Commonality within a family range is the name of the game in aircraft marketing. The A330/340 and 777 families have battled it out for a decade, but there is no clear winner in overall firm sales. Can either family offer a clear economic advantage over the other?

Head to head: A330/340 versus the 777-200/-300

The introduction of the A330/340 and 777 families has transformed fleet planning for 250- to 380-seat aircraft. These competitors offer flexibility through design for a range of mission lengths and seat capacities. Cost reduction is achieved via commonalities. The A330/340 and 777 families are positioned to replace 250- to 300-seat medium- and long-range aircraft, and the 747.

Missions start with short- and medium-haul high-density operations in the US, trans-Asian routes, long-haul markets like the trans-Atlantic and ultra long-distance markets over the Pacific.

Several modern technologies have been included to improve efficiency. These are twin-engine design in most cases, extended range twin-engine operation (Etops) capability, and flightdeck and engine commonality.

A330/340

The A330/340 family provides tri-class seat capacities of 253 to 380 seats. The 253-295 seat and shorter-range end is supplied by the twin-engined A330-200 and –300 models. There is an overlap with the A330 and A340, but the longer-range end is provided by the A340 in the 262-380 seat bracket.

Sales of the smallest A340 model, the –200, have virtually stopped, while orders for the 295-seat –300 series have dwindled since the introduction of the longer-range 313-seat –500. The –500 and 380-seat –600 now account for virtually all A340 sales.

The A330-200 has picked up orders from major North American, European, Middle Eastern and African airlines which use it for medium-range and trans-Atlantic sectors.

The A330-300 has been acquired by airlines from the same regions, but half its customers are major Asian Pacific carriers. The A330-300 is used to serve high-density routes. The A330-300 it won many of its orders when the largest twin-engined aircraft available.

Qantas selected the A330-200/-300 to have the capability to operate regional Asian routes from Australia. “We have ordered the A330-200/-300 to replace our 767-200s and grow our 767-300 routes. This is a jump from a 200- to 250-seat aircraft to 300- to 340-seat aircraft,” says David Cox, Group General Manager Engineering Technical operations at Qantas. “We need larger aircraft than the 767 because frequencies have become saturated, and we have experienced high traffic growth in the past five years”.

The A340 has sold well to European, Asia Pacific and Middle East/African airlines, but has few North American customers. The aircraft provided many carriers with an alternative to the 747.

The A340-300 was followed by the larger 313-seat –500 model and 380-seat A340-600. The –500 allowed the A340 to match the range and capacity of the 777-200LR, while the A340-600 provides a direct 747 Classic replacement and alternative to the 777-300. The A340’s four engine design was conceived to overcome Etops limitations on ultra long distance routes. Twin-engined aircraft otherwise have a cost advantage. “We did not require four engines for the missions from Australia to north Asia we selected the A330 for,” explains Cox. “In this case a twin-engined aircraft had a cost advantage. Twin-engined aircraft have to fly a longer tracked distance to South America and Africa, and in this case a quad has the advantage.”

The first feature of the A330 and A340 is engine commonality between the A330 variants, the A340-200 and –300, and the A340-500 and –600. These three sub-groups, however, have three different engine types. The other prominent feature is the common flightdeck between all six models and the highly publicised advantage of cross-crew qualification (CCQ) this allows, aided by the fly-by-wire (FBW) flight control system.

CCQ has several advantages. It reduces transition training between Airbus FBW types, making it more economic for mixed fleet flying (MFF) with two types. MFF then allows more flexible pilot rostering and switching of crews between types at short notice. This, along with different aircraft sizes in the family, allows a closer matching of seat supply with passenger demand.

777 family

The 777 family has fewer types than the A330/340. The 777, however, has a narrower seat capacity range of just two types at 305 and 368 seats. There are several gross weight and range capability variants of the 777-200 and 777-300. Each gross weight variant uses a different thrust rating of the same engine. The highest –200 and –300 models, the –200LR and –300ER, use only the GE90-110/115, forcing carriers which already have lower gross weight Trent 800- or PW4000-powered models to use a different engine type.

