The 7E7 has been conceived to provide operators with a 15-20% lower unit cost than current generation similar sized aircraft. Charles Williams analyses how the various technologies employed in the 7E7 could give it a 0.50-1.90 cents per seat-mile cost advantage over current widebody twins.

7E7: change of the game?

The 7E7 is described by some as a 'game changer', reflecting Boeing's intention for the 7E7 to change the economic parameters of air transport. The 7E7 will be a 200- to 250-seat aircraft with both a higher revenue generating capacity and greater flexibility than the similar-sized 767-400 and A330-200, and have a cost per available seat-mile (CASM) similar to the 777 and 747-400.

Vital combination

If the combination of superior revenue generating capacity and lower operating cost is actually achieved, the 7E7 will indeed transform the economics of air transport, but how much change can airlines really expect from it?

The 7E7 comes in three variants, each with a longer range performance than similar-sized types offered by Airbus and Boeing. Each 7E7 variant's longer range capability means it will be able to carry a maximum payload further than its competitors can. The 7E7 will be able to carry a high or full payload compared to a less than full payload that the 767-400 and A330-200 are able to carry on route lengths in the latter part of their payload-range profiles. This means the 7E7 will be able to carry a larger amount of belly freight in addition to a full passenger payload, and thus provide it with a higher revenue generating capacity.

The 7E7-8/-9's ultra long-range performance will allow airlines to operate city-pairs with a route length exceeding 5,500-6,000nm non-stop that have previously only been possible with the larger types. These include the 747-400, A340-300 and 777-200ER, more recently the A340-500, and soon the 777-200LR. These all have tri-class capacities of at least 280 seats. The high level of demand required to fill these aircraft at an economic level, while offering at least a five-flights-per-week service, has so far excluded a lot of city-pairs from being operated as non-stop services. While the 7E7-8's and –9's range characteristics will make it possible for airlines to operate many of these routes non-stop, they will only be economically feasible if the aircraft offers the same CASM as types like the A340-500 and 777-200ER/LR.

The past 25 years have seen several technological developments that have made large reductions in the operating performance, efficiency and CASM performance of aircraft. These reductions can be analysed in context with the L-1011 and DC-10 and with the later-introduced 767-300/-400 and A330-200; the types that are similar in size to the 7E7-8/-9. The first development was the change to twin-engine aircraft, which reduced aircraft weight, fuel burn, engine-related maintenance costs and the cost of spare engine provisioning. The next development was the introduction of a two-man flightdeck, which dispensed with the flight engineer. This led to flightdeck commonality between aircraft types, realising further savings in crew training costs. Reductions have also been made in maintenance. Many of these have been achieved through efficiency gains by airline management, however, rather than technological evolution.

Several last bastions of aircraft operating costs remain unconquered. The basis for comparing the 7E7's economic performance are the A300-600R, 767-300, 767-400 and A330-200. The three remaining major cost categories that can be attacked are fuel burn, maintenance and aircraft capital or financing costs.

Maintenance and aircraft financing elements of total CASM can be diluted by increased aircraft productivity. Aircraft productivity of generated available seat-miles (ASMs) can be increased compared to the 767-400 and A330-200 by increasing cruise speed. This was already attempted with the Sonic Cruiser concept, but the gains made in productivity were small compared to incorporating the technological advances required.

The 7E7 has instead employed a carbon fibre structure and new engines to provide reductions in weight and fuel burn. Several technologies have also been used to reduce the cost of line and structural maintenance. The use of carbon fibre and reduction in the requirement for structural maintenance has a spin-off benefit for financing costs. It is expected the 7E7 will have an operating life at least 15 years longer than current aircraft. This has implications for a longer financing period and stronger residual value retention, both of which will have the effect of lowering the aircraft financing element of total CASM.

Technical description

There are three variants of the 7E7: the –3, -8 and –9. The –3 is a lightweight, medium-range aircraft that shares the same fuselage length as the –8. Configured in a two-class arrangement, both have a capacity of 289 seats, while in a tri-class arrangement they can accommodate 217 seats. This seat capacity makes the 7E7-3/-8 similar in size to the A300-600 and 767-300. The –3 has a smaller wing than the -8 and -9, and swept winglets to aid reduction in wingtip vortices and fuel burn. The -3's wingspan also allows the aircraft to utilise airport gates used by short- and medium-haul types.

