes with scenery files for the United States (including Alaska and Hawaii), Canada, Europe, Japan, and Australia. Most of the rest of the world can be downloaded free from www.x-plane.com.

This scenery (terrain elevation and obstacle) data was obtained by an adaptive-gridding program that pulled in data from numerous different sources. The advantage is that it allows scenery for the entire planet, the disadvantage is that it does not 'hand-craft' each file, so some errors concerning lakes and rivers (and buildings that the F.A.A. does not consider to be obstacles to navigation) can occur

As a result, World-Maker was introduced to allow custom hand-crafting of the X-Plane world. You can use World-Maker to improve the existing terrain files provided on your CD or at www.x-plane.com.

Three components are responsible for X-Plane's world: the files "nav.dat" and "apt.dat" and a multitude of ".env" (environment) files plotting the landscape of most parts of the world.

- The "nav.dat" file contains all NAVAIDs for X-Plane.
- The "apt.dat" file contains all the airports.
- The ".env" (environment) files contain all the objects and terrain, thus creating the X-Plane virtual world.

You may notice by looking in your "Resources:Earth nav data" folder and "data" folder on the X-Plane CD that almost all the env files are on the CD where they cannot be modified. This will never do at all! You need to get scenery to your "Resources:Earth nav data" folder where you can modify it with World-Maker. Read on...

(see the World-Maker Instructions.txt file with the copy of X-Plane for the latest info!)

Latitudes, longitudes and .env files
To edit a scenery file to create or edit obstacles, change the height of mountains or fix a lake or river, the correct ".env" (environment) file must be in the "Resources:Earth nav data" folder. First look in the "data" folder on your X-Plane CD. Each ".env" file is named based on the latitude and longitude of the data in it. A file named "+010160", contains scenery data with its lower left corner at a latitude of +010° and longitude 160°.

Recall: Latitude or "parallels" are imaginary lines running east-west, whereas longitude or "meridians" run north-south. Both divide the Earth into degrees. Each degree is divided into 60 minutes and the minutes are divided into 60 seconds. The location of Washington D.C. is given by the crossing of latitude and longitude: "lat" 039°00"00' North and "lon" 077°00"00' West. Latitudes to the North of the equator are positive values. Longitudes East of the 0° meridian (over Greenwich, UK) are given in positive values.

Each ".env" file is marked by its name which is the lat and lon of the lower left (south-west) corner of the covered area. So, if you want to edit the +025120 area you should put the corresponding env folder ("+020-120", with all of it's ".env" files) in the "Resources:Earth nav data" folder on your hard drive.

Each ".env" file covers one square degree of latitude and longitude. Each FOLDER covers an area that is 10 degrees latitude by 10 degrees longitude, so a folder can contain up to 100 .env files. (No env files are required for empty ocean). For X-Plane to find ".env" files, the ".env" files must be in a correctly-named folder, which you see in the "data" folder on your X-Plane CD... we recommend that you simply copy whole folders-full of ".env" files from the CD to the "Resources:Earth nav data" folder for editing... that will save you from having to create and properly name folders. The ".env" files in the "Resources:Earth nav data" folder will OVERRIDE the files on the CD, so you can edit your own scenery for flight in X-Plane.

When you open World-Maker you will see at the top left the latitude and longitude of the present ".env" file. Scroll around to find the area you want to edit. If nothing is present but a dark blue grid, then the files for the area in question are simply not present in your "Resources: Earth nav data" folder, or they are in folders that are not properly named.

Remember, once you copy the ".env" files from the CD to the hard drive, Windows will think they are read-only since they came from a CD... you will have to change them to NOT read-only in Windows by right-clicking on each file you want to edit and then selecting the file properties. Macintoshes can figure these details out for themselves.

World-Maker Menus

The menus in World-Maker are self-explanatory

File Menu

You can save Airports, NAVAIDs, or the scenery area you are working on. To actually go to a new scenery area (latitude and longitude) to work on, click on the little arrows in the scenery-editing screen.

Edit Menu

Choose what to edit here... Airports, NAVAIDs, or scenery. Also choose to edit Earth or Mars here!

Special Menu

Pan and zoom and stuff here... KEYBOARD EQUIVALENTS are listed in brackets for rapid access.

The "Auto-Flatten Water" option will automatically make the water "flat" right up to the coastlines if you have let if get "wavy" during editing.

The "Massive Texture Assign Mode" will apply a texture over a large area so you can customize textures for large areas quickly.

World-Maker Terrain

Editing Terrain in World-Maker

World-Maker has four editing modes: Terrain, Obstacle, Airport, and NAVAID. Select the modes in the "Edit" menu. Use Terrain editing mode to adjust coastlines, elevations, rivers, etc.

Now suppose you want to adjust the scenery of ".env" file "+034-119". Simply press the "lat" and "lon" buttons to get to the right environment file after copying that region from the CD to the "Resources:Earth nav data" folder. Lat and lon can have either positive or negative values, so you can reach any region.

NOTE: Check our website at www.X-Plane.com for regular updates of ".env" files and important links to various related issues.

NOTE: The ".env" files on the X-Plane CD can only be changed when copied to the "Resources:Earth nav data" folder in the "X-System" folder on your hard drive. In Windows, you also need to set these files to NOT READ-ONLY, as they will initially be read-only since they came from a CD. X-Plane will look for files in the "Resources:Earth nav data" folder, and if it finds them, use them to over-ride the files on the CD.

The displayed ".env" file shows the geographical properties of the map, like hills and lakes in various green or blue shades, yellow parallel lines showing runways and various obstacles.

