

Microsoft® Flight Simulator

**Information Manual and
Flight Handbook**

for IBM® Personal Computers

Microsoft Corporation

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World War I Ace

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Learning Flight Simulator

Before you use Flight Simulator, you should be familiar with certain basics. That's what this chapter covers, including a "flying start" procedure for those who want to get off the ground even before reading this manual.

To introduce you to Flight Simulator, this chapter describes:

- The three-dimensional display where you'll be able to view your surroundings from all directions.
- Flight instruments you use to control your flight.
- Radios for communicating with the airports where you'll land and take off.
- Indicators on the control panel to help you monitor your flight.

Exactly how you use your aircraft controls depends on whether you're using an IBM[®] PCjr or an IBM PC or PC XT. A lot of controls are similar, but there are some differences. To make learning as easy as possible, you'll find two sections about the controls – one section for the PCjr and the other for the IBM PC and PC XT.

Introduction

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Microsoft® Flight Simulator is a second-generation, real-time flight simulation program for microcomputers. The simulation considers 35 important aircraft characteristics, and includes an out-the-window three-dimensional dynamic flight display, extensive flight controls, and minimum Visual Flight Rule (VFR) and Instrument Flight Rule (IFR) instrumentation as specified by the Federal Aviation Administration (FAA). Unlike first-generation simulators, Flight Simulator features detailed graphics that closely simulate a pilot's actual perspective. Flight instruments look and behave like the real thing. The "world" is more than 10,000 by 10,000 miles square with a resolution of approximately 2.5 inches.

The world encompasses the entire continental United States and extends into Canada, Mexico, and the Caribbean. The "populated" world consists of four areas and includes more than 20 airports detailed in charts at the back of this manual. Winds, clouds, time of day (for dawn, day, dusk, and night flight), and navigation aids are also included.

The added features make the aircraft more difficult to fly than first-generation simulators, so as a convenience to new pilots, two distinct flight modes are provided. If you have never flown before, you can use "easy flight mode" to learn the fundamentals of flight control. In easy flight mode, you fly in optimal conditions and use only the primary flight instruments and controls.

When you have mastered the basics of flight, or if you are already a seasoned pilot, you can select "reality flight mode" to simulate more sophisticated flight factors.

In either mode, you can add environmental conditions, such as wind, time of day, and turbulence. You can also set a reliability factor that determines the frequency with which flight problems arise. You can even set up test situations.

Flight Simulator is modeled after the performance characteristics of an aircraft of the Cessna 182 class (single engine, land, with substantial performance). It is an ideal plane for pilot training because it has climb performance and speed that keep a pilot busy, especially on landing approach. The plane is slightly superior to an advanced World War I fighter.

Flight Simulator can provide hours of rewarding entertainment. In addition to the easy and realistic simulation modes, it includes the WWI Ace war game, which lets you test your dogfighting and bombing skills. Flight Simulator will help you learn about flight. It is not, however, a substitute for a flight training course. If you want more information on learning to fly, we recommend that you read the *Flight Training Handbook* published by the FAA, or check with your local airport for information about certified flight training courses.

About This Manual

For novice pilots:

Because Flight Simulator is a program that will be enjoyed by novices and seasoned pilots alike, this manual begins with an introduction to flight procedures, operations, and control.

If you are new to flying, we recommend that you work through the manual. If you have a PCjr, you should read "Aircraft Controls for the PCjr." If you have a PC, you should read "Aircraft Controls for the PC." Both chapters are identical except for specific keystrokes you'll use to fly. The remainder of the manual is designed with both PCjr and PC users in mind.

For experienced pilots:

If you are an experienced pilot, you may want to learn how to operate the instruments and controls and then proceed directly to the section entitled "The Editor." You can use the editor to set environmental and flight conditions. You can also use the editor to shift from one of the four Flight Simulator geographic areas to another. (These areas are mapped, for use with Flight Simulator only, in Reference Charts at the back of the manual. Diagrams of airports also can be found there.) After you are familiar with the editor, proceed to "Advanced Flight Techniques." This manual explains how to use Flight Simulator and covers some basic flight techniques. Flight instruction is beyond the scope of this manual. If you would like further information on flying, we recommend you read any of the following, available at FBOs (Fixed Base Operators) or flight training schools at most airports:

Microsoft Flight Simulator

To learn about flying:

- *Flight Training Handbook*. U.S. Department of Transportation, Federal Aviation Administration.
- *Aviation Fundamentals*. 6th ed. Jeppesen Sanderson, Inc.
- *Instrument Flying Handbook*. U.S. Department of Transportation, Federal Aviation Administration.

4 Other publications:

- *Airman's Information Manual*. Aero Publishers, Inc.
- Chicago Sectional Aeronautical Chart
- Los Angeles Sectional Aeronautical Chart
- New York Sectional Aeronautical Chart
- Seattle Sectional Aeronautical Chart

Any of these publications can also be ordered directly from Sporty's Pilot Shop, Clermont County Airport, Batavia, Ohio 45103, (513) 732-2411.

If you're impatient:

Learning to fly is not easy. But if you're eager to get started immediately before reading this manual, skip to the "Flying Start" procedures at the end of this introduction.

Note Terms italicized in the text are defined in the Glossary. Single characters are italicized when they represent keys you should press.

About the Designer

Flight Simulator was written by Bruce A. Artwick. President of Sublogic Company, Champaign, Illinois, a hardware and software firm specializing in high performance graphics systems. Mr. Artwick gained extensive experience in high performance signal processor architecture design and microcomputer-based radar control systems at Hughes Aircraft Company. In addition, he has performed research in minicomputer- and microcomputer-based graphics system design at the Aviation Research Laboratory and Digital Computer Laboratories, University of Illinois, where he received a BS and MS in electrical engineering.

Using Flight Simulator With the IBM PCjr and PC

The program disk contains two versions of Flight Simulator: one for use on the IBM PCjr and the other for use on the PC (or PC XT). A small startup program automatically determines which machine is being used and loads the proper version of Flight Simulator.

The PCjr and PC versions are functionally the same. Different keys are used for the controls due to keyboard differences. You will find that the third and fourth chapters, "Aircraft Controls for the PCjr" and "Aircraft Controls for the PC," are identical except for the keys that you use. Other chapters of this manual will specify wherever keys differ. Reference Figures 2 and 3 at the back of this manual show the keyboard controls for the PCjr and PC. These figures are convenient references when reading this manual and flying the simulator.

Using the Shift Key on the PCjr

Activating most controls on the PCjr (radios, lights, and instrument knobs) entails holding down the Shift key while pressing the appropriate key. This manual notes such commands by preceding them with Shift; for example, to turn on the instrument panel lights, press Shift *L*.

In this example, type *L* on the PCjr by holding down the Shift key while pressing *L* as you would on any computer terminal or typewriter.

The Caps Lock key has no effect. Pressing Caps Lock will not hold down the Shift key or affect program operation in any way.

Using the PCjr Keyboard

The PCjr keyboard does not include a three-by-three numeric keypad. But many directional functions (flight direction control, view direction control, and slew control) use the keypad concept for "pointing" (see Figure 1). A three-by-three section of the PCjr keyboard has, therefore, been defined as a three-by-three keypad.

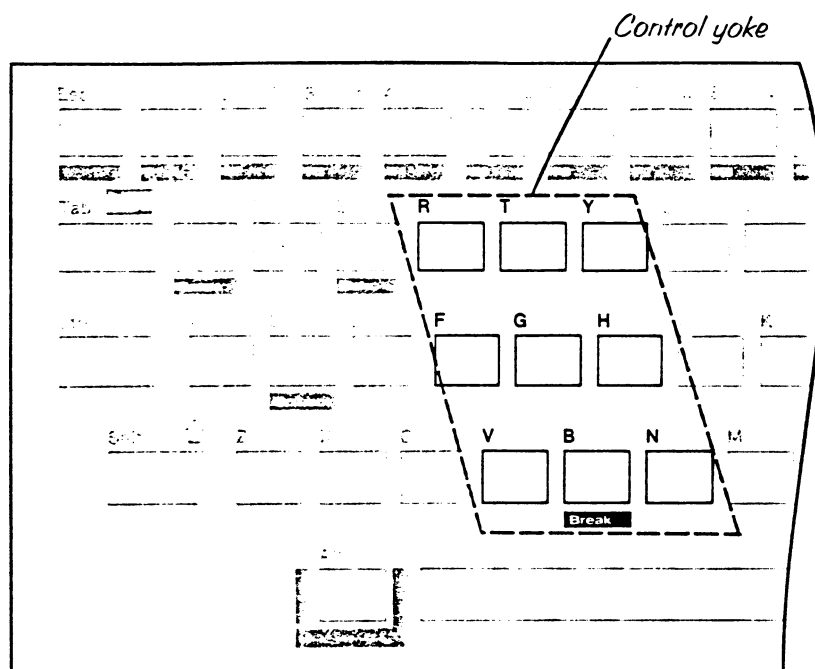


Figure 1. Control Yoke for the PCjr

As long as you remember that G is the keypad's center, that the bracket keys ([]) are the throttle controls, the 4 and 5 keys are the radar and view selectors, and the period key (.) is the brakes, you are well on your way to flying successfully. Using these keys for the directional functions does not require holding down the Shift key.

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All the radio and instrument controls can be remembered by the first letter that appears on the instrument panel (N is for NAV, C is for COM) or on the instrument knob (V adjusts the VOR, D the directional gyro). Also remember that Shift must be pressed for all control panel functions.

System Requirements

For the IBM PCjr, you'll need:

- IBM PCjr with at least 128K bytes of memory.
- A color television or a color composite, black and white, or RGB monitor.
- A disk drive.
- Optional: one or two joysticks.
- Optional: Microsoft Mouse.

For the IBM PC or PC XT you'll need:

- IBM PC with at least 64K bytes of memory.
- IBM Color/Graphics monitor adapter.
- A color television or a color composite, black and white, or RGB monitor.
- At least one disk drive (single or double sided).
- Optional: one or two joysticks and an IBM Game Control Adapter Card.
- Optional: Microsoft Mouse. (A total of 128K bytes of memory is required if the mouse is used.)

Flight Simulator will work with any monitor type. A color composite monitor or color television yields excellent results (15 colors). If you use an RGB monitor with the PC or PC XT, you will get only four colors and four shaded tones. When you load the Flight Simulator, the program will ask what kind of monitor you have and will make the best use of that monitor.

The entire Flight Simulator program is contained on the disk you received in this package. You will need an additional disk to create a backup of your disk and a third disk for saving simulation data.

How to Load Flight Simulator

To load Flight Simulator, follow this procedure:

- ▶ Open the door of disk drive A.
- ▶ Remove the Flight Simulator disk from its protective jacket.
- ▶ Holding the labeled end of the disk, insert it into the drive with the label facing up. When the disk is in as far as it will go, close the disk drive door.
- ▶ If your computer is off, turn on the System Unit Switch and monitor. If the computer is already on, press the Del key while holding down the Ctrl and Alt keys.
- ▶ The disk will whirr from five seconds to several minutes, the light on your disk drive will come on, and a few seconds later the following will appear on your screen:

MICROSOFT FLIGHT SIMULATOR
VERSION 2.1
COPYRIGHT BY BRUCE A. ARTWICK, 1984
PRODUCED BY MICROSOFT CORPORATION

WHAT DISPLAY ARE YOU USING?

- A. COLOR TV OR COLOR COMPOSITE MONITOR
- B. BLACK AND WHITE TV OR MONITOR
- C. RGB MONITOR

(TYPE A, B, OR C)

Answer by typing the appropriate letter.

- ▶ The second adjustment screen will ask:

SELECT MODE OF OPERATION

- A. DEMO MODE
- B. REGULAR FLIGHT MODE
- C. DISK BACKUP

(TYPE A, B, OR C)

Choosing option A begins a demonstration in which the plane flies itself. Choosing option B begins the program in "easy flight mode." If this is the first time you are using the Flight Simulator program, select option C to make a backup copy of the program. Proceed to the next section, "How to Back Up Your Flight Simulator Disk."

**To identify
your display:**

To choose a mode:

To identify your keyboard:

- ▶ If you selected demo or regular flight mode, the third menu screen will ask what kind of keyboard you have:

SELECT KEYBOARD MODE

- A. IBM PC JUNIOR KEYBOARD
- B. IBM PC TYPE KEYBOARD

(TYPE A OR B)

If you are using the PCjr keyboard, type *A*. If you are using a keyboard with a full set of 83 keys (numeric keypad and two rows of function keys as on the IBM PC or PC XT), type *B*.

The instrument panel will flash onto the screen. Use the Tab key to center the display on your screen. You can use this key at any time during flight to move the display to the right. When it has gone as far right as it can go, the display will shift full left.

If you chose the demo option mode, relax and enjoy the show. To end the demonstration, press Esc. This will put you in the editor, where you can select regular flight mode. To do so, press the Enter key to move the arrow to the User Mode parameter, and enter *0*.

If you chose regular flight mode, proceed to the instructional part of the manual.

If you own a Hercules Graphics Card or IBM Enhanced Graphics Adapter Card:

To use the Hercules Graphics Card or IBM Enhanced Graphics Adapter Card, you must load Flight Simulator using MS-DOS. Follow this procedure:

- ▶ Boot MS-DOS using either a floppy disk or hard drive.
- ▶ Insert the Flight Simulator disk in drive A.
- ▶ Type one of the following:
 - Hercules Graphics Card *FS H*
 - EGA color mode *FS E*
 - EGA monochrome mode *FS M*
- ▶ Follow the procedure listed on page 8, beginning with "To identify your display."

Note

To run the EGA monochrome mode, you must have at least 192K memory. You cannot use the Microsoft Mouse with either the Hercules or EGA cards.

How to Back Up Your Flight Simulator Disk

With Flight Simulator, you can make a single copy of the program for backup purposes. This copy should be used for backup purposes only. Any other use of the extra copy is a violation of copyright laws.

To back up your Flight Simulator disk, follow these instructions:

- ▶ Load the program, using the instructions in "How to Load Flight Simulator." Select option C when the option menu appears at the beginning of the program. The program will tell you to:

REMOVE THE MASTER DISK FROM DRIVE A:
AND INSERT COPY DISK INTO DRIVE A:.

HIT ANY KEY WHEN READY.

- ▶ Insert a blank disk. (Make sure it does not have a write-protect tab on it.) After a few moments, you will be instructed to:

REMOVE THE COPY DISK AND INSERT
THE MASTER DISK INTO DRIVE A:.

HIT ANY KEY WHEN READY.

- ▶ As prompted, switch disks during the copying process. When the copying process is finished, the program will say:

COPYING DONE. REBOOT THE SYSTEM
TO GET GOING AGAIN.

- ▶ Place a write-protect tab on your master disk, and store it in a safe place. Place a write-protect tab on your backup copy, and use it to reload the program, as detailed in "How to Load Flight Simulator."

Note After making a backup copy of your Flight Simulator disk, leave the write-protect tabs on both disks.

Flying Start

A quick test flight for the PCjr:

- You've got a PCjr, and you're eager for your first flight – even before you read this manual. To get flying now, just follow this procedure. You'll get an idea of what the Flight Simulator is all about.
- ▶ Boot the disk as you would any system master disk.
 - ▶ When the instrument panel and startup menu appear, press the *A* key if you have a color monitor, *B* if you have a monochrome monitor, or *C* if you have an RGB monitor.
 - ▶ On the second startup menu, press *B* to continue this test flight (pressing *A* will start an automatic demo – reboot to get out of it).
 - ▶ On the third startup menu, press *A* to select the PCjr keyboard. You'll be on Meigs Field in Chicago (a small airport on a peninsula, surrounded by Lake Michigan).
 - ▶ Press *5*, then *F*, to look out the left side of the airplane. Notice the wing at the top of the three-dimensional display.
 - ▶ Press *5*, then *B*, to look out the back of the plane. Notice the tail at the screen's center.
 - ▶ Press *5*, then *T*, to return to a forward view.
 - ▶ Press *B* four times in rapid succession (no more than 1/2 second between keypresses). This raises the elevator a bit.
 - ▶ Press the *]* key 32 times. This increases throttle to full so the plane starts rolling down the runway. The plane will take off by itself. You'll be able to see when you leave the ground.
 - ▶ Once off the ground, press *5*, then *B*, to look out the back again.
 - ▶ Press *5*, then *T*, for the front view. Watch the flight instruments. Airspeed, altimeter, and vertical velocity gauges will all show movement.
 - ▶ Press *F* to start banking the plane. The horizon will tilt. Don't let the bank get too steep.
 - ▶ After about 20 degrees of bank, press *G* to neutralize the ailerons and keep the plane in its current bank.
 - ▶ Press Esc. On the menu that appears, you can adjust flight parameters. Press the Enter key many times. The arrow will sequence through two pages of 40 adjustable parameters. After looking them over, press Esc again to get back into flight mode.
 - ▶ Now press *H* six times, and wait about a minute without interfering with the controls.
 - ▶ After a crash, Flight Simulator resets and returns you to your starting location.

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You've got a PC or a PC XT, and you're eager for your first flight – even before you read this manual. To get flying now, just follow this procedure. You'll get an idea of what the Flight Simulator is all about.

A quick test flight for the PC:

- ▶ Boot the disk as you would any system master disk.
- ▶ When the instrument panel and startup menu appear, press the *A* key if you have a color monitor, *B* if you have a monochrome monitor, or *C* if you have an RGB monitor.
- ▶ On the second startup menu, press *B* to continue this test flight (pressing *A* will start an automatic demo – reboot to get out of it).
- ▶ On the third startup menu, press *B* to select the PC keyboard. You'll be on Meigs Field in Chicago (a small airport on a peninsula, surrounded by Lake Michigan).
- ▶ Press Scroll Lock, then the left arrow (*4* on the numeric keypad) to look out the left side of the airplane. Notice the wing at the top of the three-dimensional display.
- ▶ Press Scroll Lock, then the down arrow, to look out the back of the plane. Notice the tail at the screen's center.
- ▶ Press Scroll Lock, then the up arrow, to return to a forward view.
- ▶ Press the down arrow four times in rapid succession (no more than 1/2 second between keypresses). This raises the elevator a bit.
- ▶ Press the F2 function key. This increases throttle to full so the plane starts rolling down the runway. The plane will take off by itself. You'll be able to see when you leave the ground.
- ▶ Once off the ground, press Scroll Lock, then the down arrow, to look out the back again.
- ▶ Press Scroll Lock, then the up arrow, for the front view. Watch the flight instruments. Airspeed, altimeter, and vertical velocity gauges will all show movement.
- ▶ Press the left arrow to start banking the plane. The horizon will tilt. Don't let the bank get too steep.
- ▶ After about 20 degrees of bank, press *5* in the center of the numeric keypad (not on the top row of keys) to neutralize the ailerons and keep the plane in its current bank.
- ▶ Press Esc. On the menu that appears, you can adjust flight parameters. Press the Enter key many times. The arrow will sequence through two pages of 40 adjustable parameters. After looking them over, press Esc again to get back into flight mode.
- ▶ Now press the right arrow six times, and wait about a minute without interfering with the controls.
- ▶ After a crash, Flight Simulator resets and returns you to your starting location.

Flight Instruments, Radios, and Visual Systems

Microsoft Flight Simulator has all the instruments and equipment required under FAA regulations (part 91.33) for day and night *Visual Flight Rules (VFR)* and day and night *Instrument Flight Rules (IFR)* under non-icing conditions.

When you start the Flight Simulator program, you will be in easy flight mode and auto-coordinated flight mode. You will fly in optimal conditions and use the primary instruments and controls.

The Three-Dimensional Display

The display screen is split horizontally into two sections. The upper section is a highly realistic, three-dimensional display of the view out your windshield. Through it you can see the runway, terrain, and horizon. The visual effects of the Flight Simulator program are also realistic. On clear days the sky is blue. Cloudy days bring grey skies, unless you break out of the clouds and reach blue sky. As you fly through clouds, visibility is obscured.

Radio messages scroll across the top of the screen and provide airport and weather information. This information is transmitted by the Automatic Terminal Information Service (*ATIS*), which is available near major airports.

The Instrument Panel and Radio Stack

The lower section of the screen displays the instrument panel and *radio stack*. Instruments are arranged as they would be in nearly any aircraft. The style of these instruments varies from plane to plane. The most modern form of each is used in Flight Simulator.

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The six primary flight instruments are grouped together in the *standardized instrument cluster* (see Reference Figure 1, at the back of this manual). In addition to the standardized instrument cluster, the instrument panel includes various instruments, indicators, and radios. You will use only a few of these on your first flight. Those that you will not use on your first flight are described in more detail in "Secondary Aircraft Controls."

The numbers accompanying the instrument and radio names correspond to the boldface numbers in the figure. The instruments (beginning from the left) are:

The standardized instrument cluster:

1. *Airspeed indicator*. Measures in *knots* the aircraft's speed through the air around it. The airspeed indicator is an air-pressure-activated gauge. It does not measure *ground speed*.
2. Attitude indicator, or *artificial horizon*. Shows the aircraft's pitch and bank attitudes.

Pitch is the rotation of the plane about its lateral axis (nose-up or nose-down). Pitch is measured by the center bar of the attitude indicator. When the bar is aligned with the horizon, you are flying in straight and level flight. Horizontal markings near the center indicate nose-up and nose-down pitch angles.

Bank is the rolling of a plane on its *longitudinal axis*. The bank indicator is the small arrow that points to the 10-, 20-, 30-, 60- and 90-degree markings at the edge of the attitude indicator. When the arrow points to the 0-degree bank mark, you are in straight and level flight. The arrow always points to the top of the gauge. The bank marks rotate around the edge of the instrument.

3. *Altimeter*. Measures altitude in feet above sea level. The gauge is operated by atmospheric pressure. The altimeter is read like a clock with 10 divisions instead of 12. The large hand indicates hundreds of feet above sea level (with increments of 20 feet), and the small hand indicates thousands. The small arrow near the outside of the gauge indicates tens of thousands of feet.

Sea level is not the same as ground level. At an airport at a 750-foot elevation, the altimeter registers 750 feet while the plane is sitting on the ground.

Barometric pressure changes caused by changes in the weather can cause errors in altitude readings. Pilots must often calibrate this gauge to the barometric pressure of the airspace through which they are flying. (At altitudes above 17,999 feet, you must calibrate to "standard pressure," which is 29.92 inches of mercury.)

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The small knob on the gauge is used to set the barometric pressure, which is noted in the small square window. Flight Simulator's altimeter can be adjusted for barometric pressure by pressing the *A* key on the PC or Shift *A* on the PCjr. The letter "A" on the altimeter's adjustment knob refers to the key.

4. Turn coordinator. Measures turn rate and coordination. No numerical value appears on this gauge. Instead, a single turn rate position is marked by the turn indicator (the small airplane symbol on the gauge). When the gauge aligns with the "L" (Left) or "R" (Right) indicators, a two-minute turn results. This means that the plane will complete a 360-degree turn in two minutes. The turn coordinator, unlike the turn indicator gauge used in some planes, uses a 35-degree *canted gyroscope* that reflects both bank and heading changes. Pitch, however, has no effect on the gauge. The turn indicator is also useful for timed turns.

The ball in the turn coordinator indicates slip/skid attitude, or aircraft coordination. When the ball is centered, the aircraft's longitudinal axis is parallel to the direction of flight and the flight is "coordinated." Coordinated turns are the safest turns. Some maneuvers (notably slips and skids) are not coordinated. See "Advanced Flight Techniques" for more information about slips and skids.

5. *Heading indicator* or directional gyro. Notes the direction of flight. The heading indicator is a gyroscopically controlled compass that, unlike a magnetic compass, has no inherent direction-seeking characteristics. It is much more responsive and steady than the magnetic compass. Using the magnetic compass, calibrate the heading indicator before each flight and a few times an hour while in flight. The gauge knob is used to make the adjustment. Flight Simulator's heading indicator can be set to the magnetic compass direction by pressing the *D* key on the PC and Shift *D* on the PCjr. A "D" is marked on the heading indicator's adjustment knob as a reference to that key. Always be sure that the magnetic compass has "settled down" after a turn or climb-to-level transition to avoid setting a wrong heading.
6. Vertical speed or *rate of climb indicator*. Measures *rate of climb* or descent in hundreds of feet per minute. This gauge operates on air pressure changes and is not adversely affected by absolute barometric pressure. It lags slightly behind the aircraft's responses; avoid "chasing" (flying in direct response to) the vertical speed indicator to establish a constant altitude.

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Other flight instruments and indicators:

7. Magnetic compass. A standard magnetic compass.
8. *Omni-Bearing Indicator (OBI)*, with *glideslope*. A landing approach and general navigation instrument that is used with the NAV 1 (Navigation) radio to tune into VOR (Very high frequency Omni-directional Range) radio beacons.
9. Same as above, but used with the NAV 2 radio.
10. Clock. A standard digital clock that runs in real time and measures hours, minutes, and seconds. Under 1982 FAA regulations, a digital presentation qualifies for IFR flight in lieu of an analog sweep second hand clock. The Flight Simulator clock is very accurate. (For details on setting the time, see "Selecting the Time of Day.")
11. Gear indicator. Indicates whether the landing gear is lowered or raised.
12. Lights indicator. Indicates whether the running lights and instrument lights are on. Running and instrument lights should be turned on at night so the plane is visible to other air traffic and ground observers and so you can see the instrument panel.
13. Magnetos indicator. Indicates if the left and right *magnetos* (engine ignition coils) are on or off. The magnetos can be switched on individually (left or right) or simultaneously (both). The magnetos indicator also acts as a carburetor mixture lean indicator for engine shutdown.
14. Carburetor heat indicator. Indicates if the carburetor heat is on.
15. O (Outer), M (Middle), and I (Inner) marker lights. Tell when your aircraft is over the outer, middle, or inner marker beacons during instrument approaches.
16. Left wing fuel tank gauge.
17. Right wing fuel tank gauge.
18. Oil temperature gauge.
19. Oil pressure gauge.
20. *Tachometer*.

Engine monitoring instruments:

Radios:

21. *NAV1* radio. A NAV radio is a 200-channel radio used to tune in and identify VOR (Very high frequency Omnidirectional Range) navigation aids. It also receives ILS (*Instrument Landing System*) frequencies.
The NAV radios receive frequencies between 108.00 and 117.95 MHz, with 50 kHz separations. VORs are radio stations that transmit an omnidirectional synchronization signal. This synchronization signal is followed by a circular sweeping directional signal. The NAV receiver in your aircraft decodes these signals to determine the angle or “radial” of the station you are on. Radials are directional beams that radiate from the VOR station. The NAV receiver also controls the Omni-Bearing Indicator, which you can use to guide your plane along radials as you move toward or away from VOR stations. For instruction on instrument approach and flying (using the ILS localizer and glideslope), consult a training manual, such as *Instrument Flying* by Richard L. Taylor.
22. NAV2 radio (see above). Two NAV radios are provided. Two VOR stations can be tuned simultaneously so you can cross-check your position.
23. *DME*. This works in conjunction with the NAV1 radio to tell you how many nautical miles you are from the tuned-in VOR.
24. *COM* radio. The COM radio is a 360-channel transceiver that receives and transmits at frequencies between 118.00 and 135.95 MHz, with 50 kHz separations. The Flight Simulator COM radio is used as a receiver only. Airport, weather, and approach information can be received by tuning in ATIS at most major airports. For more information on using the COM radio, see “Secondary Aircraft Controls.”
25. *Transponder*. The transponder is a radio that is used to identify your aircraft on Air Traffic Control (*ATC*) radar.

Note

The IBM keyboards, unlike real control panels, do not give you the feel of moving the controls. To compensate, the Flight Simulator instrument panel includes position indicators for the controls.

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Control position indicators:

26. Aileron position indicator. Indicates the position of the ailerons. The *ailerons* are *airfoils* on the trailing edge of the wing that control the movement of the plane on its longitudinal axis. When the arrow on the indicator is aligned with the center mark, the ailerons are centered. When the arrow points to the right of the center mark, right aileron is applied; when the arrow points to the left, left aileron is applied.
27. Elevator position indicator. Indicates the position of the elevators. *Elevators* are airfoils that control the movement of the plane on its lateral axis, moving the plane (nose) up and down. When the indicator arrow is aligned with the center mark, the elevators are centered. When it is above the center mark, the elevators are raised; when below, the elevators are lowered.
28. Rudder position indicator. Indicates the position of the rudder. The *rudder* controls the rotation of the plane about its vertical axis (left or right rotation). The rudder position indicator works just like the aileron position indicator. In *auto-coordinated* mode (one of the two modes you are in when you begin the program), the aileron and rudder position indicators work as a unit.
29. Throttle position indicator. Indicates how much throttle is applied. The throttle has 32 settings.
30. Elevator trim indicator. Indicates elevator trim setting, which is detailed in "Aircraft Controls for the PCjr" and "Aircraft Controls for the PC."
31. Flap position indicator. Shows the position of the flaps.
32. Mouse control of view select. Enables radar view.

Aircraft Controls for the PCjr

Microsoft Flight Simulator, like a real aircraft, has many controls: engine function controls, flight controls, a navigation radio, and a communications radio. All the controls are necessary for safe, efficient flight, but only the primary flight controls are needed to get you flying.

The primary flight controls cover all controls for easy flight – the ailerons, elevators, rudder, and throttle. Simulation controls are features of Flight Simulator so you can look outside your window, use radar, or pause. To navigate and control the engine, use the secondary flight controls.

Note This section describes the controls for the PCjr. If you have a PC, skip to the next chapter, “Aircraft Controls for the PC.”

Primary Flight Controls

The primary flight controls include the *control yoke* (a steering-wheel-like control on most planes, a control stick on others), the rudder pedals, and the throttle. The control yoke is arranged in a diamond-shaped pattern (a “control diamond”) on the computer keyboard; the rudder pedals are to the right and left below it, as in a real aircraft. The PCjr control yoke is located on the three-by-three block of keys, with the G key as the center key (R-T-Y; F-G-H; V-B-N). The PCjr throttle is adjusted by the [and] keys.

For a summary of all the Flight Simulator key positions for the PCjr, see Reference Figure 2, at the back of this manual. If you are unfamiliar with the parts of an airplane, see that same figure.

Note If you have IBM joysticks, you may want to use one for the control yoke and one for the throttle. For more information, see “Joystick Use and Techniques” in this section.

The Control Yoke and Rudder

The yoke operates the ailerons and elevators, which are controlled to guide the plane on its course. The ailerons, on the trailing edges of the wings, control the rotation of the plane about its longitudinal axis. Ailerons control bank, or roll, of a plane (see Figure 2).

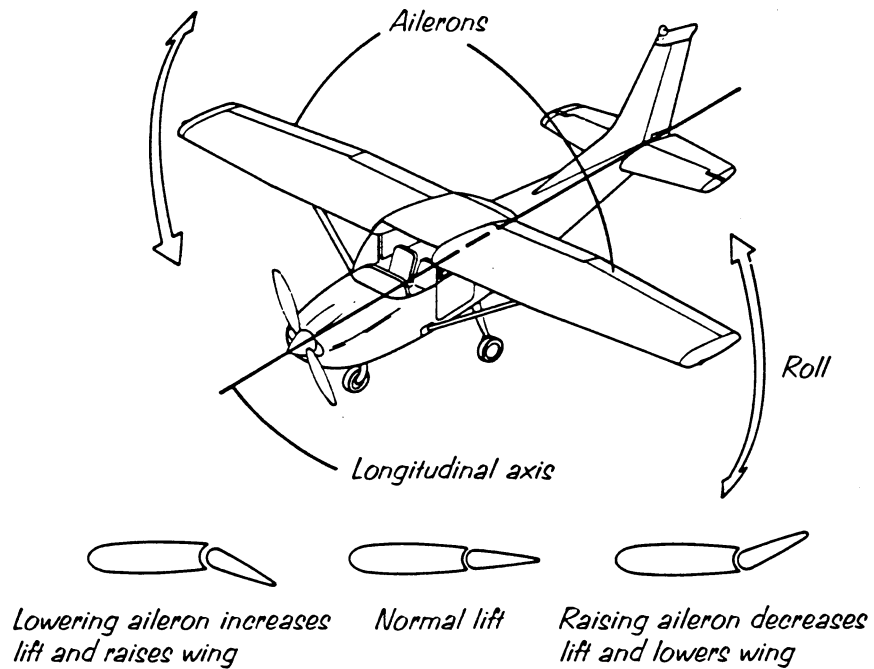


Figure 2. Ailerons

Learning Flight Simulator

The elevators, on the trailing edge of the *horizontal stabilizer* (the “rear wings”), control the movement of the plane on its lateral axis, moving the nose of the plane up or down (see Figure 3).

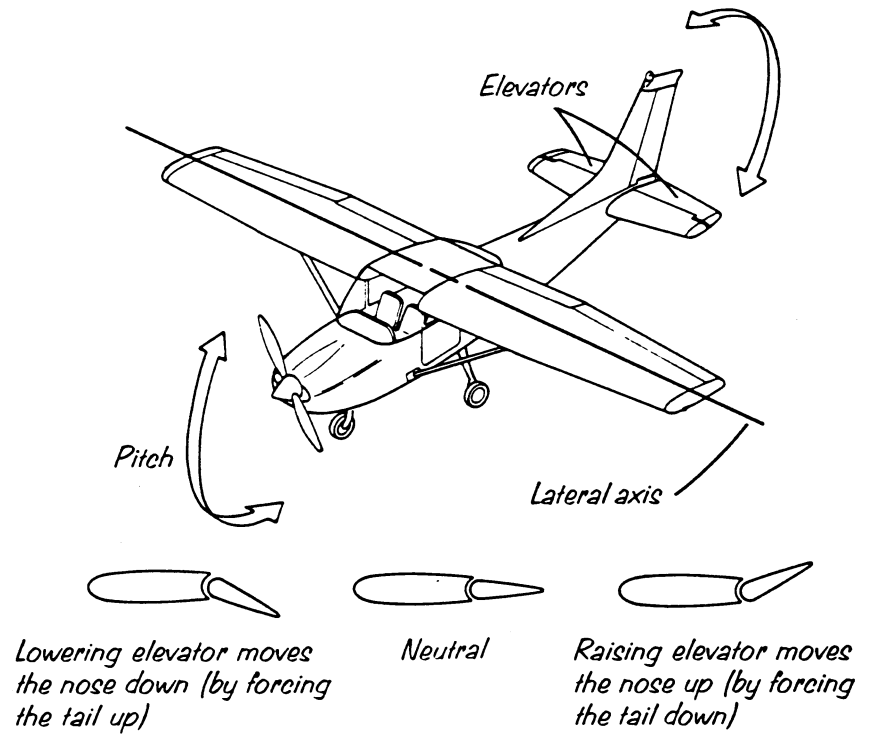


Figure 3. Elevators

Microsoft Flight Simulator

The rudder, which is located on the *vertical stabilizer* of the plane, moves the plane on its vertical axis (see Figure 4).

