Introduction

Attitude instrument flying is defined as the control of an aircraft’s spatial position by using instruments rather than outside visual references. As noted in Section I, today’s aircraft come equipped with analog and/or digital instruments. Section II acquaints the pilot with the use of digital instruments known as an electronic flight display (EFD).

The improvements in avionics coupled with the introduction of EFDs to general aviation aircraft offer today’s pilot an unprecedented array of accurate instrumentation to use in the support of instrument flying.
Until recently, most general aviation aircraft were equipped with individual instruments utilized collectively to safely maneuver the aircraft by instrument reference alone. With the release of the electronic flight display system, the conventional instruments have been replaced by multiple liquid crystal display (LCD) screens. The first screen is installed in front of the left seat pilot position and is referred to as the primary flight display (PFD). [Figure 4-21] The second screen is positioned in approximately the center of the instrument panel and is referred to as the multi-function display (MFD). [Figure 4-22] The pilot can use the MFD to display navigation information (moving maps), aircraft systems information (engine monitoring), or should the need arise, a PFD. [Figure 4-23] With just these two screens, aircraft designers have been able to de-clutter instrument panels while increasing safety. This has been accomplished through the utilization of solid-state instruments which have a failure rate far lower than those of conventional analog instrumentation.

However, in the event of electrical failure, the pilot still has emergency instruments as a backup. These instruments either do not require electrical power, or as in the case of many attitude indicators, they are battery equipped. [Figure 4-24]

Pilots flying under visual flight rules (VFR) maneuver their aircraft by reference to the natural horizon, utilizing specific reference points on the aircraft. In order to operate the aircraft in other than VFR weather, with no visual reference to the natural horizon, pilots need to develop additional skills. These skills come from the ability to maneuver the aircraft by reference to flight instruments alone. These flight instruments replicate all the same key elements that a VFR pilot utilizes during a normal flight. The natural horizon is replicated on the attitude indicator by the artificial horizon.

Understanding how each flight instrument operates and what role it plays in controlling the attitude of the aircraft is fundamental in learning attitude instrument flying. When the pilot understands how all the instruments are used in establishing and maintaining a desired aircraft attitude, the pilot is better prepared to control the aircraft should one or more key instruments fail or if the pilot should enter instrument flight conditions.

**Learning Methods**

There are two basic methods utilized for learning attitude instrument flying. They are “control and performance” and “primary and supporting.” These methods rely on the same flight instruments and require the pilot to make the same adjustments to the flight and power controls to control aircraft attitude. The main difference between the two methods is the importance that is placed on the attitude indicator and the interpretation of the other flight instruments.
Figure 4-22. Multifunction Display (MFD).

Figure 4-23. Reversionary Displays.
Control and Performance Method

Aircraft performance is accomplished by controlling the aircraft attitude and power output. Aircraft attitude is the relationship of its longitudinal and lateral axes to the Earth’s horizon. When flying in instrument flight conditions, the pilot controls the attitude of the aircraft by referencing the flight instruments and manipulating the power output of the engine to achieve the performance desired. This method can be used to achieve a specific performance level enabling a pilot to perform any basic instrument maneuver.

The instrumentation can be broken up into three different categories: control, performance, and navigation.

Control Instruments

The control instruments depict immediate attitude and power changes. The instrument for attitude display is the attitude indicator. Power changes are directly reflected on the manifold pressure gauge and the tachometer. [Figure 4-25] All three of these instruments can reflect small adjustments, allowing for precise control of aircraft attitude.
In addition, the configuration of the power indicators installed in each aircraft may vary to include the following types of power indicators: tachometers, manifold pressure indicator, engine pressure ratio indicator, fuel flow gauges, etc.

The control instruments do not indicate how fast the aircraft is flying or at what altitude it is flying. In order to determine these variables and others, a pilot needs to refer to the performance instruments.

**Performance Instruments**

The performance instruments directly reflect the performance the aircraft is achieving. The speed of the aircraft can be referenced on the airspeed indicator. The altitude can be referenced on the altimeter. The aircraft’s climb performance can be determined by referencing the vertical speed indicator (VSI). [Figure 4-26] Other performance instruments available are the heading indicator, angle of attack indicator, and the slip/skid indicator.