The geographical properties are modifiable with the "Terrain" option in the "Edit" menu. The obstacles (buildings, towers etc.) are modifiable with the "Obstacles" option in the "Edit" menu. Both information on geographical properties and obstacles are saved in the relevant ".env" file, while airports and NAVAIDs are saved in the "apt.dat" and "nav.dat" files.

To modify the geographical properties you can move nodes and change their altitudes or toggle water on and off by clicking in a quadrilateral field with the mouse. A quadrilateral is a tiny building block within the ".env" file that you can see when zooming in on the map. You can also see the map with it's textures by pressing the Spacebar. Zoom in and out with the +/- keys. Move around with the arrow keys.

Textures in World-Maker

X-Plane uses default, generic textures for water, grass, mountain, snow, city, and the borders between them. X-Plane automatically applies the borders between these textures. All of these default textures are found in the "bitmaps" folder inside your "X-System" folder.
They are simply 256x256 pixel bitmaps in 24-bit color.

In many cases, though, you may want to customize these textures to ones that are more appropriate for any given area. Perhaps you want city, desert, or harbor textures. These can easily be created and added. If required you can assign up to 500 different custom textures for each ".env" file. To do this, simply create a custom texture (for example desert) in PaintShop, PhotoShop, or any other program you like. Once you have created the custom texture that you want to see in the sim, save it as a 24-bit bitmap in the "resources:custom terrain textures" folder. Now launch World-Maker and drop it into terrain editing mode with the "Edit" menu and add the custom textures that you just created by using the toolbar on the left side of the screen.

When creating custom objects and textures, remember that fine lines will cause "jitter" and resulting eye-fatigue! The same applies for high-contrast textures, or too many colors. Many simulators manifest such line-jitter and interference by having textures with too high a contrast. A smart combination of minimally varying greens and greys (steps of max. 3-5%) will do for a landscape, provided the pattern does not repeat itself. Houses can be simulated by rectangular dark grayish shapes with a black 2 pixel wide border (shadow) at one side. Seamless welding of any BMPs is achieved by carefully copying one 5 pixel wide border to all 3 remaining sides and turning it either vertically or horizontally. Without this you would see the border of the texture. Minimize disturbances of the border pattern while working under very high magnification.

World-Maker Objects

Generic Obstacles in X-Plane

The FAA lists over 30,000 obstructions to air navigation (obstacles) and X-Plane has them all, but most of these are represented in X-Plane simply as generic-looking buildings. These obstacles that come with X-Plane include buildings, radio towers, powerlines, cooling towers, and smokestacks. You can easily modify their height and heading, or add new obstacles. Simply get World-Maker into "Obstacle" mode in the "Edit" menu and select your choice from the left-hand side of the screen. You may delete, move, add, or edit the various objects. Press 'M' (see the "Special" menu) to cycle through these options. While the default obstacles are functional from an aviation point of view, they are not very exciting to look at since they are simply generic towers, smokestacks, and a few generic building types. This being the case, you may want to customize certain buildings so that they really look just like their real-world counterparts. Examples of buildings that you may want to look just like their real-world counterparts may include the World Trade Centers, the Sears Tower, the Statue of Liberty, or your house. This is easy to do using CUSTOM OBJECTS in X-Plane
Here's how:

Custom Obstacles in X-Plane

Custom Objects in X-Plane are 3-dimensional structures that are defined by x,z,y-points and have textures on them in 24-bit BMP-format. Read "World-Maker Instructions.txt" in your "X-System" folder to see a description of the current format, and how to add your own custom obstacles. The basic idea, though, is that you create a text file in the word processor of your choice that contains the geometry of the custom object, and lists what textures you want to be used on that object.

Note: The surfaces of the custom objects must be designated clockwise as seen from the outside: topleft - topright - bottomright - bottomleft.

Note: When you are done creating the objects in your favorite word processor, be sure to save them, in the "Resources:Custom Objects" folder.

SAVE THEM AS ASCII TEXT FILES!

Note: When you save the custom object textures, be sure to save them in the "Resources:custom object textures" folder. Save them as 24-bit bitmaps!

After you have created and saved your custom objects, get World-Maker into "Obstacle" mode from the "Edit" menu, and then choose "add custom" and click on the desired location to place your custom obstacle. A small cross will appear. Click in the "change name" box to open the custom object file that you created and saved (with a word processor) in the "custom objects" folder.

Note: Don't create new env. files! Instead edit existing ones on the CD! The current elevation maps provide a good starting point for your work!

You can make the Golden Gate Bridge, the Sears Tower, the Statue of Liberty, the Mirage and GM of Las Vegas, and any other buildings you like for X-Plane. here's how:

- Look in your RESOURCES NAV DATA folder.

- Now look in your CUSTOM OBJECTS folder.

- Open the file "KSBD Example.obj" in the "SoCal" folder with any word processor... this is a custom building. (IBM users can open with WordPad...you may have to mess with the carriage return to make the carriage returns come out right).

Anyway, here is the file format that you can use to make your own custom objects, including statues, bridges, custom buildings, your house, or anything else.. the sky is the limit. Follow along in the "KSBD Example.obj" file to see it in practice:

A

The file must start with a capital 'A' or 'I' (created on Apple or IBM) FOLLOWED IMMEDIATELY BY A CARRIAGE RETURN WITH NOT OTHER COMMENTS.

2

Then enter the file version number... "2" in this case.

SoCal:KSBD_example

This is the texture that this object uses. This texture must be used for every bit of the object, but you may use a different part of the texture for each polygon on the object. Simply make a 24-bit BITMAP of anything you like and make sure it's dimensions are a power of 2 and save that texture in your 'objects' folder... that texture will then be available for your buildings... there is basically no limit to the number of textures and objects you create. Make your textures in any graphics program that can save bitmaps.

