**Fleet planning has been transformed by aircraft families. The relative differences in operating costs of competitors is not enough to indicate which is a better fleet choice. Gross profit derived from passenger revenues analysed for each family as a whole for different operating cost conditions is analysed for the A320 family and 737NG/757-200 mix.**

# Happy families: the A320 vs 737/757

Aircraft selection today involves choosing a fleet mix, rather than several types. In the case of 100-200 seat narrowbody aircraft, airlines can choose between the A320 family and a mixed 737/757 fleet, with the additional possibility of the 717. The two choices have types of similar size. Comparing their operating costs will not provide a complete picture of their economic efficiency. Each family's revenue generating capacity and ability to generate gross profit over a route network should be assessed.

## Aircraft families

It is only since 1990 that Boeing has offered a true family of narrowbodies. The arrival of the 737-500 completed the 108-146 seat 737-300/-400/-500 family. The 201-seat 757-200 provided airlines with a wider range of seat numbers to satisfy varying traffic volumes.

The 737-300/-400/-500 was improved on with the launch of the three-member 108-160 737NG family in 1994, which was later added to in 1997 with the 177-seat 737-900.

The A320 family was not truly completed until 1993 with the launch of the 124-seat A319, and was further added to in 1999 with the 107-seat A318. This widened the family's seat capacity range to 108-186.

The advent of aircraft families revolutionised airline fleet planning. A large number of the world's major narrowbody fleets now comprise some or all of the members of either the A320 or 737NG families. This compares to the mixed fleets they were operating 8-12 years ago. Lufthansa, for example, in 1989 operated the 737-200, 737-400, 727-200 and A310-200 on short-haul European routes. This has now been simplified to an A319/20/21 and 737-300/-500 fleet. Many other airlines have followed a similar strategy of fleet simplification.

## Family appeal

There are three main reasons why aircraft families have an advantage over a selection of different aircraft types.

The first, and most important, advantage is that aircraft seat numbers can be matched with variation in

*Families of aircraft have improved efficiency of fleet planning by increasing an airline's ability to match capacity closer to demand with the use of one basic aircraft type, rather than three or four. The main cost advantages are derived from more efficient pilot productivity and spare parts commonality.*


*Boeing offers the 737/757 as an alternative to the A320 family. The 737/757 option offers a wider seat number capacity, but has the disadvantage of two different aircraft types which require pilots to have different type ratings if mixed fleet flying is to be practised. While many US and European carriers have selected an A320 family fleet, few have chosen the 737/757 option.*

demand. Demand varies during the day, during the week and from season to season. The four members of the A320 or 737NG families can be scheduled to meet peaks and troughs of demand. This is an alternative to having fleets of three or four different types.

Since the A320 and 737NG family members all have the same pilot type rating, an airline is able to re-schedule types for each route at short notice when the inevitable spikes in demand occur. This is possible without changing pilot schedules and rosters, since a sudden change from an A321 to an A320 or A319 can be made without flight crews having to be re-rostered. This is not possible in mixed fleets if pilots do not have multiple type ratings.

Where airlines have a mixed fleet, pilots can only be re-scheduled onto other types at short notice if they have the ratings for different types on their licences. Multiple ratings lead to high training costs and extra downtime for this training, which leads to poor pilot productivity. Aircraft families avoid high training costs and improve pilot utilisation.

The second advantage of a family involves parts and component commonalities. Because of component commonality, a family fleet is effectively larger than the alternative of several smaller fleets, each of which would require a separate inventory of parts unique to it. A larger fleet of a single type reduces inventory cost per aircraft, which will be reflected in lower airframe maintenance costs.

The third advantage of an aircraft family is that it also reduces ground crew and equipment costs.

Overall, fewer aircraft types and an aircraft family mean reduced cost and scheduling complexities, while meeting variations in demand and avoiding passenger spill.

## 737/757 mix

The 757-200 and -300 have 201 and 243 seats (US two-class configuration). They are a small family, but the largest narrowbodies. The 757-200 and -300 have the same pilot type rating.

