Aircraft FMS Explained: Key Functions and Benefits

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10 min

Get insights into the vital role of Aircraft FMS in modern aviation. Explore its functions and discover how it enhances flight efficiency and precision.

Today we're going to deep-dive into the technical side of aviation and aeronautics and talk about a common but sometimes misunderstood component of all modern commercial aircraft: the flight management system (FMS). The FMS is kind of the 'brain' of the aircraft, a computer system that aids in reducing the workload on the aircrew.

The FMS was the original electronic brain of the aircraft, which did away with the need for flight engineers and navigators, positions that had been standard for decades. But how exactly do they work? And what do they do that takes the pressure off of flight crews? We answer all these questions and more.

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Join us as we take a closer look at flight management systems.

What is the Aircraft FMS?

Alright, so the first and most foundational question is: what is the FMS?

Well, at its core, it is the foundation of the entire avionics suite. It is easy to think of the avionics in terms of the screens (MFDs) in a glass cockpit, but those are only a piece of the framework that guides the aircraft through the different phases of flight.

The FMS is the computer that automates many tasks, allowing the aircrew more time to focus on flying the aircraft.

The FMS pulls in data from multiple sources to provide accurate information about the aircraft's speed, location, and ETA. The FMS uses

- GPS
- Inertial Navigation System (INS)
- Radio navigation (VOR and TACAN or VORTAC for military aircraft)

The FMS does all of the calculating with these systems, providing a clear course along the flight plan. It is generally accepted that the most accurate navigation is found by relying on multiple systems rather than one sole source. But in yesteryear, the navigator would be taking those individual sources of data and crafting them into a flight plan and course.

Pilots now handle all aspects of mission and flight planning in the cockpit, which is done via the Control Data Unit. While most CDUs do not look very impressive (small green screen with a keyboard below), they quickly incorporate huge amounts of data and produce tangible information for the aircrew.

What's the Difference Between FMS and FMC?

This question is not so much a difference between FMS and FMC, but instead, what is the *relationship* between FMS and the FMC?

The flight management computer, which is the FMC, is a component of the FMS rather than a competing system to the FMS. The FMS is made up of four separate components:

- The FMC
- Automatic Flight Control System or Automatic Flight Guidance System (AFCS or AFGS)
- Navigation systems (GPS, INS, VOR, ILS, etc.)
- Electronic Flight Instrument System (EFIS), or something comparable

The FMC is one of the four main components of the FMS, and it is responsible for performance calculations (take-off and landing data, or TOLD), fuel computations, and adjusting the flight path based on variances in weather, winds, and so on. The FMC is always working, adjusting the mission plan based on real-world fuel flow and speeds rather than basing it on assumptions on standardized fuel flow rates.

What is an FMS Trainer and What is its Role?

You are undoubtedly familiar with flight trainers and simulators focused on flight handling and characteristics. But with the FMS being such a significant portion of the modern pilot's responsibility, it makes sense to have an FMS familiarization trainer for pilots to familiarize themselves with the FMS of a given make and model aircraft well before they ever set foot on the aircraft.

The great thing about an FMS trainer is that it can work on just about any laptop or desktop. The trainer is "linked" to computers for auto-thrust and autopilot so that the pilot can focus on FMS inputs.

The main purpose of an FMS trainer is for type ratings, where less emphasis is needed on basic airmanship, and more is required of flight and crew resource management.

Main Components of FMS

We touched on this already, but there are four main components of the FMS:

- The FMC
- The AFCS or AFGS
- Navigation system(s)

- EFIS

What Exactly Does the Flight Management Computer (FMC) Do?

We explored this above, but let's take a closer look at the Flight Management Computer, or FMC. This critical component in modern aircraft avionics is pivotal in ensuring the efficient and precise management of a flight. Here's a more in-depth breakdown:

1. **Navigation and Route Planning:** The FMC is responsible for charting the aircraft's course by processing navigation data and creating an optimal route from departure to destination. It considers factors such as airways, waypoints, and air traffic restrictions.
2. **Auto Flight Control:** The FMC interfaces with the autopilot system, enabling automated control of the aircraft's altitude, heading, and speed according to the predetermined flight plan. It ensures accuracy and adherence to the planned route.
3. **Performance Optimization:** By continuously monitoring the aircraft's performance parameters, including fuel consumption, engine efficiency, and weight, the FMC optimizes the flight profile for fuel efficiency and operational effectiveness.
4. **Fuel Management:** Efficient fuel management is crucial for flight operations. The FMC calculates the most fuel-efficient speeds, altitudes, and descent profiles, contributing to cost savings and environmental considerations.
5. **Navigation Database Management:** The FMC maintains an extensive database of navigation information, including airports, runways, airways, and waypoints. It regularly updates this database to ensure the latest and most accurate information is available for route planning.
6. **Integration with Avionics Systems:** The FMC integrates with various avionics systems, such as the Inertial Navigation System (INS), Global Positioning System (GPS), and sensors, to gather real-time data for precise navigation and control.
7. **Flight Monitoring and Alerts:** The FMC continuously monitors the aircraft's progress, providing alerts and warnings to the flight crew in case of deviations from the planned route, weather-related issues, or any other anomalies.
8. **Approach and Landing Guidance:** During the descent and approach phases, the FMC assists in providing guidance for instrument approaches and precision landings, contributing to safe and accurate landings.

The FMC serves as the brain of the aircraft's navigation and control systems, combining advanced algorithms with real-time data to optimize flight operations, enhance safety, and contribute to the overall efficiency of air travel.

What Are AFCS & AFGS?

The AFCS or AFGS are just different names for an autopilot system, except they are more than just an autopilot. General aviation aircraft are often equipped with an autopilot system, but it does little more than keep the wings level and maintain a heading.

AFCS and AFGS are much more than that. They are systems that pull in data from the systems that are related to the autopilot. These include autothrottle systems, integrated with digital attitude heading and reference systems, and navaids, which include glide slopes. With the glideslope, you guessed it: the AFCS can fly right down the ILS. Considering human error accounts for most accidents in aviation, this is a breakthrough for aviation safety.

What Types of Navigation Systems are There?

There are a handful of standard nav systems used on almost all aircraft. They are all going about doing the same thing but using different technologies to get there.

GPS is probably one of the best known and has been a mainstay of aviation for over a quarter century now. The INS is not understood as well by those outside of the aviation community, but it is a mainstay of aircraft navigation systems. It uses gyroscopes and accelerometers with a computer to calculate dead reckoning constantly.

What are Examples of Electronic Flight Instrument System?

Electronic Flight Instrument Systems (EFIS) represent a significant advancement in aviation technology, replacing traditional mechanical instruments with digital displays for improved accuracy, efficiency, and situational awareness. Here are examples of Electronic Flight Instrument System components:

1. **Primary Flight Display (PFD):** The PFD is a key component of EFIS, presenting critical flight information directly in front of the pilot. It typically includes an artificial horizon, airspeed indicator, altimeter, vertical speed indicator, and other essential flight data.
2. **Navigation Display (ND):** The ND provides detailed navigation information, including maps, waypoints, airways, and the aircraft's position relative to the planned route. It enhances navigation awareness and aids in situational awareness during all phases of flight.

3. **Engine Indication and Crew Alerting System (EICAS):** EICAS displays real-time information related to the aircraft's engines, including parameters like fuel flow, temperatures, pressures, and warnings. It helps the flight crew monitor engine health and respond to alerts promptly.
4. **Synthetic Vision Systems (SVS):** SVS enhances situational awareness by providing a 3D virtual view of the terrain, obstacles, and runways, even in low-visibility conditions. It aids pilots in understanding their position in relation to the environment.
5. **Traffic Collision Avoidance System (TCAS) Displays:** TCAS displays on EFIS present information about nearby aircraft equipped with transponders, assisting pilots in avoiding potential collisions by providing traffic advisories and resolution advisories.
6. **Terrain Awareness and Warning System (TAWS) Displays:** TAWS displays on EFIS alert pilots to potential terrain hazards and provide visual and audible warnings to prevent controlled flight into terrain (CFIT) accidents.

These examples show the varied functionalities and capabilities offered by EFIS in modern aviation.

What Does a Flight Management System (FMS) Do?

The FMS is the heart and soul of the flight control of all modern commercial aircraft. It handles *everything*.

A flight management system (FMS) is an integrated avionics system that performs most of the navigation, guidance, and monitoring functions required during a flight. It is a computerized system that receives input from several sources, including the aircraft's navigation systems, weather radar, and autopilot. The FMS then uses this information to calculate the aircraft's route, speed, and altitude, providing the pilot with guidance and monitoring information.