4 0.5 1.0 0.0 0.5 // concrete base

The number "4" means that you are about to give a polygon (4 corners).

You may use "3" for a triangle, "2" for a line, or "1" for a point. (light)

THERE MUST BE A COMMENT AFTER THE POLYGON INDICATOR! THE COMMENT MAY BE ANYTHING YOU LIKE, BUT A COMMENT IS REQUIRED!

The 0.5 1.0 0.0 0.5 indicate the "s" and "t" parameter of the textures that this polygon will use. In this case, this polygon uses the texture from the 50% to the 100% point on the texture horizontally left to right, and the 0% to the 50% of the texture bottom to top.

```
10 10 -10
15 0 -15
15 0 15
10 10 10
```

These are the points that define the polygon, X, Y, Z for each corner.
X is positive meters EAST.
Y is positive meters UP.
Z is positive meters SOUTH.
Define points clockwise starting from the upper-right corner for your 4-sided polygon.

Make up to about 30 polygons or so, and then we get to LINES (good for antennas):

```
2 5 5 5 // antenna on roof
-10 50 -10
-10 70 -10
```

The "2" means we have a line... Lines do not have textures... instead they have colors... the 5 5 5 are the red green and blue values of the lines ON A SCALE FROM 0 TO 10, WHERE 0 IS TOTALLY DARK, 10 IS FULL INTENSITY.

1 10 10 10 // light on antenna
-9 55 -9

Here is a light... the "1" means we have a point (light) and the 10 10 10 mean it gets a full red, green, and blue... it is a white light.

Note: If you set your light color to 99 99 99 you will get a PULSING RED light.

Note: If you set your light color to 98 98 98 you will get a WHITE STROBE light.

99 // ALL OBJECTS MUST END WITH A 99 TO DENOTE THE END OF THE FILE!

You have to put a 99 at the end.

OK, that is how you make buildings.

To put them into X-Plane's world, go into world maker and add them as custom obstacles.

Here is how:

- Launch World-Maker.
- Go to an area where you like to fly.
- Select OBSTACLE mode from the EDIT menu.
- Select ADD CUSTOM from the list on the right hand side of the screen and simply click on the map to place the custom object.
- Backspace over the '?' in the CHANGE NAME field and type in the name of the custom object you want to place there... say "BUILDING1" (not BUILDING1.OBJ... there is no need to type in the ".OBJ") to place the building that we just looked at.

Now go into X-Plane, go to the airport that you just placed the building near, and look at it.

OK, you got it... it is ludicrously easy... NOW GO MAKE STUFF!

World-Maker Airports

Airports in World-Maker

To create or edit airports with World-Maker, go to "Edit:Airports" in World-Maker. Each airport in X-Plane CLASSIC may have up to 3 runways. X-Plane 5 offers unlimited runways, though, and a variety of runway surfaces like asphalt, concrete, gravel, dirt, and grass are available. Runways have approach-light options, such as glideslope indications, approach lights leading up to the runway, and the runway lights themselves. You can use the user-friendly interface to design entire airport runway and taxiway layouts with only a few clicks of the mouse!

Airports in a Word-Processor

The user-friendly interface in World-Maker is there so you do not have to edit any files by hand, but if you do want to go in and edit the airport file manually for some reason, you may certainly open the "apt.dat" file with a word processor.

To edit airports with a word processor, you need to understand the file format of the airport.dat file.
Here is a make-believe sample entry and it's meaning:

1 3127 0 1 CZML 108 Mile Airport
10 51.7352982 -121.3335037 14x 161.50 4877 100.0200
300.0400 75 1231231

Now here it is explained:

1 -------type: airport

3127 -------elevation of airport

0 1 -------does not have control tower, but does have standard hangars off to the side

CZML 108 Mile Airport -------airport ID and name

10 51.7352982 -121.3335037 -------entry type 10 means runway, then latitude and longitude

14x 161.50 4877 -------runway number, heading (true), length

100.0200 -------displaced threshold 100 feet this end, 200 feet at the other end

300.0400 -------blastpad overun 300 feet this end, 400 feet at the other end

75 -------runway width

1231231 -------runway lighting code, with source-code to generate it here:

```
xint code = 0;
if(typ==t_asph_pave )code+= 1000000;
if(typ==t_conc_pave )code+= 2000000;
if(typ==t_surf_gras )code+= 3000000;
if(typ==t_surf_dirt )code+= 4000000;
if(typ==t_surf_grav )code+= 5000000;
```