Boeing has not yet stated what the –3's maximum take-off weight (MTOW) will be, but it will have a still-air range of

7E7-3, -8 & -9 SPECIFICATIONS

7E7 variant	-3	-8	-9
MTOW lbs	Not decided	480,000	500,000
Seats	289 (2-class)	217 (3 class)	257 (3 class)
Range nm	3,500	8,500	8,300
Fwd belly capacity	5 pallets	5 pallets	6 pallets
Fwd volume-cu ft	2,035	2,035	2,442
Aft belly capacity	12 LD-3	12 LD-3	16 LD-3
Aft volume-cu ft	1,896	1,896	2,528
Total volume-cu ft	3,931	3,931	4,970

3,500nm with 289 passengers (see table, this page). This will allow it to operate most city-pairs in the Asia-Pacific region non-stop, which is clearly one of the 7E7's target markets. This model has already been ordered by All Nippon Airways.

By comparison, the A300-600R has a range of 4,000nm when configured in a two-class arrangement of 266 seats, while the 767-300 has a range performance of about 2,300nm with 261 seats. The 7E7-3's maximum range of 3,500nm with a full passenger load means it will have a similar range at maximum payload to the 767-300.

The –8 will have a 25-foot wider span and MTOW of 480,000lbs. The combination of its fuel volume and fuel efficiency will give the aircraft a range of 8,500nm with 217 passengers (see table, this page). This compares to the A300-600R's range performance of about 4,200nm when configured with 230 seats, and the 767-300ER's range of 6,150nm with 217 seats. This clearly illustrates the 7E7-8's additional range performance.

The 7E7-8 not only has a much longer range than similar sized aircraft currently available, its range is also considerably longer than most other long-range types. The 747-400, for example, has a range of about 7,200nm with 416 passengers. The 777-200ER has a range of 7,770nm with 305 passengers, and the higher gross weight model of the A340-300 has a range of 7,300nm with 295 passengers. The A340-500, which has recently entered service with Singapore Airlines and allowed it to be the first airline to operate Singapore-Los Angeles and Singapore-New York non-stop, has a range of 8,500nm with a load of 313 passengers. Similarly, the 777-200LR will have a range of 8,865nm with 301 passengers.

The –8's ultra long-range capability allows it to operate most city-pairs in the world non-stop. Like the –3, the –8's full weight specification and payload-range performance are not yet available, and so its exact payload and performance advantages over current aircraft cannot be compared. It is already known, however, that the 7E7-3/-8 will have a belly freight capacity of five pallets in the forward section and 12 LD-3 containers in the aft section, giving it a total belly freight capacity of about 3,900 cubic feet (see table, this page). Once volume for passenger baggage has been accounted for, the 7E7-8 will have about 2,800 cubic feet remaining for freight. This is based on a requirement of about 5 cubic feet per passenger, although in some cases it is likely to be higher. This remaining volume when packed at a typical density of 7lbs per cubic foot gives the aircraft a capacity of almost 18,700lbs for additional freight.

This compares to a total belly freight volume of 3,200 cubic feet for the A300-600, which has about 2,060 cubic feet remaining for freight after space has been used for passenger baggage. The 767-300 has a total belly capacity of 3,300 cubic feet, and is left with about 2,200 cubic feet for additional freight after volume for passenger baggage has been used.

The 7E7-8 will thus have 740 cubic feet more for freight than the A300-600 on routes up to 3,500nm, the A300-600's range at maximum payload. At a density of 7lbs per cubic foot and yield of $0.50 per lb, this equals an advantage of about $2,200 for the 7E7-8. This advantage for the 7E7 will increase on longer routes, since the A300-600's available payload will reduce while the 7E7-8 will still have maximum payload capability.