Boeing’s graded gross weight variants present an alternative to Airbus’s twin-engined aircraft for medium-range missions and quads for long-haul operations. Both 777 models have been designed to accommodate gross weight growth for longer-range performance.

Many A340s have been acquired to operate ultra long-range routes. These include trans-Pacific and Europe-Asia missions. While the A330 has range capability for standard long-haul operations, most of these routes are operated by the 777-200.

Lower gross weight 777-200 variants are therefore heavy relative to the similarly sized A330-300. The 777-300 is the only twin-engined, medium-range aircraft with more than 350 seats. This makes it appropriate for high-density operations, while the A340-600 has been designed for long-haul missions.

The 777 family has won orders from major airlines in North America, Europe, the Middle East/Africa and the Asia Pacific. Total firm orders for the 777 have almost caught up with the A330/340. A notable success is that six major Asia Pacific carriers have ordered the 777-300 to operate high-density regional routes, while the A340-600 has yet to secure a single sale from the region.

The 777-200ER/LR has also won orders from 25 airlines, while the A340-500, has only three customers.

The 777's main feature is that two models have the same pilot type rating. This compares with the two type ratings of the A330 and A340. This means an airline operating the 777-200/-300 will have lower overall pilot training requirements than one operating the A330 and A340. Also, for most 777 variants an airline will use just one engine type. This compares to up to three types for the A330/340 family. This should aid a reduction in spare engine-related costs. The 777's twin design also means it will have lower engine overhaul costs and engine line replaceable unit (LRU) costs compared to the A340.

The 777's disadvantage is that it does not have a type to match the A330-200. This forces Boeing to offer the 245-seat 767-400, which has a different pilot type rating to the 777. Mixed fleet flying can be practised with a 767/777 fleet, and there are reduced training requirements for pilots who already have a rating for one type to gain a rating for the other. The training required to get a second rating is 11-15 days. This compares to 1-3 days for a pilot with an A330 or A340 rating to get a second rating for the other.

A second type will mean some costs for a mixed 767/777 fleet will be higher than for an A330/340 fleet. These will include LRU-related and possible engine overhaul related charges.

A330/340 & 777 markets

There are four basic markets for the A330/340 and 777 families. The first of these is high-density routes in North America. All major North American carriers have now selected the 777-200 or A330 to operate trunk domestic services.

The second market is high-density Asia Pacific regional routes. As a consequence aircraft types are the same size as or often larger than the A330-300 or 777-200. Many routes in the Asia Pacific region were served by the 747, and some still are. The 747 has been replaced by the 777-300 in many cases, or with smaller types like the A330, 777-200 or 767 where higher frequencies are possible or desirable. It is interesting to note that the A340-600 has not been selected for this role. A 1,800nm sector is representative for this market.

The third market is the trans-Atlantic and others with similar sector lengths. Examples are routes between North and South America, and between the Middle East/Africa and Europe. These routes are in the 2,500-5,500nm range, and have varying traffic densities. This makes all A330/340 and 777 models and the 767-400 contenders for this market. The longest routes in this group will exclude the A330-300 which will have limited performance on the longest trans-Atlantic sectors.

The fourth market is ultra long-range sectors longer than about 5,000nm. Most routes can be operated by the A340-600 and 777-300, which have range capabilities of 7,500 and 7,080nm. The longest sectors, and those with performance limitations, will be left to the A340-500 and 777-200ER/LR. These markets are mainly accounted for by trans-Pacific and Europe-Asia routes, but also some sectors from South Africa.

Family selection

Selection of either the A330/340 or 777-200/-300, with the possible addition of the 767-400, will be influenced by existing fleets, route structure, traffic densities, range requirements and the need for Etops capability.

Existing fleets of 767s or A320s will be particularly instrumental in an airline's decision making, because of pilot commonality. Many A320 operators later selected the A330 and A340, and a lot of 777 customers were existing 767-200/-300 operators.