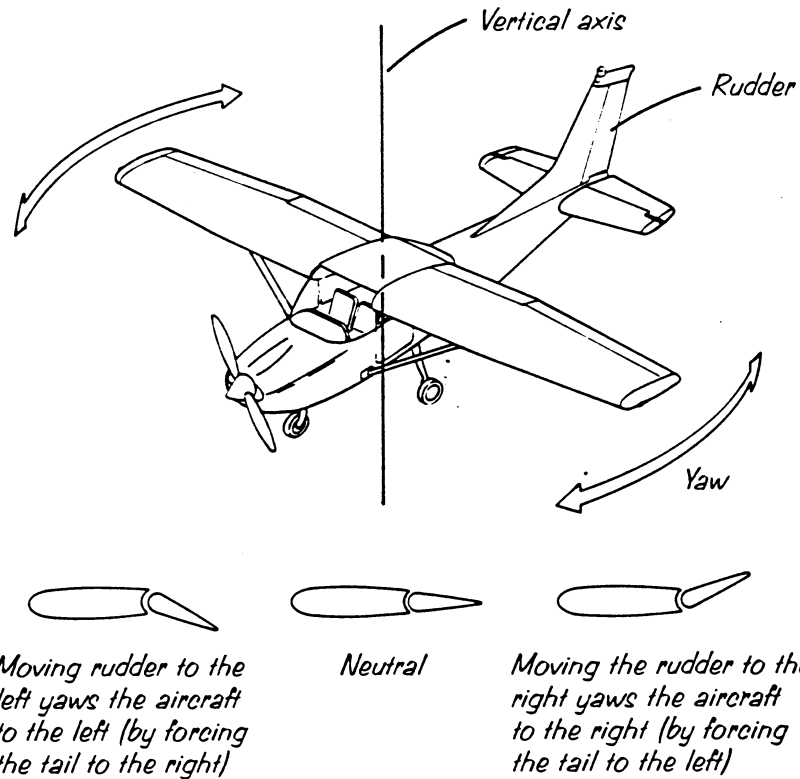


Figure 4. Rudder

Figure 5 shows the control yoke and rudder keys. In auto-coordinated flight mode, the rudder and ailerons are linked. Adjusting one also adjusts the other.

To bank and center the plane:

The ailerons are controlled by the F and H keys of the control yoke. Pressing the F key applies left aileron (yoke left) and lets you bank left. Pressing the H key banks you right. Pressing the G key centers the ailerons.

To raise and lower the nose:

The elevators are controlled by the B and T keys of the control yoke. Pressing the B key (yoke back) moves the elevators up. When you are flying, this lifts the nose of the airplane. Pressing the T key (yoke forward) moves the elevators down, lowering the nose. Rapid keypresses make broad, quick adjustments in elevator position. Pressing the elevator keys slowly, with at least one-quarter second between each press, moves the elevators by one-eighth of their normal adjustment for fine elevator control.

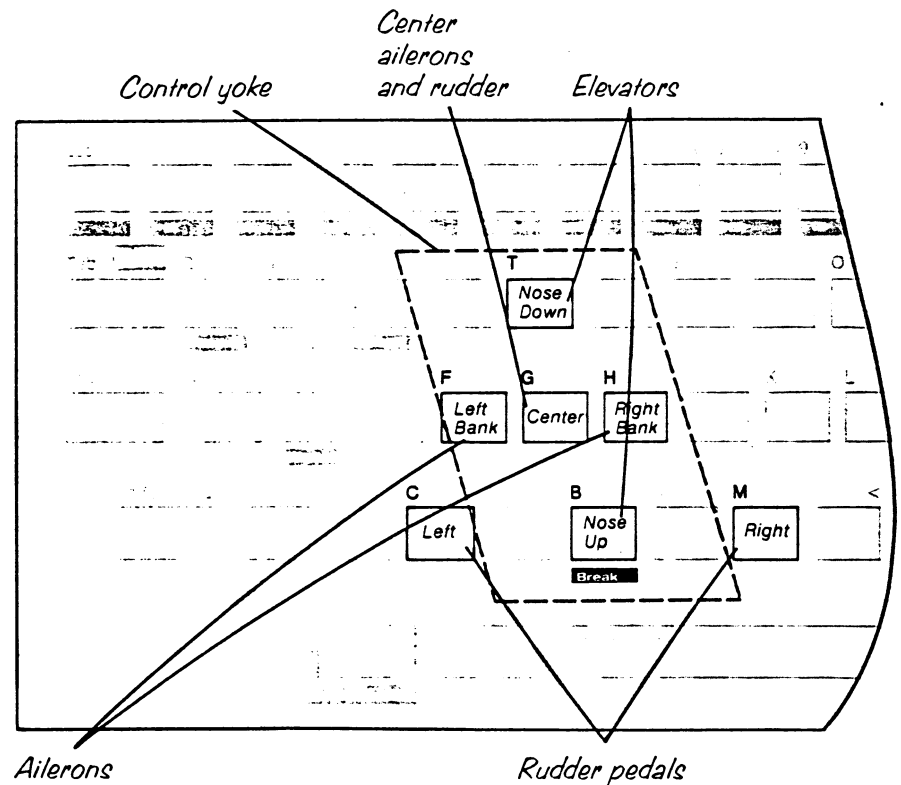


Figure 5. Control Yoke and Rudder Pedals for the PCjr

Experiment with the ailerons and elevators. Notice how the changes in position are shown on the aileron and elevator position indicators. The C and M keys adjacent to the control yoke operate the rudder. Pressing the C key *yaws* the plane left. Pressing the M key *yaws* the plane right. Pressing the G key centers the rudder. The rudder is also used to steer the nose-wheel when the plane is on the ground.

Microsoft Flight Simulator

Experiment with the rudder. See how both the aileron and rudder position indicators move as you move the rudder. Nothing else will happen, because you must be moving to ground-steer the plane.

The Throttle

The right and left bracket keys ([and]) are the throttle lever (see Figure 6). Think of these symbols as chopped-off left and right arrows meaning less and more throttle, respectively. There are 32 throttle positions (or notches). The [and] keys decrease and increase the throttle one notch per press.

The / key is the “full or cut” key and can precede a] or [press to indicate full or cut throttle. The / key is a convenience that lets you go from idle to full throttle (when beginning a takeoff, for example) without having to press the] key 31 times. Keep in mind that this is just a convenience. It is a bad practice to quickly move the throttle from idle to full as it can bog down and stall the engine. Slow, smooth throttle movements are always preferable.

The throttle position indicator on the panel shows the throttle setting.

Learning Flight Simulator

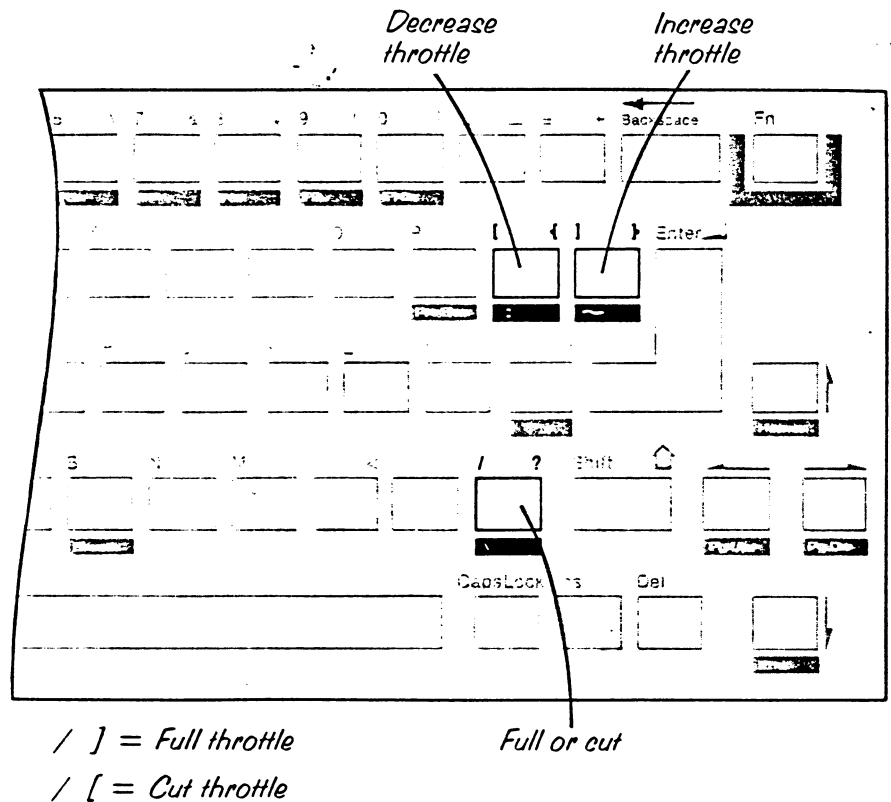


Figure 6. Throttle Controls for the PCjr

Simulation Controls

Several keys on the main keyboard control flight systems, visual systems, and the simulation itself. Those you will use during your first flight are described in this section.

Microsoft Flight Simulator

To view your surroundings:

When you fly according to Visual Flight Rules, you will need to look around frequently to observe traffic, weather, and obstacles. The view selector lets you choose from nine viewing directions. To use the view selector, press the View key (5) and then any one of the keys on the control yoke (see Figure 7). Do not press the keys simultaneously.

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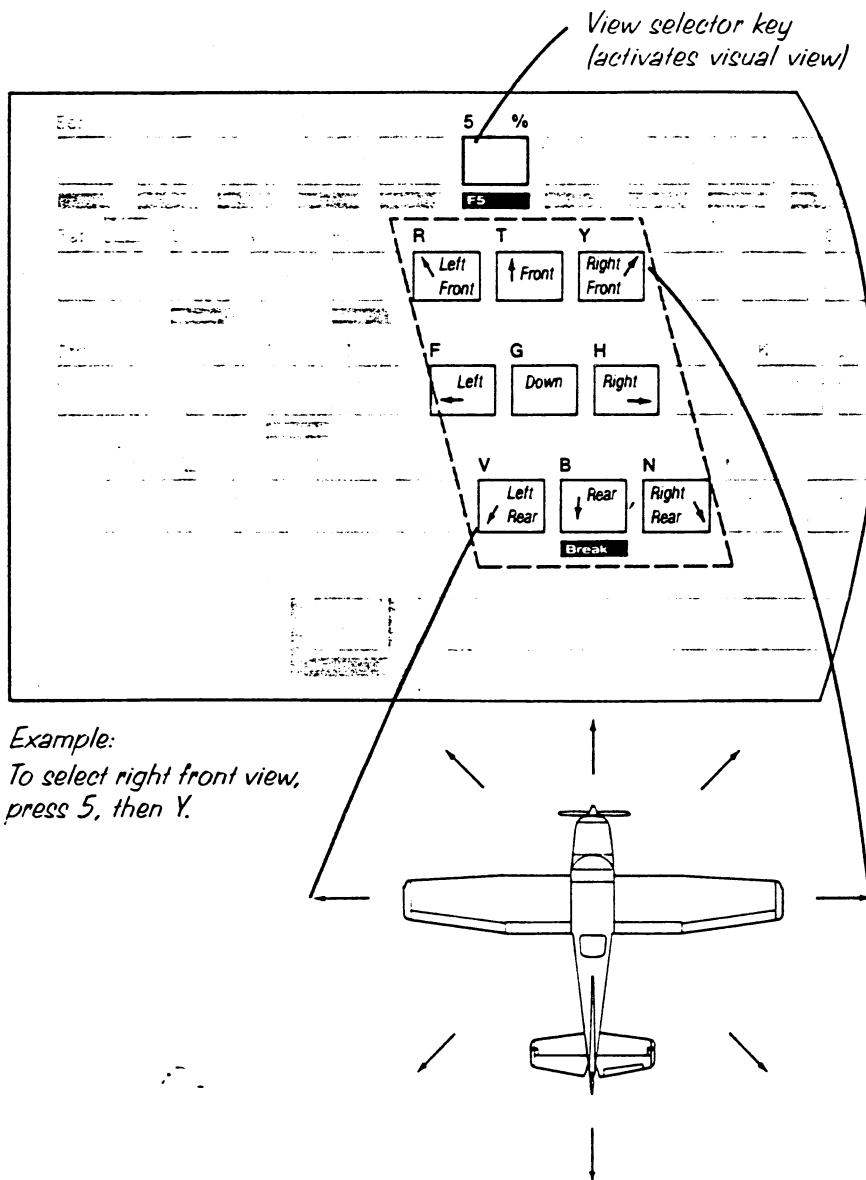


Figure 7. View Selector Controls for the PCjr

To use radar:

The keys bear a logical relationship to the selected view. For example, pressing **5** and the **B** key displays the view you would see if you could look directly behind you (notice the tail). Pressing the **5** key and the **Y** key instead displays the right front view (notice the front part of the wing). Pressing **5** and the **G** key displays the downward view (notice the landing wheel strut). You may also adjust your selected view up or down, by pressing the Backspace or Enter key respectively.

Radar gives you a top-down view with an adjustable range or zoom. This gives you an overview of the area in which you are flying. A small symbol indicates your position. You can also use radar view to guide yourself around airports and to navigate. The image it presents is unrealistically accurate and is more like a map display.

To select radar view, press the Radar key (**4**). Press the **+** or **-** keys at the top of the main keyboard to zoom in and out of the radar's sampling range. To return to the three-dimensional display, press the **5** key.

To select a new viewing direction after switching from radar to three-dimensional view, press the **5** key again and a view direction key.

The Pause key (**Q**, **P**, or Shift **P**) suspends simulation. Pressing the Pause key a second time resumes simulation where you left off. You will find this feature particularly helpful for reading ahead in the manual if you lose control of your plane.

Secondary Aircraft Controls

The primary flight controls are the only controls needed to fly the plane in easy flight mode (the mode you are in when you begin the program). The secondary controls are used to navigate, control the engine, and control the simulator itself. Their positions on the panel and functions are described in previous sections. A description of how to use these follows. If this is your first flight, you may want to return to this section later.

Flaps

Flaps are movable panels on the inboard trailing edges of the wings. They are hinged so they can be extended downward into the flow of air beneath the wings to increase lift (upward force) and *drag* (rearward pull). Their primary purpose is to permit a slower airspeed and steeper angle of descent during a landing approach. They can also be used to shorten takeoff distance or decrease stall speed on landing approach.

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To slow your plane for landing:

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The Y and N keys raise and lower the flaps one notch per press (see Figure 8). Remember these keys as the upper right and lower right keys of the control yoke. Watch the flaps position indicator, not the keyboard, while pressing these keys.

Extending and retracting the flaps affects the plane's performance considerably. Lowering the flaps increases both lift and drag. This increases glide angle, which is particularly useful if you are flying too high on an approach and want to increase your rate of descent. Airspeed can be reduced by extending the flaps.

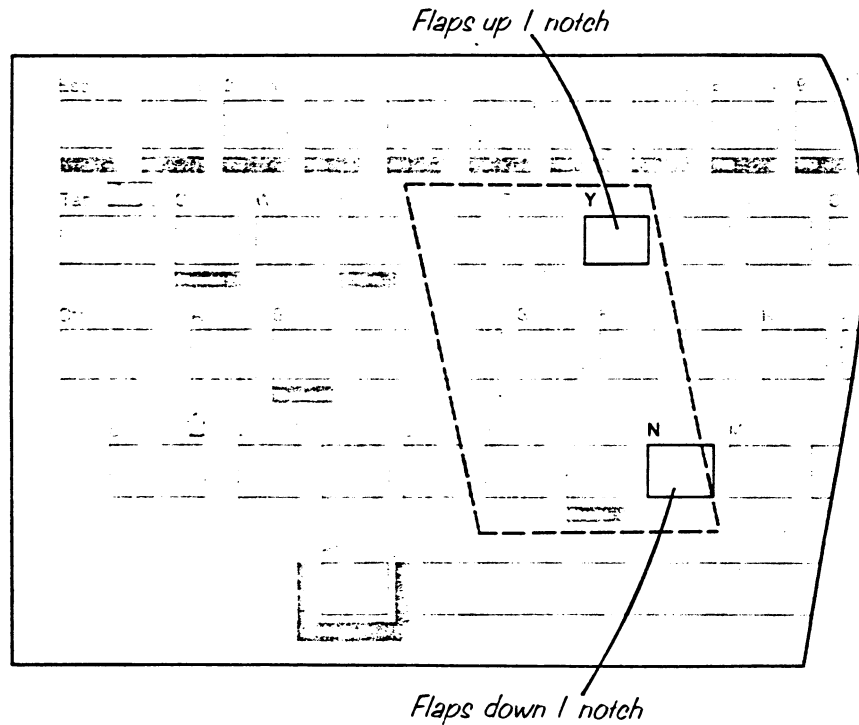


Figure 8. Flap Controls for the PCjr

To counteract forces on the yoke:

Elevator Trim

The control yoke is directly connected to the airfoils it controls. Different flight attitudes put different pressure on the airfoils. These variations also change the pressure on the yoke. The pilot must counteract these forces to keep the airfoils in their proper positions. Applying steady pressure on the yoke for hours would be fatiguing. *Trim* is used to counteract these forces and relieve the pilot from applying constant pressure on the yoke.

Flight Simulator provides elevator trim controls. The R and V keys on the control yoke control elevator trim. Pressing the R key adjusts the trim downward. Pressing the V key adjusts the trim upward. The elevator trim position indicator shows elevator trim position, with the "U" representing the up position and the "D" representing the down position (see Figure 9). Remember these keys as the upper left and lower left keys of the control yoke.

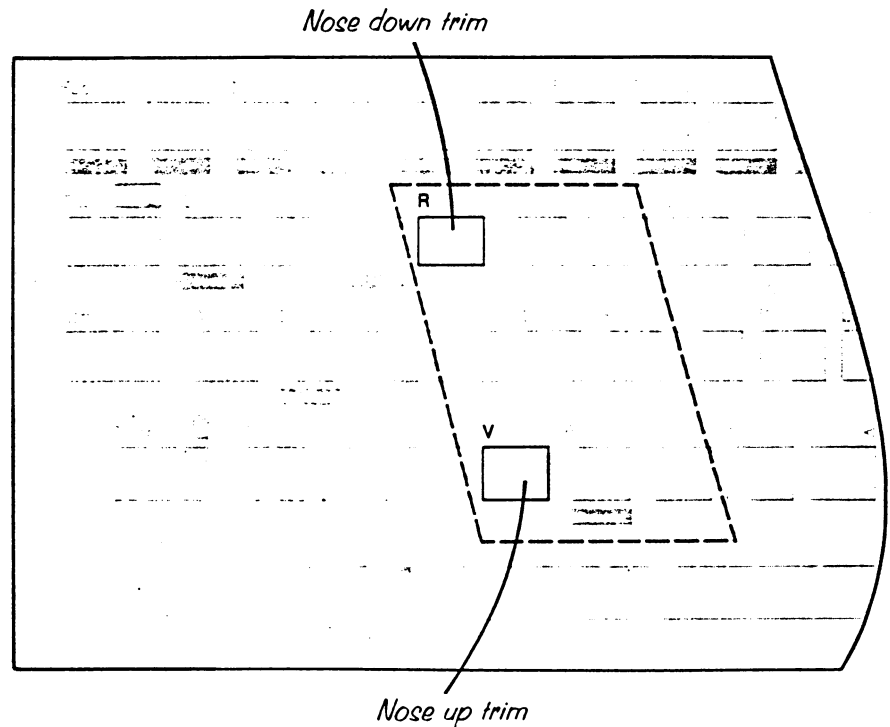


Figure 9. Elevator Trim Controls for the PCjr

Carburetor Heat

The Heat key (Shift H) is the carburetor heat toggle switch. The carburetor heat indicator on the instrument panel shows whether carburetor heat is on or off.

Carburetor heat is used to preclude icing or clear ice that has already formed in the carburetor. Apply carburetor heat for a few seconds on landing approach to avoid ice-caused engine failure.

Magneto Switch and Mixture Full Lean Control

The Magneto key (Shift M) is the magneto switch. After you press the Shift *M* key, enter one of the following numbers to indicate magneto setting.

<i>Number</i>	<i>Result</i>
1	OFF Magnetos off
2	L Left magneto on
3	R Right magneto on
4	B Both magnetos on
5	ST Start engine, then both magnetos on
0	LN Mixture full lean (engine turn-off)

Lights

The Lights key (Shift L) turns on the running and instrument lights. *Running lights* are lights on the tips of each wing – red on the pilot's left, green on the right – that help others identify your heading. Instrument panel lights illuminate individual instruments on the instrument panel, so you can see them at night. You must turn on the running and instrument panel lights for night flight. It's not advisable to fly with your lights on during the day. If you do, when night arrives you may find that a bulb on an important instrument has burned out. Bulbs are replaced during refueling and servicing stops.

**To tune into
VOR beacons:**

Navigation Radio

The NAV radio is an important navigational aid. It is used to tune in VOR radio beacons, so you can fly toward or away from them.

Two NAV radios are provided so you can tune in two VOR beacons at once. This is useful for doing cross-checks of your position. You must set the NAV radio to the VOR frequency to receive the appropriate signal. On a real aircraft, two knobs are used to set the frequency. One sets the full megahertz frequencies (121, 122, 123, etc.), and the other sets the fractional frequencies in 50 kHz increments (.00, .05, .10, etc.). Many new radios are 20-channel models with 25 kHz separations, but none of these intermediate frequencies are implemented on Flight Simulator.

To set the NAV radio to a particular frequency, press the NAV key (Shift *N*), followed by the radio number (1 for NAV1 and 2 for NAV2). Then press the + or - keys to advance or move back the current setting until you reach the desired MHz frequency. To set the fractional frequency (e.g., .00, .05, .10, etc.), press the Shift *N* key twice, in rapid succession, then press either the + or - key until you reach the appropriate setting. Pressing the radio number after the Shift *N* key is only necessary if you want to tune a NAV radio other than the one you most recently tuned.

For example, to advance from 121 to 126 MHz, press Shift *N* + + + + +. To advance from .35 to .55, press Shift *N* Shift *N* + + + +. For more information on using the NAV radio, see "Navigational Aids."

The NAV1 radio is also used to tune in ILS localizer and glideslope. For more information on instrument flying, see "Advanced Flight Techniques." For detailed information, consult a flight training manual.

Omni-Bearing Indicator

The OBI is used with the NAV radio to tune into VOR (Very high frequency Omnidirectional Range) radio stations. VORs are radio stations that transmit an omnidirectional synchronization signal followed by a circular sweeping directional signal. The NAV receiver in the aircraft decodes these signals to determine what angle or "radial" from the station you are on. Radials can be thought of as directional beams radiating outward from the VOR station like spokes of a wheel.

The OBI or VOR indicator is a panel-mounted instrument that lets you determine what VOR radial your plane is currently on. It also helps you fly along radials toward or away from the VOR station.

Two OBIs are provided. The top OBI (Reference Figure 1, item 8) corresponds to the NAV1 radio. The bottom OBI (item 9) corresponds to the NAV2 radio.

**To navigate to
and from VORs:**

Microsoft Flight Simulator

To set the OBI, press the VOR key (Shift *V*). The letter “V” on the knob of the OBI indicator refers to the Shift *V* key. Next, if you want to adjust an OBI other than the one you most recently adjusted, press number *1* for the top OBI and *2* for the bottom OBI. Then, press + or – keys as needed to select the right course and reciprocal course readings. Each keypress adjusts the course selector by two degrees. Holding the + key down rapidly sequences through the degree settings.

Communications Radio

Use the COM radio to tune into ATIS for weather, airport, and approach information. The charts at the back of this manual note the ATIS frequencies for each airport where this service is available. The same procedure that is used to set NAV radio frequencies is used to set the COM radio, except that you press the COM key (Shift *C*) instead of the Shift *N* key.

Transponder

On occasion, Air Traffic Control (ATC) will ask you to transmit a four-digit code or “squawk.” The message from ATC will scroll across the top of your screen. ATC will use the number your transponder transmits to track you on its radar screen.

To set the transponder, choose the digit you want to change. To change the left-most digit, press the Transponder key (Shift *T*), then press the + or – key on the main keyboard as necessary to select the appropriate digit. To set the second digit, press Shift *T* twice, in rapid succession, followed by the appropriate + or – keypress. Press Shift *T* three or four times to set the third or fourth digits, respectively.

Altimeter

To set the altimeter to the current barometric pressure, press the Altimeter key (Shift *A*). The altitude reading may change when you press this key. We recommend that you do this several times each hour in reality mode to ensure accurate altimeter readings.

The letter “A” on the altimeter’s adjustment knob refers to the Shift *A* key.

To help ATC track you:

Heading Indicator (Directional Gyro)

Pressing the Directional Gyro key (Shift *D*) sets the heading indicator to the same reading as the magnetic compass. (The magnetic compass does not drift with time as the heading indicator does, and it will always show a correct reading once it has “settled down” after a turn.)

Always be sure the magnetic compass has settled down to avoid setting an incorrect direction. The letter “D” on the heading indicator’s adjustment knob references the Shift D key.

Landing Gear

The Landing Gear key (Shift *G*) raises and lowers the *landing gear*.

The gear indicator on the panel shows the current status of the landing gear. You do not have to raise the landing gear after takeoff. If you do raise it, however, be sure to lower it on landing approach. Flying with the landing gear down increases drag.

Brakes

The Brakes key (*.*) applies the brakes. Each keypress reduces your speed by a few knots. Several presses are usually necessary to bring the plane to a complete stop. Brakes are used only on the ground.

Keyboard Techniques

Keypresses

Holding down most alphanumeric keys automatically generates many keypresses (at the rate of 12 per second). Holding down the elevator, aileron, rudder, or throttle control keys results in multiple notch adjustments. For example, alternately holding down the left and right aileron keys will gently rock the plane from side to side (when doing “Dutch Rolls,” for instance). The *.* key (the brakes), if held down, will eventually bring a taxiing plane to a stop.

However, toggle keys, such as the Shift *G* key (which raises and lowers the landing gear), should not be held down. Doing so will repeatedly switch between the two settings.

The PCjr keyboard can only accept keypresses at about the rate a “fast typist” would type text. Avoid typing too quickly or pressing two keys simultaneously.

Finger Positioning

Finger positioning for operating the controls located in the control diamond is not the same as that used on an alphanumeric keypad. You will find it easy to operate these controls if you follow the “ten-key-by-touch” system, used by many people to operate adding machines and calculators.

Place the middle finger of your right hand on the *G* key on the keyboard. Then place your index and ring fingers on the *F* and *H* keys. To control the rudder pedals, use your thumb and little finger to operate the *C* and *M* keys.

Using Joysticks

You can control Flight Simulator ailerons, elevators, and throttle through the keyboard or through joysticks. To use joysticks, you will need one or two joysticks with buttons. The built-in joystick circuitry supports two joysticks designated as Joystick A and Joystick B. With Flight Simulator, Joystick A is used to control ailerons and elevators, and Joystick B is used to control the throttle.

IBM joysticks are ideal for use with the Flight Simulator. One or two of them may be plugged into the PCjr's joystick sockets, located at the back of the PCjr.

Setting up the Joysticks

Joysticks are either self-centering (the stick returns to the center position when released) or non-centering. Ailerons can be controlled with either a non-centering or self-centering joystick, as you prefer.

Note Only non-centering joysticks can be used to control the elevators and the throttle.

The IBM joysticks used with the PCjr have mechanical switching levers to enable or disable the self-centering springs. These switches are usually on the underside of the joystick case. The ideal setup for Flight Simulator joystick control is:

Ailerons (Joystick A, X-movement) = self-centering

Elevators (Joystick A, Y-movement) = non-centering

Throttle (Joystick B, Y-movement) = non-centering

Installing and Turning on the Joysticks

To install joysticks:

- ▶ Turn the computer off, and plug in the joysticks.
- ▶ Turn the computer on, and load Flight Simulator according to the instructions for “How to Load Flight Simulator.”
- ▶ Enter the editor by pressing Esc, and press Enter to move to the Joystick parameter on the second edit page. (For details, see the chapter entitled “The Editor.”)
- ▶ For the Joystick parameter, enter a “1” to turn on just Joystick A, or enter a “2” to turn on both joysticks (A and B).
- ▶ Return to flight mode by pressing Esc.

Joystick A can now be used to control the ailerons and the elevators (and the rudder in auto-coordinated mode). Sideways movement (on the X axis) controls ailerons and roll, and forward and backward movement (on the Y axis) controls elevators and nose up and down. (See Figure 10.) Slowly move the stick through its complete X and Y range, watching the elevator and aileron (and auto-coordinated rudder) indicators move. The movement may be jumpy, and pushing the stick in a specific direction may not move the ailerons or elevators in that direction, but calibration will solve these problems.

If you have two joysticks and entered “2” as the Joystick parameter, Joystick B can be used to control the throttle. Full forward provides full throttle, and full back reduces engine to an idle.

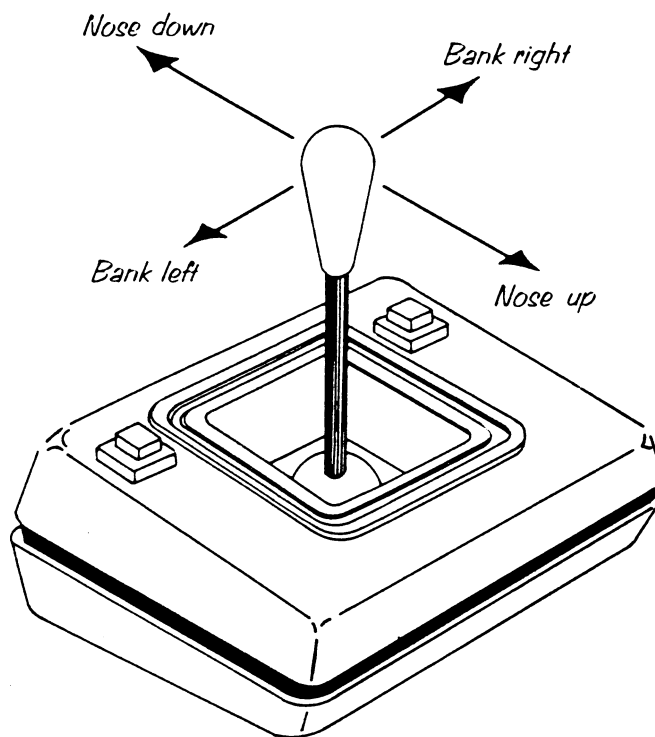


Figure 10. Joystick for the PCjr

Calibrating the Joysticks

After setting the Joystick parameter, you must calibrate the joysticks. Joysticks vary greatly from manufacturer to manufacturer. The range of numerical values generated also varies widely. The IBM joystick control circuitry calls for joysticks with 0 to 100K ohm resistance and linear response. Joysticks with these characteristics (including IBM's joysticks) work best with Flight Simulator.

The following calibration procedure will compensate for joystick tolerance and for joysticks that deviate from IBM's specification.

Important Do not enter the editor or press the Pause key during this process.

If you're using one joystick:

To calibrate the aileron and elevator joystick:

- ▶ Move Joystick A to its aileron and elevator center positions.
- ▶ Center the joystick's trim controls (if any).
- ▶ Press the *K* key.

If you're using two joysticks:

To calibrate the throttle joystick, as well as the aileron and elevator joystick:

- ▶ Move Joystick A to its aileron and elevator center positions.
- ▶ Center Joystick A's trim controls (if any).
- ▶ Make sure that Joystick B's trim controls (if any) are centered.
- ▶ Pull Joystick B all the way back.
- ▶ Press the *K* key.

When Joystick A's range is properly calibrated, the aileron indicator is set full left when the stick is fully left and full right when the stick is at its full right position. The elevator indicator is set full down when Joystick A is fully forward, and it is full up when the stick is fully back. Likewise, when Joystick A is in its center position, the ailerons and elevators are centered.

Make sure Joystick B is pulled all the way back. If it isn't, the plane will start accelerating.

During flight, you can use any trim controls on the joysticks to make minor adjustments and to keep the controls centered if the calibration drifts.

Using the Microsoft Mouse

You can use Microsoft Mouse with Flight Simulator. The mouse controls an on-screen pointer (icon) that resembles a hand and can be used to point at radio controls and instrument knobs.

Mouse Setup

To use the mouse, you must first boot the MS-DOS system disk. After installing the mouse driver, you then boot Flight Simulator from MS-DOS, instead of as a stand-alone disk.

To set up Flight Simulator for using the mouse, make sure the mouse driver is installed according to the instructions provided with the mouse. Installation consists of either having a line such as `DEVICE = MOUSE.SYS` in the file called `CONFIG.SYS` on the boot-up disk, or running a file called `MOUSE.COM`. See your Microsoft Mouse manual for complete details on installing the mouse.

- ▶ Once the mouse driver is installed, remove the mouse disk and place the Flight Simulator disk in drive A.
- ▶ Type `FS` and press Enter.

To control instruments and indicators:

After the Flight Simulator disk boots up and after the initial monitor color and flight mode questions, you will be asked if you want to use the mouse. If you respond with Y, the “hand” pointer will appear on the screen. If the mouse driver was not installed in DOS, you will get a message saying that no driver was found. You can continue without mouse control, or reboot your DOS disk and install the driver following the procedure in your mouse manual.

Microsoft Mouse can be used to adjust all instruments and indicators on your panel except elevators, rudder, flaps, and ailerons. You may want to set up Flight Simulator to use your joysticks for the control yoke and the mouse to control all other functions.

To control Flight Simulator with the mouse, move the pointer to the instrument or indicator you wish to change. Press the left button to decrease the current reading and the right button to increase it. For example, to change the NAV radio frequency to a lower number, point the hand at the digit you wish to change and press the left button. This same process applies to the transponder, COM radio, and clock. You can also reset the seconds to transform your clock into a stopwatch.

The VOR omni-bearing selector can be adjusted by positioning the hand on the “knob” (not the digits) on the VOR indicator and pressing the right or left button to increase or decrease heading. The altimeter and heading indicator can be set similarly by pointing at their “knobs” and pressing either button.

The mouse can also be used to toggle switches on or off. For example, to turn on the carb heat, point the hand at the CH indicator, and press either button. Pressing a button again will turn it off. For magnetos, the hand will cycle through the options once for every button press.

To adjust the throttle, position the mouse hand along the throttle indicator. Left decreases; right increases. The same applies for the trim. The mouse does not activate the flaps, ailerons, elevators, or rudder. To apply the brakes, position the hand along the rudder indicator and press either button.

Microsoft Flight Simulator

To change the view:

The mouse can also be used to change the view selector. To change the view, position the mouse inside the heading indicator (directional gyro) dial. (See Figure 11.) To activate the front three views – straight ahead, right front, and left front – point the mouse to the corresponding digit in the top of the readout. To look directly left or right, point the mouse to the edge of the left and right wingtips on the plane outline. To look down, point the mouse to the middle of the outline. To activate the three rear views, point the mouse on the rear of the outline of the plane, as shown.

To activate the radar view, point the mouse to the small rectangular area located directly below the outline of the plane. Pressing either button activates the radar. To zoom in, press the right button. To zoom out, press the left button. The mouse must be pointing to the small rectangle while zooming in and out. To return to the out-the-window view, simply point the mouse to any view select area, as outlined above.

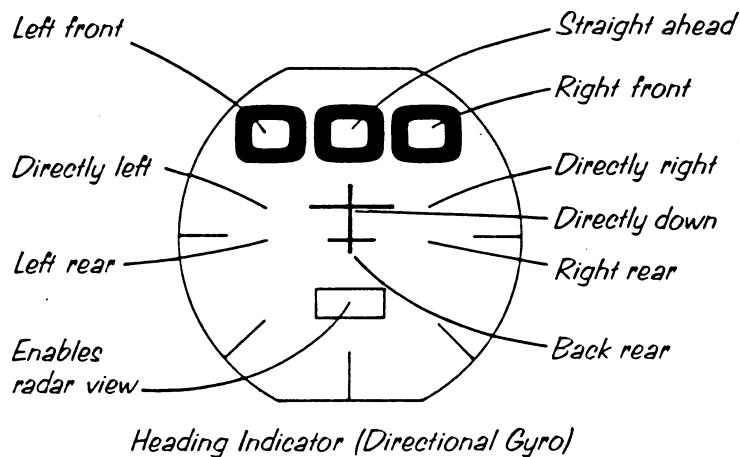


Figure 11. Mouse Control of View Select

Aircraft Controls for the PC

Microsoft Flight Simulator, like a real aircraft, has many controls: engine function controls, flight controls, a navigation radio, and a communications radio. All the controls are necessary for safe, efficient flight, but only the primary flight controls are needed to get you flying.