Where the 737-900 or A321 are not large enough, the 757 will have to be considered.

Another consideration is the 717, which is just two seats smaller than the 737-600. The 717 is a single family member and so will raise costs without increasing the ability to better match supply with varying demand, although other variants may be added. The 717 is therefore unlikely to be considered by airlines requiring a family of aircraft. Most 717 customers are those that have needed a 100-110 seat aircraft in isolation, rather than a family.

## Family economics

Economic efficiency is not just one of low unit seat-mile operating costs, but rather the gross profit difference between passenger revenue and aircraft trip costs over a range of passenger demand on a route that an aircraft can generate. It is also the gross profit that a fleet can generate on a route network.

There are several reasons for this. The first is because the closest competing aircraft from different families do not have the same number of seats, and so have different revenue generating capacities. For example, the A320 and 737-800 are the close in size, but the 737-800 has a 12-seat advantage (US two-class configuration) over the A320.

Airlines plan for average load factors in the 65-70% range to avoid passenger spill. Passenger demand is variable and there is a relationship between average load factor and the probability of passenger demand being 'spilled', that is all seats on a flight having been sold. The probability of spill is virtually zero up to a demand equal to a load factor of about 65%. A load factor constraint of 65% means no demand will be spilled. Some airlines are prepared to plan for a higher average load factor of 70%, or even higher. Spill will erode average yield per seat for load factors above 65%.

A constraint of a maximum 65% load factor means an airline can fill seven or eight more seats on the 737-800 than with the A320. This means the break even revenues, passenger fares and load factors for the two will also be different. Each airline will impose its own constraint of maximum load factor.

The larger of the two might also be expected to have higher trip but lower unit available seat-mile (ASM) costs.

A comparison of the gross profit generated by each aircraft with different passenger demand or numbers up to the airline imposed maximum load factor gives a broader picture of how two competitors compare.

## Traffic volumes

Over the short term, spikes in demand can be catered for by scheduling larger aircraft, if they are available. Over the long term higher passenger demand will be accommodated by a larger type at the same frequency, or by using smaller types at a higher frequency if practicable.

As the average passenger demand reaches the point where load factor is 65% then capacity has to be added with larger aircraft or by increasing frequencies of smaller aircraft if there is to be no risk of spilling passengers. Since seat numbers and 65% load factor seat numbers of each type in the A320 and 737NG families are different, the point at which additional capacity has to be added is also different. For example, A320 frequencies will have to increase to four flights once average passenger volumes exceed 295. A fourth 737-800 frequency will not have to be added until passenger numbers are 315. The 737-800 will therefore have an advantage between 295 and 315 passengers, since it will incur the cost of three flights compared to the A320's four.

## Gross profit profile

Analysing one aircraft in isolation, as average passenger demand increases, would see gross profit of passenger revenue, less trip costs, rising. This is until passenger demand was at such a level that frequency had to be increased by an additional flight to avoid passenger spill.

At this point trip costs would increase by the amount of one additional flight, while passenger revenue would increase by only one fare. Gross profit would fall, but then rise as average passenger numbers increased over time with growth. A comparison of gross profit plotted against passenger numbers would then reveal a saw-tooth curve for an aircraft, with a drop in gross profit each time an extra flight frequency was added and a rise thereafter as revenues increased while trip costs remained constant.

If passenger load factor constraint is kept at 65% the saw-tooth profile will be straight, since there will be no spill and average yield will not get eroded. If a higher load factor is planned for then there will be some spill, and eroded yields at higher load factors will see the saw-tooth profile for each aircraft flatten over demands equal to a 65% load factor.

Each aircraft type has a different passenger volume at which its gross profit is highest, which is equal to the maximum load-factor constraint imposed by the airline. All types of a family can then be analysed for the same passenger demand, with each one's saw-tooth gross profit curve being plotted on the same chart. This will reveal for a range of passenger demand which type and at what frequency will generate the highest gross profit.