The 7E7-9 will have the same wingspan but is expected to have a 20-foot stretch over the –8 series, being just seven feet shorter than the 777-200. This will give the 7E7-9 a tri-class seat capacity of 257. The –9 will have an MTOW of 500,000lbs and range of about 8,300nm. This aircraft is similar in capacity to the 767-400 and A330-200, but also the A340-200. The 7E7-9 will not enter service until about 2012, since Boeing needs to gain several years' operational experience with the –8 series.

The 7E7-9's range is much longer than the A330-200's 6,400nm and the 767-400's 5,600nm capability. Even the A340-200, originally intended to provide airlines with similar route opportunities to the 7E7, has a marginally shorter range capability of 8,000nm with 260 passengers, 300nm less than the 7E7-9.

The 7E7-9 will have a total belly freight volume of 4,900 cubic feet (see table, this page). This is expected to leave about 3,700 cubic feet of capacity for additional freight once the space for passenger baggage has been used.

This compares to the 2,600 cubic feet the A330-200 has available for additional freight and 3,100 cubic feet offered by the 777-200. Curiously, the 7E7-9 will be able to carry 16 LD-3 containers in the aft belly, while the 777-200 can accommodate 14. The 7E7-9 has a higher total belly capacity of just 300 cubic feet more than the 777-200, since both aircraft can accommodate six pallets in their forward belly section.

The 7E7-9 will therefore have 1,100 cubic feet more freight capacity than the A330-200 on routes up to 5,200nm, the A330-200's range with a full payload. This is about equal to an additional $3,800 for freight packed at 7lbs per cubic foot and attracting yields in the region of $0.50 per lb (see table, page 21). The 7E7-9's belly freight payload advantage will be larger on longer routes up to the distance where the 7E7-9 can carry a full payload.

Markets

The markets the 7E7 is aimed at need to be considered for the 7E7-3 on its own and the 7E7-8/-9 as a pair to serve long-haul markets. The three variants will offer airlines a flexible family to fulfil a variety of roles. The two different fuselage sizes, wide scope in range performance and technological features will allow the 7E7 to cater for a large number of markets.

The 7E7 is a direct replacement candidate for 767-200/-300/-400s, 757-200/-300s and A310/A300-600s operating high-density short- and medium-haul markets. The largest

Besides having lower fuel and maintenance costs and a longer operational life to allow lower financing charges, the 7E7 also has higher belly freight capacity than similar sized alternatives.

markets are North America, the Asia-Pacific, Oceania and China. Major airlines in the US, however, are showing a tendency to develop their fleets to smaller gauge aircraft, such as the 737-800, A320m and A321, operated at higher frequencies. The 7E7-3 will offer these carriers large reductions in CASM over smaller narrowbodies, however, on account of the 7E7's larger size and technological features that will generate lower cash operating costs per ASM. The 7E7 could thus influence the fleet development plans of these airlines.

The Asia-Pacific is a market dominated by widebodies. The majority are now at least the size of the A330-200 (285 seats in dual class), but there is still a high rate of growth and large number of new routes being opened.

China is a rapidly growing market, with an annual growth rate in available seat-miles (ASMs) of at least 10%. Chinese carriers collectively have a fleet of 750 aircraft. Forecast growth rates will increase treble traffic and capacity requirements over 20 years (see Financing China's aircraft bonanza, page 3). The majority of aircraft operated by Chinese carriers are narrowbodies, but Chinese airlines also have fleets of 767-200/-300s, 757-200s and A300-600s totalling almost 100 units, all of which will require replacement over the next 10-15 years.

The 7E7-8 and –9 have been developed with the same philosophy as the 767 and 777. With the introduction of extended range twin-engine operations (Etops) by the 767 and its ability to operate long distance routes economically with a seat capacity of 180-215 seats, the transatlantic and a few other smaller long-distance markets fragmented at a high rate during the 1980s and 1990s.

This development witnessed the change in flow of passengers away from long-haul routes that connected flights at major hubs to direct, point-to-point services. This resulted in the number of non-stop city-pairs being multiplied several times over the past 20 years.