The primary flight controls cover all controls for easy flight – the ailerons, elevators, rudder, and throttle. Simulation controls are features of Flight Simulator so you can look outside your window, use radar, or pause. To navigate and control the engine, use the secondary flight controls.

Note This section describes the controls for the PC. If you have a PCjr, skip to the preceding chapter, "Aircraft Controls for the PCjr."

Primary Flight Controls

The primary flight controls include the *control yoke* (a steering-wheel-like control on most planes, a control stick on others), the rudder pedals, and the throttle. The control yoke is arranged in a diamond-shaped pattern (a "control diamond") on the computer keyboard; the rudder pedals are to the right and left below it, as in a real aircraft. The PC and PC XT control yoke is located on the numeric keypad, with the 5 key as the center. The throttle lever is the even-numbered row of the Function keypad.

For a summary of all the Flight Simulator key positions for the PC, see Reference Figure 3, at the back of this manual. If you are unfamiliar with the parts of an airplane, see that same figure.

Note If you have an IBM Game Control Adapter Card and joysticks, you may want to use one joystick for the control yoke and one for the throttle. For more information, see "Joystick Use and Techniques" in this section.

The Control Yoke and Rudder

The yoke operates the ailerons and elevators, which are controlled to guide the plane on its course. The ailerons, on the trailing edges of the wings, control the rotation of the plane about its longitudinal axis. Ailerons control bank, or roll, of a plane (see Figure 12).

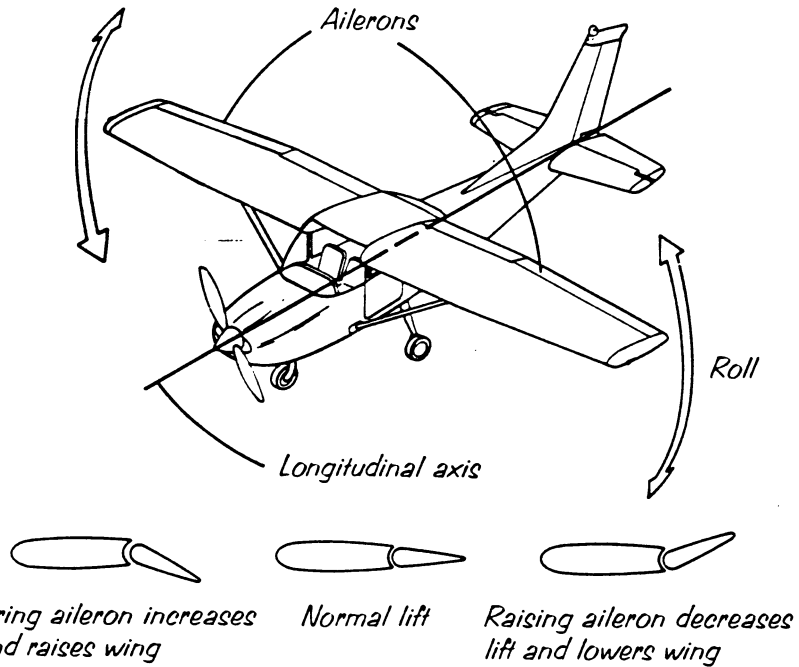


Figure 12. Ailerons

The elevators, on the trailing edge of the *horizontal stabilizer* (the “rear wings”), control the movement of the plane on its lateral axis, moving the nose of the plane up or down (see Figure 13).

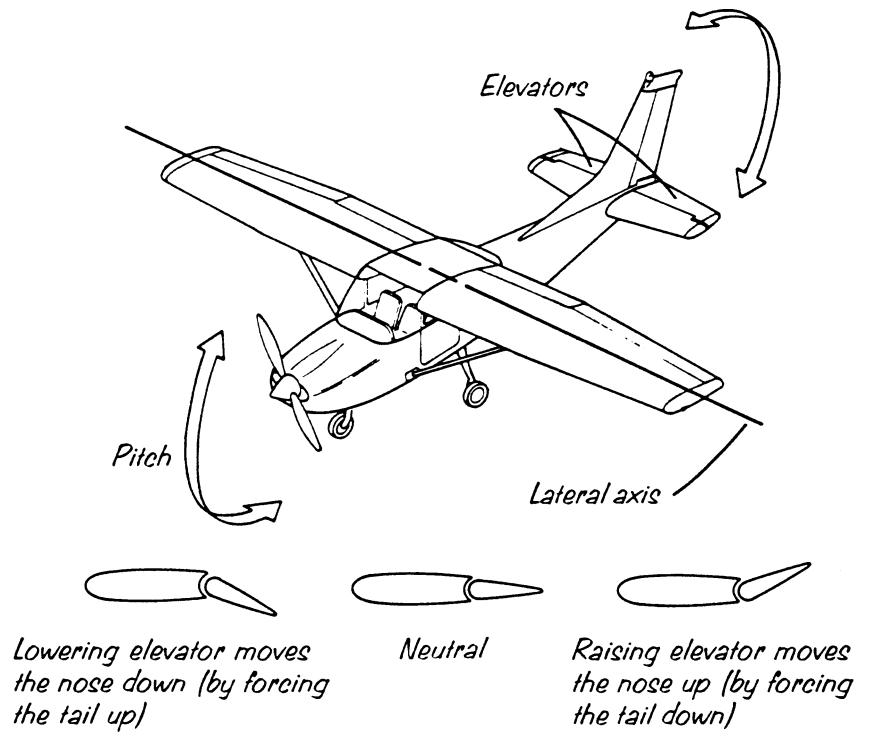


Figure 13. Elevators

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The rudder, which is located on the *vertical stabilizer* of the plane, moves the plane on its vertical axis (see Figure 14).

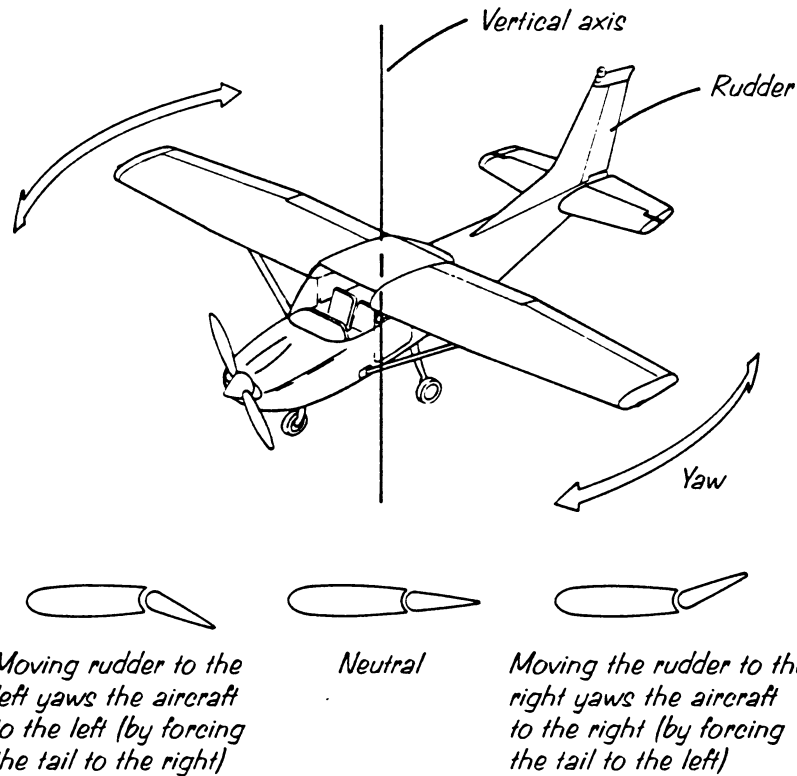


Figure 14. Rudder

Figure 15 shows the control yoke and rudder keys. In auto-coordinated flight mode, the rudder and ailerons are linked. Adjusting one also adjusts the other.

To bank and center the plane:

The ailerons are controlled by the 4 and 6 keys. Pressing the 4 key applies left aileron (yoke left) and lets you bank left. Pressing the 6 key (yoke right) banks you right. Pressing the 5 key centers the ailerons.

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To raise and lower the nose:

The elevators are controlled by the 2 and 8 keys. Pressing the 2 key (yoke back) moves the elevators up. When you are flying, this lifts the nose of the airplane. Pressing the 8 key (yoke forward) moves the elevators down, lowering the nose. Rapid keypresses make broad, quick adjustments in elevator position. Pressing the elevator keys slowly, with at least one-quarter second between each press, moves the elevators by one-eighth of their normal adjustment for fine elevator control.

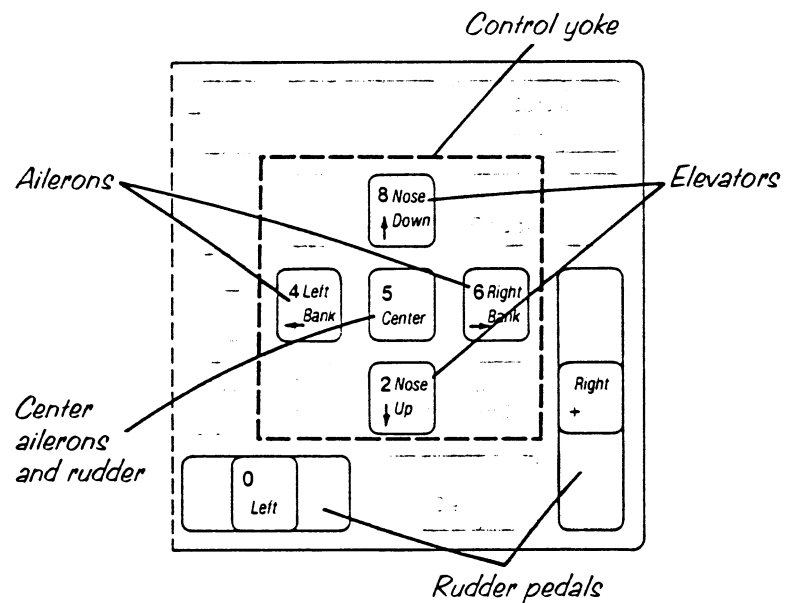


Figure 15. Control Yoke and Rudder Pedals for the PC

The Throttle

The *throttle* applies power. The vertical row of even-numbered Function keys (see Figure 16) forms the throttle lever. The throttle has 32 positions or “notches.” Pressing the F2 key applies full throttle. Pressing the F10 key cuts the throttle. Pressing the F6 key (at the center of the throttle control row) advances the throttle one notch. Pressing the F4 key advances the throttle two notches. Pressing the F8 key decreases the throttle two notches.

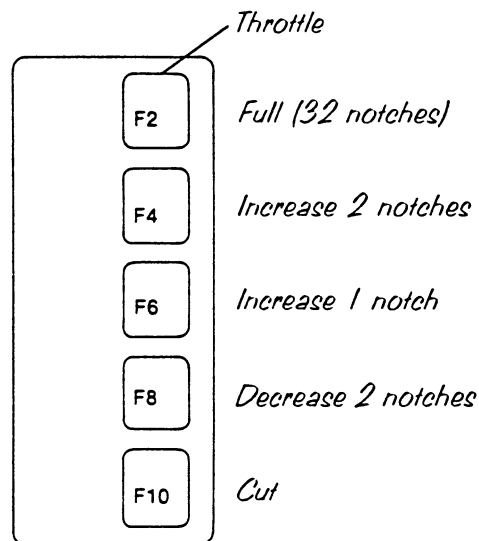


Figure 16. Throttle Controls for the PC

To move to full throttle you can use any of the three throttle-advance keys. For example, you could press the F2 key, which would automatically apply full throttle (the full 32 notches). This can cause the engine to flood and is bad flight practice. Or you could press the F6 key 31 times. Or you could press the F4 key 16 times. To decrease the throttle setting, use either the F10 key or the F8 key.

The throttle position indicator shows the throttle setting.

Simulation Controls

To view your surroundings:

Several keys on the main keyboard control flight systems, visual systems and the simulation itself. Those you will use during your first flight are described in this section.

When you fly according to Visual Flight Rules, you will need to look around frequently to observe traffic, weather, and obstacles. The view selector lets you choose from nine viewing directions. To use the view selector, press the View key (Scroll Lock) located over the upper right corner of the numeric keypad and then any one of the keys on the numeric keypad (see Figure 17). Do not press the keys simultaneously.

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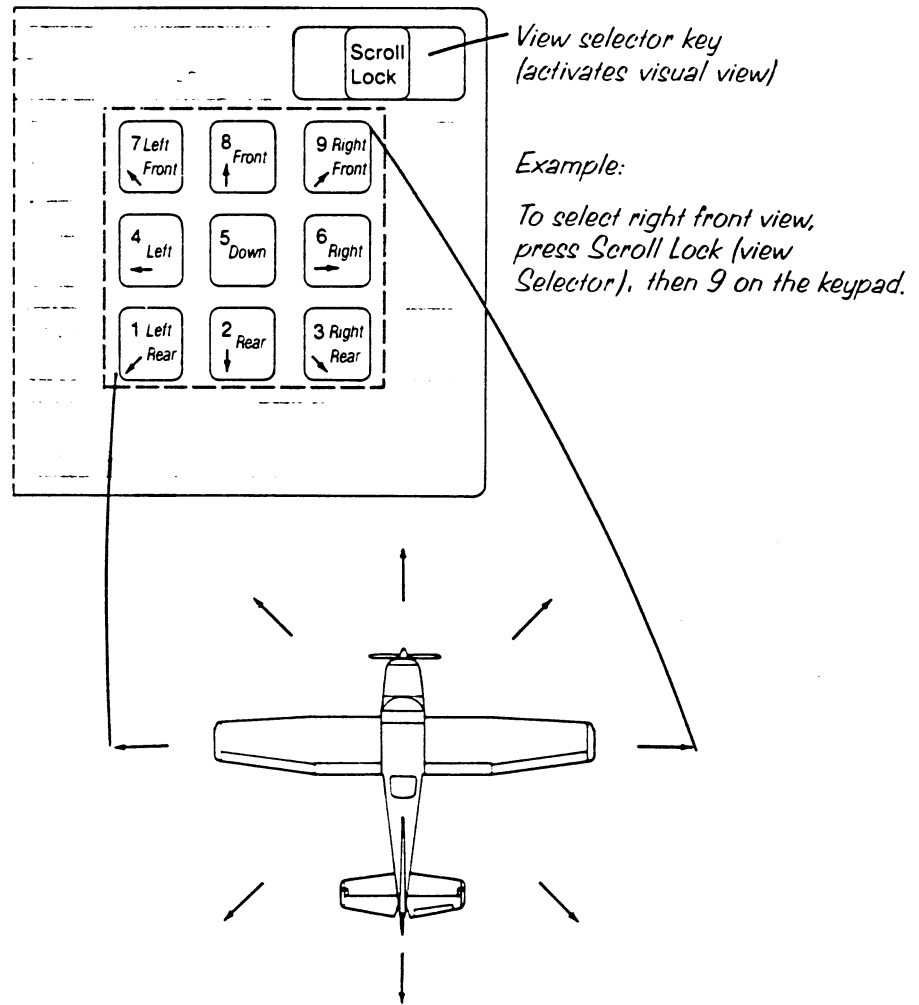


Figure 17. View Selector Controls for the PC

To use radar:

The keys bear a logical relationship to the selected view. For example, pressing Scroll Lock and the 2 key displays the view you would see if you could look directly behind you (notice the tail). Pressing the Scroll Lock key and the 9 key instead displays the right front view (notice the front part of the wing). Pressing Scroll Lock and the 5 key displays the downward view (notice the landing wheel strut). You may also adjust your selected view up or down, by pressing the Backspace or Enter key respectively.

Radar gives you a top-down view with an adjustable range or zoom. This gives you an overview of the area in which you are flying. A small symbol indicates your position. You can also use radar view to guide yourself around airports and to navigate. The image it presents is unrealistically accurate and is more like a map display.

To select radar view, press the Radar key (Num Lock). Press the + or - keys at the top of the main keyboard to zoom in and out of the radar's range. To return to the three-dimensional display, press the Scroll Lock key.

To select a new viewing direction after switching from radar to three-dimensional view, press the Scroll Lock key again and a view direction key.

The Pause key (*P*) suspends simulation. Pressing the *P* key a second time resumes simulation where you left off. You will find this feature particularly helpful for reading ahead in the manual if you lose control of your plane.

Secondary Aircraft Controls

The primary flight controls are the only controls needed to fly the plane in easy flight mode (the mode you are in when you begin the program). The secondary controls are used to navigate, control the engine, and control the simulator itself. Their positions on the panel and functions are described in previous sections. A description of how to use these follows. If this is your first flight, you may want to return to this section later.

Flaps

Flaps are movable panels on the inboard trailing edges of the wings. They are hinged so they can be extended downward into the flow of air beneath the wings to increase lift (upward force) and *drag* (rearward pull). Their primary purpose is to permit a slower airspeed and steeper angle of descent during a landing approach. They can also be used to shorten takeoff distance or decrease stall speed on landing approach.

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To slow your plane for landing:

The row of odd-numbered Function keys, F1 to F9, controls the flaps (see Figure 18). The flaps have 5 positions: UP, 10 degrees, 20 degrees, 30 degrees, and 40 degrees. Flaps in the 40-degree position are totally extended. In the UP position, they are totally retracted. The F1 key retracts the flaps, and the F9 key extends the flaps 40 degrees.

Extending and retracting the flaps affects the plane's performance considerably. Lowering the flaps increases both lift and drag. This increases glide angle, which is particularly useful if you are flying too high on an approach and want to increase your rate of descent. Airspeed can be reduced by extending the flaps.

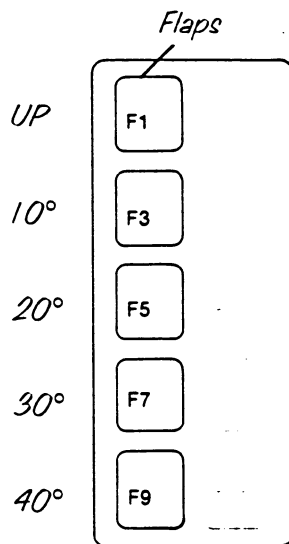


Figure 18. Flap Controls for the PC

Elevator Trim

The control yoke is directly connected to the airfoils it controls. Different flight attitudes put different pressure on the airfoils. These variations also change the pressure on the yoke. The pilot must counteract these forces to keep the airfoils in their proper positions. Applying steady pressure on the yoke for hours would be fatiguing. *Trim* is used to counteract these forces and relieve the pilot from applying constant pressure on the yoke.

To counteract forces on the yoke:

Flight Simulator provides elevator trim controls. The 7 and 1 keys on the numeric keypad control elevator trim. Pressing the 7 key adjusts the trim downward. Pressing the 1 key adjusts the trim upward. The elevator trim position indicator shows elevator trim position, with the "U" representing the up position and the "D" representing the down position (see Figure 19). Remember these keys as the upper left and lower left keys of the control yoke.

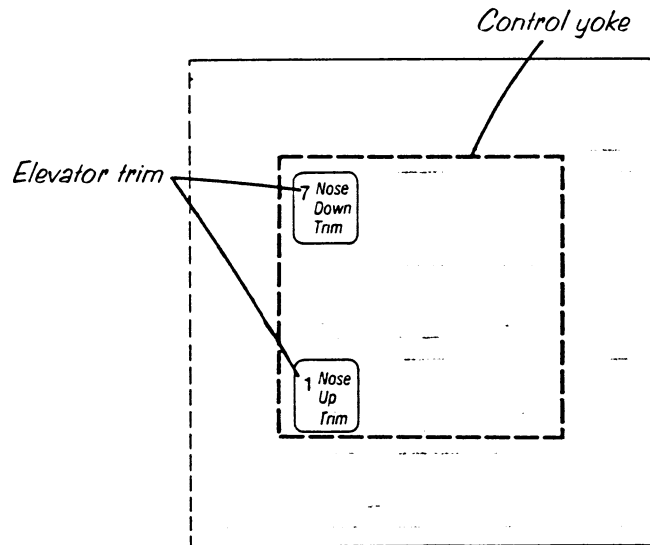


Figure 19. Elevator Trim Controls for the PC

Carburetor Heat

The Heat key (H) is the carburetor heat toggle switch. The carburetor heat indicator on the instrument panel shows whether carburetor heat is on or off.

Carburetor heat is used to preclude icing or clear ice that has already formed in the carburetor. Apply carburetor heat for a few seconds on landing approach to avoid ice-caused engine failure.

Magneto Switch and Mixture Full Lean Control

The Magneto key (M) is the magneto switch. After you press the M key, enter one of the following numbers (in the top row of keys on the main keyboard) to indicate magneto setting.

<i>Number</i>	<i>Result</i>
1	OFF Magnetos off
2	L Left magneto on
3	R Right magneto on
4	B Both magnetos on
5	ST Start engine, then both magnetos on
0	LN Mixture full lean (engine turn-off)

Lights

The Lights key (L) turns on the running and instrument lights. *Running lights* are lights on the tips of each wing – red on the pilot's left, green on the right – that help others identify your heading. Instrument panel lights illuminate individual instruments on the instrument panel, so you can see them at night. You must turn on the running and instrument panel lights for night flight. It's not advisable to fly with your lights on during the day. If you do, when night arrives you may find that a bulb on an important instrument has burned out. Bulbs are replaced during refueling and servicing stops.

Navigation Radio

The NAV radio is an important navigational aid. It is used to tune in VOR radio beacons, so you can fly toward or away from them. Two NAV radios are provided so you can tune in two VOR beacons at once. This is useful for doing cross-checks of your position.

You must set the NAV radio to the VOR frequency to receive the appropriate signal. On a real aircraft, two knobs are used to set the frequency. One sets the full megahertz frequencies (121, 122, 123, etc.), and the other sets the fractional frequencies in 50 kHz increments (.00, .05, .10, etc.). Many new radios are 720-channel models with 25 kHz separations, but none of these intermediate frequencies are implemented on Flight-Simulator.

**To tune into
VOR beacons:**

To set the NAV radio to a particular frequency, press the NAV key (*N*), followed by the radio number (1 for NAV1 and 2 for NAV2). Then press the + or - keys (on the main keyboard, not the numeric keypad) to advance or move back the current setting until you reach the desired MHz frequency. To set the fractional frequency (e.g., .00, .05, .10, etc.), press the *N* key twice, in rapid succession, then press either the + or - key until you reach the appropriate setting. Pressing the radio number after the *N* key is only necessary if you want to tune a NAV radio other than the one you most recently tuned.

For example, to advance from 121 to 126 MHz, press *N* + + + + +. To advance from .35 to .55, press *NV* + + + +. For more information on using the NAV radio, see "Navigational Aids."

The NAV1 radio is also used to tune in ILS localizer and glideslope. For more information on instrument flying, see "Advanced Flight Techniques." For detailed information, consult a flight training manual.

Omni-Bearing Indicator

The OBI is used with the NAV radio to tune into VOR (Very high frequency Omnidirectional Range) radio stations. VORs are radio stations that transmit an omnidirectional synchronization signal followed by a circular sweeping directional signal. The NAV receiver in the aircraft decodes these signals to determine what angle or "radial" from the station you are on. Radials can be thought of as directional beams radiating outward from the VOR station like spokes of a wheel.

The OBI or VOR Indicator is a panel-mounted instrument that lets you determine what VOR radial your plane is currently on. It also helps you fly along radials toward or away from the VOR station.

Two OBIs are provided. The top OBI (Reference Figure 1, item 8) corresponds to the NAV1 radio. The bottom OBI (item 9) corresponds to the NAV2 radio.

To set the OBI, press the VOR key (*V*). Next, if you want to adjust an OBI other than the one you most recently adjusted, press number 1 for the top OBI, or 2 for the bottom OBI. Then, press the + or - key as needed to select the right course and reciprocal course readings. Each keypress adjusts the course selector by two degrees. Holding the + key down rapidly sequences through the degree settings. The letter "V" on the knob of the OBI indicator refers to the V key.

**To navigate to
and from VORs:**

To help ATC track you:

Communications Radio

Use the COM radio to tune into ATIS for weather, airport, and approach information. The charts at the back of this manual note the ATIS frequencies for each airport where this service is available. The same procedure that is used to set NAV radio frequencies is used to set the COM radio, except that you press the COM key (*C*) instead of the *N* key.

Transponder

On occasion, Air Traffic Control (ATC) will ask you to transmit a four-digit code or "squawk." The message from ATC will scroll across the top of your screen. ATC will use the number your transponder transmits to track you on its radar screen.

To set the transponder, choose the digit you want to change. To change the left-most digit, press the Transponder key (*T*), then press the + or - key on the main keyboard as necessary to select the appropriate digit. To set the second digit, press *TT*, in rapid succession, followed by the appropriate + or - keypress. Press *TTT* and *TTTT* to set the third or fourth digits, respectively.

Altimeter

To set the altimeter to the current barometric pressure, press the Altimeter key (*A*). The altitude reading may change when you press this key. We recommend that you do this several times each hour in reality mode to ensure accurate altimeter readings.

The letter "A" on the altimeter's adjustment knob refers to the A key.

Heading Indicator (Directional Gyro)

Pressing the Directional Gyro key (*D*) sets the heading indicator to the same reading as the magnetic compass. (The magnetic compass does not drift with time as the heading indicator does, and it will always show a correct reading when "settled down" after a turn.) Always be sure the magnetic compass has settled down to avoid setting an incorrect direction. The letter "D" on the heading indicator's adjustment knob refers to the D key.

Landing Gear

The Landing Gear key (*G*) raises and lowers the *landing gear*. The gear indicator on the panel shows the current status of the landing gear. You do not have to raise the landing gear after takeoff. If you do raise it, however, be sure to lower it on landing approach. Flying with the landing gear down increases drag.

Brakes

The Brakes key (.) applies the brakes. Each keypress reduces your speed by a few knots. Several presses are usually necessary to bring the plane to a complete stop. Brakes are used only on the ground.

Keyboard Techniques

Keypresses

Holding down most alphanumeric keys automatically generates many keypresses (at the rate of 12 per second). Holding down the elevator, aileron, rudder, or throttle control keys results in multiple notch adjustments. For example, alternately holding down the left and right aileron keys will gently rock the plane from side to side (when doing "Dutch Rolls," for instance). The . key (the brakes), if held down, will eventually bring a taxiing plane to a stop.

However, toggle keys, such as the G key (which raises and lowers the landing gear), should not be held down. Doing so will repeatedly switch between the two settings.

The PC and PC XT keyboards can accept keypresses at any rate and in any sequence. In fact, two keys can be pressed simultaneously. This feature is particularly useful in uncoordinated flight mode, when you must adjust the aileron and rudder together to ensure smooth turns (more about uncoordinated flight later). However, you cannot hold down two keys at one time and also generate the multiple repeated effects explained above.

Finger Positioning

Finger positioning for operating the controls located in the control diamond is not the same as that used on an alphanumeric keypad. You will find it easy to operate these controls if you follow the "ten-key-by-touch" system, used by many people to operate adding machines and calculators.

Place the middle finger of your right hand on the 5 key on the numeric keypad (at the right of the main alphanumeric keyboard). Then place your index and ring fingers on the 4 and 6 keys. To control the rudder pedals, use your thumb and little finger to operate the 0 and + keys.

Using Joysticks

You can control Flight Simulator ailerons, elevators, and throttle through the keyboard or through joysticks. To use joysticks, you will need an IBM Game Control Adapter Card (or an equivalent card) and one or two joysticks with buttons. The Game Adapter Card supports two joysticks designated as Joystick A and Joystick B. With Flight Simulator, Joystick A is used to control ailerons and elevators, and Joystick B is used to control the throttle.

The IBM Game Control Adapter can handle two joysticks simultaneously. Since there is only one socket on the adapter, both joysticks must fit into a single connector. However, since joysticks are seldom sold in pairs, most use a connector designed for a single joystick only.

The documentation supplied with your Game Adapter specifies how to support two joysticks. You can build, or have your computer store build, a Y-adapter. This splits the single connector into Joystick A and Joystick B sockets, allowing you to plug both joysticks simultaneously.

Note Check with your dealer or the manufacturer of your joystick to see if an adapter has already been made for this purpose.

Setting up the Joysticks

Joysticks are either self-centering (the stick returns to the center position when released) or non-centering. Ailerons can be controlled with either a non-centering or self-centering joystick, as you prefer.

Note Only non-centering joysticks can be used to control the elevators and the throttle.

The IBM joysticks used with the PCjr have mechanical switching levers to enable or disable the self-centering springs. These switches are usually on the underside of the joystick case. The ideal setup for Flight Simulator joystick control is:

Ailerons (Joystick A, X-movement) = self-centering

Elevators (Joystick A, Y-movement) = non-centering

Throttle (Joystick B, Y-movement) = non-centering

Warning You may be able to disable the self-centering mechanism on joysticks that do not have switching levers. However, check with your joystick manufacturer before attempting any alteration.

Installing and Turning on the Joysticks

To install joysticks:

- ▶ Turn the computer off, and install the Game Control Adapter Card and joystick(s) according to the instructions that accompanied these products.
- ▶ Turn the computer on, and load Flight Simulator according to the instructions for "How to Load Flight Simulator."
- ▶ Enter the editor by pressing Esc, and press Enter to move to the Joystick parameter on the second edit page. (For details, see chapter entitled "The Editor.")
- ▶ For the Joystick parameter, enter a 1 to turn on just Joystick A, or enter a 2 to turn on both joysticks (A and B).
- ▶ Return to flight mode by pressing Esc.

Joystick A can now be used to control the ailerons and the elevators (and the rudder in auto-coordinated mode). Sideways movement (on the X axis) controls ailerons and roll, and forward and backward movement (on the Y axis) controls elevators and nose up and down. (See Figure 20.) Slowly move the stick through its complete X and Y range, watching the elevator and aileron (and auto-coordinated rudder) indicators move. The movement may be jumpy, and pushing the stick in a specific direction may not move the ailerons or elevators in that direction, but calibration will solve these problems.

Microsoft Flight Simulator

If you have two joysticks and entered 2 as the Joystick parameter, Joystick B can be used to control the throttle. Full forward provides full throttle, and full back reduces engine to an idle.

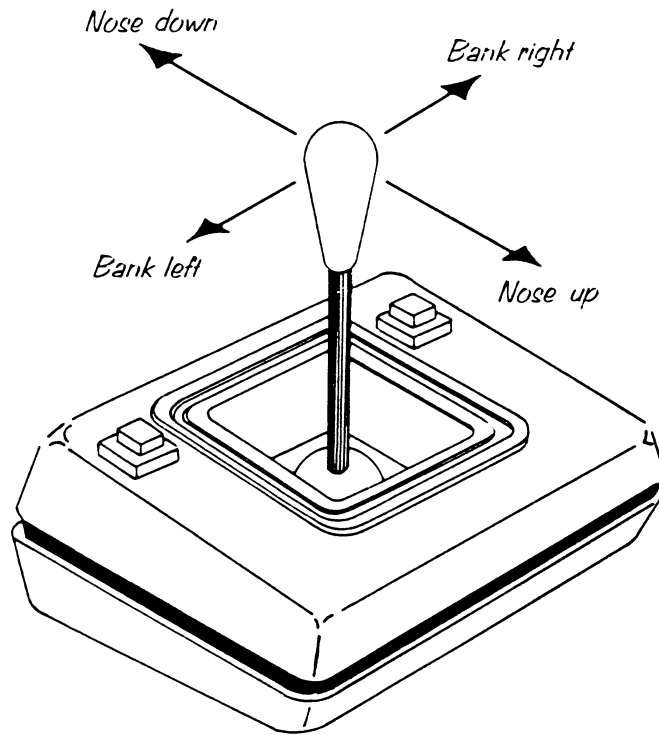


Figure 20. Joystick for the PC

Calibrating the Joysticks

After setting the Joystick parameter, you must calibrate the joysticks. Joysticks vary greatly from manufacturer to manufacturer. The range of numerical values generated also varies widely. The IBM Game Control Adapter specification calls for joysticks with 0 to 100K ohm resistance and linear response. Joysticks with these characteristics work best with Flight Simulator.

The following calibration procedure will compensate for joystick tolerance and for joysticks that deviate from IBM's specification.

Important Do not enter the editor or press the Pause key during this process.

If you're using one joystick:

To calibrate the aileron and elevator joystick:

- ▶ Move Joystick A to its aileron and elevator center positions.
- ▶ Center the joystick's trim controls (if any).
- ▶ Press the *K* key.

If you're using two joysticks:

To calibrate the throttle joystick, as well as the aileron and elevator joystick:

- ▶ Move Joystick A to its aileron and elevator center positions.
- ▶ Center Joystick A's trim controls (if any).
- ▶ Make sure that Joystick B's trim controls (if any) are centered.
- ▶ Pull Joystick B all the way back.
- ▶ Press the *K* key.

When Joystick A's range is properly calibrated, the aileron indicator is set full left when the stick is fully left and full right when the stick is at its full right position. The elevator indicator is set full down when Joystick A is fully forward, and it is full up when the stick is fully back. Likewise, when Joystick A is in its center position, the ailerons and elevators are centered.

Make sure Joystick B is pulled all the way back. If it isn't, the plane will start accelerating.

During flight, you can use any trim controls on the joysticks to make minor adjustments and to keep the controls centered if the calibration drifts.

Using the Microsoft Mouse

You can use Microsoft Mouse with Flight Simulator. The mouse controls an on-screen pointer (icon) that resembles a hand and can be used to point at radio controls and instrument knobs.

Mouse Setup

To use the mouse, you must first boot the MS-DOS system disk. After installing the mouse driver, you then boot Flight Simulator from MS-DOS, instead of as a stand-alone disk.

To set up Flight Simulator for using the mouse, make sure the mouse driver is installed according to the instructions provided with the mouse. Installation consists of either having a line such as `DEVICE=MOUSE.SYS` in the file called `CONFIG.SYS` on the boot-up disk, or running a file called `MOUSE.COM`. See your Microsoft Mouse manual for complete details on installing the mouse.

- ▶ Once the mouse driver is installed, remove the mouse disk and place the Flight Simulator disk in drive A.
- ▶ Type `FS`, and press Enter.

To control instruments and indicators:

After the Flight Simulator disk boots up and after the initial monitor color and flight mode questions, you will be asked if you want to use the mouse. If you respond with Y, the "hand" pointer will appear on the screen. If the mouse driver was not installed in DOS, you will get a message saying that no driver was found. You can continue without mouse control, or reboot your DOS disk and install the driver following the procedure in your mouse manual.

Microsoft Mouse can be used to adjust all instruments and indicators on your panel except elevators, rudder, flaps, and ailerons. You may want to set up Flight Simulator to use your joysticks for the control yoke and the mouse to control all other functions.

To control Flight Simulator with the mouse, move the pointer to the instrument or indicator you wish to change. Press the left button to decrease the current reading and the right button to increase it. For example, to change the NAV radio frequency to a lower number, point the hand at the digit you wish to change and press the left button. This same process applies to the transponder, COM radio, and clock. You can also reset the seconds to transform your clock into a stopwatch.

The VOR omni-bearing selector can be adjusted by positioning the hand on the "knob" (not the digits) on the VOR indicator and pressing the right or left button to increase or decrease heading. The altimeter and heading indicator can be set similarly by pointing at their "knobs" and pressing either button.

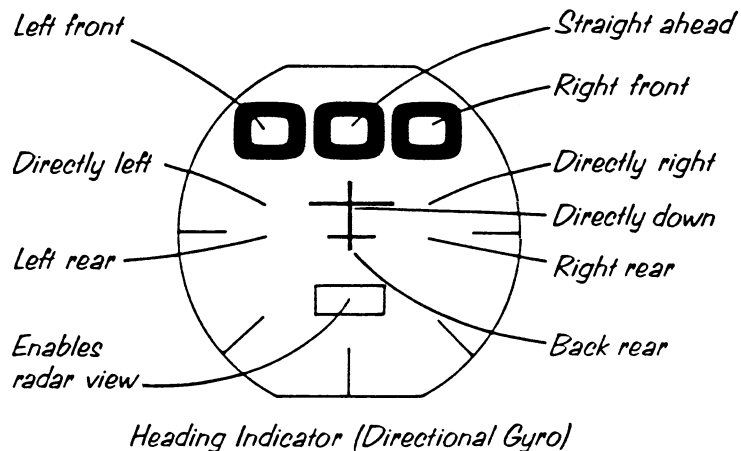
The mouse can also be used to toggle switches on or off. For example, to turn on the carb heat, point the hand at the CH indicator, and press either button. Pressing a button again will turn it off. For magnetos, the hand will cycle through the options once for every button press.