There are exceptions to this. Since the 777's introduction it has been added to fleets of airlines which had already ordered the A330/340 and MD-11. These include Air France, Cathay Pacific, Thai, Malaysian, Singapore Airlines, Garuda and Korean Air.

Comparing the 767-400/777-200/777-300 and A330-200/A330-300/A340-500/A340-600 side by side reveals that either family, irrespective of the influence of other types in an airline's fleet, has cost advantages and disadvantages. These are likely to cancel each other out.

Revenue capacity

Revenue-related issues have an influence. This will be determined by differences in seat numbers, but also additional freight capacities.

In two-class configurations Boeing aircraft have a seat number advantage over their direct Airbus competitor *(see table, page 22)*. The 767-400 has 11 more than the A330-200, while the 777-200 has 40 more than the A330-300. The 777-300 is 32 seats larger than the A340-600.

In most cases Boeing aircraft tri-class configurations are 8-12 seats less than their direct competitor. The exception is the 777-200, which has a 10-seat advantage over the A330-300. Boeing argues, however, that its standard tri-class seat numbers are not comparable with Airbus's, since it has fewer first- and business-class seats in its aircraft.

Airlines will analyse competing types configured with equal numbers of first- and business-class seats. This will then reveal the number of economy seats, and seats in total.

The 767-400 has 20 first- and 50 business-class seats, while the A330-200 has 18 and 42 respectively. Boeing argues that the A330-200's economy class of 196 would have to be reduced to 173 for it to have the same number of premium seats as the 767-400, thus reducing the A330-200's total to 245. Boeing applies the same argument to the A330-300, saying that increases in premium cabins would bring the A330-300's total seat count down by 20 to 275, 30 less than the 777-200.

The A340-500's standard configuration has just 12 first-class and 42 business-class seats. These are 12 less than both the first- and business-class cabins in the 777-200ER/LR. The A340-500's total would thus be about 282 seats if it were configured with the same number of first- and business-class seats as the 777-200ER/LR.

The A340-600 has 12 first- and 54 business-class seats, 18 and 30 less than the 777-300. If the A340-600's first and business class cabins matched the 777-300's, the A340-600's total seat count would be reduced to about 340.

This reduction in economy and total seat numbers would raise the number of premium fares on the Airbus aircraft, but reduce total seats to lower than some Boeing competitors. Airbus aircraft would thus reach a load factor where frequency on a route would have to be added at a lower level of average daily passenger demand compared to their Boeing competitors. This difference would only be in the order, however, of 4-7 passengers. The difference in passenger-revenue earning capacities between direct competitors is therefore small when their cabin configurations are adjusted to have equal premium cabin sizes.

The 777-300's additional freight payload is 14,000lbs higher than the A340-600's. All other direct competitors have similar additional freight payload capacities. The 777-200 also has a 5,000-12,000lbs advantage over the A330-300 and A340-500.

Economic analysis

A comparison of the gross profit generating potential of the competitors should be considered in these markets. The gross profit each aircraft can generate is compared for a range of average daily passenger demands that would require between one and three daily frequencies. Daily frequencies will be determined by the load factor constraint which airlines generally set. Once the load factor constraint is reached, capacity is added by either

Air China is one of several carriers which ordered the A340 and subsequently switched to the 777 when it became available.

introducing a larger aircraft or by adding another frequency.

This analysis has assumed the load factor constraint to be 70%. Daily passenger volumes used are 180-500. Four analyses are made. The first is a US domestic operation with an average route length of 1,500nm. This includes the 767-400, A330-200, A330-300 and 777-200. The A340-500 is not included because it is designed specifically for ultra long-range missions. The A340-600 and 777-300 are assumed to be too large for this market. The aircraft in this analysis are assumed to be configured in two classes, using the manufacturer's standard dual class configuration. The 777-200 variant used in this analysis has a maximum take-off weight (MTOW) of 545,000lbs *(see table, page 22)*.

