With most airlines selecting aircraft from one manufacturer, the winner in the narrowbody market race could retain the crown for the next 20 years. Many major airlines have defected to the Airbus camp in the past five years. Will this be enough to make Airbus number one?

Can the A320 take Airbus to the top?

Ten years ago no one in their wildest dreams would have thought Boeing could be toppled from its number one slot by Airbus. But then the same was thought about Pratt & Whitney (P&W) 20 years ago and McDonnell Douglas (MDC) ten years before that. History has proved that no empire is invincible. So is the stream of orders won by Airbus from traditional Boeing customers in recent years setting the stage for the unthinkable to happen?

The biggest market is for aircraft in the A320/737 size bracket. The benefits of commonality are now so important that most airlines operate aircraft supplied by just one manufacturer. It follows, then, that the manufacturer which secures the largest share of narrowbody customers over about a 10-year period is likely to dominate the market for several decades to come. For Airbus the A320 family could be the key to market domination.

Boeing's woes

Boeing has achieved some significant milestones during the 1990s. Its 737 has reached an unprecedented sales volume, which could prove impossible to beat. And the 767 is established as the dominant aircraft across the Atlantic. Even sales of the 777 temporarily caught up with its rivals, the A330-300 and A340, despite the 777 being launched three years later. Finally, Boeing secured exclusive-supplier deals with two of the US's and the world's largest carriers.

But not everything in the Boeing garden is rosy. The 737-300/-400/-500s have a low technology image compared with the A320 family. So Boeing set out to find a solution that would kill this negative perception and at the same time offer an improvement in economics. The company opted to improve its existing 737 family, partly due to customer preference, rather than take on a new family. The result was the 737-600/-700/-800/-900 (737NG).

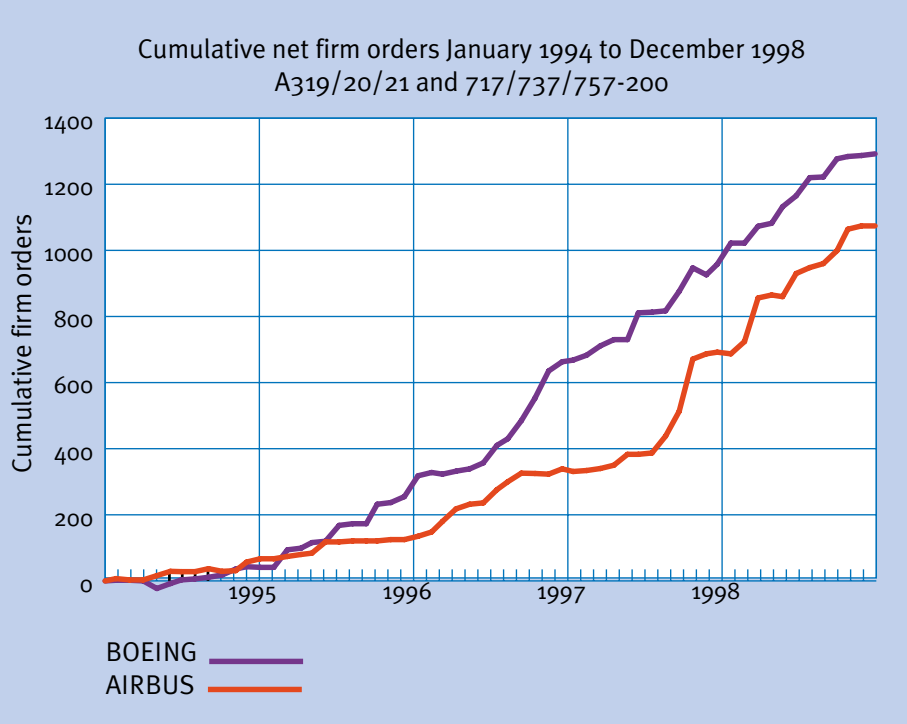
Market divisions

This solution only partially worked, since major orders have subsequently been lost to long-time Boeing customers British Airways, US Airways, United, the Taca Group, British Midland, Aer Lingus and Sabena. Many other long-time MDC customers have taken the Airbus route, including Alitalia, Finnair, Swissair and Austrian. The majority of western Europe's flag carriers were major Boeing or MDC customers and are now Airbus narrowbody customers. Most have acquired majority Airbus fleets during the 1990s.

Northwest, United, US Airways, Canadian and Air Canada in North America have also shown a preference for Airbus narrowbodies, as have major South American carriers Mexicana and the Taca Group.

The aircraft orders placed in the past few years have indicated a polarisation of many of the world's airlines into all or near-all Airbus and Boeing customers. Delta and American are the leading all-Boeing operators. Others include KLM, Varig and Southwest.