To adjust the throttle, position the mouse hand along the throttle indicator. Left decreases; right increases. The same applies for the trim. The mouse does not activate the flaps, ailerons, elevators, or rudder. To apply the brakes, position the hand along the rudder indicator and press either button.

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To change the view: The mouse can also be used to change the view selector. To change the view, position the mouse inside the heading indicator (directional gyro) dial. (See Figure 21.) To activate the front three views – straight ahead, right front, and left front – point the mouse to the corresponding digit in the top of the readout. To look directly left or right, point the mouse to the edge of the left and right wingtips on the plane outline. To look down, point the mouse to the middle of the outline. To activate the three rear views, point the mouse on the rear of the outline of the plane, as shown.

To activate the radar view, point the mouse to the small rectangular area located directly below the outline of the plane. Pressing either button activates the radar. To zoom in, press the right button. To zoom out, press the left button. The mouse must be pointing to the small rectangle while zooming in and out. To return to the out-the-window view, simply point the mouse to any view select area, as outlined above.



Using Flight Simulator

This chapter covers everything you need to know to actually taxi down the runway, take off, fly, land, and service your plane. Once you know how to fly, you'll be ready to add more challenge to your flights.

Then learn how to use the Flight Simulator editor. Choose from 10 preset user modes. Or use the editor to change environmental conditions and other parameters to create your own flight modes. At any time, you can have up to 30 flight modes.

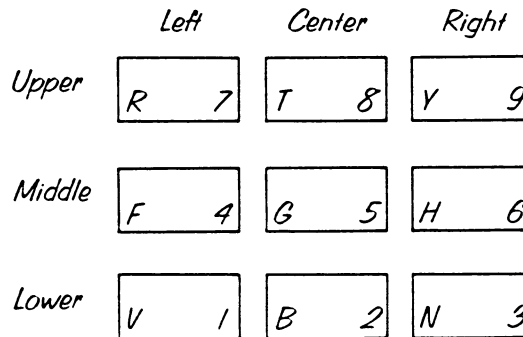
Practice your navigation throughout the world. Flight Simulator lets you travel more than 100 million square miles. Charts at the back of the manual detail 21 airports in four general areas on the East Coast, the Midwest, and the West Coast. Using navigational aids, you can fly by day or night.

After you're comfortable with easy, auto-coordinated flight, move on to advanced flight techniques. Choose uncoordinated flight where you control the ailerons and rudders independently of each other. With Flight Simulator and a flight training manual, you're ready to try maneuvers. Or use Flight Simulator's many instruments, indicators, and controls to try flying according to Instrument Flight Rules.

Flying

Now that you are familiar with the basic flight instruments and controls, prepare for your first flight with Microsoft Flight Simulator.

Note Any time you are flying, you can stop the simulation and return to where you started by pressing the Recall key (Del on the PCjr, or the PrtSc key on the PC).
If you only want to suspend the simulation, press the Pause key. Simulation will continue when you press the Pause key a second time.
If you want to return to DOS, insert the DOS disk in drive A. and press Ctrl, Alt, Del in sequence, holding each key down until all three keys are pressed.



Use the control yoke to guide your plane

Figure 22. Control Yoke Diagram

In the control yoke, letters refer to the PCjr keyboard; numbers refer to the numeric keypad on the PC. This manual refers to yoke keys by relative position. For example, on the PCjr, the Y, F, and B keys are the upper right, middle left, and lower center keys. Both G and 5 are simply called the center key.

Flying under VFR Conditions

Take off:

When you start the program, you are facing north on the runway at Meigs Field (a small field on a peninsula on Lake Michigan) in Chicago (see Chart 2). The John Hancock building is on the horizon to your left (northwest). You will take off and climb out over Lake Michigan. You are lined up for immediate takeoff. The weather is fair. The sky is blue and the ground light green, indicating a clear day without a cloud in the sky. There are no winds. This is perfect weather for Visual Flight Rule (VFR) flying.

When you fly VFR, you rely on ground references and the visible horizon for orientation and navigation. Until you get off the ground, navigation is secondary to flight control. The most important instruments for your first VFR flight are the *airspeed indicator* and the *altimeter*. You will use the other primary flight instruments, as well as the aileron, rudder, elevator, and throttle position indicators. For your first flight, concentrate on what you see out the window and how it relates to altitude, airspeed, bank, and pitch attitude.

Getting Familiar with the Aircraft

Check your instruments:

Take a moment to study the three-dimensional display on your screen. This is the view out the aircraft's windshield.

Use the view selector to look to the right. Press the View key and the upper right key on the control yoke. Try other views, then return to the front view by pressing the View key and then the upper center key. Check your altitude. Altitude is measured by the altimeter. Remember that altitude is measured as feet above sea level. Although you have not yet left the ground, the altimeter shows an altitude of 592 feet, the elevation of Meigs Field.

Now check the compass. It tells you that you are facing 0 degrees. A 270-degree reading corresponds to the aircraft pointing west. Notice the heading indicator. It notes your direction as 0 degrees. The compass and heading indicator provide similar, but seldom identical, readings. Gyroscopic precession and the earth's rotation cause the heading indicator to drift over a short period of time. In reality mode, you must adjust the heading indicator to match the magnetic compass several times each hour by pressing the Directional Gyro key.

Microsoft Flight Simulator

Your engine has already been started. (It starts automatically when you start the program.) However, you don't have enough power to move. The airspeed indicator does not register a reading until the aircraft has reached a speed of 40 knots. (Because the airspeed indicator is not registering a reading and the out-the-window view is still, you know your aircraft is standing still.)

It is best to use radar view to taxi around the runway, so take this opportunity to experiment with the radar view feature. Select radar view by pressing the Radar key. To zoom in on a narrower area, repeatedly press the + key on the main keyboard. To broaden your focus, press the - key.

Now, experiment with the ailerons. Turn the yoke full left, then full right, using the middle left and middle right keys. Notice how the adjustments in the ailerons move the aileron position indicator. Try the elevators, paying attention to how the adjustments in elevators move the elevator position indicator. Experiment with the rudder pedals. You must be moving to turn the plane, so for now just see how moving the rudder moves the rudder position indicator. Notice that the rudder and ailerons move together. In auto-coordinated flight mode, they are locked together. (You are also in auto-coordinated flight mode when you begin the program.) In uncoordinated flight mode, they move separately. Center the rudder by pressing the center key.

Taxiing

Apply the throttle:

You are on the runway positioned for takeoff. While you are on the ground, all objects on the horizon are viewed edge-on. Everything in your field of vision is clustered on the horizon. If you have not already switched to radar view, do so now by pressing the Radar key. Use the + and - keys to "zoom" in or out until you get a good view of your position at the airport.

Begin to *taxi* by applying the throttle. For now, one notch is sufficient, so press the Increase Throttle key once.

Use the rudder pedals to steer the plane. Turn the rudder left and right (by pressing the left rudder and right rudder keys) to steer the airplane down the runway. Try to stay on the center line. Press the center key to quickly center the rudder and nose-wheel, so you can taxi in a straight line.

Practice taxiing around the airport. If you need to make an abrupt stop, cut the throttle and apply your brakes by pressing the Brakes key repeatedly. If you want to roll to a gentle stop, simply cut the throttle by pressing the Throttle Cut key (/ and [on the PCjr, F10 on the PC).

If You Crash

If you crash, your three-dimensional display will temporarily go blank. If you have crashed into an obstacle, the word *CRASH* will appear on your screen. You will also get this message if you crash to the ground while flying. If you have landed in water, the word *SPLASH* will tell you so. In either case, the program will then return to the preset starting position (the same location you are moved to when you begin the simulation or press the Recall key).

Pre-Takeoff Check

Now that you know how to taxi, prepare for takeoff. Taxi to either end of the runway (*active runways* have a number on either end). Align your plane with the center line. Cut the throttle and coast to a stop. If necessary, apply your brakes by pressing the Brakes key repeatedly. Now conduct your pre-takeoff check.

To see if all systems are go:

- Check elevator operation. Move the elevators up and down and then center them.
- Check the rudder and ailerons in the same way. Center them.
- Check the engine gauges. Make sure the oil pressure is correct. The indicator should be centered between L(ow) and H(igh). Also make sure you have plenty of fuel (check both gauges).
- Finally, check the heading indicator against the magnetic compass. If they do not agree, set the heading indicator to match the magnetic compass by pressing the Directional Gyro key after the magnetic compass has settled.

If all systems are go, you are ready for takeoff.

Takeoff

Before you take off, you may want to read the sections on climbing, turns, straight and level flight, and glides and descents. If you would rather not, don't worry. This is a simulator after all. You can stop the simulation at any time by pressing the Pause key. Press it again to continue.

Switch from radar to three-dimensional view by pressing the View key. Switch to the forward view by pressing the View key, followed by the upper center key. Notice that pressing the View key once switched the display from radar view to three-dimensional view. To select a three-dimensional view direction, you must press the View key a second time, immediately followed by a heading indicator key.

Apply full throttle (by pressing the / and] keys on the PCjr, or the F2 key on the PC). As you move down the runway, steer with the rudder, adjusting it to keep a steady course and to avoid zig-zagging. (Remember, pressing the center key will center the rudder.)

Accelerate down the runway:

Notice that the airspeed indicator shows the rise in speed. When you reach 55 knots, raise the nose by pressing the lower center key rapidly six times. Pulling back the yoke and raising the nose off the ground is called the rotation. The runway drops away as you lift off. As your nose pitches up, the vertical speed indicator will register a positive reading. You are airborne. Reduce the throttle one notch, and prepare for a gentle climb. Look out the back window by pressing the View key and the lower center key. Return to front view by pressing View and the upper center key.

Climbing

Flight Simulator, like a real aircraft, climbs by itself and does not require constant adjustments. If you took off as directed, you should be steadily climbing. To increase your rate of climb, increase the throttle. Raise the elevators enough to hold a constant airspeed. Raising the elevators converts airspeed into vertical velocity.

Adjust the throttle:

Do not attempt to increase or decrease climb rate by simply raising or lowering the elevators without adjusting the throttle to maintain constant airspeed. Raising the elevators without increasing the throttle will increase your climb rate for a few seconds, but you will soon lose momentum and your airspeed will drop. This may cause the plane to stall. On the other hand, increasing the throttle without applying the up elevator will increase your speed, but not necessarily your rate of climb. Understanding the relationship between the elevators and throttle adjustments is basic to successful flight. The relationship between speed, vertical velocity, elevators, and throttle is complex. You will come to understand it only through practice.

Straight and Level Flight

Once you have reached an altitude of about 3,000 feet, settle into straight and level flight. Gradually make the transition from climbing to straight and level flight. Lower the elevators and decrease the throttle to attain a reasonable speed (about 120 knots) without gaining or losing altitude. Remember not to chase the vertical speed indicator. Instead, use the altimeter and airspeed indicator as guides, making small adjustments in the throttle and elevators as necessary. Once you have settled into a straight and level flight pattern, your vertical speed reading will drop close to zero.

Check the altimeter periodically to make sure you are not losing altitude. If you are losing altitude, increase the throttle or raise the elevators.

Turns

Use the ailerons and rudder:

Turns are made by banking and yawing the plane in the direction you want to turn. The ailerons are used to bank the plane, and the rudder is used to yaw it (from left to right). In auto-coordinated flight mode, the ailerons and rudder are connected, so you need to use only the ailerons to control your bank.

Move the aileron one notch to the left. You will begin to bank left. (Notice how your bank attitude is shown on the attitude indicator.) When the bank approaches the 20-degree mark, center the aileron/rudder. Check the attitude indicator and turn coordinator again. You are turning.

You will continue turning at the specified angle until you “roll out” of the turn. Flight Simulator is positively stable and makes provisions for wing *dihedral* effects, so if you don't manually perform a roll out, the plane will eventually straighten itself after a few minutes of flight.

To roll out of a turn, apply the opposite aileron until your attitude indicator shows that you have centered on your course. Timing is the most important factor in rolling out of a turn. As a general rule, apply the opposite aileron/rudder when your heading indicators show a reading 10 degrees short of your desired *heading*. For example, if you want to proceed on a heading of 180 degrees, begin rolling out of the turn when the compass indicates a 170-degree heading. It takes time to level your position. You are still in a bank while rolling out of a turn, so you will continue to turn even while you level off.

Always check the altimeter when you have completed a turn. Turns cause you to lose altitude: the steeper the bank, the greater the loss. To compensate, raise the elevator a notch or so as you are turning.

Glides and Descents

Glides reduce altitude with little or no engine power. Proper glide technique is essential to landing approach.

To climb, you increased the throttle and raised the elevators to increase altitude. It seems logical that to descend you would do the opposite; that is, lower the elevators and decrease the throttle. This is not proper glide procedure, however. When you decrease the throttle, the plane drops its nose. Airspeed increases if you decrease the throttle and either keep the elevators where they are or lower them.

To descend, decrease the throttle, then apply a bit of up elevator to hold constant airspeed and to keep the nose from dropping. Judging how much elevator to use takes experience. Watch the world outside when you decrease the throttle. Also study your pitch attitudes as you glide.

Now, practice gliding. Climb to 5,000 feet, level your position, and cut the throttle. You will descend at a rapid speed. If your airspeed gets dangerously high (exceeding 140 knots), raise the elevators one notch. This will raise your nose and help level your dive.

You can also increase the angle of a glide and reduce airspeed by using the flaps. This is particularly useful if you are too high on an approach to landing. Flaps also decrease stall speed during approach and landing.

Practice glides and descents.

Landing

Your approach glide should be steep:

Correct and safe landing is the most challenging part of flying. In essence, to land you will fly a foot or two above the runway, then slow down until the plane stalls and stops flying.

Descend until you can see the runway. Every active runway has a number on either end. The line down the center of the runway is your guide for touchdown.

When you have spotted the runway, align yourself with it and fly toward it at approximately 70 knots. Your approach glide should be a steep one. The throttle should be cut and the elevators raised to maintain a 70-knot approach. An engine failure during a steep glide will have little effect on where you land. However, an engine failure during a long, shallow, *power glide* could make you land short of the runway.

You must make a transition to straight and level flight when you are approximately 50 feet above the runway, so you will be in straight and level flight a foot or two above the runway. This procedure is called the *flare*.

If you didn't raise your landing gear after takeoff, it is already lowered. Otherwise, lower it by pressing the Landing Gear key.

Your airspeed will start to drop as the plane loses momentum. As the plane slows, the nose will drop. Raise the elevators to keep the plane a foot or two above the ground. As you do so, the nose will rise.

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Slow down until you stall:

Make sure your rudder is straight before you touch down. The rudder pedals, as well as the rudder, control ground steering. You will be whipped off the runway if your wheels are not straight as you touch down. An abrupt turn of the plane on the ground (a ground loop) can severely damage a real aircraft. On touchdown, your elevators will be nearly all the way up.

When your speed is reduced enough so that the plane can no longer fly, it will stall and touch down on the runway. If you “fly the plane onto the ground” above stall speed, it may bounce.

As you touch down, you will hear a sound and see the scenery on the display level off. Use the Brakes key to *bleed off* speed, guiding the plane with the rudder. Continue to apply the brakes until you come to a complete stop.

You have successfully completed your first flight. To practice the fundamentals of flying before attempting advanced flight techniques, taxi to the end of the runway and prepare for takeoff. Don't forget to perform the pre-takeoff check as discussed earlier in this chapter.

Refueling and Servicing

All of the airports (except for the small, single-runway grass strips) have fuel and servicing facilities. These areas are marked by rectangles and are located at the ramp areas. (Each rectangle has an “F” inside it.) To refuel and have your aircraft serviced, come to a complete stop inside one of these rectangles. Both refueling and repairs occur instantaneously.

The Editor

To change your flying environment:

You can add several environmental factors to flight modes to enhance visual effects and produce realistic flight environments. To set these factors, you use the editor. You also use the editor to adjust flight variables and peripheral options.

To enter the editor, press the Esc key. A menu of parameters will appear on the screen. The first column lists parameters. The second column lists the current values of the parameters.

Entering the editor suspends simulation. The North, East, and Altitude parameters always note the values of your last position before you entered the editor.

The arrow that points at the parameter list is used to select the parameter you want to change. To move the arrow from one parameter to the next, press the Enter key. To move backward through the list, press the - key (located on the top row of the main keyboard). When the arrow points to the parameter you want to change, enter the new value. If you make a mistake, press the Backspace key to erase each incorrect character, then enter the correct number. When you have entered the new parameter, press the Enter key.

Exit the editor by pressing Esc:

When you have changed all the parameters you want to change, exit the editor by pressing Esc. You will return to flight mode unless you select slew mode.

Microsoft Flight Simulator supports 30 flight modes (combinations of parameters). Two flight modes are in effect when you begin the Flight Simulator program: easy mode and auto-coordinated mode. To select other modes, you use the editor. See "Selecting and Customizing Flight Modes" later in this manual.

Note

You cannot change the parameters of the WWI Ace game.

Environmental Factors

Microsoft Flight Simulator simulates various environmental conditions that affect flying. You can select the time of day or season you want to fly in. You can also specify clouds, wind direction and velocity, and turbulence. Each of these factors increases the realism of the simulation.

Selecting the Season

Each season presents unique flying problems. Winter brings icy runways and startup problems. Summer brings hot, humid days that increase *density altitude* and reduce lift. Each situation requires different skills. To select the season you want to fly in, enter the editor and move the arrow to the Seasons parameter. Select the season by typing one of the following numbers:

<i>Code</i>	<i>Season</i>
1	Winter
2	Spring
3	Summer
4	Fall

Return to flight mode by pressing the Esc key.

Selecting the Time of Day

Flight Simulator automatically sets the visual flight conditions to correspond to the time of day (as it appears on the clock). The clock records time in 24-hour format.

The transition from one flight condition to another varies from season to season, as follows:

<i>Season</i>	<i>Dawn</i>	<i>Day</i>	<i>Dusk</i>	<i>Night</i>
Winter	7:00	7:30	17:00	17:30
Spring	6:00	6:30	19:00	19:30
Summer	5:00	5:30	21:00	21:30
Fall	6:00	6:30	19:00	19:30

The transition times are identical for all parts of the world.

Flight Simulator simulates typical visual conditions for these four times of day: dawn, day, dusk, and night. Since the visual conditions for dawn and dusk are identical (though reversed), choosing either presents the same flight conditions.

If you want to select a visual flight condition that differs from the one set based on the clock setting, use the editor to change the time displayed on the clock. Enter the editor by pressing Esc, then move the arrow to the Hours parameter.

Enter the hour in 24-hour format; for example, 09 for 9 A.M., 23 for 11 P.M. Then move to the Minutes parameter and enter the appropriate number. The range is 0 to 59. Return to flight mode by pressing Esc.

Setting Clouds

You can set either one or two cloud layers. Cloud layers are measured above sea level. To simulate a cloud layer, enter the editor by pressing Esc and move to the Cloud Layer 1 Bottoms parameter.

Set the altitude of the lower edge of the cloud, then enter the altitude (above sea level) where you want it to end next to the Cloud Layer 1 Tops parameter. If you set a second cloud layer using the Cloud Layer 2 Bottoms and Tops parameters, make sure the upper layer begins higher than the top of the lower layer. Return to flight mode by pressing Esc.

To eliminate a cloud layer, set the Cloud Layer Bottoms and Tops parameter altitudes to zero.

Setting Surface Wind

You can set wind to simulate realistic takeoff conditions by setting surface wind velocity and direction, as well as shear altitude. Shear altitude is the altitude where the wind layer ends. Unlike cloud layers, winds are set from ground level, not sea level. Thus, if you set a shear altitude of 1,000 feet, you will encounter surface wind from ground level to 1,000 feet.

To set the surface wind velocity, direction, and shear altitude, enter the editor and move the arrow to the Surface Wind parameters. Enter the speed in knots (range 0 to 99), the direction in degrees (0 to 359), and the shear altitude (Shear Zone Altitude 1 parameter) in feet (above ground level).

Setting Winds Aloft

Flight Simulator can also simulate wind layers above the surface wind level. As with surface winds, you determine wind velocity, direction, and shear altitude. Shear altitudes determine where one level ends and the next begins. Shear altitude is measured above ground level, not sea level.

To set winds aloft, enter the editor and move to the Wind Level 1 parameter. Enter velocity (speed is limited to 99 knots), and direction (from 0 to 359 degrees). This wind layer will exist between Shear Zone Altitude 1 and Shear Zone Altitude 2. Adjust Shear Zone Altitude 2 to the uppermost altitude of Wind Level 1.

You can set a maximum of three layers of winds aloft. Wind layers must not overlap.

**Set up to three
wind layers:**

Setting Turbulence

Turbulence factors ranging from 1 (very low) to 9 (very high) can be added to both winds aloft and surface wind settings.

To set turbulence, multiply the turbulence factor by 100 and add it to the wind speed. For example, to set a wind speed of 37 knots and a turbulence factor of 4, multiply 4 by 100 and add 37. This sets the wind speed for the specified wind level to 437.

The World and Navigation

The Flight Simulator world spans more than 100 million square miles, encompassing the continental United States and extending into Canada, Mexico, and the Caribbean. The center coordinate ($x = 0, y = 0$) of the Flight Simulator world is 40 degrees north latitude and 88 degrees 30 minutes west/east longitude, about 30 miles southwest of Champaign, Illinois.

The world database includes approximately 80 airports in four general areas: New York/Boston, Central and Northern Illinois, Seattle, and Los Angeles. Charts 1 through 4, at the back of this manual, are aerial charts of these areas. These charts, although highly accurate, are for use with Flight Simulator only.

You can fly beyond the database areas, into Canada, for example. However, only the four areas mapped in the charts at the back of this manual are populated with airports and other ground reference points.

Getting Around in the World

Because Flight Simulator is a real-time simulator, flying between distant points (such as Seattle and Los Angeles) would take hours. Your fuel tank holds 88 gallons of gas, enough to take you, under most conditions, approximately 1500 miles from your point of origin. There are no refueling stations outside the populated world, so the distance you can fly is limited.

However, you can move from one distant area to another by using one of two methods: setting destination coordinates or "slewing."

The faster way to move from one area to another is to set the destination coordinates. Enter the editor, move the arrow to the North parameter, and enter the north coordinate of your destination (refer to Charts 1 through 4 for each airport's precise destination coordinates). Now move the arrow to the East parameter. Enter the east coordinate of your destination. Finally, move the arrow to the Altitude parameter and enter the altitude at which you want to fly.

Exit the editor by pressing Esc. You will be at your destination at your selected altitude. Continue flying or taxiing as you would in regular flight mode.

Changing coordinates in the editor:

Microsoft Flight Simulator

“Slewing”:

The second method of moving from one flight area to another is slewing. Slewing lets you move very slowly or very rapidly (faster than you could fly) from one point to another, viewing the scenery along the way. To enter slew mode, enter the editor and set the Slew parameter to 1, or 2, then press Esc. Your previous north and east coordinates (your position before you entered the editor) will be displayed at the top of your screen. You will see the scenery out the windshield as if you were in flight mode.

When you are slewing, you use slewing controls instead of normal flight controls to move about. Figures 23 and 24 illustrate the slewing controls for the PCjr and the PC. Slewing speed and direction are set by pressing one of the four directional keys on the control yoke. Slew parameter 1 moves the plane strictly north, south, east or west. Slew parameter 2 moves the plane relative to your current heading. Pressing the upper center key slews the plane straight north (Slew parameter=1) or straight ahead (Slew parameter=2). Pressing a key once slews you very slowly. Pressing a key twice increases slew speed. Multiple keypresses increase slew rate exponentially. Pressing the lower center key slews the plane due south or backwards. These two keys control north coordinate changes when Slew parameter=1. The middle left key slews the plane west or left, and the middle right key slews it east or right. These two keys control east coordinate changes when Slew parameter=1. Note how these four keys are positioned to suggest their relationship to the direction in which they move you.

The north and east coordinates displayed at the top of the screen are also listed next to the North and East parameters in the editor. As you slew around the world, the values next to the North and East parameters change to reflect your new position.

Pressing the middle center key stops slewing and freezes the plane in its current position. To continue slewing, you must press one of the North or East keys again. If you are slewing too quickly in one direction (north, for example), you can decrease your slew rate by pressing the key for the opposite direction one or more times (in this case, the lower center, or South key).

The throttle keys control slew altitude:

Figures 23 and 24 indicate the controls that allow you to control your altitude while slewing. The PCjr allows you to only increase or decrease your altitude. Pressing G will stop altitude slewing on the PCjr. The PC allows several different rates of increase and decrease.

Check the altimeter as you slew. Your current altitude is listed next to the Altitude parameter in the editor. As your altitude changes, the number next to the Altitude parameter in the editor changes to reflect your current altitude.

Using Flight Simulator

The other keys on the control yoke operate bank and heading slew. The upper left and upper right keys control bank slew. Pressing the upper left key banks the plane left. Pressing the upper right key banks the plane right. The lower left and lower right keys control heading slew. Pressing the lower left key rotates the plane to the left. Pressing the lower right key rotates the plane to the right.

On the PCjr, the (and) keys control pitch slew. Pressing G will stop pitch slewing. On the PC, the odd-numbered Function keys control pitch slew, with the F1 key indicating upward pitch, the F9 key indicating downward pitch, and the F5 key level flight. Intermediate keys make subtle adjustments.

Changes in pitch, bank, and heading (unlike changes in north and east coordinates, and altitude) do not correspond directly to the values next to the Pitch, Bank, and Heading parameters in the editor. Changes made in pitch, bank, and heading while slewing are not automatically transferred to the edit page. This lets you adjust your attitude to select a good observation angle while slewing, yet return to your original attitude when you reenter the editor. However, if you want to transfer your slewing attitude to the edit page, press the Transfer key (Shift T on the PCjr, T on the PC).

Pressing the Alt key sets the observation angle (pitch, straight ahead; heading, north; and, bank, 0 degrees). This lets you watch the area you are slewing over as though you were looking straight ahead out of your window.

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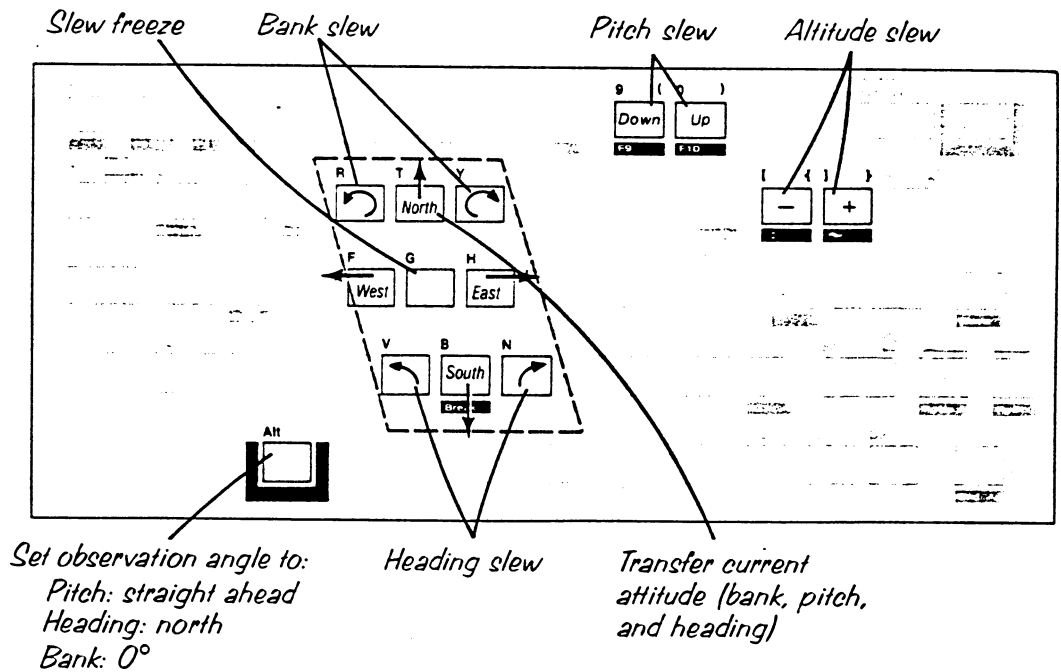


Figure 23. Slewing System Controls for the PCjr

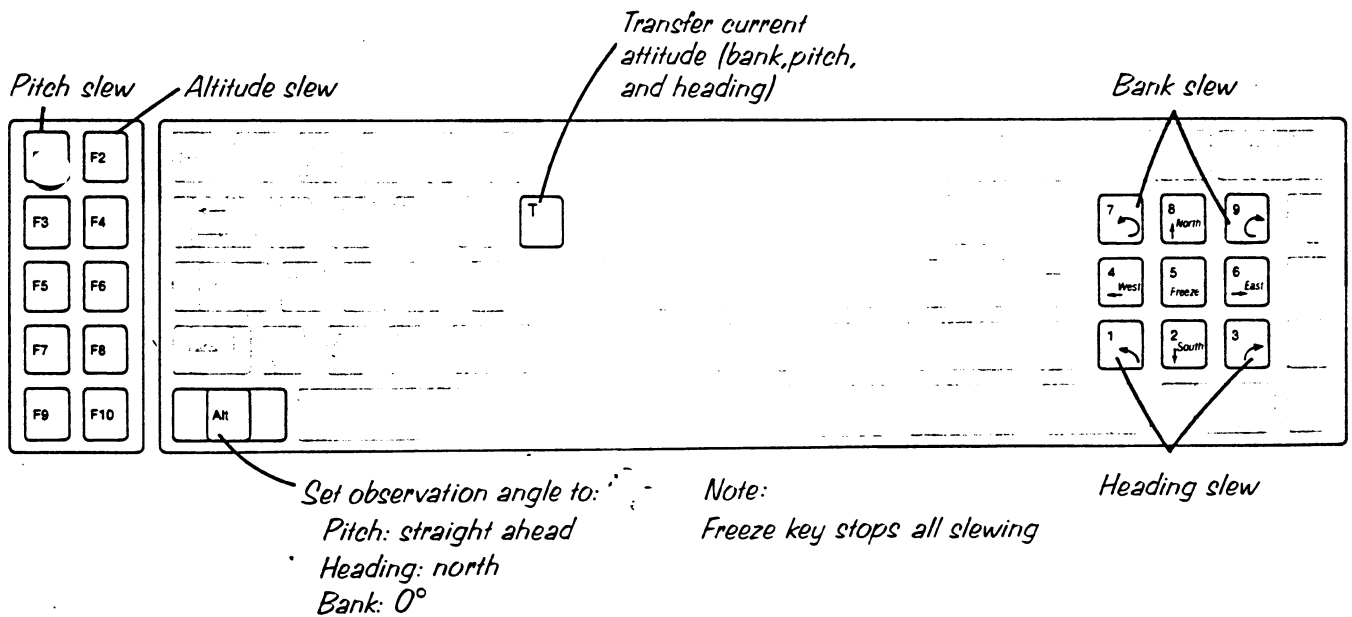


Figure 24. Slewing System Controls for the PC

Navigational Aids

Flight Simulator features two of the most commonly used navigational aids. VOR (Very high frequency Omnidirectional Range) navigation is available for day and night flight. Airport beacons are provided at night. Instrument Landing System (ILS) approaches are also available, and OMI (Outer, Middle, and Inner) marker lights and a glideslope are provided.

Use the NAV radios to navigate, day or night:

VOR Navigation

VORs are radio stations that transmit an omnidirectional synchronization signal followed by a circular sweeping directional signal. The NAV receiver in the aircraft decodes these signals to determine the angle or "radial" from the station you are on. You can think of radials as directional beams radiating outward from the VOR station like spokes of a wheel (see Figure 25).

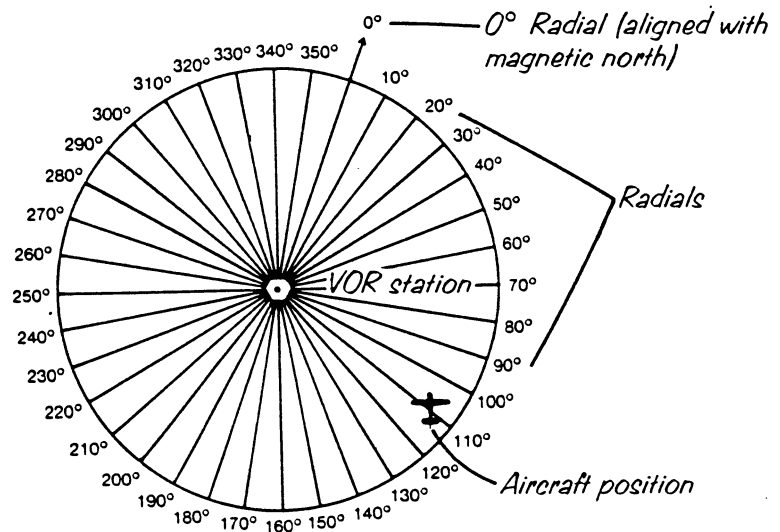


Figure 25. VOR Station and Radials

The Omni-Bearing Indicator (OBI), or VOR indicator, lets you determine what VOR radial your plane is on and helps you fly along radials toward or away from the VOR station.

Microsoft Flight Simulator

Course deviation indicator:

Course selector:

As shown in Figure 26, the OBI consists of the course deviation indicator (CDI), course selector, course selector knob or omni-bearing selector, and the TO-FROM indicator.

This is a vertical needle that shows your deviation from the VOR radial set by the course selector. If the needle points to the right of center, the radial lies to the right of your current position.

This is the numeric value that appears at the top of the OBI. This number indicates the radial your OBI receiver is set to.

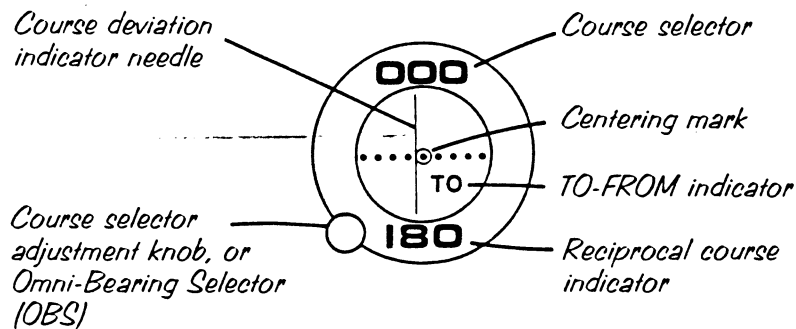


Figure 26. VOR Indicator

Course selector knob or omni-bearing selector:

TO-FROM indicator:

OBI readings:

The course selector knob is used to select the radial you want to fly on or to find the radial you are currently intercepting. The course selector value appears on the OBI. The NAV receiver interprets the radial on which the aircraft is currently located, and displays the relationship between this and the selected course on the OBI. The current radial may be "read out" by turning the course selector knob until the CDI needle is centered (and by observing the TO-FROM indicator to resolve any ambiguity).

This indicator shows whether you are on the radial shown by the course selector or on the radial 180 degrees away from it. When the TO indicator is displayed, the CDI shows course deviation as described above when you are flying toward the VOR station. When the FROM indicator is displayed, the CDI works as outlined above when you are flying away from the VOR station. You can fly toward a VOR station with a FROM indication, or from a VOR with a TO indication, but the CDI will work backwards. If the needle points to the right of center, the radial lies to the left of your current position.