With large passenger demand on a route the issue is complicated. An airline will have the option of scheduling each aircraft type at a different daily frequency. That is, an average passenger volume of 360 can be carried by six A318 flights, five A319 flights, four A320s or three daily A321 operations. Peaks and troughs of traffic and business passengers during the day and week mean airlines have the choice of scheduling larger types or more frequencies during the busy periods.

## Gross profit comparison

There are many variables when analysing a gross profit saw-tooth profile for an aircraft family. These are related to cost structure, and passenger fares and

### A320 FAMILY, 737NG FAMILY & 757 FAMILY SPECIFICATION & CHARACTERISTICS

| AIRCRAFT TYPE | A318 | A319 | A320 | A321 |
|---|---|---|---|---|
| Seats-European | | | | |
| Business | 67 | 91 | 102 | 130 |
| Economy | 39 | 32 | 48 | 51 |
| Total | 106 | 123 | 150 | 181 |
| Flight time (mins) | 103 | 103 | 103 | 103 |
| Block time (mins) | 123 | 123 | 123 | 123 |
| FC/year | 1,505 | 1,505 | 1,505 | 1,505 |
| FH/year | 2,584 | 2,584 | 2,584 | 2,584 |
| ASMs/year ('000s) | 95,718 | 111,069 | 135,450 | 163,443 |
| Seats-US | | | | |
| First | 8 | 8 | 12 | 16 |
| Economy | 99 | 116 | 138 | 170 |
| Total | 107 | 124 | 150 | 186 |
| Flight time (mins) | 94 | 94 | 94 | 94 |
| Block time (mins) | 109 | 109 | 109 | 109 |
| FC/year | 1,890 | 1,890 | 1,890 | 1,890 |
| FH/year | 2,961 | 2,961 | 2,961 | 2,961 |
| ASMs/year ('000s) | 121,338 | 140,616 | 170,100 | 210,924 |

| AIRCRAFT TYPE | 737-600 | 737-700 | 737-800 | 737-900 | 757-200 |
|---|---|---|---|---|---|
| Seats-European | | | | | |
| Business | 68 | 88 | 106 | 117 | 128 |
| Economy | 39 | 36 | 54 | 60 | 67 |
| Total | 107 | 124 | 160 | 177 | 195 |
| Flight time (mins) | 101 | 101 | 101 | 101 | 107 |
| Block time (mins) | 121 | 121 | 121 | 121 | 127 |
| FC/year | 1,505 | 1,505 | 1,505 | 1,505 | 1,505 |
| FH/year | 2,533 | 2,533 | 2,533 | 2,533 | 2,533 |
| ASMs/year ('000s) | 96,621 | 111,972 | 144,480 | 160,734 | 174,279 |
| Seats-US two-class | | | | | |
| First | 8 | 8 | 12 | 12 | 12 |
| Economy | 100 | 120 | 148 | 165 | 181 |
| Total | 108 | 128 | 160 | 177 | 193 |
| Flight time (mins) | 92 | 92 | 92 | 92 | 98 |
| Block time (mins) | 107 | 107 | 107 | 107 | 113 |
| FC/year | 1,890 | 1,890 | 1,890 | 1,890 | 1,890 |
| FH/year | 2,898 | 2,898 | 2,898 | 2,898 | 3,087 |
| ASMs/year ('000s) | 122,472 | 145,152 | 181,440 | 200,718 | 221,130 |

*The A320 family has extensive commonality and been chosen by most major European flag carriers, Air Canada and several major US airlines. The family's disadvantage is that its largest member has less than a 200-seat capacity. Airlines with high passenger demand on a route will have to consider the 757 or a small widebody if more frequencies with the A321 are not possible.*

revenues. These are not just different for every airline, but also for every route in an airline's network.

The gross profit profile analysis for the A320 family and 737/757 fleet mix should be examined over a range of passenger demand that reflects prevalent levels for many North American, South American, European and Chinese routes, since these are the largest narrowbody markets.