The performance instruments will most directly reflect a change in acceleration, which is defined as change in velocity or direction. Therefore, these instruments indicate if the aircraft is changing airspeed, altitude, or heading, which are horizontal, vertical, or lateral vectors.

**Navigation Instruments**

The navigation instruments are comprised of global positioning system (GPS) displays and indicators, very high frequency omnidirectional range/nondirectional radio beacon (VOR/NDB) indicators, moving map displays, localizer, and glide slope (GS) indicators. [Figure 4-27] The instruments indicate the position of the aircraft relative to a selected navigation facility or fix. Navigation instruments allow the pilot to maneuver the aircraft along a predetermined path of ground-based or spaced-based navigation signals without reference to any external visual cues. The navigation instruments can support both lateral and visual inputs.

![Image of Performance Instruments](image)

**Figure 4-26. Performance Instruments.**

![Image of Navigation Instruments](image)

**Figure 4-27. Navigation Instruments.**
The Four-Step Process Used to Change Attitude

In order to change the attitude of the aircraft, the pilot must make the proper changes to the pitch, bank, or power settings of the aircraft. Four steps (establish, trim, cross-check, and adjust) have been developed in order to aid in the process.

Establish

Any time the attitude of the aircraft requires changing, the pilot must adjust the pitch and/or bank in conjunction with power to establish the desired performance. The changes in pitch and bank require the pilot to reference the attitude indicator in order to make precise changes. Power changes should be verified on the tachometer, manifold pressure gauge, etc. To ease the workload, the pilot should become familiar with the approximate pitch and power changes necessary to establish a specified attitude.

Trim

Another important step in attitude instrument flying is trimming the aircraft. Trim is utilized to eliminate the need to apply force to the control yoke in order to maintain the desired attitude. When the aircraft is trimmed appropriately, the pilot is able to relax pressure on the control yoke and momentarily divert attention to another task at hand without deviating from the desired attitude. Trimming the aircraft is very important, and poor trim is one of the most common errors instructors note in instrument students.

Cross-Check

Once the initial attitude changes have been made, the pilot should verify the performance of the aircraft. Cross-checking the control and performance instruments requires the pilot to visually scan the instruments as well as interpret the indications. All the instruments must be utilized collectively in order to develop a full understanding of the aircraft attitude. During the cross-check, the pilot needs to determine the magnitude of any deviations and determine how much of a change is required. All changes are then made based on the control instrument indications.

Adjust

The final step in the process is adjusting for any deviations that have been noted during the cross-check. Adjustments should be made in small increments. The attitude indicator and the power instruments are graduated in small increments to allow for precise changes to be made. The pitch should be made in reference to bar widths on the miniature airplane. The bank angle can be changed in reference to the roll scale and the power can be adjusted in reference to the tachometer, manifold pressure gauge, etc.

By utilizing these four steps, pilots can better manage the attitude of their aircraft. One common error associated with this process is making a larger than necessary change when a deviation is noted. Pilots need to become familiar with the aircraft and learn how great a change in attitude is needed to produce the desired performance.

Applying the Four-Step Process

In attitude instrument flight, the four-step process is used to control pitch attitude, bank attitude, and power application of the aircraft. The EFD displays indications precisely enough that a pilot can apply control more accurately.

Pitch Control

The pitch control is indicated on the attitude indicator which spans the full width of the PFD. Due to the increased size of the display, minute changes in pitch can be made and corrected for. The pitch scale on the attitude indicator is graduated in 5-degree increments which allow the pilot to make correction with precision to approximately 1/2 degree. The miniature airplane utilized to represent the aircraft in conventional attitude indicators is replaced in glass panel displays by a yellow chevron. [Figure 4-28] Representing the nose of the aircraft, the point of the chevron affords the pilot a much more precise indication of the degree of pitch and allows the pilot to make small, precise changes should the desired aircraft performance change. When the desired performance is not being achieved, precise pitch changes should be made by referencing the point of the yellow chevron.

Bank Control

Precise bank control can be developed utilizing the roll pointer in conjunction with the roll index displayed on the