The second scenario studies all types, except the A340-500, on an intra-Asian route network with an average sector length of 1,800nm. Although the A340-600 is designed for long-haul missions, it is the 777-300's only competition from Airbus. This analysis reveals if the A340-600 has a serious cost disadvantage to the twin-engined 777-300. This will thus also reveal if an airline will suffer an economic disadvantage if operating an all-Airbus family for this market, despite the A340-600 being designed for a different type of mission. In this analysis it is assumed that the aircraft are to be configured in the same way as in the first scenario. The 777-200 model used in this analysis is the aircraft with an MTOW of 545,000lbs, and the 777-300 an MTOW of 582,000lbs *(see table, page 22)*.

The third scenario considers the trans-Atlantic and routes of similar lengths. All types except the A340-500 are included. The A340-500 is omitted because the lighter A330-300 can operate most of these routes more efficiently. The mission length used for this analysis is 3,750nm. It is assumed that aircraft are configured in manufacturers' standard tri-class configurations. The 777-200 and 777-300 models used in this analysis are aircraft with MTOWs of 580,000lbs and 660,000lbs *(see table, page 22)*.

The fourth scenario is the ultra long-haul market, which analyses only the A340-500, A340-600, 777-200LR and 777-300ER, using standard tri-class configurations, over a sector length of 6,500nm. These routes are limited to the trans-Pacific, Europe-Asia Pacific and many from South Africa. Longer routes in these markets will be confined to just the A340-500 and 777-200LR.

Gross profit potential

The basis for these analyses is to examine the gross profit generated by each aircraft over a range of passenger demand volumes. Comparison of gross profit for all types across a range of passenger volumes will thus reveal which type in a family generates the highest gross profit.

It will also reveal if one particular family has an overall advantage over the other.

Three basic elements will determine the gross profit at a particular passenger volume. The first is the maximum load factor constraint at which an extra frequency has to be added. This is assumed to be 70% for all cabins. Load factor constraints are usually lower in first and business classes. This can then force airlines to add frequencies at lower load factors to avoid passenger spillage in these cabins. Average load factors can be higher in economy cabins before the risk of passenger spill is reached.

The second element is average fare level. This is assumed to be equal for all aircraft types at the same level of average daily passenger demand. In this case the same portions of first-, business-, full-fare economy and different economy discount fares will have to be sold irrespective of passenger demand level and load factor.

Average fares, net of agency commissions, distribution and marketing costs are assumed to be $300, $325, $500 and $700 for the four scenarios.

The third element is aircraft direct operating costs (DOCs).

Aircraft DOCs

The DOCs included in calculating gross profit profiles for the aircraft are fuel, maintenance (including line, airframe, engine overhaul reserves, components and LRU inventory charges), total flight crew and flight attendant employment costs, navigation and landing fees, passenger catering and aircraft lease charges. Ground and airport handling charges are omitted.

Total annual costs of operation, and consequently trip costs, are influenced by aircraft utilisation and number of available seat-miles (ASMs) generated.

In the first scenario, assumed utilisation is based on 770 flight cycles (FC) achieved, consequently generating about 2,900 flight hours (FH) per annum.

The second scenario is based on a similar style of operation, although the longer average sector length will allow utilisations in the region of 720FCs and 3,200-3,300FC to be generated, depending on type and cruise speed.

The third scenario assumes 510FCs per year, generating higher utilisations of 4,400-4,500FH per year, again depending on type and cruise speed.

The fourth analysis generates the highest annual ASMS because of the sector length. An annual utilisation of 340FCs, and consequently 4,700-4,900FH, is assumed.