These passenger demands should therefore be enough for one airline to require 2-9 daily flights with the A318 or 737-600 at a load factor of 65%. This is 140-400 passengers available per day to the airline on the route. This is also equal to 2-5 daily flights with either the 737-900 or A321.

The actual passenger demand at which another daily frequency for each aircraft has to be added depends on the load factor constraint the airline imposes to avoid passenger spill. In this analysis maximum passenger load factor constraint has been set at 65%, so there will be no spill, and saw-tooth profiles will be straight *(see charts, pages 18 & 19)*. This will result in frequencies or larger aircraft being added for a lower passenger demand compared to higher load factor constraint. A higher load factor constraint will have the opposite effect, and so result in lower aircraft trip costs for a given level of passenger demand.

We have analysed the two competing families on a sector length of 600nm, which is representative of many European and North American route networks.

## Cost base

The costs of operating aircraft on a route network with an average route length of 600nm vary by geographic region. European unit costs of operation are generally higher compared to US domestic services. There are five main reasons for this: style of operation and factors affecting aircraft utilisation, landing and navigation fees, seat number differences in the same aircraft, cabin service level, and aircraft lease rates and finance charges, and finally flight crew and labour costs.

US carriers have an advantage over European carriers in all but the final category. The US suffers from less airspace and airport congestion than Europe. US airlines therefore can achieve shorter block times for the same route lengths and higher ASM productivity per block hour as a result. They can also have shorter turnaround times between flights. The shorter block times mean US airlines will burn less fuel.

For the 600nm it is assumed US carriers can complete 5.4 sectors per day. At 350 available days per year this is 1,890 flight cycles (FC) for the A320 and 737NG *(see table, page 13)*. Flight and taxi times, and block hours in the US are also shown.

In Europe, congestion and longer turn times will increase flight and block times to 103 and 123 minutes, and only allow an average of 4.3 sectors per day. The number of block hours and FCs generated are shown *(see table, page 13)*.

US carriers also configure aircraft in first and economy seating, while European carriers have business and economy seats. This means an aircraft operating with US airlines will have a few more seats than under a European operation *(see table, page 13)*.

Some major European airlines also use variable geometry seats in business class. This changes a six-abreast seat arrangement to a five-abreast one in the A320, 737NG and 757, so reducing the seat numbers by a number equal to the number of rows of business-class seats. The number of business-class seat rows can also vary.

The seat numbers and FC generated by each type generates a certain number of ASMs for each aircraft type *(see table,* *page 13)*. It is this ASM productivity that determines the cost efficiency of the aircraft. Generally, aircraft are about 6% less productive in Europe than the US.

Fuel burns for European operations will be higher due to the corresponding flight and block times. Fuel prices in this case are assumed to be 65 cents per US Gallon in the US and Europe.

Maintenance costs used are a total cost per flight hour, and take into consideration all elements: line; airframe checks; major components; line replaceable unit inventory ownership; repair charges; and engine shop visits. All these elements have their costs charged on a time and material basis and apportioned into a total cost per FH.

It should be noted that rotable and repairable inventory ownership costs are sometimes included together with finance or lease costs.

Congestion also means European airlines pay the price of higher airport landing and handling and navigation charges. Airport charges are zero in some cases in the US. The analysis has been made on the assumption that all 737NG and A320 family members will have a $200 landing fee in the US, but $650 in Europe. Navigation charges will be on a sliding scale of $280-$340 for the A320 and 737NG in the US and Europe.

Service levels of European airlines are also higher, which incur higher catering costs. These are assumed to be $3 per seat in the US and $11 per seat in Europe.

Many US airlines have higher labour costs, especially pilot salaries. Pilot salaries in the US are more consistent, however, between airlines than they are in Europe. Average annual captain and first officer salaries are about $138,000 and $95,000 for US airlines for A320 and 737 sized aircraft. In Europe these are lower, at $82,000 for captains and $49,000 for first officers. Pilots flying all types in the same family are assumed here to be paid the same salaries. It is also assumed the salary scales do not differ between the A320 and 737NG.

