Self-monitoring maintenance: 7E7 makes a technological leap

Boeing is using every available technology to help the 7E7 deliver the biggest possible improvements in cash operating costs. One innovation is the use of sensors in the aircraft's structure used to detect damage. Coupled with health monitoring systems, they will be used to recommend the schedule and workscope of airframe maintenance. This will replace traditional structural inspections.

The 7E7 will incorporate several technological features that will overcome some of the last bastions of aircraft operating costs. These are mainly in the area of fuel burn and maintenance. All technological features are intended to give the 7E7 a 20% lower direct operating cost than equivalent sized aircraft, the 767-300/-400 and A330-200.

There are three 7E7 models. The first is a low gross weight -3 model. This will have a range of 3,500nm with a dual-class load of 290 passengers.

The higher weight -8 and -9 models will have tri-class capacities of about 200 and 250. Their respective ranges will be 8,500nm and 8,300nm. The 7E7-8 will have a maximum take-off weight (MTOW) of 480,000lbs, close to the 767-400. The 7E7-9 will have a MTOW of 500,000lbs, close to the A330-200.

The first noticeable feature of the 7E7 is that its primary structure will be about 82% carbon fibre which is significantly higher than any other civil aircraft to date. This will result in low weight for its size, contributing to greater fuel efficiency. Carbon fibre is also damage and corrosion resistant. This will reduce the amount of unscheduled maintenance that the 7E7 would incur from damage during operation. Resistance to corrosion will require less scheduled maintenance tasks to begin with, and also reduce non-routine maintenance as the aircraft ages.

As well as benefiting from lightweight carbon fibre, the 7E7 will have two new engines: the General Electric GENX and Rolls-Royce Trent 1000.

Both engines will have a high bypass ratio; the GENX 9.5:1; and the Trent 1000 11.0:1. In addition to several other technologies, a traditional air bleed system from the engine to the airframe will be absent. These features will combine to give the 7E7 a 15-20% lower fuel burn than equivalent sized aircraft.

In addition to fuel burn, the other main area of direct operating cost that can be targeted for reduction is maintenance cost. Strides have been made over the past 20 years to reduce an aircraft's maintenance burden. These have included reduction in the number of engines, improved engine reliability and on-wing times, adoption of modern maintenance programmes and schedules, changes to inventory planning and better health monitoring. Aircraft are still susceptible to corrosion and also require regular structural inspections, although the interval for these has been extended from four or five years to between eight and 10 in many cases.

Boeing will introduce an innovative concept in the 7E7: the use of neural sensors in the aircraft's structure, which. will monitor it for physical damage. Piezoelectric transducers will be placed within a 'smart layer' in the aircraft's structure, which will be a surface layer next to the composite material. These transducers will detect and analyse surface damage, as well as provide alerts and recommend repair techniques. These sensors are part of an improved aircraft health monitoring system. The sensors will therefore go so far as to eliminate the need for heavy structural inspections.

This is revolutionary, and will naturally reduce the aircraft's maintenance burden and bring considerable maintenance cost savings. It has even been suggested that the 7E7 will have just three global maintenance facilities: one in Europe, one in North America and one in the Asia Pacific.

A further consequence of a dramatically reduced requirement for structural maintenance is that the aircraft will remain with initial operators for longer than normal. This may cause challenges with respect to financing the aircraft, since the usual economic life and issues relating to residual value performance will change.

Other technological features that will bring further benefits in reduced maintenance cost are an improved health monitoring system. This goes together with sensors used to detect structural integrity, but the aircraft will be able to continuously report its maintenance status, determine its own maintenance schedule and recommend the repairs it requires.

The 7E7 has also been designed with open systems architecture, which will allow new powerplant, avionic and systems technologies to be adopted as they are developed. As an example, the 7E7 will be able to operate without an auxiliary power unit once fuel cell technology has matured enough. AC

The 7E7 is employing several new technologies to deliver large reductions in cash operating costs, mainly in fuel burn and maintenance burden. One of the most innovative is sensors in the aircraft's primary structure that will detect damage, and via a health monitoring system alert the operator to requirement for maintenance. This will replace the traditional system of structural inspections.