Flight Management Systems

1. What do you know about Flight Management Systems on modern airliners?

The flight management system typically consists of two units, a computer unit and a control display unit. The computer unit can be a **standalone** unit providing both the computing platform and various interfaces to other avionics or it can be integrated as a function on a hardware platform such as an Integrated Modular Avionics cabinet (IMA). The Control Display Unit (CDU or MCDU) provides the primary human/machine interface for data entry and information display. Since hardware and interface implementations of flight management systems can vary **substantially**, this discussion will focus on the functional aspects of the flight management system. The flight management system provides the primary navigation, flight planning, and optimized route determination and en route guidance for the aircraft and is typically comprised of the following interrelated functions: navigation, flight planning, trajectory prediction, performance computations, and guidance. To accomplish these functions the flight management system must interface with several other avionics systems. As mentioned above, the implementations of these interfaces can vary widely depending upon the vintage of equipment on the aircraft but generally will fall into the following generic categories.

- Navigation sensors and radios
- Inertial/attitude reference systems
- Navigation radios
- Air data systems
- Displays
- Primary flight and navigation
- Multifunction
- Engine
- Flight control system
- Engine and fuel system
- Data link system
- Surveillance systems

Today, flight management systems can vary significantly in levels of capability because of the various aviation markets they are intended to serve. These range from simple point to point lateral navigators to the more sophisticated multisensor navigation, optimized four-dimensional flight planning/guidance systems. The flight management system in its simplest form will slowly diminish as reduced **separation** airspace standards place more demands on the aircraft's ability to manage its trajectory more accurately, even though lateral-only navigators will continue to have a place in recreational general aviation. With its current role in the aircraft, the flight management system becomes a primary player in the current and future CNS/ATM environment. Navigation within RNP airspace, data-linked **clearances** and weather, aircraft trajectory-based traffic management, time navigation for aircraft flow control, and **seamless** low-visibility approach guidance all are enabled through advanced flight management functionality.

At the center of the FMS functionality is the flight plan construction and subsequent construction of the four-dimensional aircraft trajectory defined by the specified flight plan legs and constraints and the aircraft performance. Flight plan and trajectory prediction work together to produce the four-dimensional trajectory and **consolidate** all the relevant trajectory information into a flight plan/profile buffer. The navigation function provides the dynamic current aircraft state to the

other functions. The vertical, lateral steering, and performance advisory functions use the current aircraft state from navigation and the information in the flight plan/profile buffer to provide guidance, reference, and advisory information relative to the defined trajectory and aircraft state.
• The navigation function — responsible for determining the best estimate of the current state of the aircraft.
• The flight planning function — allows the crew to establish a specific routing for the aircraft.
• The trajectory prediction function — responsible for computing the predicted aircraft profile along the entire specified routing.
• The performance function — provides the crew with aircraft unique performance information such as takeoff speeds, altitude capability, and profile optimization advisories.
• The guidance functions — responsible for producing commands to guide the aircraft along both the lateral and vertical computed profiles.

Depending on the particular implementation, the **ancillary** I/O, BITE, and control display functions may be included as well. Since the ancillary functions can vary significantly, this discussion will focus on the core flight management functions. There are typically two **loadable** databases that support the core flight management functions. These are the navigation database which must be updated on a monthly cycle and the performance database that only gets updated if there's been a change in the aircraft performance characteristics (i.e., engine variants or structural variants affecting the drag of the aircraft). The navigation database contains published data relating to airports, navaids, named **waypoints**, airways and terminal area procedures along with RNP values specified for the associated airspace. The purpose of the navigation data base is **twofold**. It provides the navigation function location, frequency, elevation, and class information for the various ground-based radio navigation systems. This information is necessary to select, auto-tune, and process the data from the navigation radios (distance, bearing, or path deviation) into an aircraft position. It also provides the flight plan function with airport, airport-specific arrival, departure, and approach procedures (predefined strings of terminal area waypoints), airways (predefined enroute waypoint strings), and named waypoint information that allows for rapid route construction.[1]

I. Decide if the following statements are true or false. Justify your answers.

1. The FMS is always able to operate independent from other aircraft systems. T / F
2. FMS is only used to manage the aircraft in relation to space. T / F
3. The increasing air traffic will result in the increased popularity of the more sophisticated FMS. T / F
4. FMS contributes to the increased efficiency in air traffic management. T / F
5. The aircraft performance database must be updated on a regular basis. T / F

II. Complete the sentences with the appropriate words in bold in the text.

1. When you pay an additional twenty dollars for extra legroom on a plane, you are paying the airline an _____ fee.

[1] Spitzer, Cary R., The Avionics Handbook

2. _____ may be a simple named point in space or may be associated with existing navigational aids, intersections, or fixes.
3. We haven't received take-off _____ yet.
4. Dynamically _____ libraries are typically used to develop add-ons for other programs
5. In air traffic control, separation_____ is the name for the concept of keeping an aircraft outside a minimum distance from another aircraft to reduce the risk of those aircraft colliding, as well as prevent accidents due to secondary factors, such as wake turbulence.
6. ICAO Secretary General highlights secure and _____ travel and its benefits for aviation development.
7. As 3D printing has found its place in product development and mass production, its benefits to the maintenance and repair functions of private aviation have only recently started to take shape. The savings are _____: time and money.

III. Look at the sentences below and find verbs in the text which can precede the prepositions.

1. The document contains data _____ to UK airport operations, including passenger numbers, numbers of flights, freight carried, and much more.
2. FAA's Aviation Safety organization is _____ of some of the most dedicated professionals in the aerospace industry.
3. General aviation flights _____ from gliders and powered parachutes to rotorcraft and corporate business jets.
4. Variants of an aircraft type may _____ into different wake turbulence categories.

Work in groups of three. Discuss the following incidents and accidents with relation to FMS. How might the accidents have been avoided?

Student A:

http://www.aviation-accidents.net/ryanair-boeing-b737-8as-flight-ry6876/

Student B:

http://www.aviation-accidents.net/cobham-aviation-boeing-b717-200-vh-nxd/

Student C:

http://www.aviation-accidents.net/delta-airlines-mcdonnel-douglas-md11-n-803de-flight-dl129/