US pilots also tend to achieve fewer block hours (BH) per year (about 600) than do Europeans (about 650). This will mean more crews are required per aircraft in US fleets.

These average productivities will be improved upon with the effects of pilot commonality in either A320 or 737 selection. The average pilot productivities have therefore been increased by 50 BH to 650 and 700 per year in the US and Europe for both types.

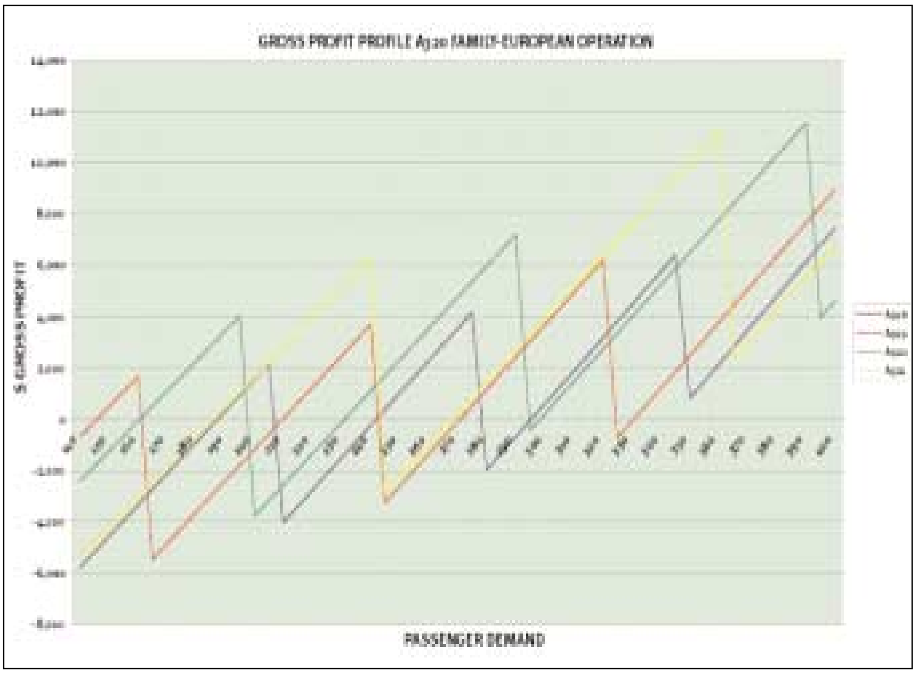
Operating the 757 in addition to the 737NG should result in some efficiencies, but 757 pilots are assumed to achieve 625 BH in the US and 675 BH in Europe.

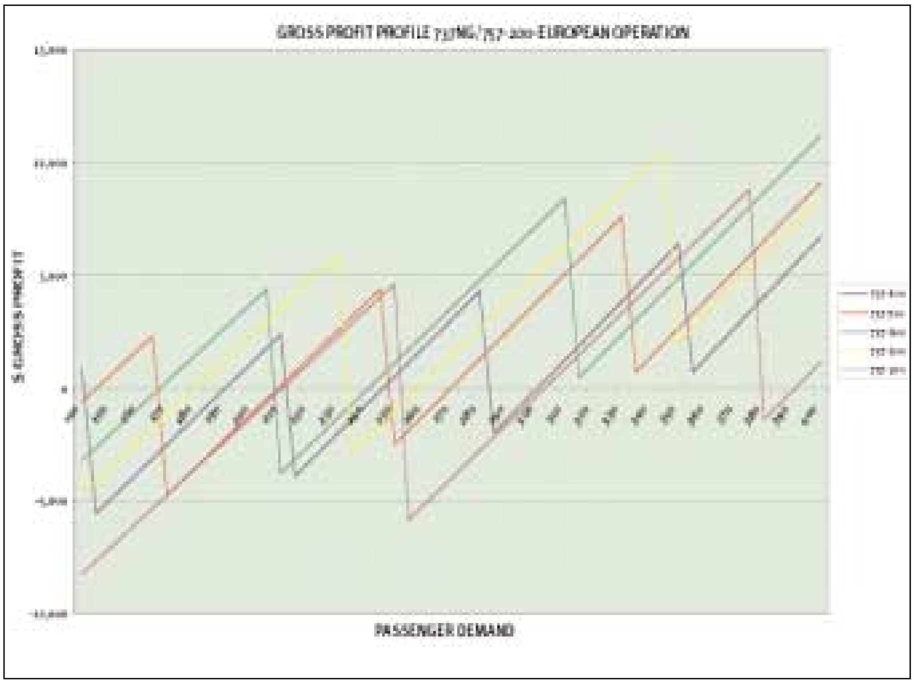
Flight crew salaries are escalated by allowances, pension contributions, subsistence, uniforms, transport, accommodation and training. The same pilot ratings in the A320 and 737NG families will increase BH productivity and lower training costs. The escalation factors used are 1.45 of salary in the US and 1.60 in Europe.