Fuel burns are based on the described sector lengths representing equivalent still

AIRCRAFT CONFIGURATION DATA

Aircraft type	767-400	777-200/-200LR	777-300/-300ER
Seats 2-class	304	375	451
Seats 3-class	245	305/301	368
MTOW-lbs			
Scenario 1	451,000	545,000	N/A
Scenario 2	451,000	545,000	582,000
Scenario 3	451,000	580,000	660,000
Scenario 4	N/A	750,000	750,000
List price-$m			
Scenario 1	126	160	N/A
Scenario 2	126	160	180
Scenario 3	126	170	200
Scenario 4	N/A	200	230

Aircraft type	A330-200	A330-300	A340-500	A340-600
Seats 2-class	293	335	359	419
Seats 3-class	253	295	313	380
MTOW-lbs				
Scenario 1	507,000	507,000	N/A	N/A
Scenario 2	507,000	507,000	N/A	807,000
Scenario 3	507,000	507,000	N/A	807,000
Scenario 4	N/A	N/A	807,000	807,000
List price-$m				
Scenario 1	123	134.5	N/A	N/A
Scenario 2	123	134.5	N/A	169
Scenario 3	123	134.5	N/A	169
Scenario 4	N/A	N/A	158.5	169

air distances (ESADs). Fuel price is taken at 65 cents per US Gallon, generating fuel trip costs of $4,000-4,500 for aircraft in the first scenario, but up to $20,000-27,000 in the fourth analysis.

Maintenance charges are based on an FH rate for all the major elements. These elements are based on the amortisation of costs for each element over the relevant interval. This provides total FH costs. Total FH costs for each type vary depending on mission length. This is largely explained by average FC time influencing engine reserves. Engine reserves are higher for the same engine operating shorter cycles.

Total costs are about $1,000-1,250 for the 767-400 and A330-200/-300, $1,100-1,300 for the 777-200, $1,100-1,150 for the 777-300, $1,300 for the A340-500 and $1,300-1,400 for the A340-600.

The A340's higher costs to the 777 are explained by the A340's four engines, which result in higher engine overhaul related and LRU charges. The 777-200's higher charges compared to the A330 are explained mainly by the higher airframe check and engine reserve costs.

Flight crew costs have some of the most complicated elements. Besides annual salaries, pilots are paid various benefits. All aircraft have a standard two-man flightdeck. Annual salaries for a standard two-man flightdeck are $164,000 for the 767-400 and A330-200, $170,000 for the A330-300, $175,000 for the 777-200 and A340-500, and $190,000 for the 777-300 and A340-600.

Costs of employment are also raised by employers' pension schemes and items such as family medical insurance. Airlines then also have the burden of training charges, meals, transport, uniforms and hotels where applicable. The need for hotels increases with longer routes because of the need for more layovers to provide crew rest after long flights.

These elements raise the annual salaries by a factor that rises with longer average mission length, but also according to environment of operation. The escalation factor applied is 1.2 for the US domestic operation, 1.25 for the intra Asian mission, and 1.5 for both long-haul scenarios.

Despite having standard two-man crews, aircraft will have to be rostered with supernumerary crew for flights longer than 8FH in the case of most airlines. Average crew size is therefore assumed to be two in the first scenario. This is raised to 2.3 in the trans-Atlantic operation and 4.0 in the ultra long-haul analysis.

Total pilot employment costs per aircraft, and so per trip, are then determined by the average number of FH a flight crew achieves each year, and so the number of crews per aircraft.

Annual FH achieved by crews each year will also depend on the airline's policy of MFF. Practising MFF should increase annual crew FH slightly, since pilots will be able to operate short-distance flights between long-haul sectors. The analyses here assume MFF is practised for the A330 and A340 and 777-200/-300. All aircraft types are assumed to have crew FH productivities of 650FH per year for all scenarios. The number of crews per aircraft is therefore about 4.5 for the US domestic mission and rises to 7.7 for the long-haul analysis.

The resulting trip costs for flight crew are therefore about $1,200 in the US domestic operation, rising to $1,400-1,700 for the intra-Asian analysis, $3,700-4,400 and $11,300-12,600 for the trans-Atlantic mission and ultra long-haul missions.