The FMS has a number of advantages over traditional navigation systems. It is more accurate and can provide the pilot with more information about the aircraft's position and progress. It can also be used to plan complex flight paths and automatically adjust the aircraft's course and speed in response to weather or traffic conditions.

The FMS is a critical part of the modern aircraft's avionics system. It helps to ensure the safety and efficiency of flights, and it has made a significant contribution to the advancement of aviation.

Here are some of the specific tasks that an FMS can perform:

- Calculate the aircraft's route, speed, and altitude.
- Provide the pilot with guidance and monitoring information.
- Plan complex flight paths.
- Automatically adjust the aircraft's course and speed in response to weather or traffic conditions changes.
- Monitor the aircraft's systems and provide warnings of potential problems.
- Record flight data for later analysis.

How Does a FMS Work?

FMS is a system of components and interrelated systems and subsystems.

As the head of the system, the FMS collects *all* of the information from the four core components of the FMS and collates it into actionable information for the pilots. Most aircraft are outfitted with dual FMS control units to add redundancy so that either the captain or first officer can input information

From the operational perspective, the FMS works to take in information from a huge array of systems that used to require an additional two crewmembers to sift through and integrate. Now, two pilots handle all of this information because almost the entire job of the flight engineer and navigator has been automated.

When Do Pilots Follow the FMS?

This question is a misnomer. Pilots don't necessarily follow the FMS, but they generally do follow the course suggested by the FMS. The FMS is a system that provides the most accurate information available and possible to the aircrew, but the captain is ultimately responsible for what is done with that information.

A captain can choose to hand-fly an airplane if need be, and sometimes it does need to be. Of course, this also relies largely on company policy, which varies from operator to operator.

Why Might a Pilot Program Change Into the FMS Mid-Flight?

There are a number of reasons why pilots' programs change mid-flight. These include:

- **Weather Variability:** Weather changes often. Wind direction and velocity change *very often*. Any of these, as well as unexpected turbulence, can necessitate adjustments to the flight plan.
- **Traffic Density Fluctuations:** Traffic density is in a constant state of change. Adjustments may be required to maintain safe separation and accommodate changes in traffic flow.
- **Runway Changes:** Runways are routinely changed to compensate for traffic flow or because the wind shifted. If you were expecting to take the ILS for 31 but now have to plan on 13, it can put a kink in your operations at such short notice. Thankfully, the FMS handles that workload.
- **Terminal Area Dynamics:** Contained areas pose unique challenges, and factors such as air traffic control instructions, runway availability, or airspace constraints can prompt mid-flight adjustments. This is particularly true when operating in terminal areas, which are usually defined as within 50 nm of the terminal airport.
- **Unforeseen Air Traffic Situations:** Sudden changes in air traffic situations, diversions, or unexpected instructions from air traffic control may necessitate real-time modifications to the flight plan.
- **Equipment or Aircraft Performance Considerations:** Technical issues, changes in aircraft performance characteristics, or the need to optimize fuel efficiency can prompt alterations to the initial flight program.
- **Operational Changes for Traffic Flow:** To manage air traffic effectively, controllers may alter the route or altitude of an aircraft, requiring the FMS to recalculate the flight plan accordingly.

The FMS serves as a vital assistant, allowing pilots to respond promptly to the fluid nature of aviation operations. Whether adapting to weather shifts, accommodating changes in traffic patterns, or recalculating routes due to unforeseen circumstances, the FMS ensures that the flight program remains flexible and responsive throughout the trip.

Could Airliners Use an FMS in the Cloud?

With everything going to cloud-based systems, the question has been posed of whether or not the FMS could become a Cloud operating system.

The problem with current FMSs is that the information is all contained within the confines of that cockpit. The operator has no visibility to what it is saying beyond communicating with the pilots.

Right now, a group of industry experts have set out to answer just that question of whether or not a secure internet connection can be used to connect the aircraft with a system similar to Amazon Web Services or Microsoft Azure to sync ground operations with the FMS.

The answer is obvious: exploring this technology is occurring because the transition will eventually happen.

Contact Greenwood Aerospace for all Your Aviation Logistics Needs

The FMS is a crucial component on all commercial and military aircraft and is even making its way into modern general aviation aircraft as small as the Cessna 182. This is a wise move on all fronts; the FMS makes flight safer by taking the burden off of the pilots so that they can focus on airmanship.

Make sure to check out our News tab for all of the latest news in the aircraft parts and procurement industry, and if you have any questions about parts, procurement, logistics, or service contracts, give us a call, or start an online quote!