Chapter 1

Overview

Electronic flight decks show flight, navigation, and aircraft data on electronic displays instead of mechanical and electrical instruments. More information is provided in the same amount of space, which enables pilots to find and read needed data quickly. Electronic displays also facilitate accurate readings because parallax errors are eliminated. (Parallax is most obvious in the Beechcraft King Air's mechanical fuel gauges.)

Although electronic flight decks are considered modern compared to mechanical and electrical instruments, they date back to military aircraft of the 1960s. They entered commercial aviation in the 1980s and 1990s as computers became more powerful and occupied less space. Early versions used a few electronic instruments alongside mechanicals. With steady advances in computer technology, mechanical instruments were gradually replaced with electronics except for a few backup instruments that are more redundant than necessary. As personal computer technology advanced, electronic flight decks became available and affordable for general aviation in the 1990s and 2000s. Manufacturers such as Beechcraft, Cessna, and Piper offered them

as options for new aircraft and later as standard equipment in new aircraft. Private pilots have retrofit some flight decks with electronic instruments.

Early electronic instruments used cathode ray tubes (CRT) like desktop monitors of the period and later liquid crystal displays (LCD). CRTs required a lot of space, and both devices generated considerable heat. Modern electronic flight decks use light emitting diode displays (LED) that occupy less space behind the panels and generate little heat. The latest technology is touch-screen LEDs.

Three electronic displays are common in commercial and general aviation: Primary Flight Display (PFD), Multi-Function Display (MFD), and Engine Indicating and Crew Alerting System (EICAS). Flight Management Computers (FMC) are used in commercial aviation, and Synthetic Vision Systems (SVS) are advanced features in some general aviation aircraft. Modern electronic flight decks take full advantage of the Global Positioning System (GPS).

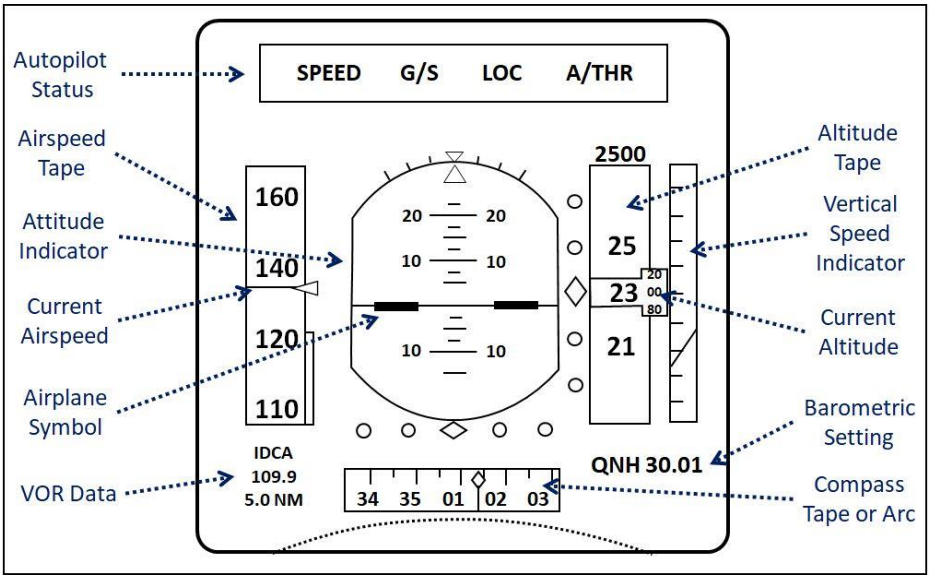
Major manufacturers of electronic flight equipment are Collins, Dynon, Garmin, Honeywell, and Thales. Airbus and Boeing have in-house avionics departments in addition to outsourcing some devices to independent suppliers.

Whether in large commercial airliners or small general aviation aircraft, electronic flight decks generally contain equivalent devices in similar arrangement.

Although electronic flight decks can seem complicated at first glance, they are carefully and deliberately designed for ease of use. Learning one will help you learn others. You will benefit from familiarizing yourself with these instruments prior to your flights so you can use them easily aloft.

Primary Flight Display

The PFD is almost always in front of the pilot, or left seat. As one of the first glass instruments introduced to commercial aviation, it stood alone on the instrument panel among mechanical and electrical instruments for years. Modern devices present much more information than early devices, and they are similar among various manufacturers with a few differences.



Typical Primary Flight Display

All modern PFDs display an attitude indicator (AI), an airspeed indicator (ASI), a vertical speed indicator (VSI), and an Altimeter. Most PFDs include a horizontal situation indicator (HSI) and a course deviation indicator (CDI). An HSI combines an omni-bearing indicator (OBI) with a compass rose or arc. In most PFDs, the arc spans 90 degrees from left to right. PFDs with HSIs usually include indicators for instrument landing system (ILS) localizers and glide slopes. Some PFDs include autopilot data and a flight director. In high performance aircraft, PFDs include an angle-of-attack indicator (AOA).

- The large instrument in the middle is the AI. It rises, falls, and rotates left and right as the aircraft's attitude changes. Degrees of pitch and bank are marked and sometimes labeled.

- Below is the HSI with compass rose or arc and a CDI. The compass turns left and right as the aircraft's heading changes. The CDI points toward the next waypoint and indicates whether the aircraft is on or off course, and by how much it is off course.
- The ASI is on the left as a moving tape plus a digital window. In jet aircraft, mach speed is shown in digital form above or below the ASI depending on the manufacturer.
- The Altimeter is on the right as a moving tape and digital window.
- The VSI is usually to the right of the altimeter.
- The current barometric setting is a digital readout above or below the altimeter.
- When autopilot data are presented, they are usually on the top and abbreviated due to space restrictions. Specific abbreviations differ among manufacturers. Altitude settings are shown in digital form above or below the altimeter tape. In aircraft with auto-throttles, airspeed settings are usually above the ASI tape.
- Some PFDs include navigation data such as distances to navaids and waypoints. Some show wind data and allow pilots to choose how they are displayed. Transponders are included in the PFDs in the Garmin electronic flight decks.