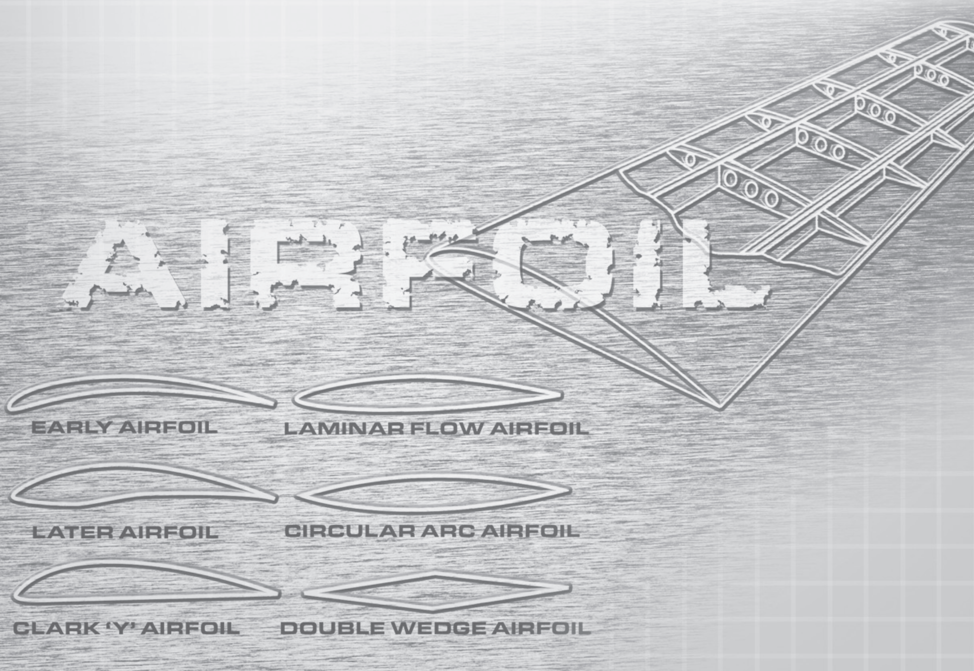
```
if(typ==t_surf_asphH)code+= 6000000;
if(typ==t_surf_concH)code+= 7000000;
if(typ==t_surf_grasH)code+= 8000000;
if(typ==t_surf_dirtH)code+= 9000000;
if(typ==t_asph_turn )code+=10000000;
if(typ==t_conc_turn )code+=11000000;
if(typ==t_surf_lake )code+=12000000;
xint end;
for(end=0;end<=1;end++)
{
xint mfac=(end==0)?1000:1; // end=0 means front of runway,
end=1 means back of runway
if(gls[end]==lgt_gls_none )code+=100*mfac;
if(gls[end]==lgt_gls_vasi )code+=200*mfac;
if(gls[end]==lgt_gls_papi )code+=300*mfac;
if(gls[end]==lgt_gls_papi2)code+=400*mfac;
if(rwy[end]==lgt_rwy_none )code+= 10*mfac;
if(rwy[end]==lgt_rwy_mirl )code+= 20*mfac;
if(rwy[end]==lgt_rwy_reil )code+= 30*mfac;
if(rwy[end]==lgt_rwy_rcls )code+= 40*mfac;
if(rwy[end]==lgt_rwy_tdzl )code+= 50*mfac;
if(rwy[end]==lgt_rwy_taxi )code+= 60*mfac;
if(app[end]==lgt_app_none )code+= 1*mfac;
if(app[end]==lgt_app_sals1)code+= 2*mfac;
if(app[end]==lgt_app_sals2)code+= 3*mfac;
if(app[end]==lgt_app_alsf1)code+= 4*mfac;
if(app[end]==lgt_app_alsf2)code+= 5*mfac;
if(app[end]==lgt_app_odals)code+= 6*mfac;
}
```

World-Maker NAVAIDs

Ancient Roman sailors realized: "Navigare necesse est". It is necessary to stay on course. They erected lighthouses along the Mediterranean Sea, something we can hardly think of when flying above clouds nowadays. X-Plane uses the standard aeronautical navaids, like non-directional beacons (NDB's), very high frequency omni-range beacons (VOR's), instrument landing systems (ILS's).

X-Plane comes with over 40,000 NAVAIDs, but if you want to add a few more you can do it in World-Maker in NAVAID editing mode in the "edit" menu. You can use World-Maker to edit and add these navaids, or simply open the "nav.dat" file with a word processor and edit it manually.

INTRO TO AIRFOIL-MAKER



X-Plane uses aircraft designed with Plane-Maker. These aircraft use airfoils designed with Airfoil-Maker!

In other words, you can use Airfoil-Maker to enter the airfoil characteristics of any airfoil, and then use those airfoils on your aircraft in Plane-Maker and X-Plane.

Remember, an AIRFOIL is NOT a wing! A WING has wingspan, size, is made of metal or some other material, and is usually attached to an airplane!

An AIRFOIL is simply a mathematical CROSS SECTION used to define the wing! Any airplane from a small Cessna to a giant Boeing could in theory use the same AIRFOIL, the Boeing would just use that mathematical cross-section on a much larger wing!

In Airfoil-Maker, you define the AIRFOIL, which is simply a cross-section of a wing, and this airfoil may be used without restriction on any of your airplanes that you design in Plane-Maker.

If you decide to make custom airfoils for your airplane, make a folder called "AIRFOILS" in the same folder as the your ACF file, and save the foils you make in Part-Maker in there. This is needed for X-Plane to find them.

Now, X-Plane comes with a bunch of airfoils, including at least one for every reasonable use... Therefore it is probable that, for recreational purposes, these will be the only airfoils you will ever need! In other words, there are enough airfoils included with X-Plane that you will probably never have to design your own if you are just flying and designing for fun.

Airfoil-Maker is available to you, however, if want to input your own airfoils for your own aircraft designs because your airplane uses airfoils that were not included with the simulator.

NOTE: AIRFOILS ARE STORED IN THE "AIRFOILS" FOLDER WITHIN THE "RESOURCES" FOLDER... GET YOUR AIRFOILS FROM THERE TO LOOK AT EXISTING AIRFOILS.

Airfoil-Maker Menus

The menus of Airfoil-Maker are very simple:

The File Menu
The file menu works just like the file menu of any word processor or spreadsheet you have used. You create, load, and save your files just like you do with a word processor. The only difference is that you are opening and saving files that represent airfoils rather than word processing documents.

New
Use this to generate a new airfoil

Open
Use this to open an existing airfoil for viewing or modification.