It is important to remember that OBI readings indicate your aircraft's position relative to the VOR station's radial. The aircraft's heading has no effect on the OBI reading. You can, however, use the course selector to estimate the heading you must fly on to remain aligned with the radial.

Since the OBI's reading is independent of the aircraft's heading, you can fly along a selected radial and the OBI indicator will indicate valid course deviations in either flight direction. If the TO-FROM indicator reads FROM, the course selector's course is approximately the heading you should fly. If the TO-FROM indicator says TO, the reciprocal course, as indicated by the digits displayed at the bottom of the OBI, is the approximate heading. On windy days, you will have to compensate for any crosswinds that may blow you off your radial by increasing or decreasing your heading.

The TO-FROM indicator prevents disorientation. You can, if you wish, fly toward a VOR station on the FROM radial, and, as long as the CDI needle is centered, you will stay on course. However, the course deviation noted on the indicator will be backward. If the needle is to the right of center, you will have to fly to the left to intercept the radial again. Avoid this confusion by always flying on the FROM radial away from the station and on the TO radial toward the station.

If you intercept a radial and decide to fly along it, only to find that the needle sense is backward, adjust the course selector to 180 degrees from its current position. This will change the FROM to TO, or vice versa, and will reorient the needle.

To change the course and reciprocal course readings, press the VOR key, followed by either a series of + keypresses to advance the setting or a series of - keypresses to move the setting back. Each keypress adjusts the selector by two degrees. The letter "V" on the knob of the OBI is a reference to the VOR key.

The Uses and Advantages of Two NAV Radios

Two NAV radios and corresponding OBIs are provided to allow you to tune in two VORs simultaneously. There are several advantages to using two NAV radios.

First, you can identify your exact position by tuning in two VORs and finding the radials on which you lie for both VORs. The point where the two radials intersect (cross) is your position. Figure 27 shows this technique.

**To pinpoint
your position:**

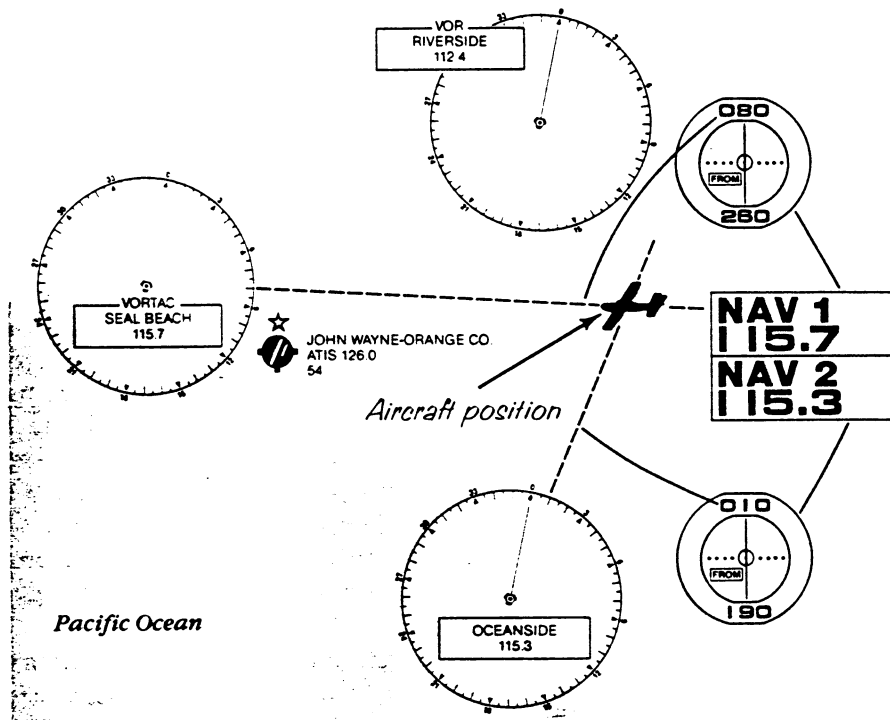


Figure 27. Using Two VORs to Identify Position

When determining your position using radial intercepts, you must be careful that you are on the radial shown by the course selector and not on the one 180 degrees away from it. It is possible to center the needle at two course selector settings; one on the radial you are really on, with FROM showing on the TO-FROM indicator, and the other one on the radial 180 degrees away, with TO showing. Make sure FROM is displayed when you are reading the radial off the course selector, and TO is displayed when reading the radial off the reciprocal course indicator.

To determine flight progress:

Two NAV radios can also be used to determine flight progress while flying toward a VOR. If you are flying toward a VOR tuned in on NAV1, you can set NAV2 to another VOR and set its OBI to a radial you will be crossing on your flight path. When you cross this preselected check point, the VOR needle for NAV2 will swing past center.

With two NAV radios, you can rapidly switch to the other radio (on which you have your VOR frequency and heading already adjusted) when air traffic control tells you to immediately take up a course toward the VOR station.

Finally, a second radio can serve as a backup if the other fails.

Distance Measuring Equipment (DME)

DME registers nautical miles from the VOR you are tuned to. Most VORs in real-world navigation, and all VORs in Flight Simulator, have DME capabilities.

The Flight Simulator DME system is connected to the NAV1 radio. The VOR station tuned on this radio is the one the distance measured corresponds to. Occasionally the DME will be blank when you have a valid VOR tuned in and working. The DME system does not have the range that the VOR's directional navigation signal has. If you are so far away from a VOR that its DME is no longer working, you are too far from the VOR to rely on its directional signal for navigation. In such a case, switch to a new VOR.

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OMI lights and glideslope:

Instrument Landing System (ILS) approaches are available at several airports. Consult your airport chart or tune in your COM radio to the ATIS frequency to determine if ILS is available.

The glideslope needle and the Outer, Middle, and Inner (OMI) marker lights are used for ILS approaches. They work in the Flight Simulator program just as they do in real aircraft. Refer to an instrument flying handbook, such as the *Flight Training Handbook*, for information on instrument approach techniques and how to use these instruments.

The Outer, Middle, and Inner marker indicators will also emit tones related to each marker in the form of dots (short tones) or dashes (long tones) in a unique sequence:

<i>Marker</i>	<i>Tones</i>
Outer Marker	Repeated sequence of dashes
Middle Marker	Alternating sequence of dots and dashes
Inner Marker	Repeated sequence of dots

Airport Beacons

You can spot airports at night by their flashing beacons. Beacons alternate between green and white. Locations of beacons are shown on the charts at the back of this manual.

Selecting and Customizing Flight Modes

Microsoft Flight Simulator features 30 flight modes. Ten preset modes are contained on your disk. You can create 20 more flight modes by setting parameters or adapting any of the 10 preset modes. To create and select flight modes, you use the editor.

Each of the 30 Flight Simulator flight modes is the unique combination of 37 parameters that control flight and environmental conditions. To review the parameters and their current values, enter the editor by pressing Esc.

Note For PC keyboard users, the number keys (0 to 9) that are pressed to set parameters are those on the main keyboard, not the numeric keypad.

Adjustable Parameters

The adjustable parameters are divided into three categories: simulation control, aircraft position, and environmental control. Aircraft position parameters let you set up test conditions and position yourself in the world.

Simulation Control

User Mode Selects a mode.

Sound Turns sound on and off. Flight Simulator produces normal engine sounds and propeller windmilling sounds (when gliding without power). It also features a stall horn. In the "WWI Ace" game, you will also hear machine-gun fire and the sound of bombs dropping. Press *1* to turn sound on, *0* to turn sound off.

Auto-coordination Links and unlinks ailerons and rudder. Pressing *0* unlinks the rudder and ailerons, allowing them to be controlled separately (as in uncoordinated flight). Pressing *1* links them for coordinated flight. You can fly in either coordinated or uncoordinated modes in easy mode and in reality mode (see below).

Microsoft Flight Simulator

Slew Turns the slew system on and off. Pressing *1* or *2* turns the slew system on. Pressing *0* turns it off. (See “Getting Around in the World” information on slewing.) If you have selected slew mode, pressing Esc moves you out of the editor and into slew mode, not flight mode.

Reality Mode Sets the realism factor of the simulator. Pressing *0* simulates easy flight conditions. Pressing *1* simulates a realistic flying environment, which includes the following restrictions:

- The engine must be started using the magneto switch and starter.
- Applying too much throttle too quickly will kill the engine.
- Elevators must be trimmed periodically.
- You must maintain adequate fuel or the engine will stop.
- You can get stuck in mud or a snowbank if you leave the runway.
- The heading indicator will drift from the correct magnetic heading and must be reset by pressing the Directional Gyro key.
- The altimeter will register altitude improperly unless the barometric pressure is periodically reset by pressing the Altimeter key.
- Flying all day with the lights on can burn out a bulb. Burned bulbs are replaced during refueling/servicing stops.
- Carburetor icing will usually occur on warm, humid days. (Ironically, icing is less of a problem on very cold days.)

You can fly in either coordinated or uncoordinated flight in both easy mode and reality mode.

Demonstration Mode Activates a demonstration in which the plane flies itself.

Europe 1917 Sets up the “WWI Ace” aerial battle game. Pressing *1* sets up the game. Pressing *0* sets normal flight simulation. (See “WWI Ace.”)

Communication Rate Controls the rate at which the ATIS communication radio messages scroll across the top of the screen. The rate at which information scrolls across the screen ranges from very slow (1) to faster than an air traffic controller talks (255). Values that are powers of two (2, 4, 8, 16, 32, etc.) produce the smoothest scrolling. Others tend to be jerky.

Aircraft Position

North Position Sets the aircraft's north positional coordinate to automatically transfer you from one location to another, or to create test situations (used in conjunction with the East Position parameter). These values are specified in north and east coordinates as cited on the area charts (see Charts 1 through 4). Each unit represents 256 meters. Your current position (your position before you entered the editor) is always displayed here.

East Position Like the North Position parameter, sets the coordinates to automatically transfer from one location to another, or to create test situations (used in conjunction with the North Position parameter). These values are specified in north and east coordinates as cited on the area charts (see Charts 1 through 4). Your current position (your position before you entered the editor) is always displayed here.

Altitude Sets the altitude for transfer destinations (see "Getting Around in the World"). It can also be used to set the altitude for a test situation. This value is specified in feet above sea level. Your current altitude (your position before you entered the editor) is always displayed here.

Pitch Sets pitch attitude for test situations. Must be in the range of 0 to 359 degrees. Your current flight mode pitch attitude is always displayed here.

Bank Sets bank attitude for slew mode or for test situations. Must be in the range of 0 to 359 degrees. Your current flight mode bank attitude is always displayed here.

Heading Sets the heading for slew mode or for test situations. Must be in the range of 0 to 359 degrees. Your current heading is always displayed here.

Airspeed Lets you set airspeed for a test situation. Airspeed is specified in *knots*. (Note: 1 knot = 1.15 mph.)

Throttle Sets the throttle position so you can create test situations. The range is 0 to 32767 (Cut = 0).

Rudder Sets the rudder position so you can create test situations. The range is 0 to 65535 (Center = 32767).

Ailerons Sets the aileron position so you can create test situations. The range is 0 to 65535 (Center = 32767).

Flaps Sets the flaps position so you can create test situations. The range is 0 to 32767 (No flaps = 0).

Elevators Sets the elevator position so you can create test situations. The range is 0 to 65535 (Center = 32767).

Environmental and Peripheral Control

Time *Sets the clock.*

Hours: Sets the hour of the day (local time, not Greenwich mean time). Time is set in 24-hour format, so the range for hours is 0 to 23.

Minutes: Sets the minutes on the clock. The range is 0 to 59.

Season Sets weather conditions that are typical of the specified season. The codes that represent the seasons follow.

<i>Code</i>	<i>Season</i>
1	Winter
2	Spring
3	Summer
4	Fall

Cloud Layers Sets lower and upper limits of cloud layers. Specifies beginning (bottoms) and ending (tops) altitudes in feet above sea level. Top limits must be set above lower limits and layers must not overlap. To eliminate clouds, set tops and bottoms to zero.

You can specify two cloud layers as follows:

- Cloud Layer 2 Tops
- Cloud Layer 2 Bottoms
- Cloud Layer 1 Tops
- Cloud Layer 1 Bottoms

Using Flight Simulator

Wind Sets wind levels. Wind levels can be set at ground level and at three additional elevations. You must set velocity (in knots), direction (in degrees), and shear altitude (in feet above ground level) for each wind level. Shear altitude determines where wind levels begin and end, as follows:

Wind Level 3: Knots
Degrees
Shear Zone Altitude 3
Wind Level 2: Knots
Degrees
Shear Zone Altitude 2
Wind Level 1: Knots
Degrees
Shear Zone Altitude 1
Surface Wind: Knots
Degrees

One level ends where the next level starts.

Reliability Factor Sets the probability factor for problems arising in reality mode. The reliability value is specified as a percentage. A value of 100 ensures a totally reliable aircraft, while a value of 0 presents frequent problems.

Joystick Selects between joystick and keyboard control: "0" assumes keyboard control; "1" selects single joystick operation; and "2" selects dual joysticks. See the section on "Joystick Use and Techniques" for details.

When you enter the editor, the North, East, Altitude, Pitch, Bank, and Heading parameters show the current position of the aircraft. When you leave the editor and return to flight mode, these settings change to reflect your new position as you fly the aircraft.

Preset and User Flight Modes

The flight modes (unique combinations of the above parameters) are numbered 0 through 29. Modes 0 through 9 are preset. They are standard flight modes in which the fundamental parameters are slightly varied. The preset modes follow.

<i>Mode</i>	<i>Function</i>	<i>Location</i>
0	Easy flight	Chicago, IL
1	Realistic, fair weather flight	Seattle, WA
2	Automated flight demonstration	Chicago, IL
3	Dusk flight	Los Angeles, CA
4	Night flight	Chicago, IL
5	Moderate weather flight	New York, NY
6	Bad weather flight	Boston, MA
7	WWI Ace battleground	Europe
8	Airborne startup situation (normal)	San Diego, CA
9	Airborne startup situation (emergency)	Champaign, IL

Mode 0 is the mode you are in when you start the program. Mode 2 is a flight demonstration. Mode 1 and modes 3 through 6 simulate special flying conditions. Mode 7 sets up the WWI Ace battleground. Mode 8 simulates normal flying conditions; however, you begin in the air, not on the ground. Mode 9, like mode 8, starts in midair, but simulates emergency situations.

The preset modes (0 through 9) are recorded on the Flight Simulator disk. Modes 10 through 29 are user modes. No parameters have been set for these modes, so you can create your own customized modes. Each time you load Flight Simulator, the program reverts to 0 (easy flight) mode.

Creating User Flight Modes

There are three ways to create your own modes. The first method involves using the editor to enter values next to the parameters. You can start from scratch by selecting a mode (23, for example), then setting the values for the parameters. Then press the Ins (Insert) key if you intend to use the mode with those values later. You can create several modes with this method. When you have created as many as you want, press Esc. You will immediately begin flying in the last mode you created. To select another mode, enter the editor, type in the appropriate mode number next to the user mode parameter, and press Esc. You can enter the editor at any time to modify parameters of user modes. Just enter the appropriate mode number next to the user mode parameter and change the values.

Important When you switch to a user mode for the first time, you will find it filled with random data. Flying in a mode before setting up parameters for it creates unpredictable results.

If you attempt to alter the parameters of any of the preset modes (0 through 9), that mode, with your modifications, will be entered under one of the user mode numbers. The user mode number it is entered under is the number that is the sum of the preset mode you attempted to change and ten.

For example, if you attempt to alter the altitude of the cloud layer level of mode 4, your modifications will create mode 14. Mode 14 will be identical to mode 4, but the altitude of the cloud layer will match your specifications. Any mode that was previously within user mode 14 is thus destroyed.

To avoid accidentally destroying a mode, do not put modes you want to protect in modes 10 through 19, as any changes you make to any of the preset modes will automatically write over the parameters saved under modes 10 through 19.

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In creating your own modes, you will rarely want to start from scratch. In most cases, any mode you will want to create will consist of a few modifications to an existing mode. Or you may want to create several similar modes with only minor differences. The second method of creating a mode involves making a copy of a mode, then changing the values of the parameters in the copy. You can make one or more copies of any mode and modify the copies without affecting the original.

To copy a mode, use the following procedure:

Copy, then modify a mode:

- ▶ Specify the mode you want to copy by entering its number next to the User Mode parameter.
- ▶ Note the number of a vacant mode. Enter the sum of its number and 100. This will copy the original mode to the number that was vacant.
- ▶ Make your changes by modifying current parameters or adding new ones. (Press the Ins key if you plan to use the mode with those parameters again.)
- ▶ Press Esc. You will return to flight mode and can then test the mode you just created.

For example, if you want to copy and change parameters of mode 21, select mode 21. Copy mode 21 to mode 28 (a vacant mode) by specifying the sum of 28 and 100, or 128. When mode 21 has been copied to mode 28, you can change any of the parameters of mode 28 you wish.

Record the current flight position:

The third method of creating a new mode also involves altering a current user mode. As you already know, when you fly, the North, East, Altitude, Pitch, etc., values in the editor change to reflect your current position. You may, on occasion, encounter a particularly interesting situation which you would like to recreate at a later time. Pressing the Ins key while in the editor replaces the flight mode's parameter values with the current values; that is, the current parameter values are written over the original parameter values. If you are flying in any of the preset modes and enter the editor hoping to record the current values to that mode, then your current values will be recorded under the mode whose number is the sum of the preset mode you are in and ten.

Generally you will want to press Ins after creating a new user mode. Simply exiting to the flight mode will put you in the situation you set; however, the values in the parameters that reflect your flight status and position (e.g., North, East, Altitude, Pitch, etc.) change as you fly.

Store your flight modes:

Pressing the Ins key stores the values for the mode selected in a special memory area called the "Mode Library."

Each time you reselect that mode (provided you have not quit the Flight Simulator program, or, if you have, you have saved the mode to disk), the values for that mode will be transferred back from the Mode Library to the editor parameters and the situation you were in when you pressed the Ins key will be recreated.

As soon as you begin to fly, the parameter values begin to change. Pressing the PrtSc key resets the original parameter values from the Mode Library for the mode you are in. Or, entering the editor and typing the mode number next to the User Mode parameter has the same effect.

Pressing the Ins key is also necessary if you intend to save a mode to disk. The information "saved" on the disk is the values stored in the Mode Library. See Figure 28.

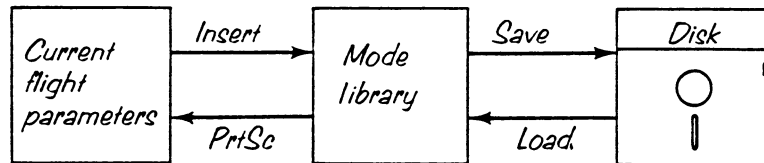


Figure 28. Saving Flight Modes

You cannot modify the parameters of the WWI Ace game or create user modes with those parameters, since doing so could provide an unfair advantage in the game. Attempting to modify or use the parameters will cause the game to revert to its standard parameters and restart the game (it will also zero out your score).

Saving User Modes

Once you quit the Flight Simulator program, all modes except modes 0 through 9 (the preset modes) are erased, unless you save them on disk. Saving a mode on disk is the second step in creating user modes. When you have created a new set of user modes that you will want to use at a later date, you must save them on a disk. Each time you save modes, all 30 modes will be saved. Therefore, all modes on the user mode disk will be written over (except the preset modes, which always remain the same). You can use any disk that suits your system, since no special formatting is required.

Note	Quitting the Flight Simulator erases all user modes except those you have saved on disk. You cannot save user modes on the Flight Simulator disk.
-------------	--

To save user modes:

- ▶ Remove the Flight Simulator from disk drive A.
- ▶ Insert a blank disk or a disk that has user modes (that you don't wish to save) recorded on it into disk drive A. If the disk has a write-protect tab on it, remove it.
- ▶ Press Esc to enter the editor if you are not already there.
- ▶ Press the S key (for Save). All 30 modes will be saved on the disk. All modes previously saved on the disk will be overwritten with the new mode data. The message:

MODES SAVED

will be displayed indicating a successful save.

- ▶ Replace the write-protect tab.

Loading User Modes

To load user modes from disk:

- ▶ Remove the Flight Simulator disk from disk drive A.
- ▶ Insert the user mode disk.
- ▶ Enter the editor by pressing Esc.
- ▶ Press the *L* key (for Load). The message:

MODES LOADED

confirms a successful load.

- ▶ Remove the mode disk from the drive, and reinsert the Flight Simulator disk. All 30 modes are now in effect.

Disk Swapping

Databases for airports and scenery in different general geographic areas (Seattle or Los Angeles, for example) require too much memory to be stored in system memory simultaneously, so they are stored on the Flight Simulator disk. If you decide to move to a different geographic location, you must replace the Flight Simulator disk in disk drive A.

We recommend that you remove a mode disk when you are not using it and leave the Flight Simulator disk in the disk drive when you are not loading or saving modes.

If the Flight Simulator disk is not in the disk drive when you move to a different location, the message:

DISK LOAD ERROR
RE-INSERT PROGRAM DISK
AND PRESS ANY KEY TO RETRY

will be displayed. This message will also occur if there is difficulty reading the Flight Simulator disk.

Advanced Flight Techniques

Easy, auto-coordinated flight is ideal for learning flight control. However, once you have mastered the fundamentals, you will want more challenges. You can add environmental factors to simulate real flight conditions. Or select one of the other preset modes to fly in realistic conditions. Or select uncoordinated flight mode (see below) so you can learn how to control the rudder and ailerons separately. To test your skills, you can devise test situations by setting the Pitch, Bank, Heading, Airspeed, Altitude, or Throttle, Rudder, Ailerons, Flaps, or Elevators parameters. For highly realistic conditions, reality mode can be selected. While in reality mode, you can select either auto-coordinated or uncoordinated mode. Or, you can increase the problems you encounter in reality mode by setting a low reliability factor.

Before you attempt many of these challenges, you may want to practice some advanced flight techniques as described in the following section, "Uncoordinated Flight." If you need more information on flight performance than is included here, consult the *Flight Training Handbook*. When you have mastered uncoordinated flight, instrument navigation, and a few basic maneuvers, you will have a solid foundation for any situation you can devise with Microsoft Flight Simulator.

Uncoordinated Flight

When you begin the Flight Simulator program, you are in easy and auto-coordinated flight modes. In auto-coordinated mode, the ailerons and rudder are linked. Auto-coordinated flight is the safest flight attitude. The aircraft is usually in its best aerodynamic position when it is flying in a coordinated attitude – flying straight through the air, as opposed to flying through the air slightly sideways with the airflow battering one side of it and leaving one wing in an "airflow shadow."

In uncoordinated flight, the pilot controls the ailerons and rudder independently of each other. You cannot do this in auto-coordinated flight mode. To fly in uncoordinated flight mode, enter the editor and enter 0 next to the Auto-coordination parameter. This breaks the link between the ailerons and the rudder and lets you control them independently.

Control the ailerons and rudders independently:

With auto-coordinated flight mode disabled, it is possible to fly the aircraft in uncoordinated attitudes. Slips and skids (uncoordinated maneuvers in which you fly slightly sideways) can be performed. The pilot must *manually coordinate* turns in uncoordinated mode by responding to the slip/skid indicator.

As you already know, to turn you apply the aileron, causing the plane to bank. During a bank, your wing's lifting force (which normally points straight up in straight flight) points at the bank angle. Some of the force is distributed in the upward direction, as usual. But the remaining force points sideways. It is the side force that causes the aircraft to start its turn, or to move slightly sideways through the air. The lifting force is reduced during a bank (force is deflected to the side, and the aircraft tends to lose altitude).

Once the aircraft starts flying slightly sideways due to the bank, it is in uncoordinated flight. It is no longer flying straight through the air around it. The rudder can be used to straighten out the plane again, relative to the wind coming on sideways. When the rudder is applied, the flight becomes coordinated again as the aircraft yaws. The yaw results in a change of heading. The aircraft has just turned.

If the slip/skid indicator ball (on the turn coordinator) remains centered, the aircraft is in coordinated flight; that is, the aileron and rudder are properly positioned for the turn (even though they are not mechanically linked). If the ball is to the right of center, the rudder must be adjusted to the right. Likewise, if the ball is to the left of center, the rudder must be adjusted to the left. A plane that has too little rudder applied flies through the air slightly sideways. This is known as a *slip*. If aileron only is applied, a slip results. Even in a slip, the plane will still turn. The aerodynamics of the aircraft cause a plane to tend to point into the wind. As a result, a plane in a slip will gradually turn around to a new heading to align itself with the flight path and oncoming wind. This is an uncoordinated turn and a poor flight practice.

Slips are useful for moving the plane slightly right or left without changing heading (to line up with the runway in landing approach, for example). A bit of reverse rudder can be applied in a slip to keep the plane from turning. This is where a slip becomes useful. You can move the plane sideways without changing your heading.

Climb to 3000 feet. Apply right aileron and left rudder. The attitude indicator will show that you are banking to the right. Apply left rudder. This prevents the plane from yawing to a new heading. You are now in a slip, and although your aircraft is still pointing in the same direction, you are moving in a direction slightly to the right of the indicated direction.

Turn the plane by "slipping":

Slips are useful for crosswind landings. It is essential that you land with your nose pointing straight down the center of the runway. If you land at a slight angle, in a "crab," your wheels will pull you off the runway. However, when landing in a crosswind, you must fly at a slight crab angle to compensate for the crosswind and to prevent the plane from drifting away from the runway. The plane can be aligned with the runway by adjusting the rudder, and the ailerons can be used to increase bank until the plane is flying sideways at the right rate to compensate for the crosswind. This is called a side slip. Maintain the slip until you touch down. You will land on one wheel. Do not be alarmed; that is the correct crosswind landing technique.

Slips can also be used to lose altitude, particularly on final approach. Slips, like any uncoordinated flight maneuver, put drag on the aircraft. You will lose altitude faster in a slip than in straight, coordinated flight. This can be put to good use on final approach. When you are too high, a slip can be used to lose some altitude. This practice is used very seldom on modern aircraft, but was used extensively on older aircraft, especially those with no flaps. A slip used to dissipate altitude without increasing airspeed is known as a forward slip.

Slips can be dangerous. Severe slips can stall a wing; however, a stall during a slip will bank you in the opposite direction of the turn, which tends to correct the problem.

Avoid skidding:

When more aileron than rudder is used, a slip results. When more rudder than aileron is used, a *skid* results. Skids cause the inner wing to stall, resulting in a spin or spiral in the direction of your bank. Skids have no practical value and should be avoided.

Maneuvers

There are two types of flight maneuvers: those that are performed in normal flight attitudes, but require skill, thought, and precision (for example, turns about a fixed point, figure eights, rectangular courses); and those that put the aircraft into unusual attitudes, putting severe demands on it (for example, barrel rolls, spins, and loops). Maneuvers are fun and challenging, and they help build skills that are useful in everyday and emergency situations.

Flight Simulator includes enough ground reference points to allow you to perform ground-reference maneuvers, and the power and airframe strength to allow you to perform maximum performance flight maneuvers. Use the view selector to view ground reference points while you make turns. (Be sure to reselect the front view before you proceed to other maneuvers.) Set wind speed and direction to increase the challenge of your maneuvers.

Maneuver procedures are beyond the scope of this manual. We recommend you consult a flight training manual, such as the *Flight Training Handbook*, for details on how to perform the following maneuvers:

- Turns in the wind.
- “S” turns across a road.
- Turns around a point.
- Figure eights along and across a road.
- Figure eights around and on pylons.
- Line of sight to pylons.

All these maneuvers, as well as many stalls, can be performed in either auto-coordinated or uncoordinated flight modes.

Instrument Flight

Flight Simulator provides adequate instrumentation and enough VORs, airports, Instrument Landing Systems, and marker beacons to support Instrument Flight Rules (IFR) flight and approaches.

No ADF (Automatic Direction Finder) is available. Approaches at busy airports, such as Kennedy, Los Angeles International, and O’Hare, are not recommended without the use of this instrument. However, general approach techniques that do not require these instruments can be practiced at less congested airports. (The Flight Simulator allows you to land at busy airports without using ADF.)

Many of the 81 airports in the Flight Simulator allow instrument approach. By tuning in to ATIS frequencies on the COM radio (see Charts 1 through 4 for frequencies for each airport), you can receive approach information, including approach-in-use, localizer frequency, etc. This combination of information is normally supplied by ATIS, approach control, the tower, and approach plates.

**Try IFR flight
and approaches:**

Microsoft Flight Simulator

If ATIS is not available at a particular airport, tune in to the tower by selecting the VOR frequency with your COM radio. This information scrolls across the top of the screen. If it moves too fast, enter the editor, move the arrow to the Communication Rate parameter, and reduce the speed by entering a smaller number.

A discussion of instrument approach techniques is beyond the scope of this manual. If you are not an instrument-rated pilot, you can find details of instrument approaches and flying in training manuals such as *Instrument Flying* by Richard L. Taylor.

World War I Ace

To begin:

WWI Ace is a three-dimensional battle game that lets you test your flying skills against those of your computer-controlled enemy. You will go on several bombing runs and engage in numerous dogfights with your enemy. Your goal is to down five enemy aircraft and to become a WWI Ace.

Begin the game by entering the editor and setting the Europe 1917 parameter to "1," or enter "7" next to the User Mode parameter. Press Esc to reenter flight mode. Figure 29 shows the battleground. You are currently positioned on the runway of Friendly Base 1 (your main airbase). You are fueled, armed, and ready for takeoff.

Friendly Base 1: Fuel and ammunition available

Friendly Base 2: Fuel only available

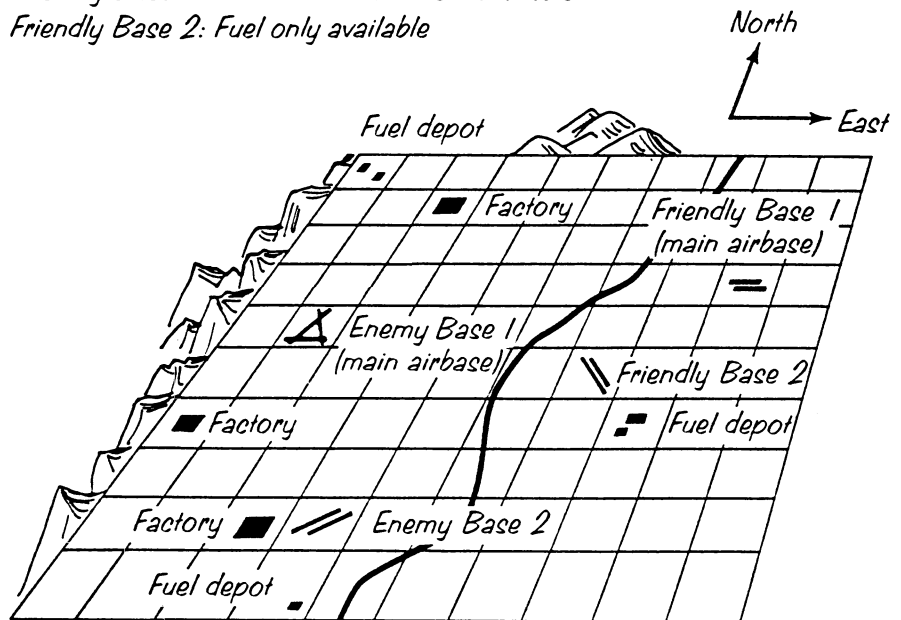


Figure 29. WWI Ace Battleground

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To declare war:

A truce is in effect and battle will not begin until you declare war by pressing the War key (Shift W on the PCjr, W on the PC).

The enemy occupies the territory west of the river. They have established two airbases, a fuel depot for each, and several factories. Six enemy fighters stand ready to protect the fuel depots and the factories. It is your duty to shoot down as many of the enemy fighters as possible and bomb the depots and factories.

To locate your targets, you will have to use the view selector (in conjunction with the keys on the control yoke). The downward view includes a bomb sight. The bomb sight helps direct you over your target so you have a better chance of scoring a hit. Pressing the X key on either the PCjr or PC releases one bomb.

To become an Ace, you must down at least five enemy aircraft. You can earn additional points for other actions.

To release bombs:

<i>Action</i>	<i>Points</i>
Downing an enemy aircraft	1
Bombing a factory	20
Destroying a fuel depot	10

These extra points won't make you an Ace, but they will indicate your skill as a fighter. Your score is displayed on the attack radar screen.

The Report key (Shift R on the PCjr, R on the PC) causes the simulation to pause and displays the War Report that indicates your present status. Pressing the key again will return you to the game.

The enemy pilots have orders to intercept any invader. However, each pilot has different instructions for when to launch and when to return to base. The skills of your opponents vary. The Aces are proficient and score quickly. Their lesser-skilled compatriots are less likely to hit you.

The enemy flies a wide variety of fighter aircraft. Their fleet contains two planes that are fast and rugged, but equipped with unreliable guns; one plane that is fast and easily maneuvered; one that is a fair fighter, capable of medium range speed, maneuvered fairly easily, and equipped with average guns; and two super fighters. Be assured that the enemy Aces will be in the best planes.

Although World War I aircraft were not equipped with radar, when you play WWI Ace, radar is implemented to compensate for the viewing limitations of the three-dimensional screen.

To request a War Report:

To use radar:

The lower right corner of the instrument panel becomes your attack radar screen. The attack radar screen displays your score, as well as various messages about war occurrences. It also has a bomb indicator and an ammunition indicator, which display your current bomb and ammunition supply.

The small plane in the center of the radar screen shows your position and orientation. Enemy aircraft are represented by dots on the screen. These dots are color-coded to indicate their altitude.

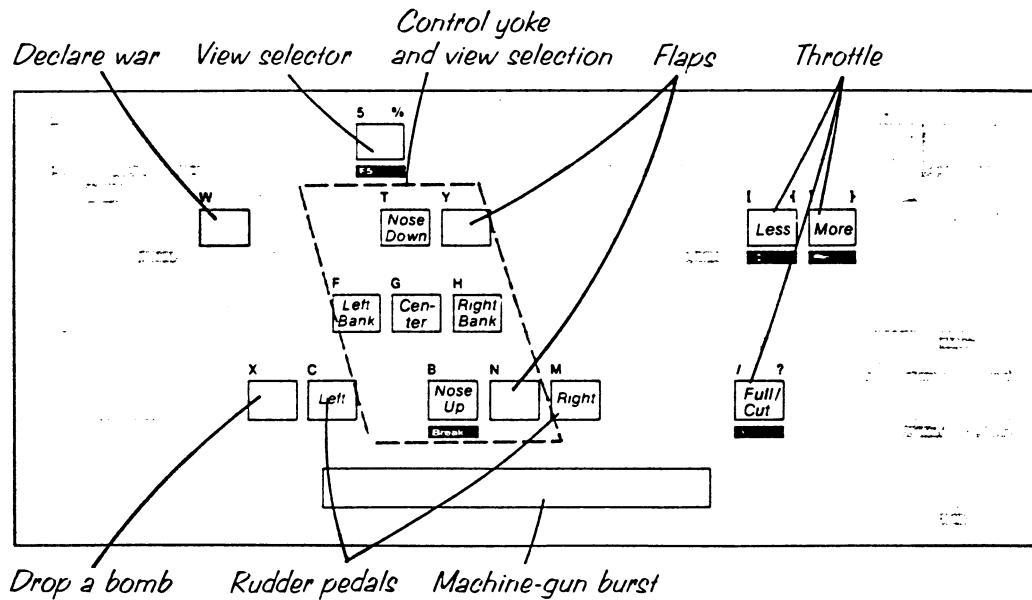
<i>Color</i>	<i>Meaning</i>
Orange	Enemy below you
White	Enemy within 100 feet above/below you
Green	Enemy above you

Note If you have a black and white monitor, we recommend you rely on your out-the-window display to determine the position of the enemy. Though you will be able to distinguish planes within 100 feet above and below you (the bright dots on the radar screen), you will not be able to determine whether the dim dots represent planes far above you or planes far below you.