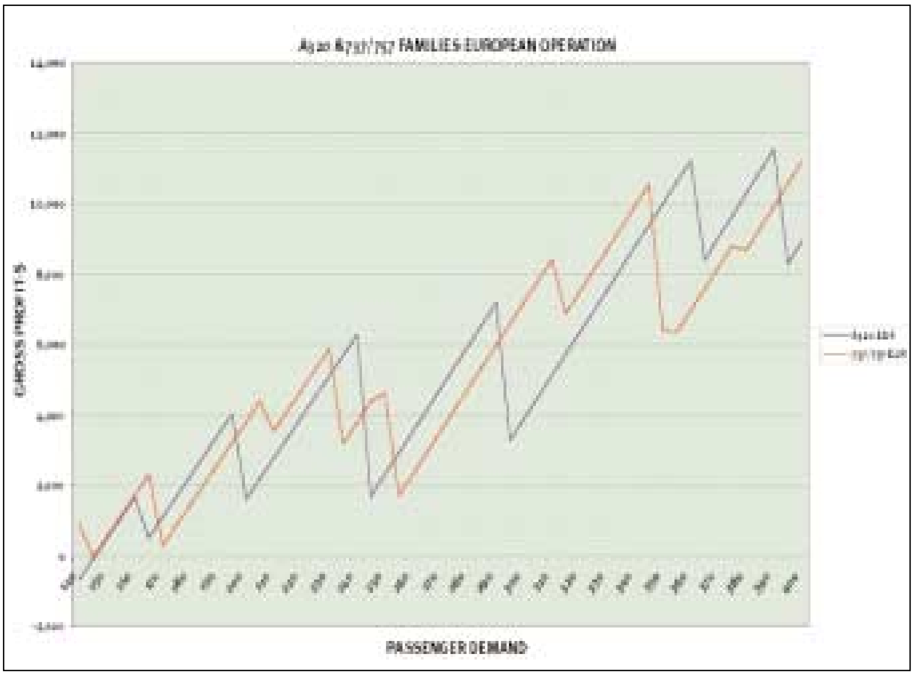
Flight attendant numbers and salaries will be similar in the US and Europe.

For the same original purchase price, US airlines also enjoy relatively lower financing rates than European carriers. In recent years the tax depreciation allowances available to many European airlines have been reduced by their governments, while the US continues to offer favourable tax depreciation to US airlines. This and new financing techniques, such as Enhanced Equipment Trust Certificates (EETCs) has allowed US airlines to achieve monthly lease rate factors in the region of 0.8%. European rates are generally 0.2% higher at 1.0%.

A 20% purchase discount on list price is assumed for airlines from both global regions. Both manufacturers have a list price range for each aircraft. This reflects different options for take-off weight, engines and other items. The median price for each aircraft has been used here.