Several aircraft have been developed to allow a similar proliferation of new routes across the Pacific. The rate of route development has been far slower than the transatlantic, since the 777-200ER and A340-500 have only been in operation for a few years, and the liberalisation of trans-Pacific bilateral air agreements has not matched that of the transatlantic.

Besides the issues of bilateral air service agreements and liberalisation of major markets, the 7E7-8/-9's long-range performance increases the number of low-density long-haul city-pairs whose operation has already been made economic by the 767-200/-300. Prior to the market entry of the 767-200/-300 and A310-300, airlines only had the DC-10-30 and 747-200 to choose from for long-haul operations. The high seat capacity and relatively high cash operating costs on account of three-/four-engine configurations and three-man flight crews meant these types had to be operated on high-density sectors. The 767's long range and twin-engine, two-man flight crew configuration made it possible to operate routes with thinner traffic volumes, and this fragmented the transatlantic market and a few others to a smaller degree. This market fragmentation and route proliferation has since continued with the A330-200/-300 and 777-200.

The 7E7-8/-9, while similar in size to the 767-300/-400, will make another group of ultra long-distance city-pairs economic to operate non-stop because of the combination of low cash operating costs, range capability of 8,500nm and seat capacity. The 7E7 is thus intended to have the same effect on ultra long-range markets operated by the 747-400, A340 and 777-200 that the 767-200/-300 had on markets dominated by the 747-200 and DC-10-30 in the early 1980s.

In its market studies for the long-range 7E7 models, Boeing identified 450 city-pairs that the aircraft could make economically viable. While these are all point-to-point sectors, they are not all ultra long-range. Vancouver-Sao Paolo, San Francisco-Manchester, Dubai-Taipei, Amsterdam-Taipei, and Auckland-Beijing are examples. These city-pairs are already served with connecting services, but it is forecast they would have enough passenger and freight demand to support non-stop services.

Boeing maintains these, and others, are not currently served as non-stop routes because the right aircraft is not yet available. That is, they are not economic with current generation aircraft. One reason for the economic transformation that new routes will have is that city-pairs with no direct service have no available freight capacity. Opening a non-stop route thus provides freight forwarders with the desired capacity, and it is easier to build freight volumes in the initial period than it is to generate passengers. The 7E7's higher belly freight capacity helps in this regard.

The 7E7-8/-9 are thus intended to appeal to several markets. These include the direct replacement and provision for growth where the 757, 767, A300/310 and A330-200 currently operate. They also include new markets the 7E7-8/-9 are anticipated to stimulate through their combination of size, range and low cash operating costs.

Technology

The 7E7 will combine several features to offer an aircraft with lower cash operating costs than the equivalent sized 767-300/-400 and A330-200. Boeing's objective is for the 7E7 to have 20% lower CASM than these current generation types.

The first feature is two all-new powerplants; the General Electric GENX;

The 7E7 is intended to have the same effect on ultra long-range markets operated by the 747-400, A340 and 777-200 that the 767-200/-300 had on markets dominated by the 747-200 and DC-10-30 in the early 1980s.

and Rolls-Royce Trent 1000. Their main contribution to lower operating costs is lower fuel burn, with a target of 20% lower consumption compared to the 767-300/-400 and A330-200.

The GENX will be developed to deliver 55,000-70,000lbs thrust and will have a 111-inch fan diameter. It will operate with a bypass ratio of 9.5:1.0. This will deliver an engine with a high propulsive efficiency, but other technologies are being used to increase the engine's aerodynamic efficiency. The engine will use 3-D aerodynamic blades throughout, a twin annual pre-swirl combustor to reduce thermal stress on the engine's turbine, and a contra-rotating turbine. All these will combine to deliver an engine with 15% lower specific fuel consumption (sfc) than the CF6-80C2/-80E1. Combined with the 7E7's superior aerodynamic efficiency, when combined with the GENX, the 7E7's different variants are expected to have about 20% lower fuel burn than equivalent-sized aircraft. The 767-300 burns about 3,900 US Gallons on a 1,200nm trip and about 11,300 US Gallons on a 3,500nm trip. The 7E7-3 and -8 might therefore be expected to use about 800 US Gallons and 2,300 US Gallons less respectively on these two trip lengths (see table, page 21).