The radar has a radius of approximately 1 mile and displays the enemy positions when the forward view is selected.

When you play the WWI Ace game, the regular instrument panel is augmented with fighter aircraft instrumentation. The yoke, flap, rudder, and throttle controls perform the same functions they do in regular flight mode. In addition, the Space Bar or joystick push buttons control gun-fire, and the X key releases a bomb. As previously mentioned, the Report key displays the War Report and the War key commences action (begins the war). If you choose to use a joystick in the WWI Ace game, be sure to calibrate it before entering the game. If you need to recalibrate, exit the game temporarily to do so. Figures 30 and 31 show the battle mode flight controls for the PCjr and the PC.

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Note: For certain controls, press Shift and one of these keys:

<i>Shifted Key</i>	<i>Result</i>
<i>R</i>	<i>Displays war report</i>
<i>W</i>	<i>Declares war</i>

Figure 30. WWI Ace Battle Mode Flight Controls for the PCjr

Note The Europe 1917 parameter must be set to 1 using the editor for these controls to take effect.

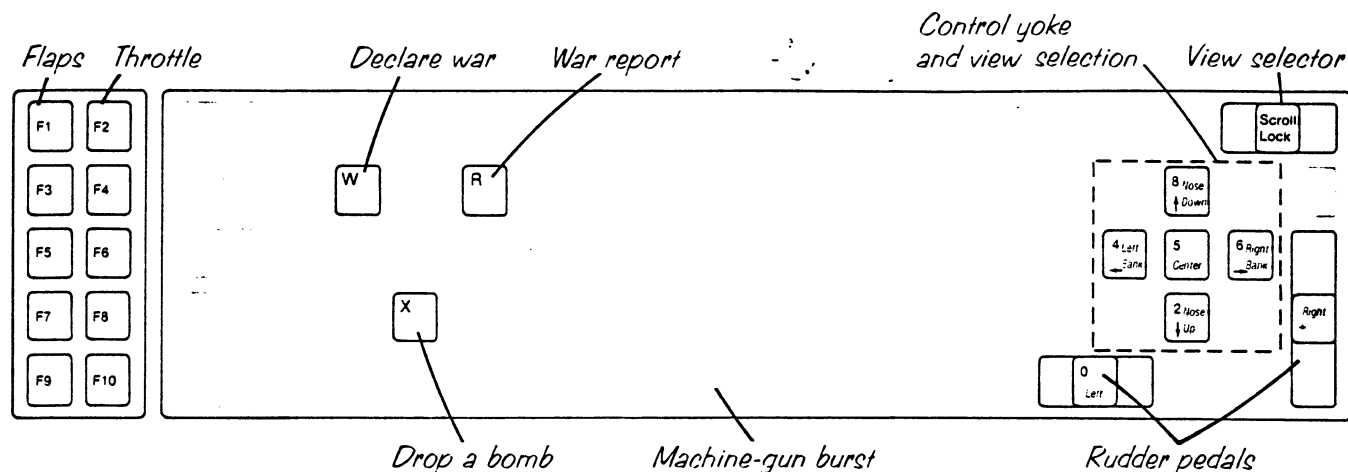


Figure 31. WWI Ace Battle Mode Flight Controls for the PC

When you're ready to start:

First, scout the enemy's territory. Decide where you want to be when the battle begins. (You do not have to be at your airbase to declare war. In fact, you will probably find it to your advantage to begin elsewhere.)

After you have declared war, you will have to watch the radar screen and look out the windshield for the approach of the enemy. Move as close to an enemy plane as possible and fire by repeatedly pressing the Space Bar or either joystick's push button. You have a better than average chance of hitting your enemy if the enemy is anywhere on the screen and within range of your gun. Your gun has excellent straight range, but poor side range. Consequently, you must be very close to a plane to hit it when it moves to the sides of the screen.

You, too, are open for attack. Although the enemy can and will shoot you down, every firing does not register a hit for them. Each enemy pilot's success will depend on his skill level. Every hit the enemy scores reduces the efficiency of your plane. If you are hit and your aircraft has been damaged (if it is acting strangely, losing fuel, or dropping oil pressure), return to base for repairs and refueling.

Refueling at Friendly Base 1 automatically replenishes your bomb supply. You can carry only five bombs at a time, so you can destroy a maximum of five targets (fuel depots and factories) per mission. Friendly Base 2 only has fuel, so any time you need more bombs you must return to Friendly Base 1.

Six enemy fighters patrol the skies above the enemy airbases. Their location varies from game to game and during the game. Damaged enemy planes are replaced while you refuel and repair your plane.

Now that you know the rules, declare war. Good luck!

Reference

This section includes information about your plane. It also contains a diagram of the cockpit, airport maps, and a glossary.

Reference Figures and Charts

The Standardized Instrument Cluster

1. Airspeed indicator (knots)
2. Attitude indicator (artificial horizon)
3. Altimeter
4. Turn coordinator with slip/skid indicator
5. Heading indicator (directional gyro)
6. Vertical speed (rate of climb indicator)

Other Instruments and Indicators

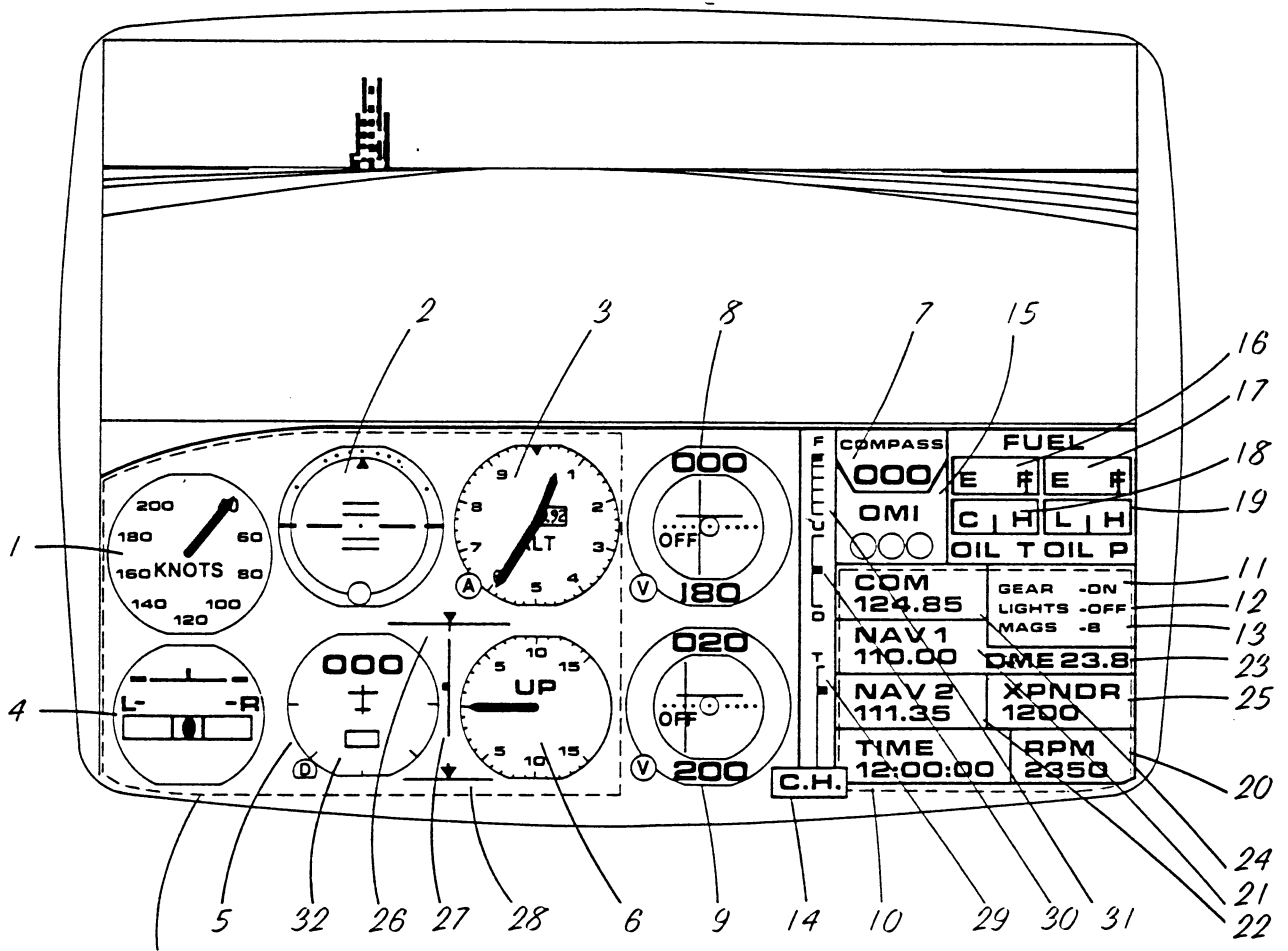
7. Magnetic compass
8. Omni-Bearing Indicator with glideslope (NAV 1)
9. Omni-Bearing Indicator with glideslope (NAV 2)
10. Clock
11. Gear indicator
12. Lights indicator
13. Magnetos indicator
14. Carburetor heat indicator
15. Outer, Middle, and Inner marker lights
16. Left wing fuel tank gauge
17. Right wing fuel tank gauge
18. Oil temperature gauge
19. Oil pressure gauge
20. Tachometer

Radios

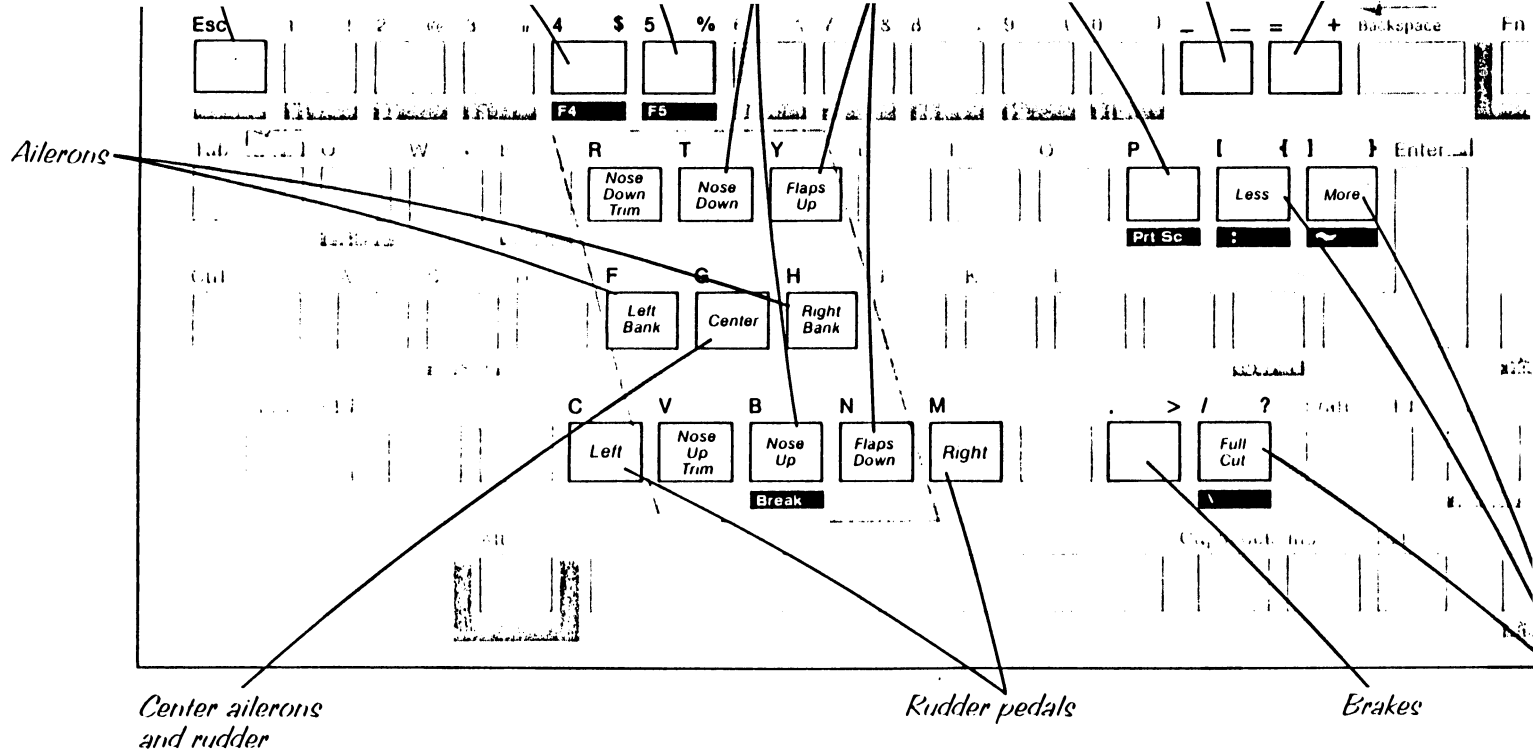
21. NAV 1 radio
22. NAV 2 radio
23. DME
24. COM radio
25. Transponder

Control Position Indicators

26. Aileron position indicator
27. Elevator position indicator
28. Rudder position indicator
29. Throttle position indicator
30. Elevator trim indicator
31. Flap position indicator
32. Mouse control of view select

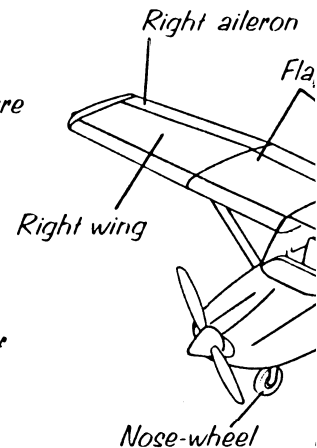


Reference Figure 1. The Three-Dimensional Display and Instrument Panel

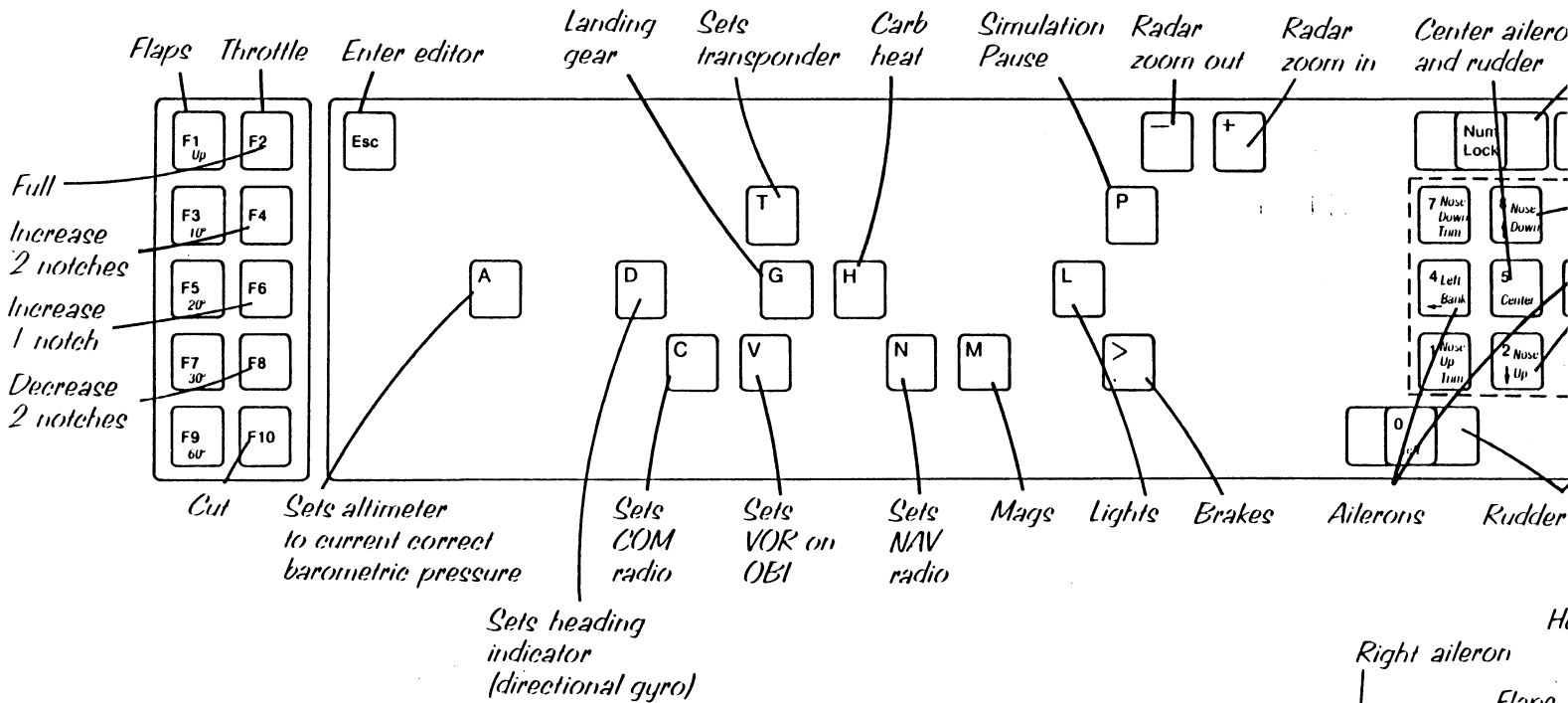


Note: For certain controls, press Shift and one of these keys:

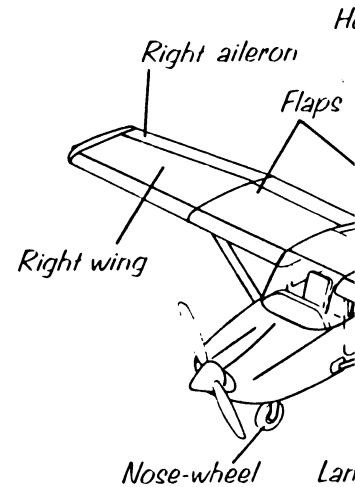
<i>Shifted Key</i>	<i>Result</i>
<i>A</i>	<i>Sets the altimeter to the current barometric pressure</i>
<i>C</i>	<i>Sets the COM radio frequency</i>
<i>D</i>	<i>Sets the directional gyro heading indicator to the magnetic compass</i>
<i>G</i>	<i>Raises or lowers the landing gear</i>
<i>H</i>	<i>Toggles the carburetor heat on or off</i>
<i>L</i>	<i>Toggles the instrument and running lights on or off</i>
<i>M</i>	<i>Adjusts the magnetos</i>
<i>N</i>	<i>Sets the NAV radio frequency</i>
<i>T</i>	<i>Sets the transponder "squawk"</i>
<i>V</i>	<i>Sets the OBI to a VOR frequency</i>



Reference Figure 2. Complete Control Key Set for the PC jr.



Reference Figure 3. Complete Control Key Set for the PC



Airport Directory

NEW YORK AND BOSTON AREA

<i>CITY</i>	<i>AIRPORT</i>	<i>NORTH</i>	<i>EAST</i>	<i>ALT.</i>	<i>F (Fuel)</i>	<i>ILS (Rwy/Freq.)</i>
Block Island	Block Island State	17352	21749	105	•	
Boston	General Edward Lawrence					
	Logan Intl.	17899	21853	20	•	
Bridgeport	Igor I. Sikorsky Memorial	17287	21249	10	•	
Chester	Chester	17404	21434	416		
Danbury	Danbury Muni	17360	21120	457		
Danielson	Danielson	17617	21607	239		
Farmingdale	Republic	17089	21177	81		
Hartford	Hartford-Brainard	17551	21371	19		
Islip	Long Island MacArthur	17132	21278	99		
Martha's Vineyard	Martha's Vineyard	17490	22043	68	•	24/108.7
Meriden	Meriden Markham Muni	17447	21327	102		
New Haven	Tweed-New Haven	17339	21322	13		
New York	John F. Kennedy Intl.	17034	21065	12	•	
New York	LaGuardia	17091	21026	22		
Oxford	Waterbury-Oxford	17422	21229	727		
Southbridge	Southbridge Muni	17733	21543	697		
White Plains	Westchester Co.	17226	21065	439		
Willimantic	Windham	17573	21521	246		
Windsor Locks	Bradley Intl.	17638	21351	174		

North and east coordinates are canted at -10° (clockwise) to compensate for orthogonal coordinate grid overlaid on Lambert conformal conic projection.

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CHICAGO AREA

<i>CITY</i>	<i>AIRPORT</i>	<i>NORTH</i>	<i>EAST</i>	<i>ALT.</i>	<i>F (Fuel)</i>	<i>ILS (Rwy/Freq.)</i>
Aurora	Aurora Muni	17152	16393	706		
Bloomington	Bloomington-Normal	16593	16246	875		
Champaign (Urbana)	University of Illinois Willard	16400	16465	754	*	31/109.1
Chicago	Chicago Midway	17156	16628	619	*	
Chicago	Chicago-O'Hare Intl.	17243	16578	667	*	
Chicago	Lansing Muni	17049	16697	614	*	
Chicago	Merrill G. Meigs	17189	16671	592	*	
Chicago/Blue Island	Howel	17100	16627	600		
Chicago/Schaumburg	Schaumburg Air Park	17247	16515	795		
Chicago (West Chicago)	DuPage	17213	16466	757		
Danville	Vermilion Co.	16471	16685	695		
Dwight	Dwight	16874	16404	630		
Frankfort	Frankfort	17025	16596	775		
Gibson City	Gibson City Muni	16594	16461	759		
Joliet	Joliet Park District	17038	16490	582		
Kankakee	Greater Kankakee	16846	16597	625	*	
Monee	Sanger	16980	16646	786		
Morris	Morris Muni	17004	16413	588		
New Lenox	New Lenox-Howell	17025	16571	745		
Paxton	Paxton	16578	16507	780		
Plainfield	Clow Intl.	17116	16502	670		
Romeoville	Lewis University	17081	16518	672		
Urbana	Frasca Field	16448	16482	735		

North and east coordinates align with orthogonal coordinate grid overlaid on Lambert conformal conic projection.

Flight Simulator Reference

SEATTLE AREA

<i>CITY</i>	<i>AIRPORT</i>	<i>NORTH</i>	<i>EAST</i>	<i>ALT.</i>	<i>F (Fuel)</i>	<i>ILS (Rwy/Freq.)</i>
Alderwood Manor	Martha Lake	21502	6670	500		
Arlington	Arlington Muni	21616	6737	137		
Auburn	Auburn Muni	21290	6586	57		
Bremerton	Bremerton National	21407	6470	481		
Everett	Snohomish Co.	21525	6665	603	*	16/109.3
Issaquah	Issaquah	21362	6668	500	*	
Monroe	Flying F. Ranch	21481	6738	50		
Olympia	Olympia	21218	6343	206	*	
Puyallup	Pierce Co.-Thun Fld.	21206	6534	530		
Port Angeles	William R. Fairchild Intl.	21740	6375	288	*	
Port Orchard	Port Orchard	21373	6483	370		
Renton	Renton Muni	21351	6612	29		
Seattle	Boeing Fld./King Co. Intl.	21376	6596	17	*	
Seattle	Seattle-Tacoma Intl.	21343	6584	429	*	
Shelton	Sanderson Fld.	21353	6316	278		
Snohomish Co. (Paine Field)	see Everett					
Snohomish	Harvey Fld.	21505	6711	16		
Spanaway	Shady Acres	21201	6501	425		
Spanaway	Spanaway	21215	6491	385		
Tacoma	Tacoma Narrows	21300	6480	292		

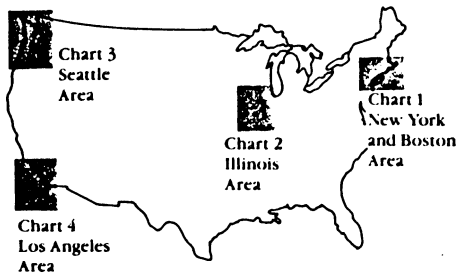
North and east coordinates are canted at -21° (counter-clockwise) to compensate for orthogonal coordinate grid overlaid on Lambert conformal conic projection.

Microsoft Flight Simulator

LOS ANGELES AREA

<i>CITY</i>	<i>AIRPORT</i>	<i>NORTH</i>	<i>EAST</i>	<i>ALT.</i>	<i>F (Fuel)</i>	<i>ILS (Rwy/Freq.)</i>
Carlsbad	McClennan-Palomar	14931	6112	328		
	Catalina (PVT)	15149	5744	1602	*	
Chino	Chino	15319	6079	650		
Compton	Compton	15334	5859	97		
Corona	Corona Muni	15280	6083	533		
El Monte	El Monte	15397	5952	296		
Fallbrook	Fallbrook Community					
	Airpark	15023	6144	708		
Hawthorne	Hawthorne Muni	15358	5831	63		
Huntington Beach	Meadowlark	15244	5911	28		
LaVerne	Brackett Fld.	15378	6038	1011		
Los Angeles	Hughes (PVT)	15386	5808	22	*	
Los Angeles	Los Angeles Intl.	15374	5805	126	*	
Oceanside	Oceanside Muni	14974	6095	28		
Ontario	Ontario Intl.	15347	6099	952		
Riverside	Riverside Muni	15288	6141	816		
San Diego	San Diego Intl.-					
	Lindbergh Fld.	14761	6102	15	*	
Santa Ana	John Wayne Airport/					
	Orange County	15211	5961	54	*	
Santa Monica	Santa Monica Muni	15402	5799	175	*	
Torrance	Torrance Muni	15308	5815	101		
Van Nuys	Van Nuys	15498	5811	799	*	16R/111.3

North and east coordinates are canted at -19° (counter-clockwise) to compensate for orthogonal coordinate grid overlaid on Lambert conformal conic projection.



Legend

Civil---Public use airport



Restricted/Private---Nonpublic
use airport, having emergency
use or landmark value



Rotating light in operation,
sunset to sunrise

NAME
CT 124.4
206

Airport name
Control Tower (CT)---Primary
frequency
Elevation in feet

NAME
ATIS 118.0

Airport name
Automatic Terminal Information
Service ---
Communication radio frequency

NFCT

Non-Federal Control Tower



VOR (VHF Omni Range)---
Civilian navigation beacon



VORTAC (VHF Omni Range
TACAN)---Civilian
and military navigation
beacon

JOLIET
112.3

VOR---Navigation radio
frequency

VOR (T)
KANKAKEE
111.6

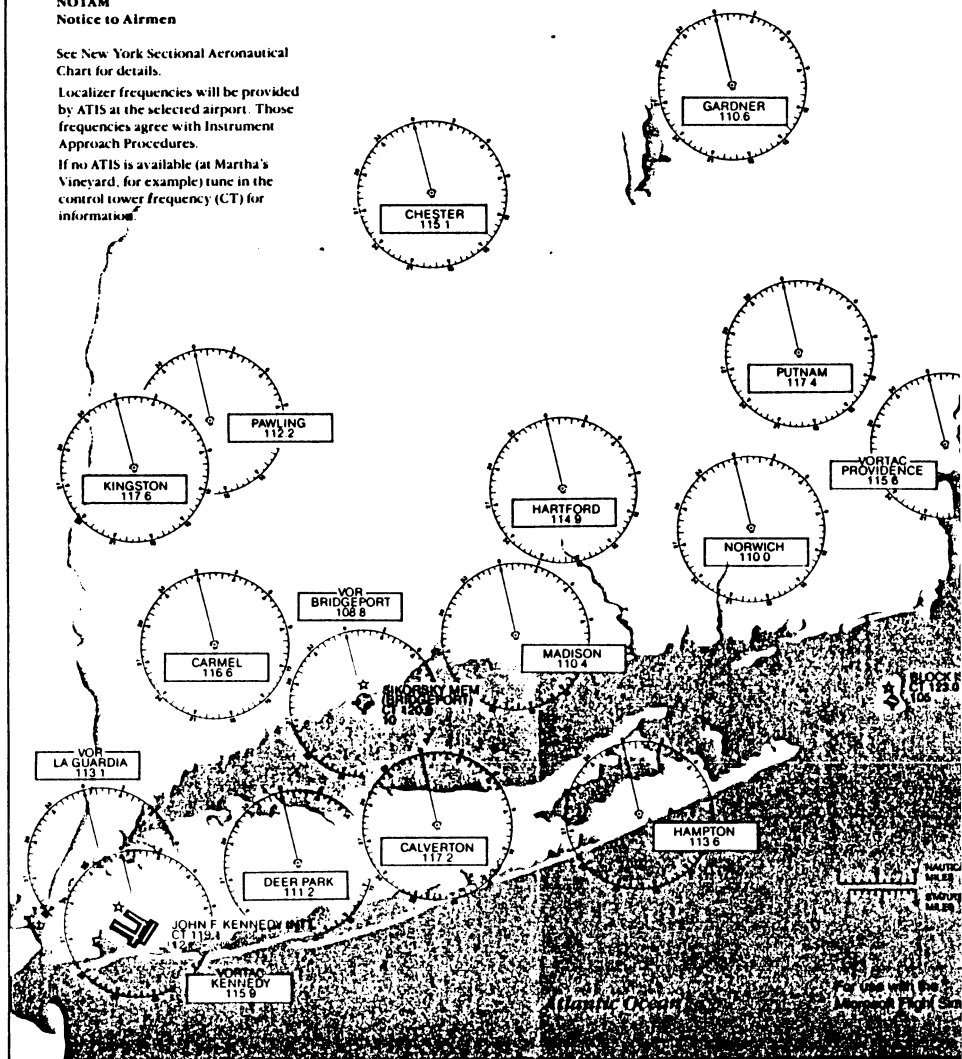
VOR (T)---Terminal VOR

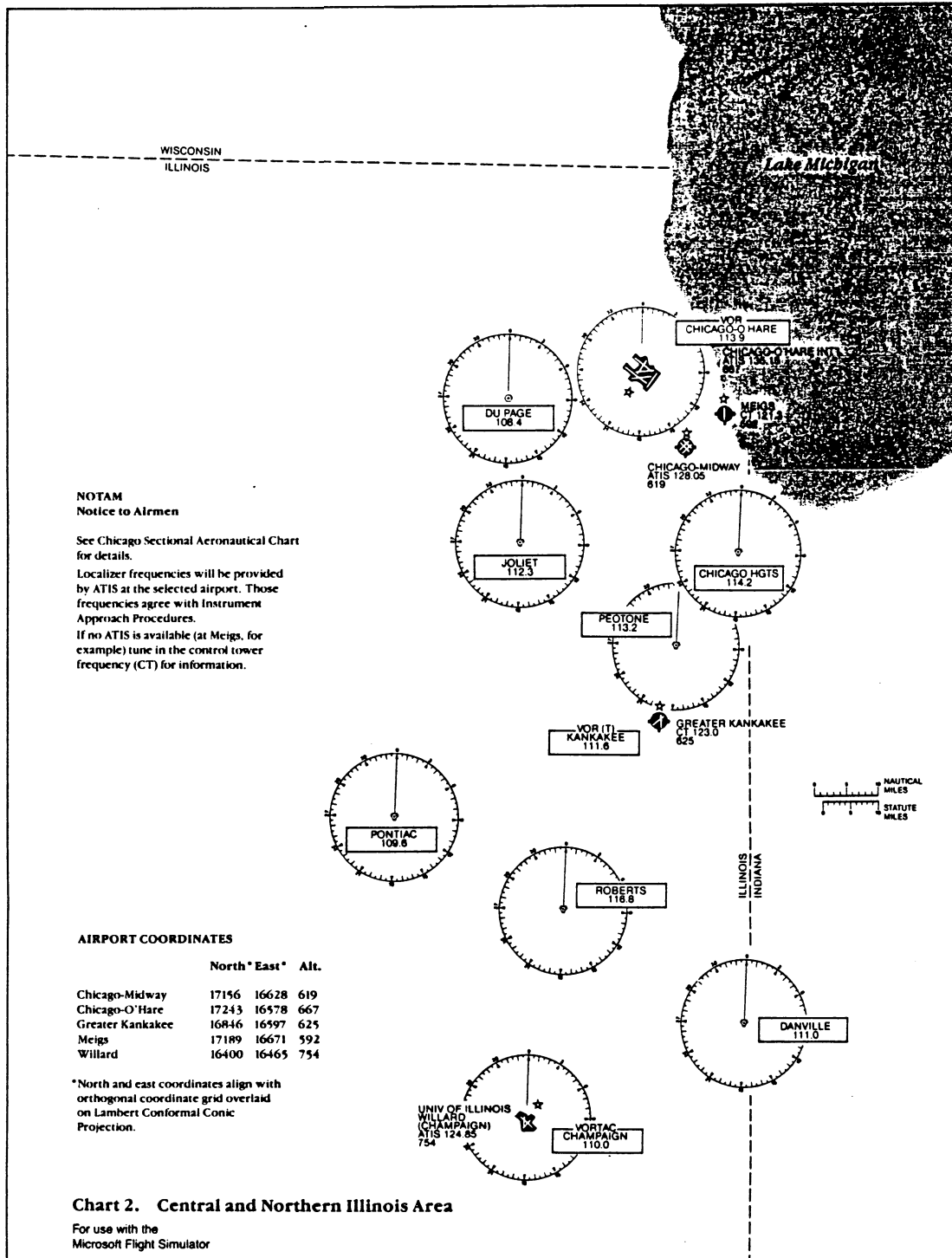
NOTAM Notice to Airmen

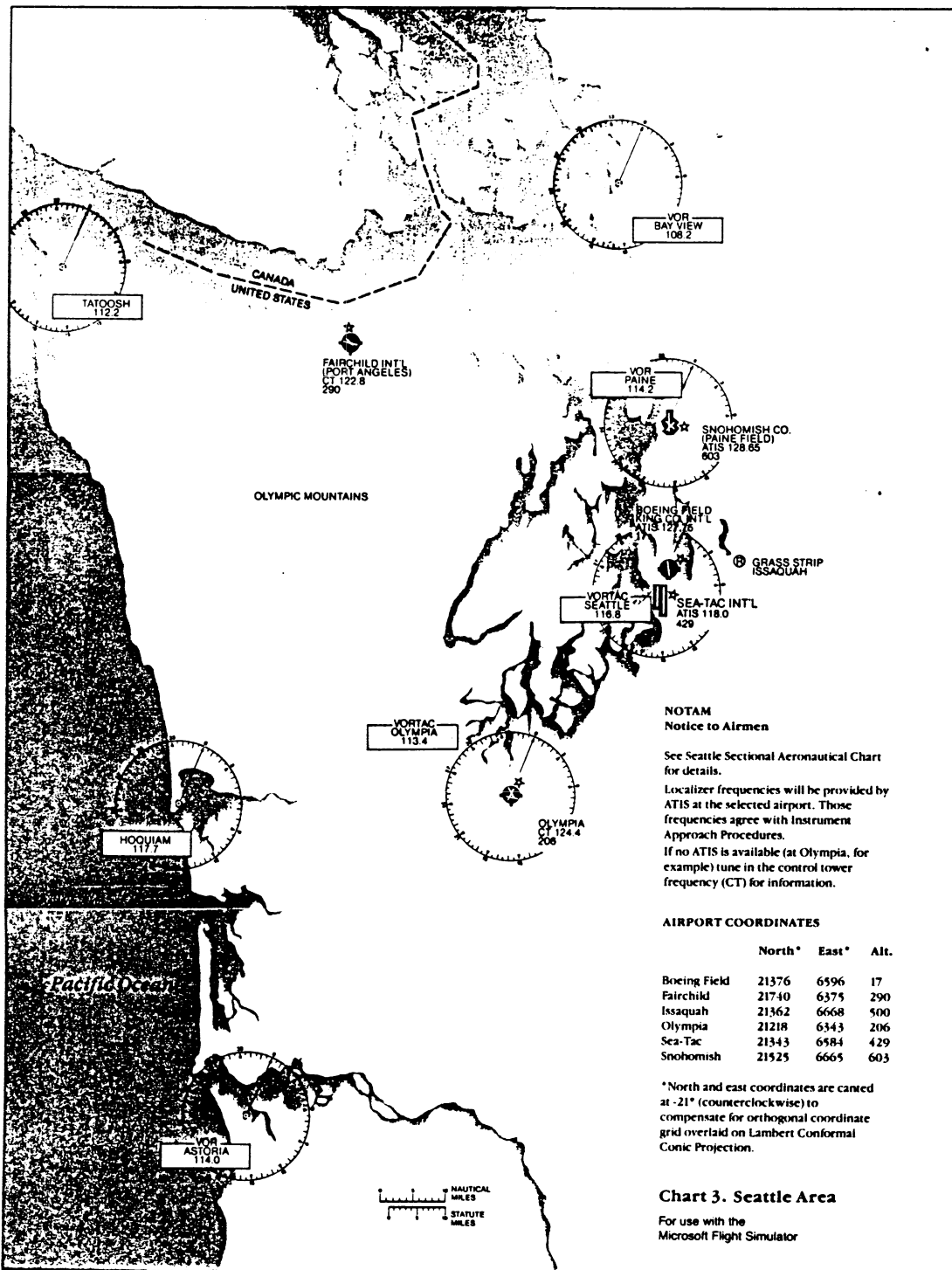
See New York Sectional Aeronautical
Chart for details.