## Revenue

While the dynamics of costs are complex, revenues and average fare per seat are more complicated.

Factors affecting the average fare on a route include competition forces, market maturity, the proportions of business and leisure travellers, the number of fare classes, the discount level on each fare class, the proportion of total passengers on each trip buying each fare level and flight frequency.

Frequency has generally stimulated total traffic and increased the proportion of business traffic on a route. Therefore average fare would be expected to increase as an airline increased frequency level, since the proportion of business passengers would increase.

Frequency, however, also goes in hand with competition levels and maturity. Most markets served by European and major US markets are now mature and frequencies are already high. Average fare rises will therefore be relatively low in response to increased frequency. Rises to additional frequencies also begin to reduce after about five or seven daily frequencies have been added on short-haul routes. Additional frequencies above this number are usually offered on the highest-density routes, such as London Heathrow-Paris Charles de Gaulle.

This analysis has used a simple fare profile for the US and European analyses for illustrative purposes. In the European scenario the average fare starts at $117 for a twice daily frequency and rises to $136 for eight services per day, the rise in the average fare being similar for each additional flight. The corresponding range of average fares is lower at $94-111 for the US analysis.

## Gross profit profile

The relation between average fare, passenger volume and aircraft trip costs determines the gross profit saw-tooth profile for each aircraft type.

A pronounced profile indicates average fare per seat is high compared to average seat cost. Gross profit will increase as passenger demand rises.

Lower average fares and reduced margins between fare and seat cost flatten saw-tooth profiles and bring profiles for aircraft in a family closer together. This will make one or two types in a family dominant over others.

More pronounced profiles tend to make more of a case for operating smaller types, while flatter profiles on a mature route with high traffic volumes and frequencies and low fares favour larger aircraft. Larger aircraft have lower costs per seat and break-even load factors and so will make profits on a wider range of passenger volumes.

## A320 vs 737NG/757-200 mix

The gross profit profiles shown do not include indirect operating costs such as ground crew. Only costs which reflect the relative efficiencies of two families are included. The gross profits will therefore be further reduced by cost elements not included. Addition of non-aircraft related costs could reduce the steepness of gross profit saw-tooth curve profiles. The gross profit comparisons still indicate which aircraft types and family will be the most efficient under the conditions described.

The aircraft have more pronounced saw-tooth curves in the US than in Europe. This is because of the lower trip costs the aircraft have in the US, despite lower fares also being charged. Because of tougher competition fares in the US are lower than in Europe. Lower fares in the US compared to those used would then reduce gross profit profiles on many routes compared to those shown.

Both families in both scenarios are close *(see charts, page 18 & this page)*. First, however, analysing the members of each family first, as the passenger demand on the sector increases, the larger aircraft become more dominant because they generate the highest gross profits for the majority of passenger demand levels. Larger aircraft will have lower costs per seat and higher seat numbers before reaching the 65% load factor constraint at which capacity has to be added. This implies that the A318, A319, 737-600 and 737-700 are more likely to have the better gross profit profile and be required on routes with smaller passenger volumes for each airline and where fares are higher. Small types are also required during troughs in demand.

The 757 rarely has the highest profit profile, either in Europe or the US. This is explained by it having 13% and 17% higher trip costs than the A321 and 737-900 in Europe and 17% and 20% higher costs in the US. The 757's cost per seat is equal to aircraft between the A319 and A320, or 737-700 and 737-800.

The 757 is theoretically confined to longer routes which an airline operating the 737-900 may feel requires a larger aircraft type. Most 737NG customers, however, have not ordered the 737-900, and so the 757-200 still has an important role to fill in providing the right size of aircraft on a route network. The 737-900 is the best performer out of the 737NG family on several ranges of passenger demand. The 737-800's gross profit profile, however, seems to dominate. The A321 dominates the A320 family.

Since no family dominates, fleet choice will first be determined by the type which generates the highest gross profit at the expected level of passenger demand on each route, and then the best solution across the route network. AC