Save
Use this to save an airfoil that you have created or modified.

Save As
Use this to save an airfoil that you have created or modified, but under a different name.

Quit/Exit
Exit Airfoil-Maker.

Designing Airfoils in Part-Maker

Every airfoil ever designed has it's own characteristics, which are its coefficients of:

lift, (how much the airfoil wants to lift up)
drag, (how much the airfoil wants to pull back), and
moment, (how much the airfoil wants to pitch up).

What you see on the Screen
You'll see a big black box dominating the screen with green, red, and yellow lines on it.

The left edge of the chart corresponds to an angle of attack of 20 degrees, and the right edge corresponds to an angle of attack of +20 degrees.

The center of the chart represents an angle of attack of zero degrees. (Remember the angle of attack is the angle of the wing to the air. It is the angle at which the wing hits (or "attacks") the air).

The green line is the coefficient of lift. The red line is the coefficient of drag. The yellow line is the coefficient of moment. We'll look at the behavior of each of these lines.

You will see a number labeled "Reynolds number" on the upper left. The "Reynolds number" is simply the air density times the speed of the airplane times the chord of the wing divided by the viscosity of air (Wow!). Experiments have shown that the coefficients of lift, drag and moment of wings vary somewhat with Reynolds number. For recreational purposes, you can probably neglect any change in performance with Reynolds number, so you can just ignore this setting altogether. The number entered in the Reynolds number box may have some impact however on the simulation. For highest realism you can generate 2 different airfoil files for the same airfoil, each file at a different Reynolds number, and assign them both to your wing! X-Plane will figure out the Reynolds number on each piece of the plane at least 10 times per second and interpolate between the two airfoil files to give the most realistic coefficients for that flight Reynolds number.

Pilots should realize: very good accuracy can be obtained without messing with the Reynolds number at all, and without generating two airfoil files for each airfoil. You can ignore the above paragraph and the "Reynolds number" slot in the airfoil generation screen without sacrificing a good simulation.

What the coefficients are:

Coefficient of lift
Look at the green line. It is the coefficient of lift. Notice that at zero degrees angle of attack (center of screen) the coefficient of lift is fairly low. (It is close to the thin white line, which represents zero). As the angle of attack increases, the coefficient of lift increases right along with it, until you get to around 16 degrees angle of attack, at which point the coefficient of lift falls abruptly...that is the stall! If you go to negative angles of attack, you see that the coefficient of lift actually gets negative. If you go to a large enough negative angle of attack, the airfoil stalls then, too. It is possible to stall upside down! A good wing will have a decent coefficient of lift (maybe 0.4) at angles of attack close to zero, and a nice high coefficient of lift (maybe 1.6) at the maximum angle of attack. A safe airfoil will also have a stall that is not too abrupt. In other words, the coefficient of lift will fall off gradually at the stall, rather than sharply.

Coefficient of drag
Look at the red line. It is the coefficient of drag. Notice that the coefficient of drag is lowest close to zero degrees angle of attack. The drag gets higher and higher as the wing goes to larger and larger angles of attack. That is not surprising, is it? The higher the angle you

offset the wing from the airflow, the greater the drag! It doesn't matter much whether you are going to positive or negative angles of attack (aiming the wing up or down)... moving the wing away from it's most streamlined position increases it's drag. A good airfoil will obviously have the lowest drag possible. (Notice that this drag coefficient does NOT include the drag due to the production of lift. X-Plane will figure this drag out automatically).

Coefficient of moment
Look at the yellow line. It is the coefficient of moment. The coefficient of moment is the tendency of the wing to pitch up about its axis, or rotate upwards about the spar. Most wings actually want to pitch down, so the coefficient of moment is usually negative. The moment varies a bit with angle of attack, often in ways that are a little bit surprising. Typically the moment will be negative for all normally-encountered angles of attack, getting especially large in the negative direction as the angle of attack is increased, until the stall, at which point the moment heads back to zero. A desirable characteristic of an airfoil is usually to have a low coefficient of moment.

General Info

Coefficient display box
One thing that you have probably noticed is that the axis are not labeled, and don't have numerical values to tell you exactly what the coefficients are. Look at the little box in the upper left-hand corner of the airfoil generation screen. The top number (white) is "alpha" or the angle of attack of the wing. The next numbers are the coefficients of lift, drag, and moment at that angle of attack. Wiggle the mouse back and forth all the way across the monitor, and notice that the angle of attack display changes, and the coefficients with it. The coefficient display box is giving the angle of attack and coefficients of the airfoil at the angle of attack that the mouse is currently pointing at. Just point the mouse at the part of the curve you are interested in, and look at the exact coefficients in the coefficient display box! Easy!

One question you might be asking yourself is:

How do I find what the coefficients are for the airfoils on my airplane?

First, you need to find what airfoil your aircraft uses, probably from the manufacturer. Then you need to see if that airfoil is included with our program. If you are flying a Cessna 182, for example, that aircraft uses the NACA 2412 airfoil, which is included, so you do NOT need to generate your own airfoil for that wing. If you do not know what foil to use, then just leave them as the defaults of Plane-Maker.

Airfoil selection is a fun and interesting process, because you will be looking for the best possible combination lift, drag, and moment characteristics for your particular airplane. If you will be experimenting with your own airplane designs, and are new to the matters discussed in this manual, we highly recommend:

R/C Model Airplane Design
A.G. Lennon
Motorbooks International Publishers and Wholesalers, Inc.

to get you started. The book is intended for radio control designs, but is very straightforward, easy to understand, and all of the principles apply to full-scale aircraft.

