Flight Training Fundamentals – Instrumentation

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This is a continuing series of the Pilot's Handbook of Aeronautical Knowledge for flight training students. The handbook is published by the Federal Aviation Administration and provides important information for flight training students and for pilots who already know how to fly. Here is a part from the chapter about Aircraft Structure which discusses Instrumentation.

Instrumentation: Moving into the Future

Until recently, most general aviation aircraft were equipped with individual instruments utilized collectively to safely operate and maneuver the aircraft. With the release of the electronic flight display (EFD) system, conventional instruments have been replaced by multiple liquid crystal display (LCD) screens.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). The second screen, positioned approximately in the center of the instrument panel, is referred to as the multi-function display (MFD). These two screens declutter instrument panels while increasing safety. This has been accomplished through the utilization of solid state instruments which have a failure rate far less than those of conventional analog instrumentation.

With today's improvements in avionics and the introduction of EFDs, pilots at any level of experience need an astute knowledge of the onboard flight control systems as well as an understanding of how automation melds with Aeronautical Decision-Making (ADM).

Whether an aircraft has analog or digital ("glass") instruments, the instrumentation falls into three different categories: performance, control, and navigation.

Performance Instruments

The performance instruments indicate the aircraft's actual performance. Performance is determined by reference to the altimeter, airspeed or vertical speed indicator (VSI), heading indicator, and turn-and-slip indicator. 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 VSI. Other performance instruments available are the heading indicator, angle of attack indicator, and the slip-skid indicator.

Control Instruments

The control instruments display immediate attitude and power changes, and are calibrated to permit adjustments in precise increments. The instrument for attitude display is the attitude indicator. The control instruments do not indicate aircraft speed or altitude. In order to determine these variable and others, a pilot must reference the performance instruments.

Navigation Instruments

The navigation instruments indicate the position of the aircraft in relation to a selected navigation facility or fix. This group of instruments includes various types of course indicators, range indicators, glideslope indicators, and bearing pointers. Newer aircraft with more technologically advanced instrumentation provide blended information, giving the pilot more accurate positional information.

Navigation instruments are comprised of indicators that display GPS, very high frequency (VHF) omni-directional radio range (VOR), nondirectional beacon (NDB), and instrument landing system (ILS) information. The instruments indicate the position of the aircraft relative to a selected navigation facility or fix. They also provide pilotage information so the aircraft can be maneuvered to keep it on a predetermined path. The pilotage information can be in either two or three dimensions relative to the ground-based or space- based navigation information.

Global Positioning System (GPS)

GPS is a satellite-based navigation system composed of a network of satellites placed into orbit by the United States Department of Defense (DOD). GPS was originally intended for military applications, but in the 1980s the government made the system available for civilian use. GPS works in all weather conditions, anywhere in the world, 24 hours a day. A GPS receiver must be locked onto the signal of at least three satellites to calculate a two-dimensional position (latitude and longitude) and track movement. With four or more satellites in view, the receiver can determine the user's three-dimensional position (latitude, longitude, and altitude). Other satellites must also be in view to offset signal loss and signal ambiguity. The use of the GPS is discussed in more detail in Chapter 15, Navigation. Additionally, GPS is discussed in the Aeronautical Information Manual (AIM).