Flight attendant costs are less complicated than flight crew costs. Cabin crew remuneration is raised by pension schemes, transport, meals and hotels where required. Training costs are less than for flight crew. The used salary escalation factor for total employment costs is 1.2 for the US domestic operation, 1.25 for the intra-Asian mission, 1.3 for the trans-Atlantic analysis and 1.4 for the ultra long-haul scenario.

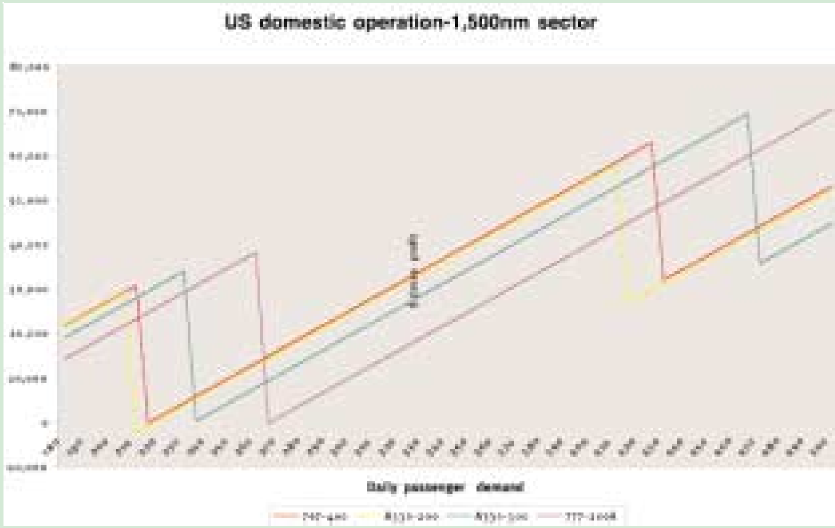
In all cases average crew member salary is taken as $37,000. Crew numbers per aircraft are 10 for the 767-400 and A330-200, 12 for the A330-200, 13 for the 777-200 and A340-500, and 16 for the A340-600 and 777-300. This generates costs per trip of $2,300-3,000 for the US domestic mission, $2,900-4,300 for the intra-Asian mission, $5,900-9,400 for the trans-Atlantic and $16,500 for the ultra long-haul analyses.

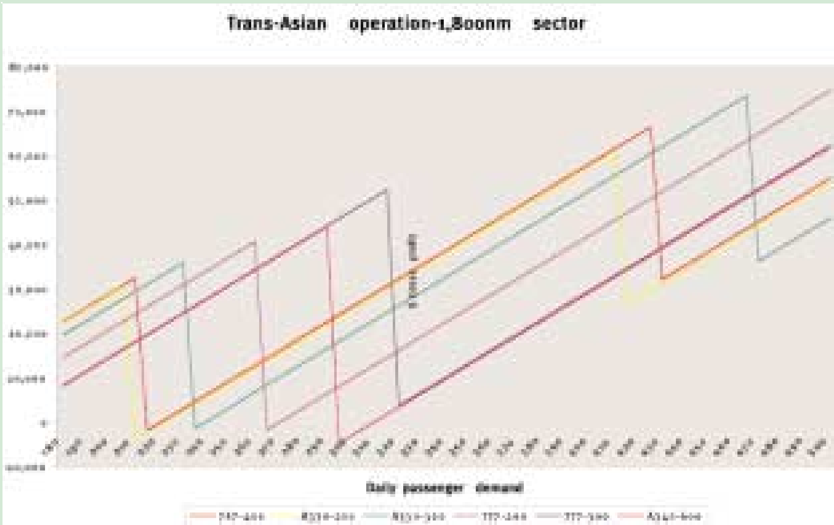
Landing and navigation charges are based on maximum take-off weights and an average landing fee of the aircraft at a range of airports in the appropriate regions for each analysis.

Catering costs are based on relevant seat configurations for each analysis. Rates per passenger are taken as $70 for first class, $60 for business and $12 for economy class in the first three analyses. First-, business- and economy-class rates are taken as $90, $70 and $17 for the ultra long-range mission.