Once you understand the basics of airfoil theory and nomenclature, we recommend:

Theory of Wing Sections
Abbot and Von Doenhoff
McGraw-Hill, New York (1949)

...an oldie but goodie! This books has the lift, drag, and moment plots of many airfoils in it, so you can choose your favorite airfoil for your design and then enter it into the computer using the technique that is about to be explained.

In the following discussion, thin symmetrical, thick highly cambered, and "normal general aviation" airfoils will be discussed. These are three types of airfoils that are good for discussion purposes because they are so different.

Thin symmetrical airfoils are thin and have the same shape on both the top and bottom surfaces. They do not produce very much lift or drag. They typically are used for vertical stabilizers and often horizontal stabilizers as well because they are not called upon to produce a lot of lift, and are not expected to produce much drag, either.

Use thick, highly-cambered airfoils in the foreplanes of canards, or other applications where you want a LARGE amount of lift from a SMALL wing area. These foils are known for providing a large amount of drag as the penalty for providing a large amount of lift.

So-called "normal general aviation airfoils", like the NACA 2412, are compromises between the two, and are good candidates for the wing of a general aviation aircraft.

Supercritical, laminar-flow, and other possible groupings of airfoils exist, but for the purposes of our discussion we will concentrate on the thin symmetrical, thick and highly cambered, and "normal general aviation" airfoils just outlined.

Airfoil generation buttons

Now let's actually generate an airfoil. The first button to click on is the coefficient of lift intercept button, the green one labeled "intercept" in the upper left hand corner. To increase this number, just click right above the numbers that you want to increase, and below the ones that you want to decrease. For example, if the lift intercept on the screen is 0.25, and you want to change it to 0.33 to model your airfoil, just click right above the "2" in "0.25" and twice below the "5" in "0.25". You change all of your data that way for the entire design and simulation system. Easy! Now what exactly is a coefficient of lift intercept, anyway? Read on to find out!

Coefficient of lift intercept, "INTERCPT"
This is the coefficient of lift at an angle of attack of 0 degrees. For a symmetrical airfoil, this will always be zero, since the air is doing exactly the same thing on the top and bottom of the wing for a symmetrical airfoil at zero degrees angle of attack. Symmetrical airfoils are sometimes used for horizontal stabilizers, and are almost always used for vertical stabilizers. Sleek, skinny wings with low camber might have a lift intercept of 0.1. Fat, highly cambered foils have a value around 0.6. A typical airfoil like the NACA-2412 (commonly used in general aviation) has a value of about 0.2.

Coefficient of lift slope, "SLOPE"
This is the increase in coefficient of lift per degree increase in angle of attack. A thin airfoil has a value of about 0.1. A really fat airfoil has a value of about 0.08. Fatter airfoils have slightly lower lift slopes. (You will find, however, that lift slopes are almost always very close to 0.1).

Coefficient of lift curvature near the stall, "POWER"
As the angle of attack gets close to stall, the lift slope is no longer linear, but gradually "levels off" as it approaches the maximum, or stalling, coefficient of lift. Just play with the power button until you find a power curve that connects the linear and stalling regions smoothly. Chances are a power of around 1.5 will work pretty well. Just play with it until the lift comes up smoothly, then gradually levels off to the stall, since that is what happens with a real airfoil.

Coefficient of lift maximum, "MAXIMUM"
This is the maximum coefficient of lift, or the coefficient of lift right before the stall. A very thin, symmetrical airfoil has a value of around 1.0. A thick, highly cambered airfoil has a value of around 1.8. A typical general aviation foil might have a value of around 1.6.

Coefficient of lift immediate drop at stall, "DROP"
This is the drop that immediately follows the stall. For thin airfoils, which tend to stall sharply, this value might be 0.2. For many airfoils, however, there is no immediate drop, but instead a more gradual one as the angle of attack is further increased. In most cases, this number will be zero or very close to zero.

Coefficient of lift curvature after stall "POWER"
Different airfoils have different lift slopes after the stall. For skinny, sharply-stalling airfoils the power should be fairly low, perhaps around 1.4. For fat airfoils (which usually have more gentle stalling characteristics) this number may be closer to 2.0. Just play with the power button until the data looks like the data you are trying to model from the airfoil chart in whatever book you are getting your airfoil data from.

Coefficient of lift drop from stall to 20 degrees "DROP"
This is the decrease in coefficient of lift from the stall to an angle of 20 degrees. This number might be in the 0.4 range for a thicker airfoil, 0.6 for a thinner one.

The NACA-2412 has a value of about 0.4 . (The coefficient of lift goes from around 1.6 to 1.2 as the angle of attack goes from around 16 to 20 degrees).

Coefficient of drag minimum "DMIN"
This is the minimum coefficient of drag of the airfoil. (Again, not including induced drag, which is determined automatically by the simulator "X-Plane"). This minimum coefficient of drag also should

not include the "low-drag bucket" of a laminar flow wing. A thick or highly cambered airfoil has a value of about 0.01, a typical older general-aviation airfoil such as the NACA-2412 has a value of about 0.006, and a really thin, symmetrical airfoil has about a 0.005 value. Laminar flow airfoils can approach values of 0.004, but that number should not be entered here, because it will be addressed in the laminar drag bucket buttons soon to come...

Coefficient of lift at which minimum drag occurs "MIN D CL"
Enter the coefficient of lift at which the minimum drag occurs. This value is probably very close to the coefficient of lift at zero degrees angle of attack, which is the "lift intercept". The very first number you entered! If anything, the minimum coefficient of drag occurs at a coefficient of lift a little lower than the lift intercept coefficient of lift. This is because an airfoil usually has the least drag at an angle of attack of about zero degrees or just a hair lower.