The A330-200 consumes about 21,050 US Gallons on a 5,500nm trip, and so the 7E7-9 might be expected to burn about 4,200 US Gallons less on the same route length (see table, page 21).

The Trent 1000 will deliver 53,000-70,000lbs thrust for the 7E7 family, and use a 112-inch diameter fan. This will give the powerplant a bypass ratio of 11.0:1. The fan will also have a low tip speed on account of a reduced fan hub diameter. The lower fan tip speed will in turn allow the engine to have a smaller turbine and thus operate with better efficiency. The engine will also use counter-rotating high pressure and low pressure turbine sections, as well as similar types of airfoils used in the Trent 900 for the A380.

Like the GENX, the Trent 1000 is expected to provide the 7E7 variants with 15-20% lower fuel burn than their current equivalents on the same routes.

Another feature relating to lower fuel burn is that the 7E7 will not have a traditional air bleed system to provide cabin pressure as this decreases engine efficiency. The 7E7 will instead use an airframe-mounted air bleed system, which will reduce fuel burn, as well as use electrical power for its systems rather than power derived from its engines.

The 7E7 will also have a carbon fibre content exceeding 80%. Carbon fibre has several advantages, the first being that it is strong and light. This lightness will contribute to the aircraft's fuel burn efficiency over current aircraft. It will also help with respect to lower weight-related charges for navigation and landing.

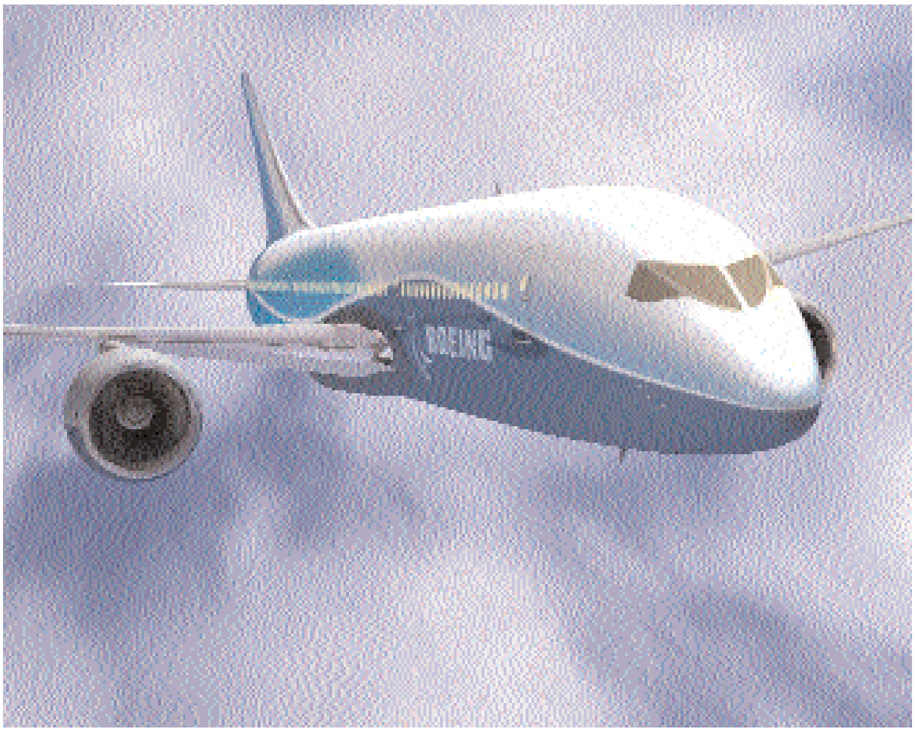
Another main benefit of carbon fibre is its strength and consequent resistance to structural damage and corrosion. This has to be considered in relation to aircraft maintenance, whose cost has several elements. These are line maintenance, base check maintenance, engine repair and overhaul, component repair and inventory management, and overheads associated with management and organisation.

