General Electric & Rolls-Royce make 7E7 power offerings.

Boeing's target for the 7E7 is to have 20% lower fuel burn and available seat-mile costs compared to similar sized current generation aircraft. Much of this efficiency improvement will have to be provided by the aircraft's engines. General Electric and Rolls-Royce have been selected to develop powerplants for the 7E7.

After several paper aircraft projects, Boeing is making real progress with the 7E7. Boeing's main objective with the 7E7 is to provide a 20% reduction in fuel burn and cost per available-seat mile (ASM) cost over current aircraft; the 767-300 and -300ER. This fuel burn target will be met by a combination of aerodynamic efficiency and propulsive efficiency provided by new engines developed by General Electric (GE) and Rolls-Royce (RR) for the 7E7.

There are three 7E7 variants. The 7E7-3 is a lower weight aircraft with a dual-class capacity of 300 and range of 3,500nm.

The higher weight version of this aircraft, the 7E7-8, has a tri-class seat capacity of 200, similar to the 767-300, a MTOW of 452,300lbs (similar to the 767-400) and range of 8,500nm.

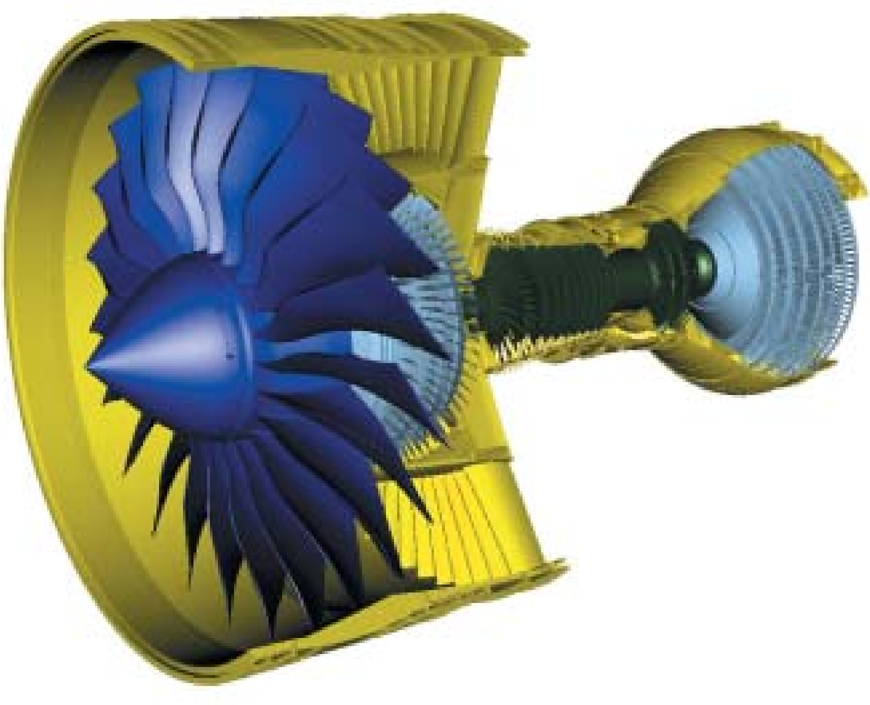
The 7E7-9 has a similar range and is a stretch development with a 250-seat capacity; close to the 767-400. The 7E7-9's MTOW of 500,000lbs (similar to the A330-200) is the highest of the 7E7 family.

GE's GENX is an all-new engine being developed for thrust ratings of 55,000-70,000lbs; covering the higher thrust range of the CF6-80C2 for the 767-300/-400 and lower range of the CF6-80E1 for the A330. The main drive behind Boeing's 20% ASM cost reduction is in reduced fuel burn and lower maintenance costs. The GENX is being configured with a bypass ratio of more than 9.5:1 which will be its main contributor to reducing the 7E7's fuel burn. Tom Brisken, general manager for the GENX product line at GE explains the GENX will use proven architecture used in the GE90 and GP7000. "The GENX will have a two-spool design and there will be one basic engine with several thrust rating plugs, as used in the CFM56-5B and -7B. The highest rating of 70,000lbs should satisfy the requirements for the probable MTOW of 510,000lbs of the stretch aircraft."

The first 7E7 is scheduled to enter service in May 2008, and the first GENX will be run in April 2006 with certification following in mid 2007. The engine will undergo a flying test programme on GE's 747 testbed.

The GENX will incorporate several new technologies. These include a third generation composite wide-chord fan blade; the first and second generation blades being used in the GE90 in the initial 777-200 model and on the higher thrust GE90 used on the 777-300ER. The engine will have a single-stage 111-inch wide fan, four-stage LPC, 10-stage HPC, two-stage HPT and seven-stage LPT. The large turbine will be required to turn the large fan and achieve the high bypass ratio. "We will use 3-D aerodynamic blades throughout the engine, and these will be validated through component rig tests during the course of this year," says Brisken. "We will also use a new combustor, known as a twin annual pre-swirl (TAPS) combustor, which will have a lean air-to-fuel ratio which was already used in the Tech 56 programme. This will have the lowest emissions of all combustors, and will be 50% below CAEP IV standards. The combustor will also have lower thermal gradients between outlet nozzles and this will cause less thermal stress in the turbine, increasing its durability." In addition to these features, the GENX will also use a contra-rotating turbine, and will be the first time GE has used this on a commercial engine, and improves efficiency by reducing swirl losses at the HPT's exit.