Coefficient of drag at angle of attack of 10 degrees "D ALPH=10"
For a thin, symmetrical airfoil, this value might be around 0.015. NACA-2412 comes in with a surprisingly good 0.012. A really highly-cambered airfoil might be around 0.025, though.

Coefficient of drag curvature "POWER"
The power curve is simply the curvature of the drag curve as it changes with angle of attack. You will have to fiddle with the curvature until the curve looks like the experimental data, but theoretically this number will be around 2.

Laminar drag bucket location "CL LOCTN"
Some airfoils, called "natural laminar flow" or "NLF" airfoils, have perfectly smooth airflow across a large part of the wing, a flow pattern called "laminar flow" (Where did you think this company got the name "Laminar Research"?) This super-smooth, low-drag flow can only happen at fairly small angles of attack, though, so there is a "low-drag

bucket", or area in a small angle of attack range, that has lower-than-normal drag. The drag bucket location is usually thought of in terms of the coefficient of lift. In other words, the center of the drag bucket occurs at some coefficient of lift of the airfoil. This might happen at a coefficient of lift of around 0.6.
Laminar drag bucket width "WIDTH"
This refers to how "wide" the bucket is, or what range of coefficient of lift the drag bucket covers. 0.4 is a decent guess.

Laminar drag bucket depth "DEPTH"
This is the all-important variable: how much do you reduce your drag by going to laminar flow? Answer: 0.002 if you're lucky. (But that is actually quite a bit. That might turn a cd of 0.006 to 0.004. Quite a large percentage difference.).

Laminar drag bucket curvature "POWER"
The power curve is the simply the curvature of this low drag bucket. You will have to fiddle with the curvature until the curve looks like the experimental data, but chances are this number will be around 3 to 5.

Coefficient of moment low-alpha change point "ALPHA 1"
The coefficient of moment is usually linear across the non-stalled angle of attack range. In other words, if the airfoil is not stalled, the moment curve is usually a straight line. After the stall, however, the moment coefficient tends to change direction. For the NACA-2412, the moment coefficient has it's low angle of attack moment-change at 10 degrees, a point corresponding to roughly +4 degrees before the stall.

Coefficient of moment high-alpha change point "ALPHA 2"
The NACA-2412 airfoil has it's high angle of attack moment-change right at the positive stalling angle of 16 degrees.

Coefficient of moment at 20 degrees "CM 1"
For the NACA 2412, this number is about 0.075. Notice that this is a positive number. This means that if the airfoil is at a clear negative

angle of attack, it will stall and try to pitch back up to an angle of attack closer to zero. This is a nice effect, because the airfoil tends to try and recover from the stall automatically.

Coefficient of moment at low-alpha change point "CM 2"
For the NACA 2412, this number is about -0.05, which is a light pitch-down. A wing with a higher camber will have a value of around -0.10, perhaps even 0.13. A symmetrical airfoil will have no pitch tendency at all here, so 0.0 should be entered for that type of airfoil.

Coefficient of moment at high-alpha change point "CM 3"
For the NACA 2412, this number is about 0.025, which is a very light pitch-down. A wing with a higher camber will have a value of around 0.10, perhaps even 0.13. A symmetrical airfoil will have no pitch tendency at all here, so 0.0 should be entered for that type of airfoil.

Coefficient of moment at 20 degrees "CM 4"
This is the coefficient of moment well into the stall. For the NACA 2412, it is about -0.10. This is a moderate pitch-down, which is desirable because this pitch-down will help recover from the stall.

Finishing Up
Change all of the parameters we just discussed around a bit, and select "Save As" from the "File" menu. Now type in an airfoil name and hit return. Congratulations! You have just generated your own airfoil! Drop it in the "Resources:Airfoils" folder in your X-System folder (to be usable by ALL planes) or a folder that you make called "Airfoils" in the same folder as your airplane designs to be used only by that airplane.

WEATHER BRIEFER

Briefer

Weather-Briefer (or "Briefer" for short) is a simple program that will give you a weather briefing before your flight. It will do this using the syntax that a real Flight Service Station Specialist would use to give you a briefing before your flight in an actual plane.

Just run the program before you flight, select your departure and destination airports from the large scrolling menus, select your airplane and cruising altitude, and hit the "OK What can you tell me?" button. The program will scratch its head for a few moments devising your briefing (as a real Flight Service Station Specialist would!) and then give you your weather briefing in the appropriate language.

Now here is where it gets interesting: If you have downloaded Real-Weather (actual current weather conditions!) from the internet, then you will get an accurate briefing for the flight you have planned, based on the actual weather that really exists! In theory, the briefing you get from Weather-Breifer will be exactly the same as the briefing you would get from a real flight service station if you picked up the phone and called them for real! We used to advocate actually calling a real flight service station weather-briefer before your flights in X-Plane with Real-Weather downloaded from the net, but then the briefer got mad at us since they were busy enough with the REAL pilots... so now we ask you not to do that!

Want to see where you can get Real-Weather to fly in, and get a briefing with in Briefer? See www.X-Plane.com, Real-Weather section... you can download Real-Weather there!

If you do not have Real-Weather downloaded from the net, then Briefer will give you a rather boring prediction: It will simply tell you to expect the weather that is currently stored in X-Plane's preferences! A boring prediction for sure, but an accurate one... until you change the weather in X-Plane!

HACKING X-PLANE

Hacking X-Plane

First the easy stuff: Changing the keys on the keyboard that you press to do stuff in the sim:

Open the following file: resources/keys/x-plane.txt

This file has all the keys for X-Plane. You can simply type in whatever key you want for each function right in that file to change the keys to suit your preference! X-Plane scans that file for key commands each time it loads!