Carbon fibre's resistance to structural damage and corrosion is expected to reduce MH used in base checks, in particular the heaviest check at the end of a base check cycle. This has an interval of five to six years on the 767. Not only will carbon fibre and composite materials reduce the number of routine MH required to perform structural inspections, they will also reduce the ratio of non-routine repairs to scheduled inspections. Non-routine ratio is typically in the region of 0.75-1.0 to routine MH in the first base check cycle. This increases with age and each base check cycle, and can typically reach about 2.5 in the third or fourth base check cycle in types like the 767. The use of carbon fibre and composites is not only expected to reduce the non-routine ratio in the first base check cycle, but is also expected to result in a lower rate of increase in the non-routine ratio as the aircraft ages. The 7E7 will thus not only consume less MH in its first base check cycle, but the MH consumed in subsequent cycles will increase at a slower rate and so be proportionately smaller compared to current generation aircraft.

One of the most advanced technological features of the 7E7 is the use of piezoelectric sensors in its structure to monitor physical damage. It is possible that, through a sophisticated health monitoring system, the sensors could be used to alert the operator to physical damage to the aircraft, as well as recommending repair techniques. Ultimately these sensors could be used to inform the operator when the aircraft requires a structural inspection, and so eliminate the need for structural inspections at regular intervals. These are every four to six years in the case of the 767 and A330.

This system would be revolutionary and further reduce MH consumption in the aircraft's base maintenance check cycle. The piezoelectric sensors, however, will not be used for this purpose in initial operation. The sensors will first be used in the areas of the aircraft most prone to physical damage and corrosion, which are the areas surrounding the cargo doors and landing gear attachments.

The 7E7 will also use an advanced health monitoring system. These were first used in the 757 and 767 to provide fault and failure messages via the aircraft's central maintenance computer on the flightdeck. Health monitoring systems are also used to relay maintenance-related messages and data to



The 7E7 family could have unit seat-mile costs up to 1.90 cents lower than similar sized current aircraft, but the majority of this advantage is due to lower financing charges. The 7E7's expected longer operating life and higher residual value retention will present a challenge of how it will be financed.

an airline's maintenance operation control centre via the aircraft communication and reporting system (ACARS). The aircraft health management (AHM) system is designed to monitor the aircraft's health during flight, and the information can be used to prepare mechanics and crews to deal with problems when the aircraft lands. Boeing started developing AHM in 2002 and is testing the system with a number of airlines. Singapore Airlines is the first carrier to have the system in operation. Later versions of AHM will provide a continuous stream of health monitoring data for an entire flight. Ultimately, the system is intended to reduce the time and resources used to clear technical problems and defects that occur during operation, thereby reducing the costs of line maintenance.

CASM performance

Fuel, maintenance and financing charges are the three cost elements that will effect a reduction in CASM for the 7E7. Other charges for flight crew, flight attendants, catering and passenger handling will be almost identical compared to similar-sized aircraft. The 7E7 may deliver some small cost savings from lower landing and navigation charges. These cannot be relied upon, however, since these are often based on MTOW and the 7E7 variants are actually heavier than most of their closest competitors.

The 7E7-3 should be considered against the A300-600R and 767-300/-300ER, the 7E7-8 against the 767-300ER, and the 7E7-9 against the 767-400ER, A330-200 and even the A340-200.

In examining the probable CASM of each 7E7 variant compared to these current generation alternatives, the type of operation has to be examined. Likely savings in fuel and maintenance have been examined and analysed in relation to the current generation of aircraft, with the assumption that costs in all other cost categories are equal. The possible differences in financing charges are then considered to see what additional impact this would have on total operating cost.

The 7E7-3 has been analysed operating a short- and medium-haul, or US domestic, operation with an average stage length of 1,200nm. As discussed, the 767-300's fuel burn on this route length is about 3,900 US Gallons, and so the 7E7-3 may have an 800 US Gallon lower fuel burn. The actual cash saving has become harder to establish in the past year, since fuel prices have fluctuated. The global oil price has declined again by about $10 per barrel in recent months. A fuel price of 80 cents per US Gallon has therefore been used, which would generate a saving of $640 for the 7E7-3 (see table, page 21).