Localizer frequencies will be provided
by ATIS at the selected airport. Those
frequencies agree with Instrument
Approach Procedures.

If no ATIS is available (at Martha's
Vineyard, for example) tune in the
control tower frequency (CT) for
information.







NOTAM
Notice to Airmen

See Seattle Sectional Aeronautical Chart for details.

Localizer frequencies will be provided by ATIS at the selected airport. Those frequencies agree with Instrument Approach Procedures.

If no ATIS is available (at Olympia, for example) tune in the control tower frequency (CT) for information.

AIRPORT COORDINATES

	North*	East*	Alt.
Boeing Field	21376	6596	17
Fairchild	21740	6375	290
Issaquah	21362	6668	500
Olympia	21218	6343	206
Sea-Tac	21343	6584	429
Snohomish	21525	6665	603

*North and east coordinates are carried at -21° (counterclockwise) to compensate for orthogonal coordinate grid overlaid on Lambert Conformal Conic Projection.

Chart 3. Seattle Area

For use with the Microsoft Flight Simulator

NOTAM
Notice to Airmen

See Los Angeles Sectional
Aeronautical Chart for details.
Localizer frequencies will be provided
by ATIS at the selected airport. Those
frequencies agree with Instrument
Approach Procedures.
If no ATIS is available (at Catalina, for
example) tune in the control tower
frequency (CT) for information.

AIRPORT COORDINATES

	North	East	Alt.
Catalina	15149	5744	1602
Hughes	15386	5808	22
John Wayne- Orange Co.	15211	5961	54
Los Angeles	15374	5805	126
San Diego	11761	6102	15
Santa Monica	15102	5799	175
Van Nuys	15498	5811	799

*North and east coordinates are cited
at -19° (counterclockwise) to com-
pensate for orthogonal coordinate grid
overlay on Lambert Conformal Conic
Projection.

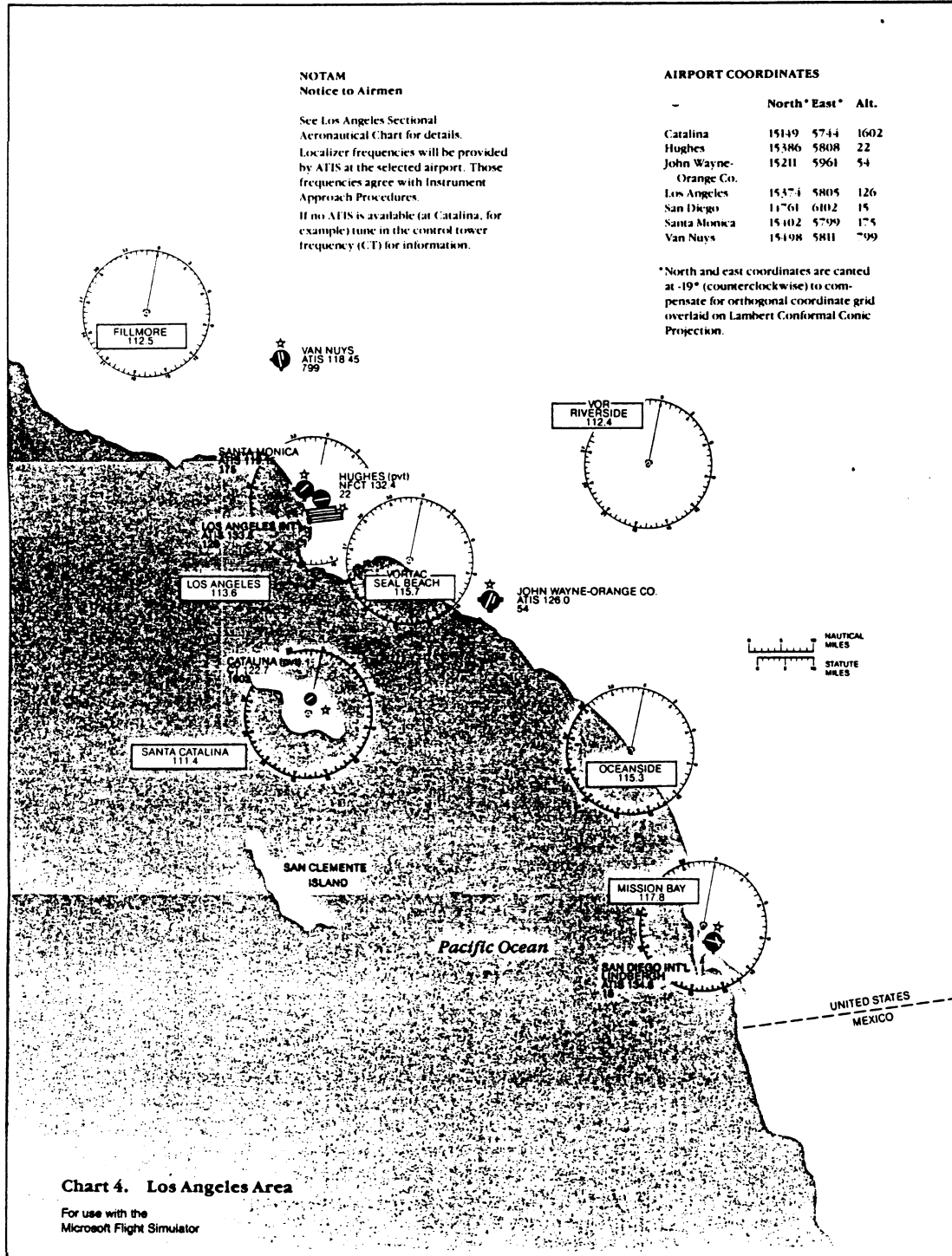
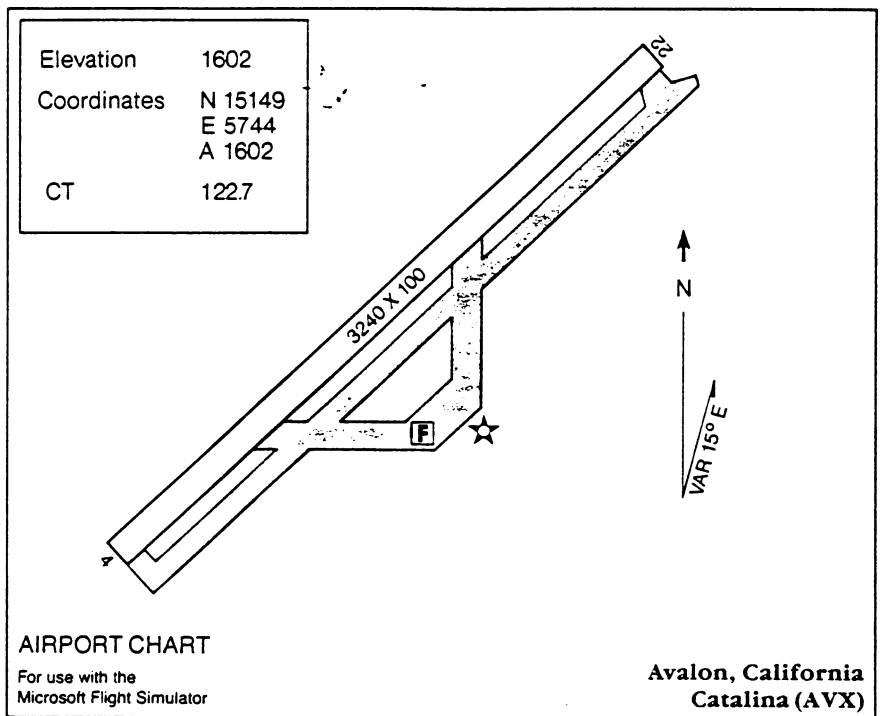


Chart 4. Los Angeles Area

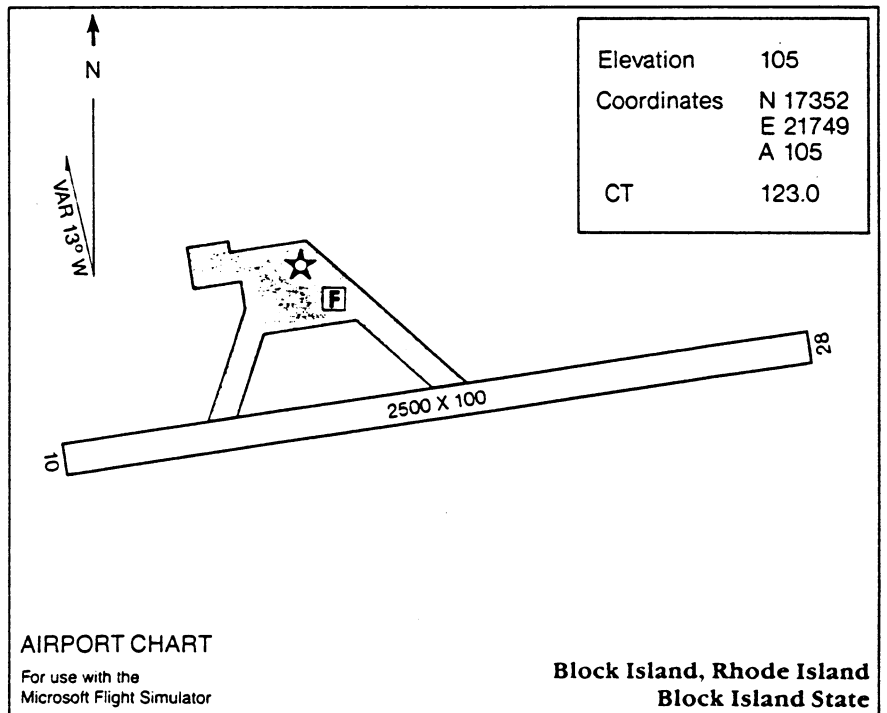
For use with the
Microsoft Flight Simulator

Flight Simulator Reference

Avalon

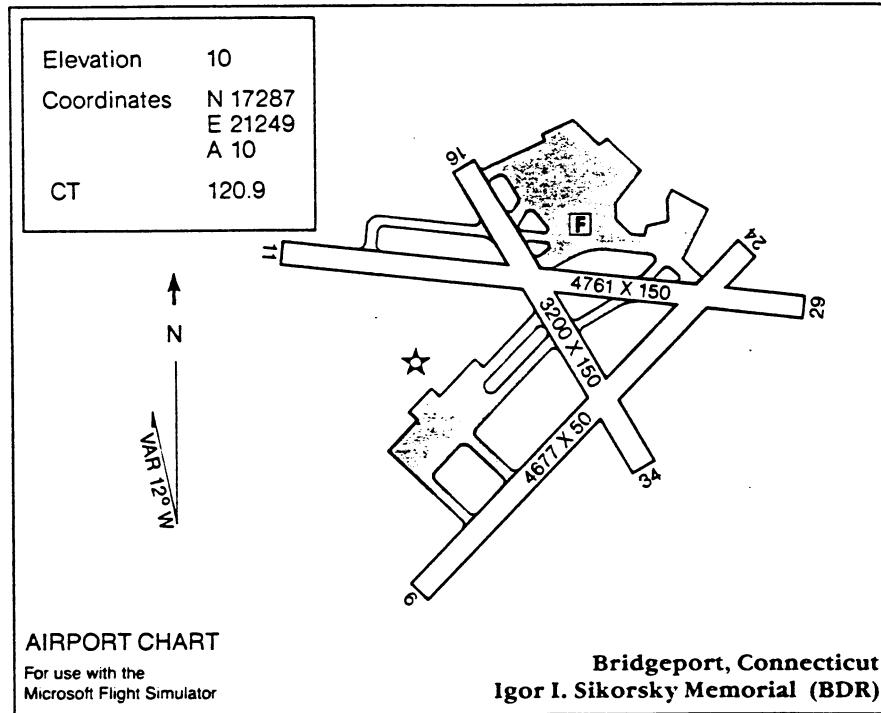


Block Island

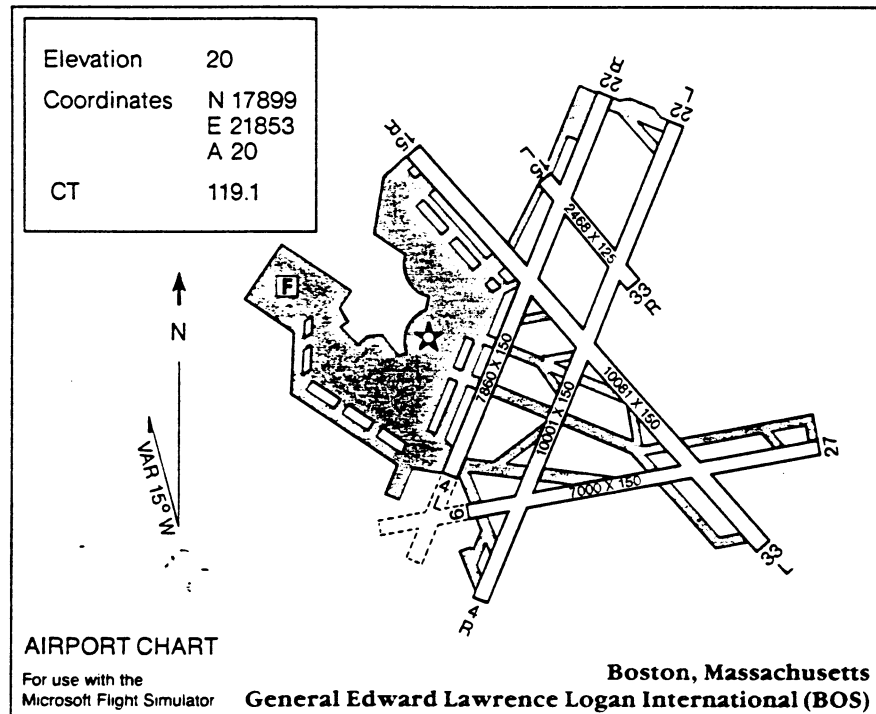


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Bridgeport

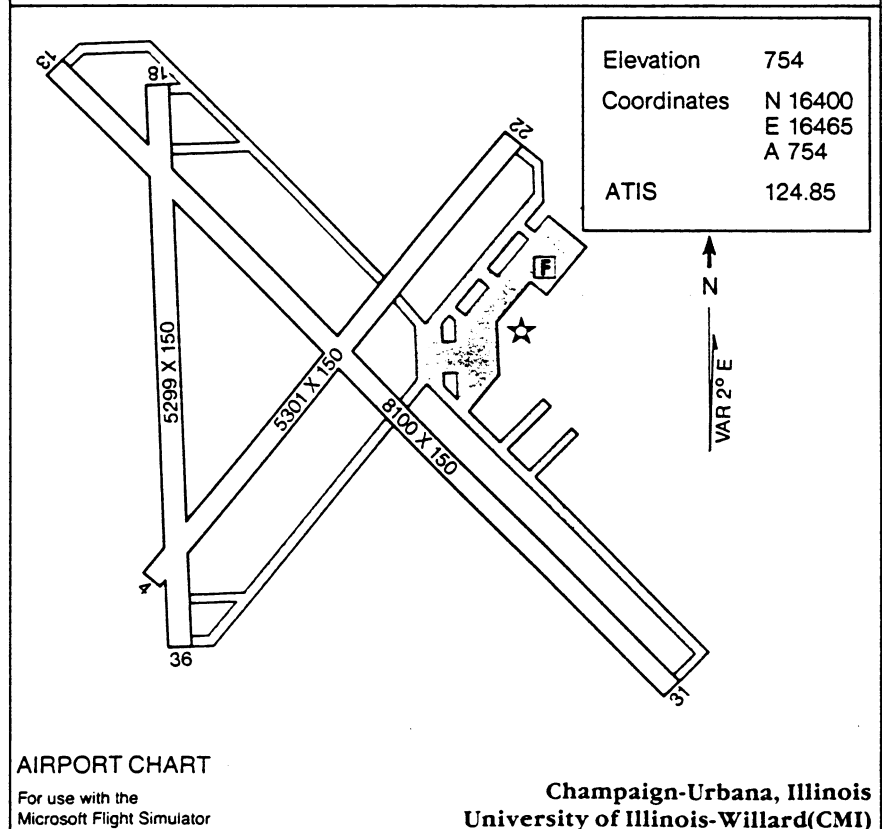
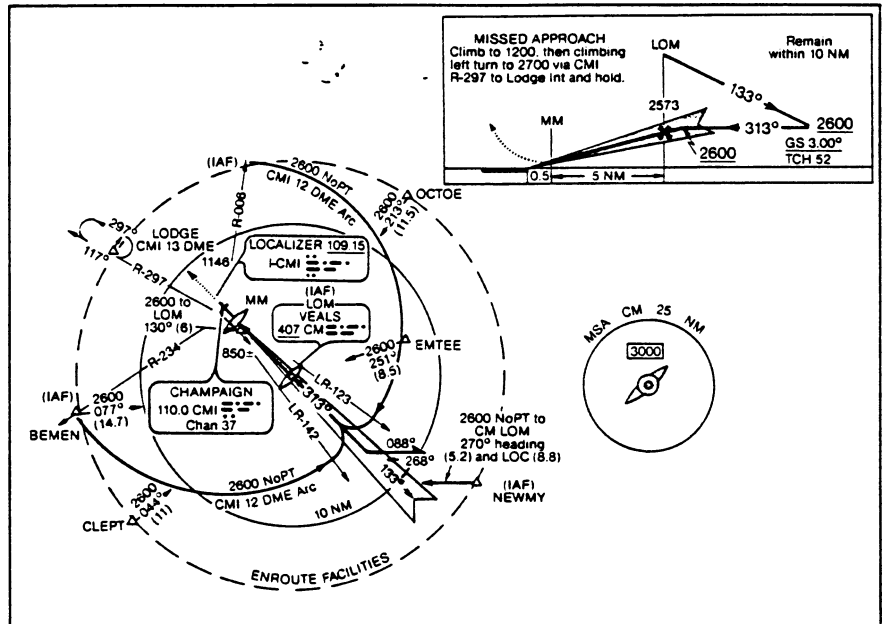


Boston



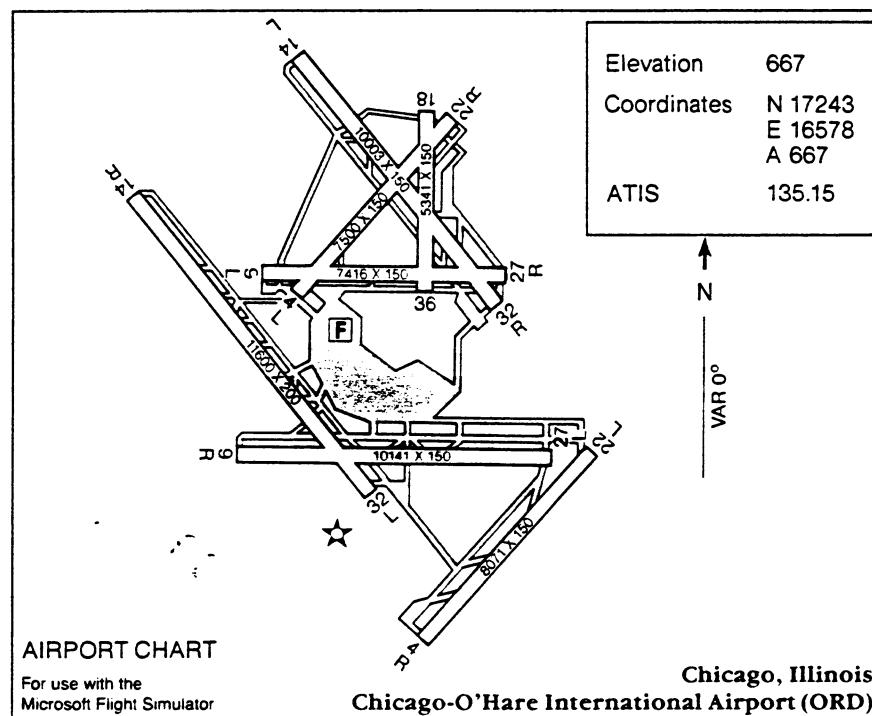
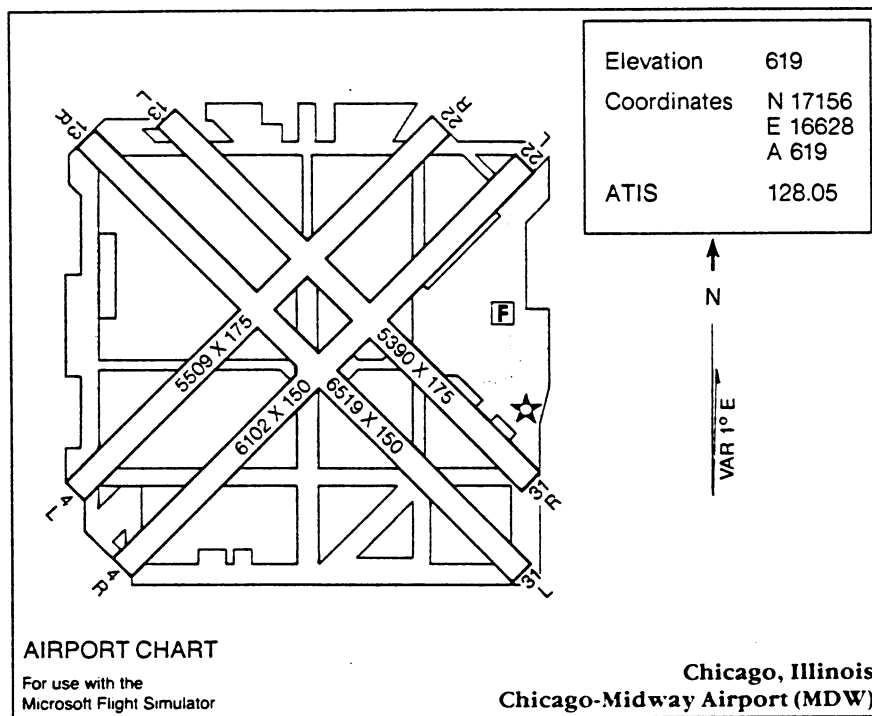
Flight Simulator Reference