- Customize Your Textures For Any Airplane

  To make your own textures for ANY airplane, simply go into Plane-Maker, open the airplane you want to make textures for, and select "OUTPUT TEXTURE STARTING POINTS' from the "SPECIAL" menu. This will create a bitmap that you can then open with any graphics program, such as Photoshop or PaintShop Pro. The bitmap is an outline of the parts of the airplane! Now you can edit that image with a graphics program to make the textures (or "paint schemes") for your airplane! Make sure to save your handywork with the right filenames, as described below!

  See the C-119 in the Vintage folder for an example, and the "paint reference. bmp" in the Instructions folder for a map of the paint bitmap.

  If the aircraft name is "aaa", then the custom paint schemes are:

  aaa_paint.bmp <-paint scheme
  aaa_paint_LIT.bmp <-paint scheme at night

- Customize Your Instrument Panel For Any Airplane

    - To make your own instrument panel, simply edit the panel ’til your heart’s content in PLANE-MAKER, setting the instruments where you like, etc.
    - Then go into X-Plane with the airplane that you want to customize, and take a screenshot (use a graphics program, or hit shift-Apple-3 on a Mac).
    - Then open up the screenshot with a graphics program and CROP it down to 1024x750 pixels (cutting out the menu bar), and edit the bitmap (removing the needles and stuff) until it is like you want it... save it in 24 or 32 bit color.

    - Now save it as follows:

      aaa_panel.bmp <-custom panel, 1024 x 750
      aaa_panel_LIT.bmp <-custom panel, lit up for night use
      1024 x 750
      aaa_panel_RF.bmp <-custom panel, looking to right front,
      1024 x 750
      aaa_panel_R.bmp <-custom panel, looking to right , 1024 x 750
      aaa_panel_RB.bmp <-custom panel, looking to right back ,
      1024 x 750
      aaa_panel_B.bmp <-custom panel, looking to back , 1024 x 750
      aaa_panel_LF.bmp <-custom panel, looking to left front ,
      1024 x 750
      aaa_panel_L.bmp <-custom panel, looking to left , 1024 x 750
      aaa_panel_LB.bmp <-custom panel, looking to left back ,
      1024 x 750
      aaa_test_nearest <-needles and gages,
      copy from the panel_test_nearest in the resources/bitmaps folder
      aaa_test_nearest_LIT<-needles and gages,
      copy from the panel_test_nearest_LIT in the resources
      /bitmaps folder

aaa_test_linear <-needles and gages,
copy from the panel_test_linear in the resources/bitmaps folder
aaa_test_linear_LIT <-needles and gages,
copy from the panel_test_linear_LIT in the resources
/bitmaps folder
aaa_blend_linear <-needles and gages,
copy from the panel_blend_linear in the resources/bitmaps folder

- Customize Your Sounds For Any Airplane

  Notice that there is a "sounds" folder in the X-System folder. The sounds are simply wave files, and are the sounds used by X-Plane. Modify them in any way you like, or create new ones, and save them with a filename that is simply the airplane name followed by a word that indicates what the sound is to be used for... Be sure to save them in the sounds folder inside the airplane folder.

  For example:

  sounds folder/aaa engn1.wav (the engine sound)
  sounds folder/aaa engn2.wav (the engine sound)
  sounds folder/aaa wind.wav (the wind-noise sound)
  sounds folder/aaa gear.wav (the landing gear activation sound)
  sounds folder/aaa land.wav (the soft touch-down sound)
  sounds folder/aaaboom.wav (the hard touch-down sound)
  any other sound listed in the SOUNDS folder (you can do this with any other sound in the SOUNDS folder that comes with X-Plane)

  See the C-119 for an example.

- Customize Your Scenery Texture

  To put your custom scenery textures in place, simply create your ideal textures in a graphics program such as Photoshop or PaintShop. Save the textures as BITMAPS. Then simply drop your textures into the following folder:

  EARTH NAV DATA:CUSTOM TERRAIN TEXTURES

  Now go into World-Maker and get into Terrain editing mode in the Edit menu... select the "Apply texture below" button and load the textures into World-Maker by clicking on the texture-name boxes. Now just click on the terrain polygons to put your custom textures in place. Easy!

- Populate The X-Plane World with Objects

  To make your own objects for the X-Plane world (such as the Sears Tower, Golden Gate Bridge, Statue of Liberty, or your house) go into the following folder:

  ADDITIONAL NAV DATA:CUSTOM OBJECTS

  building1.OBJ (an example building located just South of San Bernardino field)

  CUSTOM OBJECT TEXTURES
  build1.BMP (a texture used in this building)
  concrete1.BMP (a texture used in this building)
  roof1.BMP (a texture used in this building)

  You will see a sample building and some sample textures for that building...you can create your own objects and textures, too. Follow those examples (using the file "World-Maker Instructions.txt" in your X-System folder) to create your own objects... you can easily create as many objects as you like, using as many textures as you like.. there is virtually no limit on the World-Building you can do.

- Share Your Work!

Share your work with others! Upload your custom airplane textures, instrument panel bitmaps, airplane wave sounds, or scenery textures to ftp.X-Plane.com! Or put them on your own web page, or your friend's web page, or send them to us for inclusion in later versions of X-Plane if you think they are better than ours!

Special For Cockpit Designers and HardCore Hackers:

New power in the data output screen allows UDP data to go OUT...but now X-Plane can also receive data IN so you can let your cockpits or controller or whatever you want drive X-Plane! See the UDP Data I/O section of the instructions for more info.

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