Maintenance cost has several elements. A saving can be expected in line and base maintenance, but it is not clear if any reductions can be made from engine-related or line replaceable unit (LRU)-related costs. The combined cost per FH for line, base and heavy component maintenance for the 767-300 on an average flight cycle (FC) time of 3.0FH is about $645 (see 757 & 767-200/-300 maintenance costs, Aircraft Commerce, June/July 2004, page 22). The element of this that accounts for base maintenance checks, and thus the heavy structural inspection, is about $160 per FH. A reduction can be expected for this. Another reduction may come from line maintenance, but it is unlikely that much of a reduction will come from wheels, brakes, landing gear, thrust reversers and auxiliary power unit (APU). The 7E7 could eventually dispense with the APU and so realise another saving. A saving of $80 per FH might therefore be expected for airframe-related maintenance costs.

Another consideration are engine-related maintenance costs. The exhaust gas temperature (EGT) margins and expected on-wing life of the Trent 1000 and GENX are not very different from those of current generation engines. It is therefore assumed that engine reserves will be similar for the 7E7 variants and current generation equivalents.

On an average FC time of 3.0FH, engine reserves for the CF6-80C2 and PW4000-94 are in the region of $140 per engine FH (EFH). An allowance has been made for the 7E7, and a reserve of $125 has been assumed.

LRU and other costs for inventory management are in the region of $250 per FH for the 767-300 at an average FC time of 3.0FH. Little or no savings can be expected for the equivalent costs in the 7E7. Overall, the 767-300's total maintenance costs per FH on this type of operation are in the region of $1,445. On the basis of a saving of $80 per FH in airframe-related costs and a small reduction in engine maintenance costs, the 7E7-3's maintenance costs would be about $1,315 per FH. This would thus generate a saving of about $470 per FH for a trip of 3.0FH (see table, page 21).

Combined with a fuel saving, the 7E7-3 would have a total cash operating cost about $1,100 less than the 767-300. When the other costs of flight crew, flight attendants, and landing and navigation charges are added, the 767-300 has a total trip cost of about $12,400. The 7E7-3's costs will thus be about 9% less.

The remaining cost to consider is financing charges. Purchase discounts are common and can be deep, and a 20% discount of list price has been assumed to compare the aircraft on an equal basis. The 767-300 has a list price of about $120 million. Although it is not yet clear what the 7E7-3's list price will be, it is likely to be higher than the 767-300's. The difference in financing charges for the two aircraft is highlighted by analysing the difference in their monthly lease rate factors. A typical monthly lease rate factor of 0.9% might be expected for the 767-300ER, which equates to $864,000 per month.

It is not yet clear how the 7E7 will be financed, but its ability to operate for up to 15 years more than current aircraft and have a better residual value retention, is likely to mean that financing techniques used will translate into lower monthly lease rate factors for the 7E7. One example is where straight debt financing with a 50% balloon would allowed for the 7E7. Debt might be borrowed over 15 years and an interest rate of 5%. This would be on the basis that the 7E7 could be re-financed after this length of time for another extended period. Such terms on the 20% discounted price would result in a monthly debt repayment of $580,000.

These two monthly rates translate into financing charge trip costs of $11,400 for the 767-300 and $7,700 for the 7E7-3. Together with cash operating costs analysed, the 767-300 would have a total trip cost of $23,800 and the 7E7-3 a cost of $18,900; a total advantage of $4,900 for the 7E7-3 (see table, this page). These translate into CASMs of 7.4 cents for the 767-300ER and 5.5 cents for the 7E7-3.

The 7E7-3's lower cost of 1.9 cents per ASM is clearly a large saving for the aircraft, and one that will certainly alter the economics of short- and medium-haul operations. The majority of the difference, however, comes from the financing charge element and ultimately depends on the 7E7-3's actual financing terms.

The 767-300ER can be analysed against the 7E7-8 for long-haul missions with stage lengths averaging 3,500nm. In this case the difference in fuel burn saves about $1,800 for the 7E7-8.