Champaign-Urbana

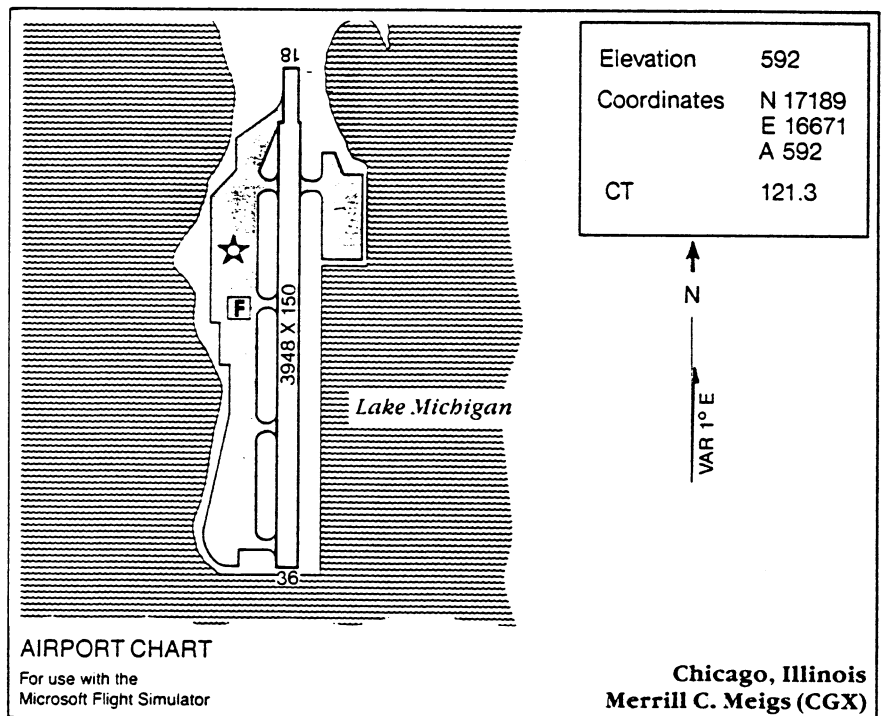


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Chicago

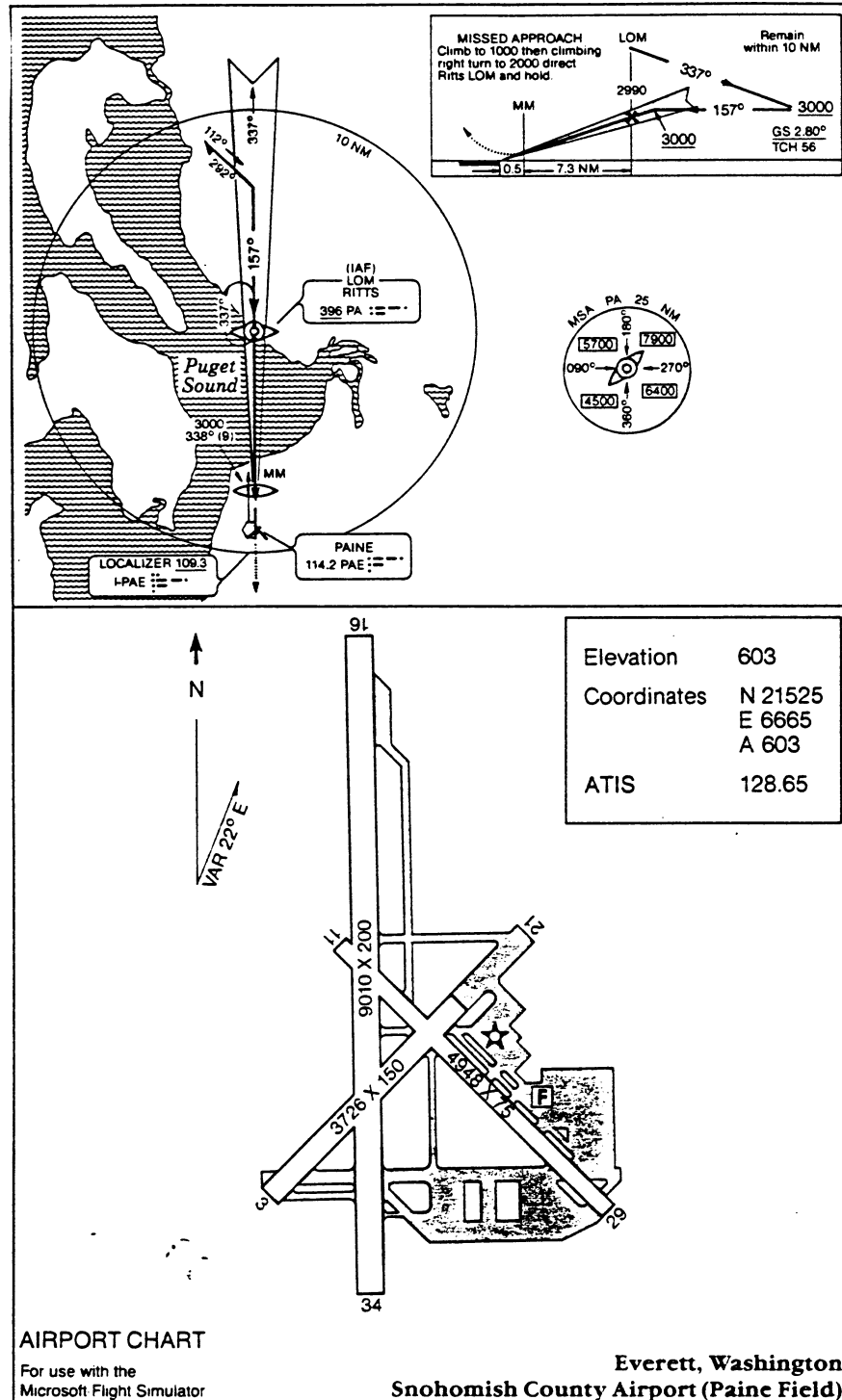


Chicago



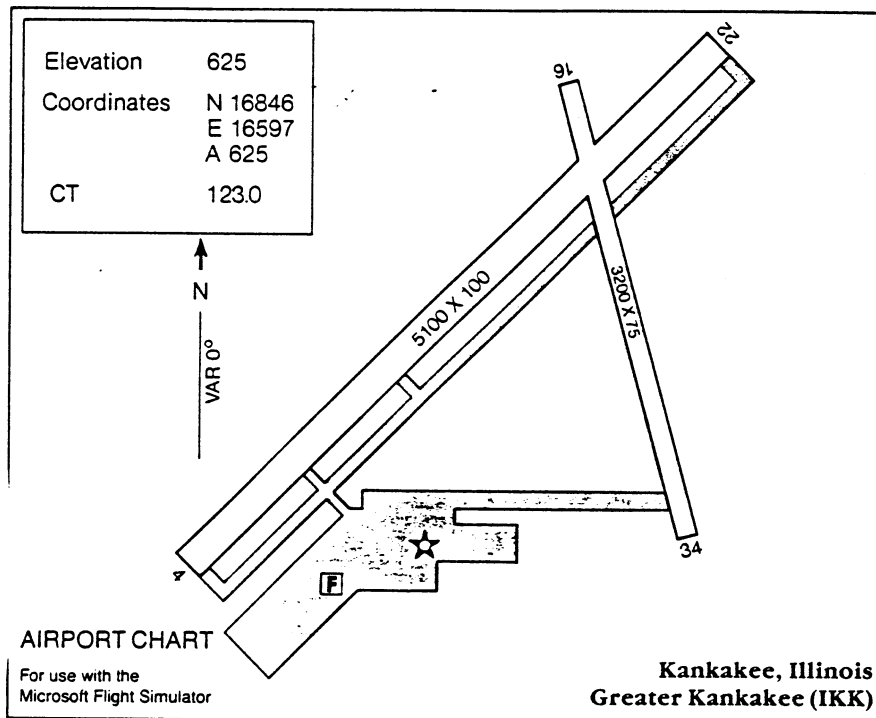
Microsoft Flight Simulator

Everett

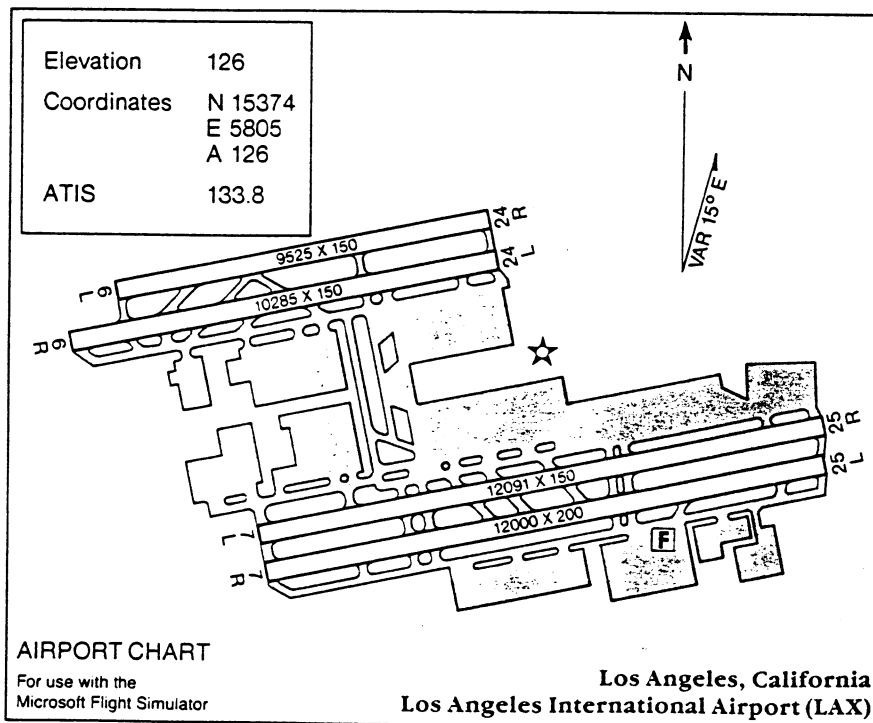


Flight Simulator Reference

Kankakee

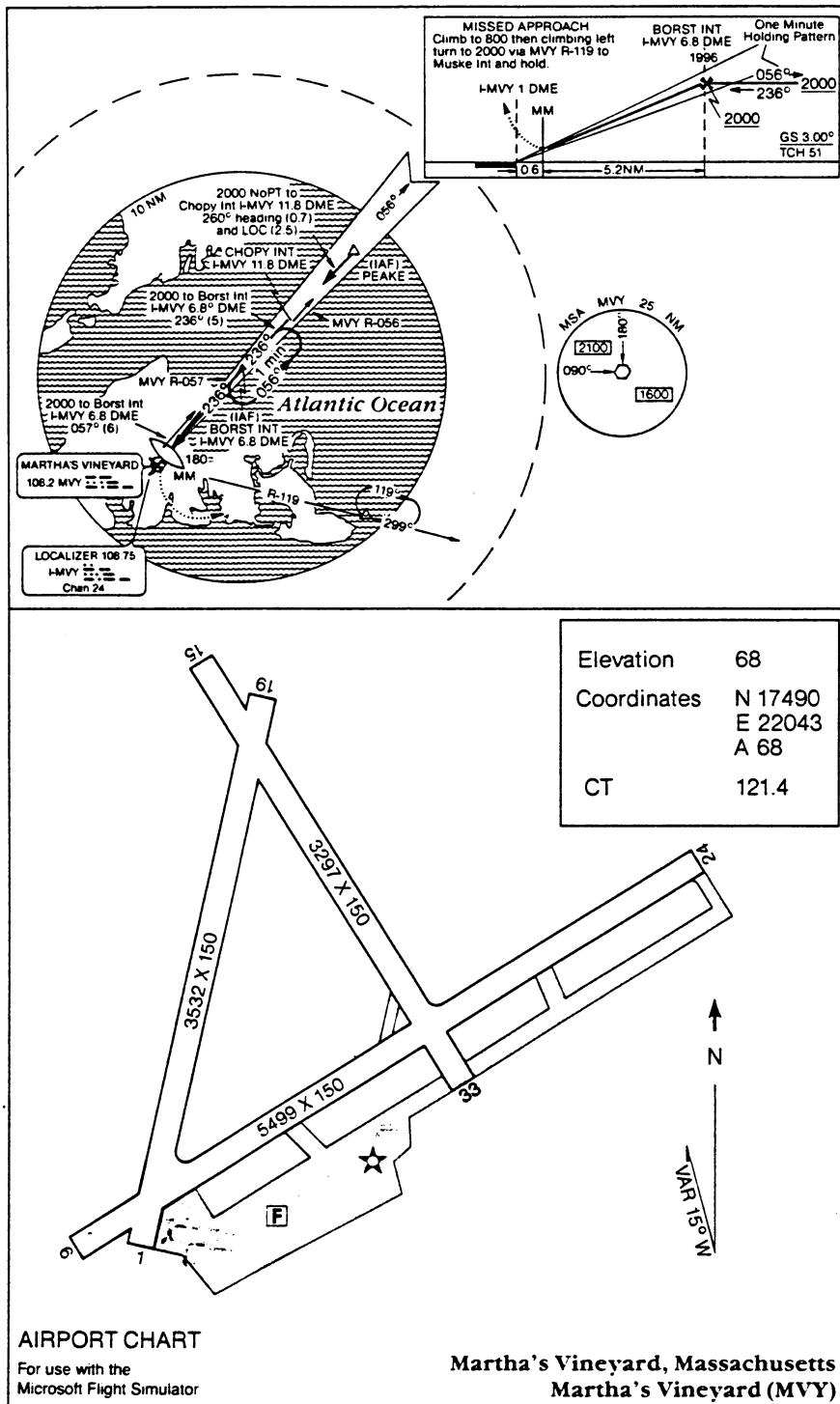


Los Angeles



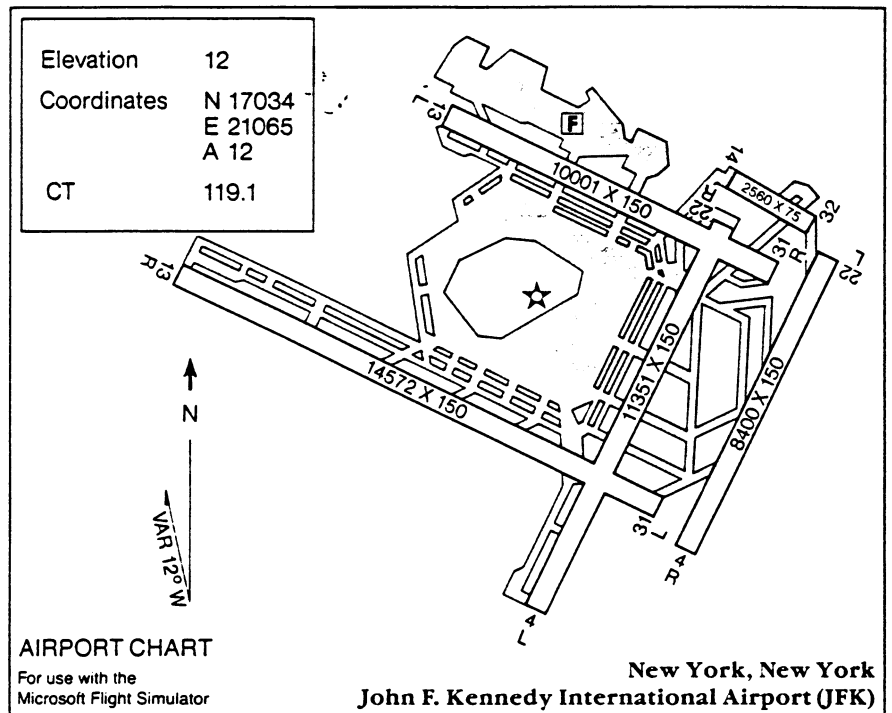
Microsoft Flight Simulator

Martha's Vineyard

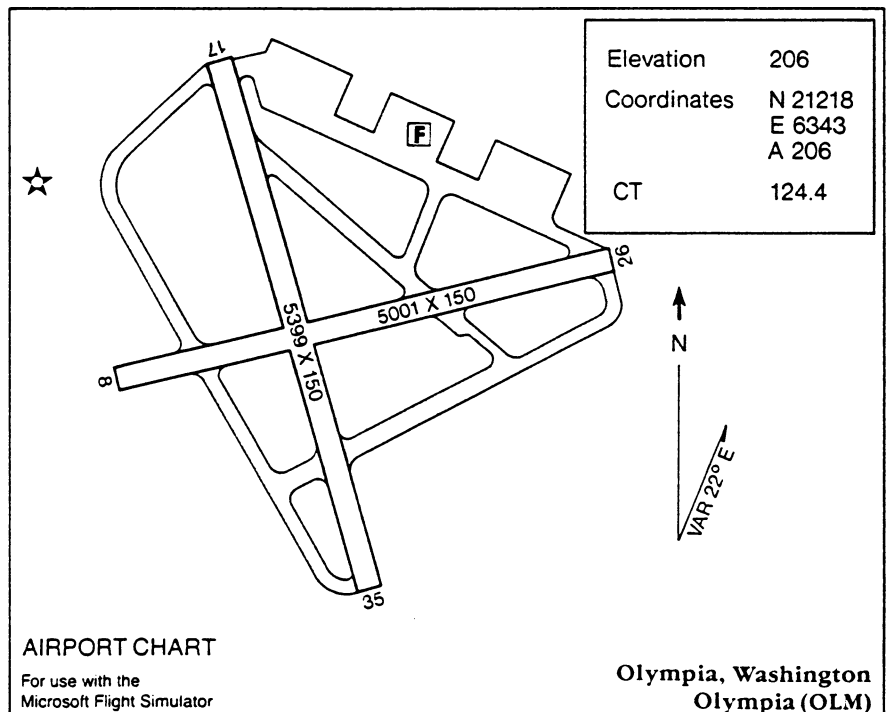


Flight Simulator Reference

New York

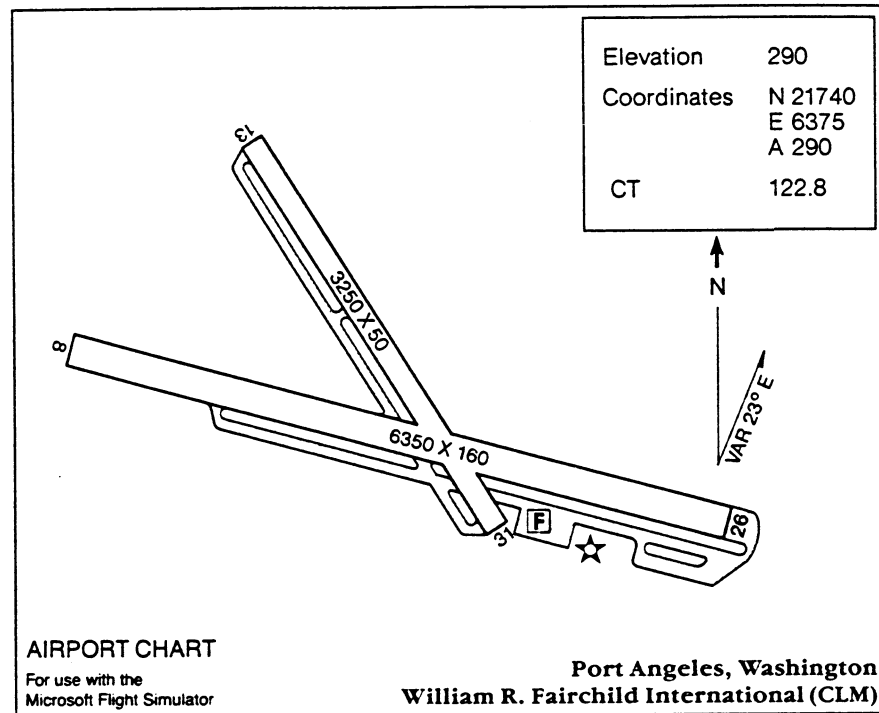


Olympia

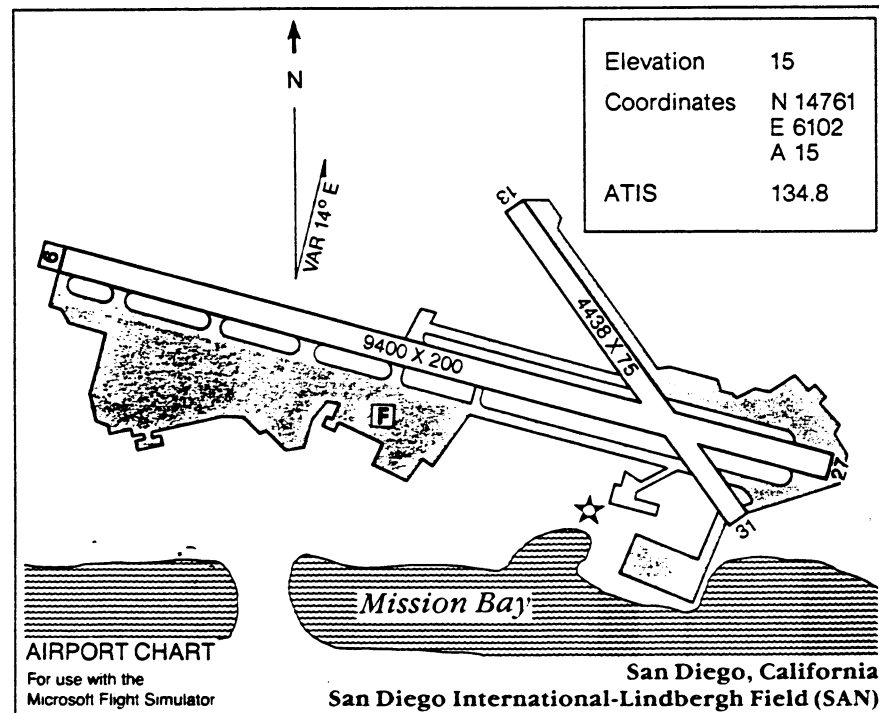


Microsoft Flight Simulator

Port Angeles

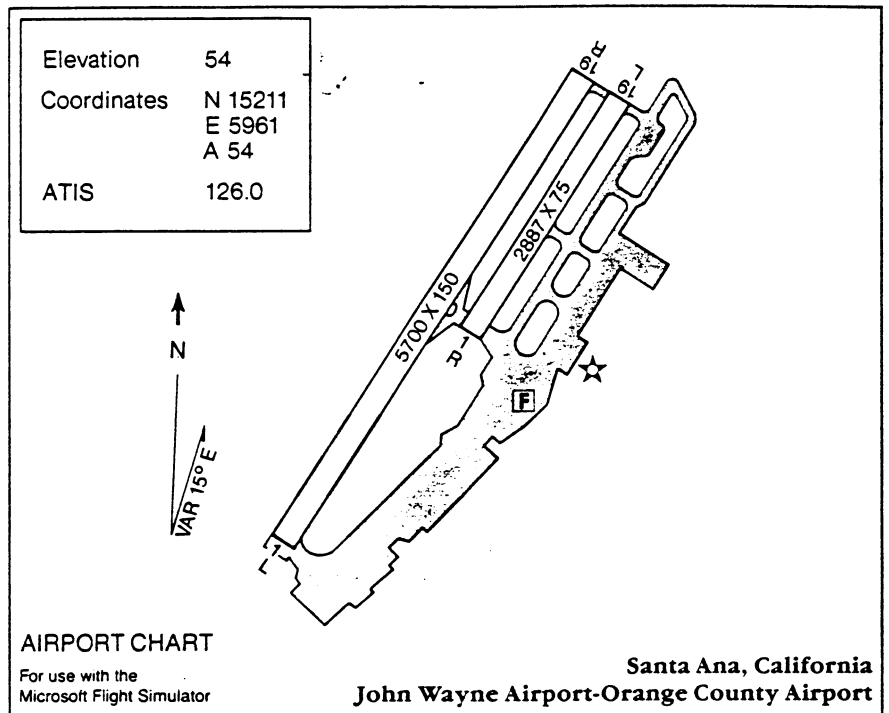


San Diego

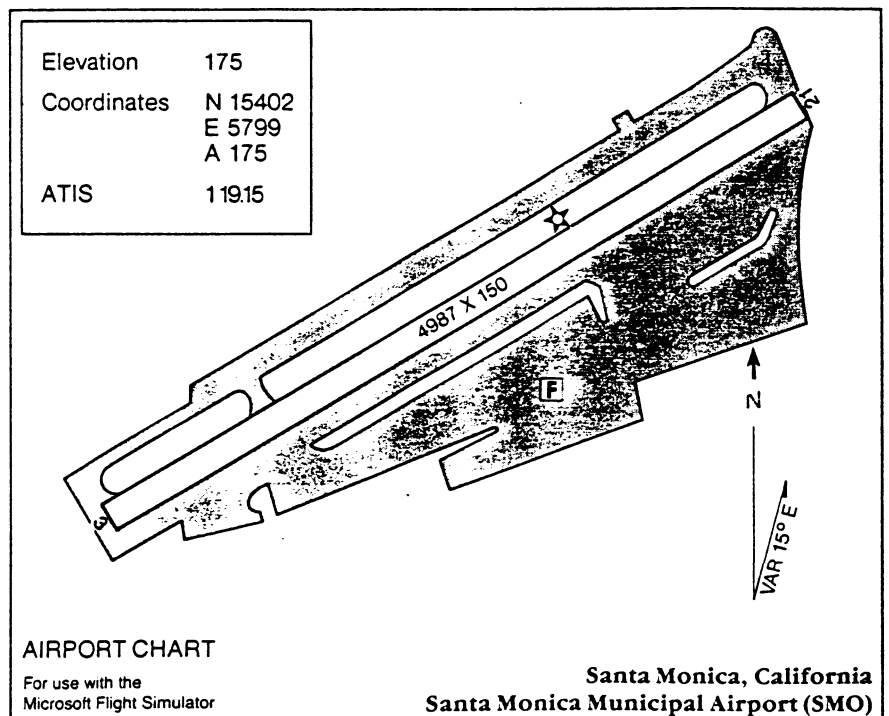


Flight Simulator Reference

Santa Ana

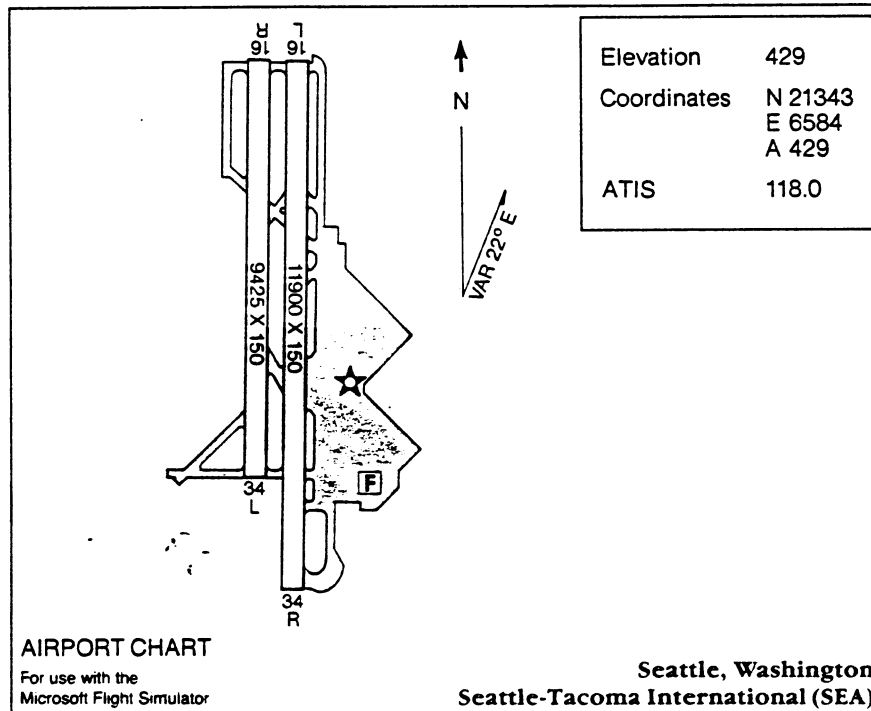
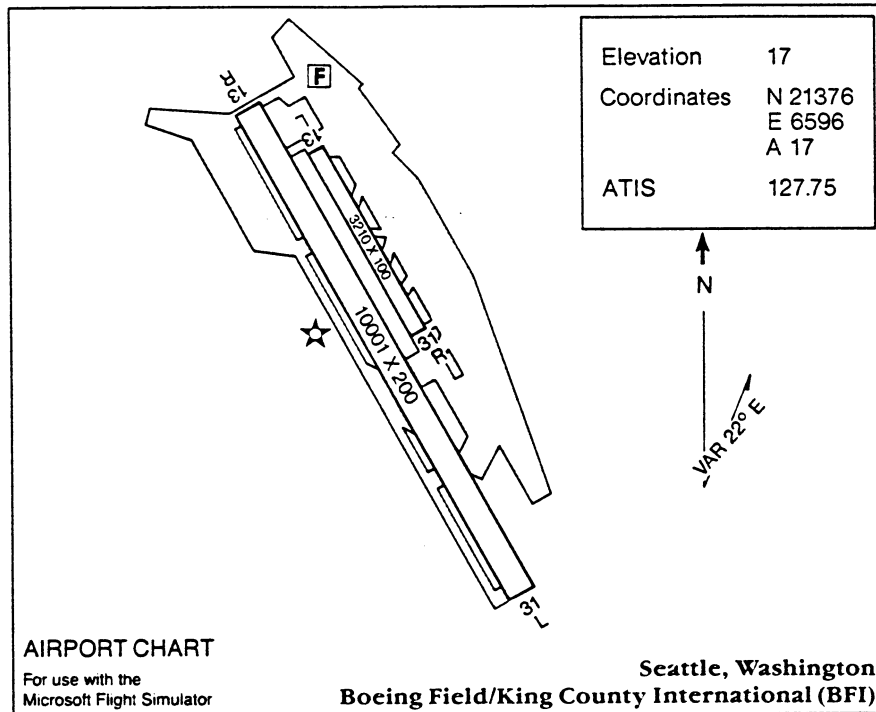


Santa Monica



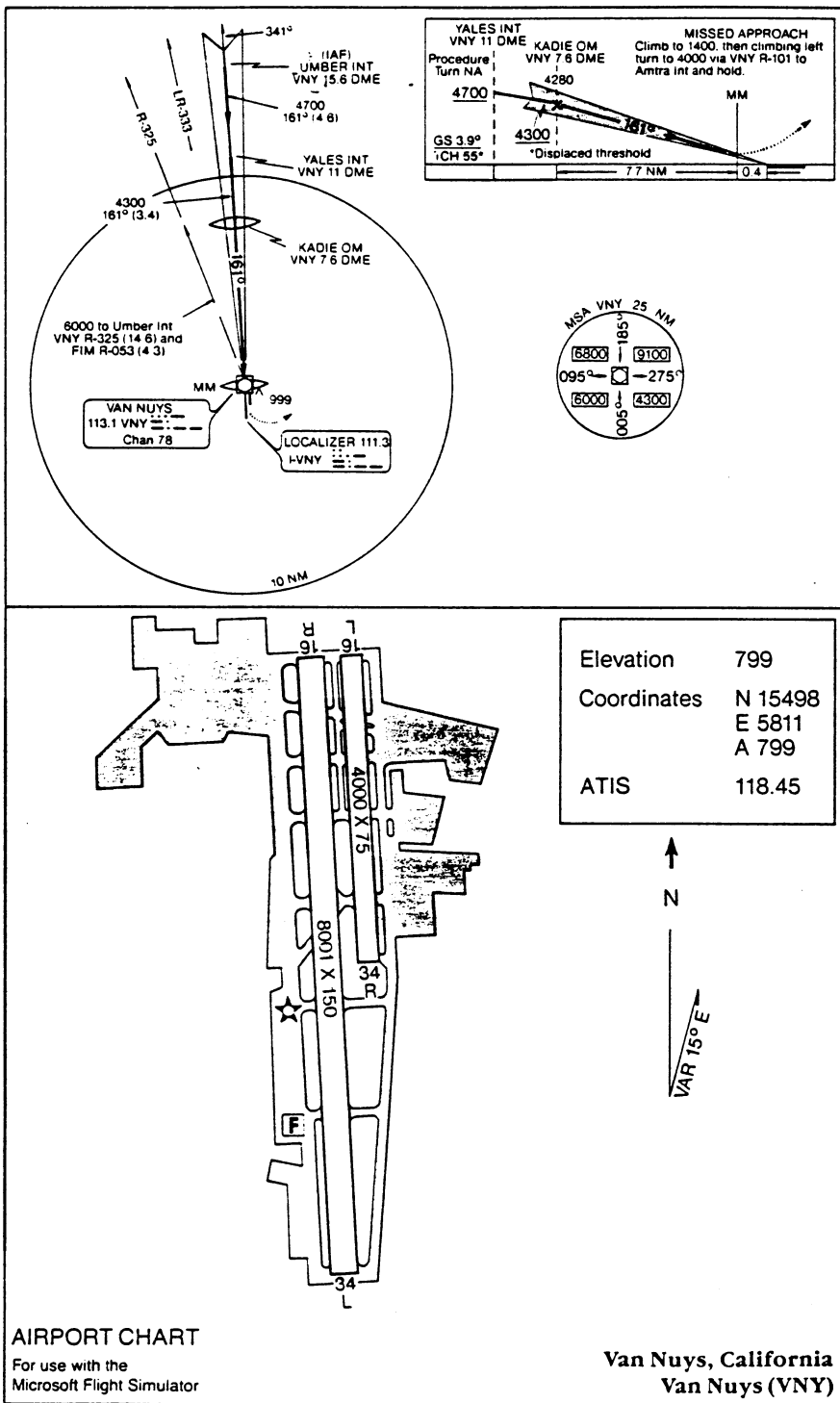
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Seattle



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Van Nuys



Appendix: Performance Specs

Flight Simulator Performance Specs

Length	28 ft.
Height	9 ft. 3 in.
Wingspan	36 ft.
Wing Area	174 sq. ft.
Maximum Takeoff Weight	3100 lb.
Empty Weight	1752 lb.
Maximum Useful Load	1360 lb.
Maximum Landing Weight	3100 lb.
Wing Loading	17.8 lb. per sq. ft.
Power Loading	13.2 lb. per hp
Maximum Usable Fuel	88 gal. (526 lb.)
Maximum Rate of Climb at Sea Level	1050 ft. per min.
Maximum Rate of Climb at 8000 ft.	455 ft. per min.
Service Ceiling	14900 ft.
Maximum Speed	146 knots
Cruise, 65% Power at 8000 ft.	133 knots
Endurance at 65% Power	7.5 hr.
Stall Speed Clean	54 knots
Stall Speed Flaps Down	49 knots
Turbulent Air Penetration Speed	110 knots
Landing Gear	Retractable tricycle, steerable nose-wheel

Glossary*

Active runway	Most large airports have more than one runway. It is usually impractical to have takeoffs and landings from more than one of them at a time (they usually cross each other so that the airport can handle planes taking off and landing under varying wind conditions). Therefore, the runway that is being used is called the "active runway."
Ailerons	The control surfaces on the outside trailing edge of the wings that control <i>roll</i> .
ATC	Air Traffic Control. The ground-based radio network consisting of Ground Control (controls taxiing to and from the <i>active runway</i>), Tower (controls the runway itself, giving permission to land and take off), Departure (controls the <i>airspace</i> immediately surrounding the airfield), Center (controls the airspace at higher altitudes), and Approach (controls those aircraft arriving into the airspace immediately surrounding the airfield).
Airfoil	A general term describing the wings, <i>vertical stabilizer</i> , <i>horizontal stabilizer</i> , etc. Engineers use the term to describe the special shape that produces lift.
Airspace	Roughly, the air around a given area. For example, the air around the United States is called "United States' airspace."
Airspeed indicator	The indicator that provides the aircraft's present indicated airspeed. See also <i>ground speed</i> and <i>true airspeed</i> .

* Terms printed in italics in the Glossary are defined elsewhere in the Glossary.

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Altimeter	The indicator that gives information on the aircraft's present altitude. Usually calibrated to give Mean Sea Level (MSL) altitude. Most altimeters are called pressure altimeters because they measure the decrease in pressure as the aircraft climbs. It is due to this fact that the altimeter must be calibrated to the local <i>atmospheric pressure</i> to compensate for local variations in the pressure which would otherwise make the readings inaccurate.
Angle of attack	The angle between the wing's <i>chord</i> line and the relative wind.
Artificial horizon	The indicator that provides an in-the-cockpit reference for the attitude of the aircraft with respect to the ground. Used to provide attitude references in circumstances where the true horizon cannot be seen (e.g., flying into a cloud).
Atmospheric pressure	The pressure exerted by the air on the earth and everything on it. This is measured in inches (or millibars) of mercury on an instrument called a barometer. Thus, the term <i>barometric pressure</i> is frequently interchanged with atmospheric pressure. Typically, the pressure is between 28 and 32 inches of mercury at sea level.
Auto-coordinated	The term which describes the interconnection between the <i>rudder</i> and <i>ailerons</i> that automatically moves one as the pilot moves the other, resulting in properly coordinated turns (no <i>slips</i> or <i>skids</i>).
ATIS	Automatic Terminal Information Service. A continuous-loop recording played over a specified frequency giving weather and other important information on a given airfield. Usually updated once an hour. It is referred to by air traffic controllers by the <i>phonetic alphabet</i> .
Bank	See <i>roll</i> .
Barometric pressure	See <i>atmospheric pressure</i> .
Bleed off	The process where a given parameter (such as airspeed or altitude) is slowly decreased in a carefully controlled manner.

Canted gyroscope	A gyroscope within a flight instrument (usually the turn coordinator) with a rotational axis that is tilted or canted with relation to the aircraft's <i>longitudinal axis</i> . The tilted axis causes the gyro to respond to <i>rolling</i> or <i>yawing</i> motion.
Ceiling	The altitude of the base of the cloud cover.
Chord	The measurement of the wing taken from the leading edge to the trailing edge.
COM	Short for communications. Usually taken to mean the communications radio.
COM-NAV or NAV-COM	A radio that combines the functions of a communications radio with those of a navigational radio.
Control yoke	The control wheel and connections that control the <i>ailerons</i> and <i>elevator</i> . The ailerons are controlled by turning a "steering wheel," and the elevator is controlled by pushing the wheel toward or away from you.
Correction card	A card mounted near a magnetic compass that lists amounts of deviation to be expected between <i>magnetic</i> and indicated <i>headings</i> .
Density altitude	The altitude in the standard atmosphere (surface temperature 59° F and pressure 29.92 inches at sea level) where air has the same density as the air at the altitude being considered.
Dihedral	The angle (if any) that the wings are tilted upward. Upward dihedral, which forms a slight "V" shape as you look at an aircraft's front view, increases stability and tends to automatically level a plane after a turn.
Directional gyro	See <i>heading indicator</i> .
Distance Measuring Equipment (DME)	A radio that determines and displays distance from a VOR in nautical miles.
Drag	Those forces that oppose the movement of an aircraft through the air.

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Elevators

The control surfaces on the trailing edge of the *horizontal stabilizer* that control the aircraft's *pitch*. When the elevators are down (the yoke is pushed forward), the stabilizer is pushed up by the air. This forces the nose down and causes the aircraft to dive. The opposite is true for climbs.

FAA

The Federal Aviation Administration. The agency (under the direction of the Department of Transportation) charged with maintaining safe and efficient use of the nation's *airspace* by military and civil aviators, for fostering civil aeronautics and air commerce in the U.S. and abroad, and for supporting the requirements of national defense.

Flaps

Movable *airfoil* sections, located on the trailing edge of the wings, that are lowered on takeoff and landing to increase the wings' lift and *drag*.

Flare

The last segment of a landing approach. It is the act of leveling off a foot or two above the runway prior to landing by raising the nose of the aircraft just prior to touchdown.

Glideslope

A navigation aid used on ILS approaches in the terminal area electronic navigation system that provides vertical guidance to aircraft as they approach the runway for landing.

Ground speed

The aircraft's actual speed relative to the ground. For example, if an aircraft is flying at 120 knots *true airspeed* and has a 15-knot headwind, its ground speed is 105 knots.

Heading

The direction that the aircraft is pointed. This is not necessarily the direction the plane is traveling. It is usually referred to as a magnetic heading, but "degrees" is typically omitted by experienced pilots ("My heading is 324").

Heading indicator (directional gyro)

A gyroscopically controlled compass that is designed to give *heading* information based on the forces acting upon a gyroscope, rather than any actual *magnetic* reading. It is used to provide a more accurate readout of heading without having to deal with magnetic compass lag and "settling time" after turns and climbs.

Horizontal stabilizer	The surface that is used to provide stabilization along the aircraft's lateral axis (helps to control <i>pitch</i>). Usually thought of as part of the airplane's "tail."
Instrument Flight Rules (IFR)	The "rules of the road" that cover flight in <i>Instrument Meteorological Conditions (IMC)</i> .
Instrument Landing System (ILS)	A system of radio transmitters and receivers and special flight rules that provide a three-dimensional in-the-cockpit reference for landing. The radio signals consist of a localizer, which is very similar to a <i>VOR</i> , except that it only transmits a single very directional signal that will lead you to a specific runway at an airport on the correct <i>heading</i> ; the <i>glideslope</i> , which does much the same, except that it does so in the vertical, thereby assuring that touchdown will be on the runway, and not before or after; outer, middle, and inner marker beacons that indicate distance from the runway; and approach lights. The instruments used are the glideslope needle and the localizer needle. These instruments are part of the <i>Omni-Bearing Indicator</i> .
Instrument Meteorological Conditions (IMC)	The weather conditions that force flight under <i>Instrument Flight Rules</i> .
Isogonic lines	Lines of equal <i>magnetic variation</i> of true north from magnetic north due to the different locations of the true and magnetic poles of the earth.
Knots	Nautical miles per hour. A "nautical mile" is described as 1 minute of longitude at the equator, or 1.15 "statute miles." To convert from knots to statute miles per hour, multiply knots by 1.1507. To convert the other way, multiply statute mph times .869.
Landing gear	The wheels, struts, etc. that the aircraft uses to land and maneuver on the ground. Landing gear typically come in one of two variations: "tail dragger," in which the aircraft seems to sit on its tail; and "tricycle," in which the plane sits level with the ground with one nose-wheel and two wheels farther back on the plane. The main landing gear are those nearest the aircraft's center of gravity, and almost always come in pairs (left and right main gear). They are designed to take more landing shock than the more fragile nose-wheel or tail-wheel.

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Longitudinal axis	The imaginary axis running from front to rear through an aircraft's center of gravity and approximately parallel to the thrust line (the propeller's axis).
Magnetic	Refers to the reading on a magnetic compass.
Magnetic variation	The variation angle between "true north" and "magnetic north." This varies from location to location and must be taken into account for long-range navigation.
Magneto	A device that combines the functions of an automobile engine's coil and distributor. It takes energy from the aircraft engine in the form of rotational energy and, by use of magnetics and induced electricity, creates the high voltages required for the spark plugs.
Manually coordinated	The mode of flight in which the pilot coordinates the <i>ailerons</i> and <i>rudder</i> (see <i>auto-coordinated</i>).
NAV	Short for Navigational. Usually taken to mean the navigational radio.
Omni-Bearing Indicator (OBI)	The indicator that provides information about the aircraft's position relative to the presently tuned <i>VOR</i> station. Usually provides the ability to "dial in" or select a given course or radial, a TO-FROM indicator, and a Course Deviation Indicator (CDI). On aircraft with <i>ILS</i> capabilities, a Glideslope Deviation Indicator (GDI) is also incorporated in this instrument. There is no official name for this instrument. It is sometimes referred to as the Omni-Bearing Selector (OBS) or VOR receiver and indicator.

Phonetic alphabet

A special way of saying letters and numbers that makes them less likely to be misunderstood when they are transmitted over radios.

A	ALPHA	N	NOVEMBER	1	WUN
B	BRAVO	O	OSCAR	2	TOO
C	CHARLEY	P	PAPA	3	TREE
D	DELTA	Q	QUEBEC	4	FLOWER
E	ECHO	R	ROMEO	5	FIVE
F	FOXTROT	S	SIERRA	6	SIX
G	GOLF	T	TANGO	7	SEVEN
H	HOTEL	U	UNIFORM	8	EIGHT
I	INDIA	V	VICTOR	9	NINER
J	JULIET	W	WHISKEY	0	ZEEROH
K	KILO	X	XRAY		
L	LIMA	Y	YANKEE		
M	MIKE	Z	ZULU		

In addition, numbers are usually spoken as individual digits. For example, 123 would be read as "wun too tree."

Pitch

The movement of the aircraft about its lateral axis (nose up or nose down). If the nose is pointed down, we say it is "pitched forward," and when it is pointed up, we say it is "pitched backwards."

Power glide

A long, shallow approach in which engine power is used to maintain the glide. Power glides should be avoided when they are not required to maintain *IFR* approach angles because engine failure can cause you to land short of the runway.

Radio stack

The area where the *COM*, *NAV*, and *transponder* radios are installed in the instrument panel. They are usually installed "on top of one another" as though they were stacked.

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Rate of climb	The rate (measured in feet per minute) at which an aircraft is climbing. The term is also loosely stretched to include the rate of descent. The rate of climb is read on the <i>rate of climb indicator</i> . If an aircraft is at 1000 feet and is climbing at 500 feet per minute, then in 1 minute it will be at 1500 feet.
Rate of climb indicator	The indicator that gives information on the rate of increase and decrease of an aircraft's altitude. Also known as a "Vertical Speed Indicator" (VSI) or "Vertical Velocity Indicator" (VVI).
Roll	Those actions taking place about the aircraft's <i>longitudinal</i> (or roll) <i>axis</i> .
Rudder	The control surface, mounted on the trailing edge of the <i>vertical stabilizer</i> (the tail), that controls <i>yaw</i> .
Running lights	The anti-collision light system that is required by the <i>FAA</i> on an aircraft in flight. The system includes flashing or rotating beacon position lights (a red light on the left wingtip, a green on the right, and a white on the tail). These tell another aircraft which direction an aircraft is flying when only the lights can be seen.
Skid	An aircraft's sideways sliding away from the center of the curve while in a turn.
Slip	An aircraft's sideways motion while turning.
Standardized instrument cluster	An industry-accepted de facto standard for the placement of the six most commonly used flight instruments. The top row includes (from left to right): the <i>airspeed indicator</i> , attitude indicator, and <i>altimeter</i> . The bottom row includes (from left to right): the turn coordinator (or needle/ball), <i>heading indicator</i> , and <i>rate of climb indicator</i> .
Tachometer	The instrument that gives information concerning the speed of rotation of the engine. It is marked in rotations per minute (RPM).
Taxi	The action of moving the aircraft on the ground.
Throttle	The control that determines the speed of the engine.

Transponder	An airborne radio beacon transceiver that receives interrogation signals from <i>ATC</i> and selectively replies with a preset identification code (a “squawk code”) set by the pilot. The squawk code is received by <i>ATC</i> and identifies and appears next to the aircraft on <i>ATC</i> radar.
Trim	The smaller control surfaces that affect the <i>elevators</i> in such a way as to make it less necessary to continually hold force on the yoke to maintain straight and level flight. Large aircraft also have <i>aileron</i> and <i>rudder</i> trim.
True airspeed	The actual speed of an aircraft through the air after compensating for <i>density altitude</i> .
Vertical stabilizer	The surface of the aircraft that is used to help control motion about the aircraft’s vertical or <i>yaw</i> axis.
VOR	Short for Very high frequency Omnidirectional Range. This is a ground-based radio transmitter that provides positive guidance on pilot-selected <i>magnetic</i> course “radials” or straight lines. It is used in conjunction with the <i>NAV</i> radio and the VOR indicator. See the text for a discussion of its use.
Visual Flight Rules (VFR)	The “rules of the road” that cover flight in those conditions wherein flight can be safely controlled by “looking out the window.”
Yaw	The rotation about the aircraft’s vertical or yaw axis.

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