Finance and lease charges will form the largest portion of total costs, although it will be a lower portion of total costs for longer sector lengths where higher annual utilisations are achieved. The list and so purchase prices of lower gross weight 777s will be lower in the first two scenarios compared to the higher gross weight models used in the long-haul missions *(see table, page 22)*. This cost element is based on a 20% discount of list price for all types and a monthly lease rate factor of 0.9%.

This then generates a monthly lease rate of about $900,000 for the 767-400 and $1.3 million for the 777-300. Aircraft lease rate trip costs are $14,000-18,600 for the US domestic operation, and rise up to $37,000 and $40,000 for the A340-500 and 777-200LR in the ultra long-haul analysis.





Trip costs

Total trip costs for the US domestic analysis are $32,400 for the 767-400 and virtually the same for the A330-200, and are close in all categories. They rise to about $35,200 for the A330-300 and are $39,900 for the 777-200. The 777-200's higher charges compared to the A330-200 are a combination of maintenance costs, one more flight attendant, catering costs and in particular lease charges. The higher lease charge is attributed to the 777-200's $25 million higher list price. The A330-300 and 777-200 have similar fuel burns.

The longer trans-Asian mission of 1,800nm generates higher trip costs of $35,900-43,900 for the same aircraft, $50,100 for the 777-300 and a $50,300 for the A340-600. Costs in all categories, except lease charges, are similar between direct competitors. This illustrates how purchase price discounts and financing terms are influential in determining final aircraft selection.

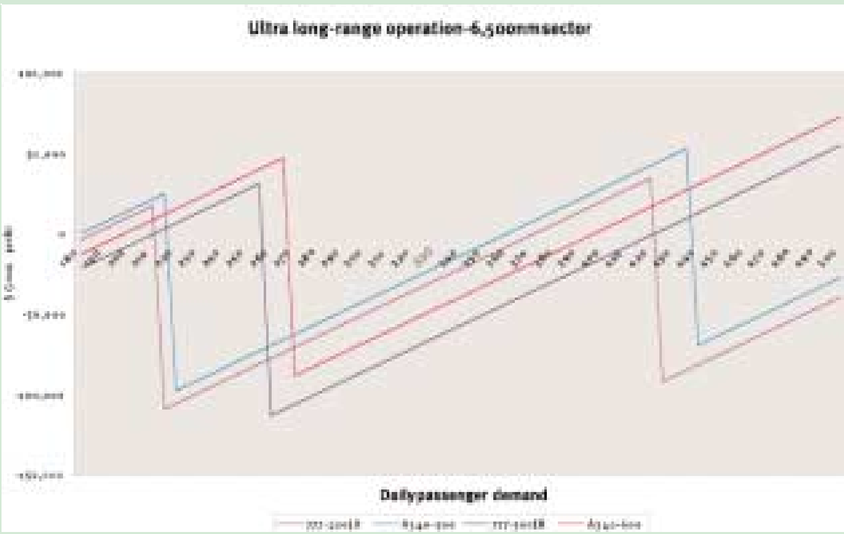
Trip costs for the same six aircraft in the trans-Atlantic operation are in the order of $58,000-85,000. Again, the 767-400 and A330-200 have similar costs, but there is a difference of about $10,000 between the A330-300 and 777-200, in the A330's favour. The difference between 777-300 and A340-600 is less, at about $4,500 in the A340's favour. This is, however, mainly due to the 777-300's higher seat count and so larger catering charges. In this scenario a higher gross weight 777-200 is used than in the shorter missions, thereby increasing the relative difference in lease costs between the 777-200 and the A330-300. Overall, the 777-200 has a 10% higher seat cost than the A330-300 with standard tri-class configurations. Using Boeing's lower seat count 275 for the A330-300 raises its cost per seat close to the 777-200's level.

On the ultra long-haul mission, trip costs for the A340-500 and 777-200LR are in the region of $126,000 and $129,000. The A340-500 has about 23% higher fuel burn and 20% higher maintenance cost. The A340-500 overcomes these disadvantages because of its $40 million lower list price. The 777-300ER has a trip cost of $148,000, $9,000 higher than the A340-600. The 777's low fuel and maintenance cost advantage is offset by its higher list price.