The GENX is designed to have a 15% better specific fuel consumption (SFC) that the current engines it is replacing; the higher thrust variants of the CF6-80C2 and the CF6-80E1. Brisken says 40% of this improvement will come from a higher bypass ratio and a high pressure ratio, while the remaining 60% will come from better component efficiency within the engine. The 7E7's improved aerodynamics will combine with engine



The GENX will incorporate several new technologies. These include a third generation wide-chord composite fan, 3-D aerodynamic blades, a TAPS combustor and a contra-rotating turbine. The engine will have ratings between 55,000lbs and 70,000lbs thrust, a 112-inch diameter fan, bypass ratio of 9.5:1 and have a 15% lower specific fuel consumption compared to the CF6-80C2.

The Trent 1000 will be derived from the Trent 900. main technological features will be a low fan tip speed, reduced fan hub diameter, IPC air bleed and contra-rotating turbine. The engine will have a 112-inch fan diameter and bypass ratio of 11.0:1.

efficiency to give it a 20% lower fuel burn per seat than the 767-300ER.

With respect to reduced maintenance costs, GE is designing the GENX with a minimal number of airfoils and better materials in order to reduce shop visit costs. The engine on the 7E7-8 aircraft will have an installed exhaust gas temperature (EGT) margin of about 75 degrees centigrade, while the engine on the short range -3 variant will have an EGT margin of about 90 degrees. Brisken expects the GENX to have similar rates of EGT margin deterioration to the GE90, but should have longer on-wing intervals than the CF6-80C2, especially when the GENX's likely longer average flight cycle time is considered.

The GENX will also use 'intelligent engine technologies' which will provide a larger number of sensors on the engine to allow improved engine health monitoring.

The other engine offering for the 7E7 is the Rolls-Royce (RR) Trent 1000. RR has so far developed four other variants of the Trent. These are the Trent 700 for the A330, the Trent 800 for the 777, the Trent 500 for the A340-500/-600 and Trent 900 for the A380. The Trent family itself is a derivative of the RB211; the two families sharing the same three-shaft architecture.

Like the GENX, the Trent 1000 will have a high bypass ratio, afforded by its wide fan diameter of 112 inches. The Trent 800 has a fan diameter of 110 inches and the Trent 900 a fan diameter of 116 inches; the largest fan diameter in the Trent family.

The Trent 1000's wide fan will provide a bypass ratio of 11.0:1, which compares to the GENX's bypass ratio of 9.5:1. The Trent 1000's bypass ratio will naturally contribute to greater fuel efficiency and reduction in noise emissions. The engine will also have a pressure ratio of 50, which will improve its thermal efficiency over other Trent models.

The Trent 1000 is derived most closely from the Trent 900. The Trent 900's technology has been evolved for the Trent 1000. The Trent 1000's configuration will consist of eight intermediate pressure compressor (IPC) stages and six high pressure compressor (HPC) stages. The HPC will be driven by a single-stage high pressure turbine (HPT), the IPC driven by a single-stage intermediate pressure turbine (IPT) and the fan powered by a six-stage low pressure turbine. The Trent 1000 will incorporate the airfoil technologies developed for the Trent 900.

The Trent 1000 will be a single engine type with thrust ratings of 53,000lbs to 70,000lbs for the various 7E7 variants; with thrust ratings governed by a data entry plug.

Detailed design will start in 2005 with the engine's first run scheduled for the first quarter of 2006. Certification is expected in mid 2007, the same date GE is targeting for GENX certification. The Trent 1000's entry into service is expected in May 2008, making it ready to go straight into service with the first 7E7s if selected by its launch customer.

Boeing has set GE and RR aggressive targets for reducing fuel burn as a part of offering the 7E7 with 15-20% lower seat-mile costs against similar sized aircraft.

RR will use several technologies to enable it to meet these goals, and the first is a low-speed fan. Fan tip speed will be 5% slower than the Trent 900, and thrust will be maintained with this lower speed by reducing the diameter of the fan hub. This will increase the hub-to-tip fan blade length, allowing a higher ingestion of air, which in turn allows a slower tip speed. Lowering of tip speed reduces the power requirement from the turbine, and so improves engine efficiency.

Boeing has also designed the 7E7 as an E-enabled aircraft. Conventional aircraft have bleed air from the engine to provide cabin air pressure. The 7E7 will instead have an airframe mounted air bleed system.

The 7E7 will also have a higher than normal electric power requirement. Electrical power is conventionally taken from the engine's HPC, but RR says this can cause stability problems and with the Trent 1000 will take power from the IP spool instead. RR explains this will improve IPC stability, since it allows the engine to operate without handling bleed. The normal requirement to take bleed from the engine represents wasted power, and removing this requirement will improve fuel burn by the order of 6% on the short-range 7E7 variant, since fuel burn in the descent phase of flight is halved.

The Trent 1000 will also employ a counter-rotating HPT and IPT, improving turbine efficiency. This was first used on the Trent 900.

The Trent 900's fourth main technological feature is an improved engine health monitoring system. This will involve a dedicated computer on the engine that will provide real time or continuous information on a large number of engine parameters. The computer will recognise operational abnormalities. Mechanics will be able to download data at the end or during flight. AC