Maintenance costs per FH are lower than for an average FC time of 3.0FH, and in the case of the 767-300ER are about $930 (see 757 & 767-200/-300 maintenance costs, Aircraft Commerce, June/July 2004, page 22). The only likely savings for the 7E7-8 are in the element for airframe-related costs, and again $85 per FH has been used. This takes the 7E7-8's maintenance costs to about $845 per FH, generating a trip cost saving of about $650 over the 767-300ER.

Again all other cash operating costs are assumed to be equal for both types, with the 767-300ER having a total of $25,000 and the 7E7-8 about $22,600.

Financing charges are calculated on the same basis and again this makes a difference of $7,200 for the 7E7-8. Total trip costs for the 767-300ER are in the region of $44,000, while totalling about $34,200 for the 7E7-8; almost $10,000 less than for the 767-300ER. These two translate into ASM costs of 5.8 cents for the 767-300ER and 4.4 cents for the 7E7-8. The CASM difference of 1.4 cents would clearly be something long-haul operators could not ignore.

The 7E7-9 has been analysed against the 767-400ER and A330-200. In this case it has been on a sector length of 5,500nm. The 7E7-8 and -9, however, will operate similar route lengths, their main difference being seat capacity.

A 20% fuel burn saving over the 767-400ER would generate a saving of about $3,100. The same maintenance cost parameters as used for the 7E7-8 and 767-300ER gives the 7E7-9 an advantage of $1,600 maintenance cost per trip, resulting in $5,000 and $4,500 lower cash operating costs over the 767-400ER and A330-200 respectively. Using the same financing costs parameters as the other analyses, but with a higher list price of about $130 million for the 7E7-9 and $126 million for the 767-400ER and A330-200, the 7E7-9 will have $8,000 and $10,400 lower trip financing charges than A330-200 and 767-400ER. The 7E7-9 will therefore have lower total trip of costs of $15,500 and $12,600 compared to the 767-400ER and A330-200. This this translates into the 7E7-9 having a CASM of 0.70 and 0.50 cents lower than the 767-400ER and A330-200.

7E7-3, -8 & -9 OPERATING COST & REVENUE DIFFERENTIAL TO COMPETITORS

7E7 variant	-3	-8	-9
Stage length nm	1,200	3,500	5,500
Competitor	767-300	767-300ER	767-400ER/ A330-200
Fuel burn reduction-USG	800	2,300	4,200
Fuel burn reduction	$640	$1,800	$3,400
FH maintenance reduction	$130	$85	$80
Trip maintenance cost reduction	$470	$640	$1,000
Trip finance charge reduction	$3,700	$8,560	$12,500/ $15,500
Total trip cost saving	$4,900	$11,000	$16,600/ $20,000
CASM saving for 7E7	1.90	1.40	0.70/0.50
Trip freight revenue advantage	$2,200	$2,200	$3,800

Summary

The analysed differences in CASM that the three variants of the 7E7 could offer over their competitors are clearly large enough to change the economic parameters of air transport. This assumes these differences in CASM, or similar differences, could be realised.

These savings also have to be considered against potential revenue capacity advantages the 7E7 might have. As discussed, the 7E7-3/-8 has about 740 cubic feet extra volume for belly freight than the A300-600, which could be worth about $2,200 in additional revenue. With the savings in operating costs of about $5,000 on a 1,200nm trip and up to $11,000 on a 3,500nm trip, the 7E7 would clearly transform the economics of operating such aircraft in medium-density markets. While the 767-200/-300 and A300/A310 have transformed several markets by making large numbers of city-pairs economically viable, the 7E7-3/-8 will take this a step further.

The 7E7-9's freight revenue advantage in the order of $3,800 over the A330-200 (and A340-200), as well as the 7E7-9's trip cost savings of $12,500-15,500 again will be hard for airlines to ignore.

This new level of economics will transform the viability of another group of city-pairs. Those with traffic volumes too small to be viable with the A340-500 or 777-200ER/LR are more likely to be viable with the 7E7-9. The 7E7-9 will be able to stimulate passenger and freight traffic and have a lower break-even point, thus increasing the number of city-pairs on which it could be deployed. AC