Flight Management Systems

1. **What do you know about engine systems on modern airliners?**

Engine systems

In spite of the fact that engine control systems have become very **comprehensive** in maintaining operating conditions at the most economic or the highest performance, depending on the application, there is still a need to provide the pilot with an indication of certain engine parameters. Under normal conditions the pilot is interested in engine condition only at engine start or when something goes wrong. The engine control system, with its monitoring and warning capability, should inform the pilot when something **untoward** does happen. However, there may be circumstances when human intuition wins the day.

During engine start, the pilot monitors (and checks with his copilot in a multicrew aircraft) that start progresses satisfactorily with no observed **sluggish** accelerations and no low oil pressures or overtemperatures. Much of this monitoring involves pilot familiarity with the aircraft type and engine type, obtained over many starts. The crew may accept certain criteria that an automatic system would not. During normal operation the control system should provide sufficient high-integrity observation by self-monitoring and by checking certain parameters against preset values. In this way the system can monitor accelerations, rates of change, value **exceedances**, and changes in state and issue the necessary warning using experience and judgement.

Until recently, all aircraft had at least one panel dedicated to engine instruments. These were in view at all times and took the form of circular pointer instruments, or occasionally vertical strip scales, reading such parameters as:

. Engine speed
. Engine Gas Temperature (EGT).
. Engine Pressure Ratio (EPR).
. Engine vibration.
. Thrust (or torque).

In modern aircraft cockpits the individual indicator has largely given way to an integrated engine display, either an Engine Indication and Crew Alerting System (EICAS) or, on Airbus aircraft, Electronic Centralised Aircraft Monitor (ECAM). With such a system, any information can be shown in any format, in full colour, at any time. This facility is often **exploited** to ensure that the pilot is only given the information that is essential for a particular phase of flight. This means that engine displays may occur on a single screen or page that is automatically presented to the pilot at certain times, say starting, take-off, and landing, but may be hidden at all other times. **Provision** is made for the pilot to select any page so that the engine can be checked from time to time, and an engine warning will automatically **trigger** the engine page to appear. Engine indications are obtained from the same type of sensors and transducers that provide the inputs to the control system, as described earlier. However, for integrity reasons at least two independent sources of signal are required - one (or more) for control, another for the indicator. For example, the engine speed signal will be obtained from two separate **coils** of a common speed sensor. This guards against a common mode failure that would otherwise affect both the control system and the indication system.

Engine control on a modern civil aircraft

[…] Most[of the engines] are twin-shaft engines with Low- Pressure (LP) and High-Pressure (HP) shafts. Some Rolls-Royce engines such as the RB211 and Trent family are triple-shaft engines with

LP, Intermediate-Pressure (IP), and HP shafts. A high proportion of air bypasses the engine core on a modern gas turbine engine; the ratio of bypass air to engine core air is called the bypass ratio. The bypass ratio for most civil engines is in the region of 4:1.5:1. Most modern civil engines use a Full-Authority Digital Engine Control system (FADEC) mounted on the fan casing to perform all the functions of power-plant management and control. Effective control of engine parameters is a **contributory** factor to achieving stress-free operation of the engine. This, together with major advances in materials technology and engine build quality, has led to high availability of the commercial aircraft turbofan engine.[…]

The key areas of monitoring and control are:

. Various speed probes (N1, N2) and temperature and pressure sensors (P2/T2, P2.5/T2.5, and T3). Exhaust Gas Temperature (EGT), Engine Pressure Ratio (EPR), and oil temperature and pressure sensors are shown.

. The turbine case cooling loops . HP and LP.

. Engine start.

. Fuel control for control of engine speed and, therefore, thrust.

. The engine Permanent Magnet Alternators (PMAs) are small dedicated generators that supply primary power on the engine for critical control functions.

. Various turbine blade cooling, Inlet Guide Vanes (IGVs), Variable Stator Vanes (VSVs) and **bleed air** controls.[1]

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

1. Engine control systems should provide pilots with all the available data at all times. T / F
2. Engine control systems are always superior to humans. T / F
3. The system uses the redundancy principle. T / F
4. Most of the air goes through the core engine. T / F

II. Explain the words in bold in the text and provide example sentences.

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

1. There is a need to ___________ the ATC with precise information about the emergency.
2. The data was ___________ over many take-offs and landings.
3. For long-haul flights turboprop engines _____________ to by-pass turbofans.
4. The development of the jet engine _____________ to cheaper air travel.

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

[1] Moir, Ian. Seabridge Allan G., *Civil Avionics Systems*

Student A:

http://www.aviation-accidents.net/singapore-airlines-boeing-b777-300er-9v-swb-flight-sq368/

Student B:

http://www.aviation-accidents.net/british-airways-boeing-b777-236-g-ymmp/