Gross profit

The similar costs and same revenues of the 767-400 and A330-200 are clear from the fact that their gross profit profiles almost overlap on the US domestic operation *(see chart, this page)*. The 767's slightly higher capacity means it can cater for a higher daily passenger demand at the same frequency, but is otherwise almost identical to the A330-200. The 777-200's higher trip costs are reflected by its gross profit profile being lower than the A330-300's.

The 777-200's 40 seat higher capacity



allows it to generate a higher profit at a single frequency than all other types at a twice-daily operation. Over most levels of passenger demand the 767-400 and A330-200 generate the highest contributions, while the A330-300 is second best.

In the intra-Asian analysis the 767-400 and A330-200 again generate the highest margins over most levels of passenger demand, with the larger types only coming into their own when an additional frequency has been added for a smaller type. The relative difference between the A330-300 and 777-200 is the same as in the US domestic operation *(see chart, this page)*. "We had no Etops limits for our Australia-Asian routes, so a twin-engined aircraft was preferred. When we make aircraft selections we look at the optimum type in 1,000nm mission length intervals. We needed a medium-range aircraft, and the 777-200 is too heavy for our requirements, as well as having too many seats. It is better for inter-continental missions," says Cox at Qantas. "The A330-200/-300 provided the most flexible option in terms of capacity because of the two sizes. The 767-400 could have provided another size, but this would have meant introducing two different types."

The 777-300 and A340-600 have virtually equal trip costs, but the 777-300 has a 32-seat higher standard seat capacity. The 777-300 is therefore able to operate at one frequency lower than the A340-600 while traffic continues to grow, and so generates a total higher margin. At the same frequency, the 777-300 and A340-600 generate equal gross profits. Overall, the A330-300's efficiency compared with the 777-200 means the A330-200/A330-300/A340-600 combination may provide the most economic solution. The Boeing option, however, is a better choice at levels of passenger demand where they can operate at one frequency less than the Airbus competitors.

In the trans-Atlantic scenario, all Airbus options have higher gross profit profiles than their direct Boeing competitors *(see chart, this page)*. These differences are explained by the higher trip costs of the Boeing aircraft at the same passenger demands, and so revenues. At two daily frequencies, the A330-200 and A330-300 generate the highest margins between demands of 270 and 410 passengers. The A340-600 and 777-300 continue to generate the highest margin, for daily passenger volumes between 220 and 270, after frequencies for all other types have been raised to three. If Boeing's lower seat counts for the A330-200, A330-300 and A340-600 they would generate the same gross profits at levels of passenger demand where they could operate at the same frequencies as shown in the chart. Frequencies would have to be increased at a lower level of passenger demand than shown in the chart, increasing trip costs and so reducing gross profit. In contrast the direct Boeing competitor of each Airbus type would be able to maintain the same frequency for a higher level of passenger demand and revenue, without increasing trip costs.

In the ultra long-range scenario the A340-500 and 777-200LR are almost identical *(see chart, this page)*. This is because of their virtually equal trip costs. The 777-200's eight-seat higher capacity would allow the same frequency to be maintained for a slightly higher level of passenger demand with traffic growth. Adding a frequency will reduce gross profit generated to a loss.

If the A340-500 were configured with 282 seats, as suggested by Boeing, the A340 would have to increase frequency at about 22 passengers less than the 777-200LR. Once a second daily frequency is added the losses incurred by two daily flights are substantial. These would increase until average daily passenger demand increased beyond at least 350. The A340-600 and 777-300ER could both then fill this gap up to 260-270 daily passengers. This would still leave a large gap where losses would be incurred at this fare level for a band of passenger demand of 270-340. On longer routes where only the A340-500 and 777-200LR could operate losses would be incurred over a wide range of passenger demand, unless average fare achieved was higher. AC