Specific functions and variations are explained in detail in respective chapters.

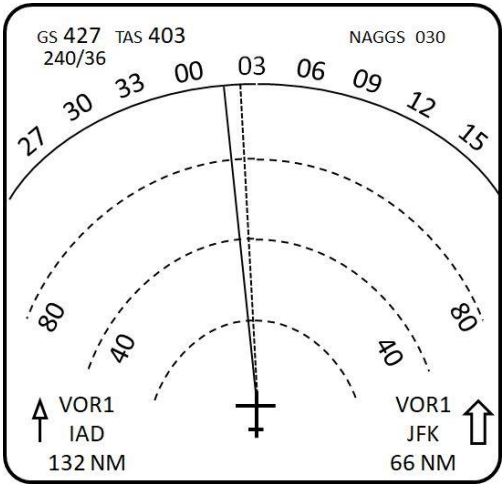
Engine Information Systems

Another early glass display reports status and performance data about the engines. Most are called Engine Indicating and Crew Alerting System (EICAS). Some manufacturers use titles such as Electronic Centralized Aircraft Monitoring (ECAM) and Engine Monitoring System (EMS). They all provide fundamental information such as temperature, pressure, and rotation speed. A few report engine vibration. Some provide data about the aircraft's electric and hydraulic systems. They are installed in most commercial and some general-aviation aircraft. Fuel is always reported as quantity on board and flow rate. Sometimes quantity used is reported.

These instruments are in various locations depending on the aircraft manufacturer. Some are on the PFD, others on the MFD, and some on the pedestal (sometimes called “center console” or “aisle stand”). In some aircraft, data are grouped according to categories and displayed on separate pages that can be selected by the pilots.

Navigation Display

Navigation information is provided in the Navigation Display (ND) in the Airbus A320, Cessna CJ4, Boeing 747, and Boeing Dreamliner. It is dominated by a moving map. In the center is a compass rose that covers the entire 360 degrees or an arc spanning 90 to 135 degrees from left to right, depending on the aircraft. Both compasses contain rings for various distances from the aircraft in nautical miles such as five, 10, and 20. Pilots can select rose or arc and increase or decrease range of these maps. Navigation displays also show digital data for radio navigation aids, ground speed, true airspeed, and wind direction and speed.



Typical Navigation Display

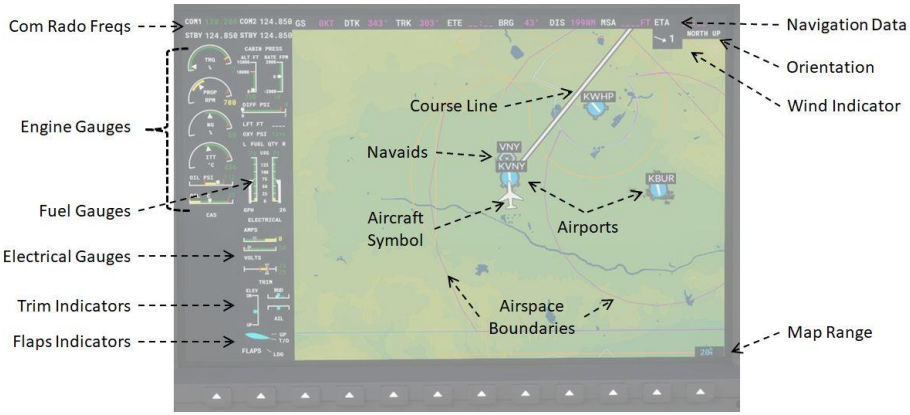
Multi-Function Display

The MFD is the last major glass instrument added to modern flight decks. Its main feature is a moving map that consumes about four-fifths of the screen and resembles GPS devices used on the ground by ordinary citizens. The map displays major navigation data such as airports, navaids, airspaces, waypoints, and intersections. Some maps display traffic in the area. Pilots can zoom in and out of maps. In this regard, an MFD is similar to an ND.

Some MFDs intended for general aviation also display engine information that are displayed by EICAS in jet aircraft.

Most Garmin MFDs include pages of specific navigation data in tabular form such as airports and navaids. Pilots can look up information about most airports such as elevations, runways, and Air Traffic Control (ATC) frequencies. This ability is most useful for departure and destination airports when planning flights.

Typical Multi-Function Display



Typical Multi-Function Display

Flight Management Systems

Flight Management Systems (FMS) are on-board computers that automate many pre-flight and in-flight tasks such as flight planning, navigation, and aircraft performance. These computers are linked to GPS receivers, radio-navigation receivers, navigation databases, aircraft system monitors, input devices, and display screens.

Jet pilots use Control Display Units (CDU) with keypads and screens to interact with FMS. These devices resemble hand-held calculators in appearance. Pilots use them to manage their flight plans, determine current positions, estimate time to waypoints and destinations, manage fuel consumption, and monitor aircraft performance. In MSFS 2020, they are rendered in the Airbus A320, Boeing 747, and Cessna CJ4. (Airbus calls its CDU a Multi-Function Control Display Unit, or MCDU.)

Autopilots

Some Garmin glass fight decks include autopilot controls with their glass instruments, usually in the MFD and sometimes in the PFD. Because autopilots are not limited to electronic flight decks, this book does not explain them in detail.

Global Positioning System

Being modern high-tech instruments, electronic flight decks incorporate functions of the Global Positioning System (GPS). Because GPS is not limited to electronic flight decks, this book does not explain it in detail.