The customers that Boeing lost to



The A320 family has allowed Airbus to win a large number of customers in recent years that had previously been Boeing or McDonnell Douglas customers for decades. This recent success could pave the way for Airbus' domination of the market.

Airbus in recent years would have provided the former with substantial spare parts provision, training and customer support revenue for at least another 25 years.

The problem with the 737NG is that it has several apparent weaknesses. One is a lack of flightdeck commonality with the 777. Boeing opted to maintain a conventional flight control system, rather than put in a fly-by-wire (FBW) system and an identical flightdeck to the 777. Boeing therefore missed the opportunity to have the same flightdeck commonality advantages that Airbus claims it has between the A320 and A330/340 families. This feature has had further benefits for Airbus. The A340-500, with which the A320 shares appreciable flight crew commonality benefits, has been able to offer a longer range than the 777. So when the 777-200X's development stalled, Airbus was able to seize the orders that Boeing wanted.

A320 family vs 717/737/757

The single airframe-supplier factor, the A320 family's appeal over and above the 737NG, the A340-500/-600's range performance and the extensive commonality throughout most of the Airbus product line, have all made a large contribution to the A320 family's success in recent years.

The A320 family's cumulative sales, net of firm orders and cancellations *(see chart, page 31)* in the five years between 1994 and 1998 have been less than those of the competing Boeing aircraft. However, the three A320 family members are catching up with the 737 and 757; more A319/20/21s have been sold than their six Boeing competitors in the two years since January 1997.

The particular Airbus and Boeing aircraft that actually compete with one another is not always clear-cut. For example, the A321 was launched as an alternative to the 757-200. But the A320's design limited the A321's size, so it was 15 seats smaller than the 757. The A321 is at an advantage because of its much lighter airframe. Also, the 757 is a totally different aircraft to the 737NG.

Boeing launched the 737-900 as a lighter alternative to the A321. The 737-900 is 15 seats larger than the -800, but still nine less than the A321, and 24 seats smaller than the 757. The 737-900's size was capped because more seat rows would have required more emergency exits and consequently disproportionately more weight and less efficiency. A new narrowbody family to replace the 737 would have avoided this problem.

The 737-900 is, at least for now, the limit of the 737's development. Some would argue that the 757-200 is in a different class and does not compete with the A321. The answer to providing more seats than the A321 is still, therefore, the 757-200.

The 757-300 is much larger at 240 seats. Although it has commonality with the 757-200, the -300 does not compete with the A320 family. The chart of cumulative sales therefore excludes the 757-300.

The 737NG is accompanied by the smaller 717. This aircraft is just two seats smaller than the 737-600. Both therefore compete with the 107-seater A318, the latest A320 family member.

The four members of the A320 family therefore compete with the 717, four members of the 737NG family and the 757-200; six aircraft in all, or five Boeing aircraft in some opinions. This immediately puts the Boeing option at a disadvantage, not only because of the larger number of aircraft types covering a similar seat capacity, but because there are three basic Boeing types against one basic Airbus type.

The basic specifications of the two competing groups of aircraft *(see tables, pages 34 and 36)* show their capabilities. The peculiarity of the Boeing option is the extreme closeness in size of the 717 and 737-600. Yet the 717 is being marketed as a lightweight alternative to the 737-600.

The A318 has been offered recently as an Airbus alternative. Despite securing letters of intent to order from ILFC and Trans World Airlines, Airbus has yet to formally launch it.

Family economics

An increase in traffic on a route eventually requires an increase in aircraft capacity. A family of aircraft allows flight frequency on a route to be increased by one, while seat capacity is only increased by a small percentage. That is, rather than adding a second A321 flight to an existing route, two A318s or one A318 and a A319 can be flown instead. This increases seat capacity from 186 to 214 or 231, rather than doubling it to 372.

This incremental growth in capacity means operating costs are increased by the smallest degree and in the closest

AIRBUS NARROWBODY AIRCRAFT SPECIFICATION AND PERFORMANCE DATA

AIRCRAFT TYPE	A318	A319	A320	A321
MTOW lbs	135,600	162,000	169,800	196,200
MZFW lbs	116,840	125,700	134,500	157,600
OEW lbs	85,930	89,700	92,200	105,800
APS lbs	88,790	92,995	96,020	110,460
Maximum payload lbs	28,050	32,705	38,480	47,140
Seats	107	124	150	186
Freight payload lbs	6,115	7,285	7,730	9,010
Engine types	2 x PW6000	2 x CFM56-5B6	2 x CFM56-5B4	2 x CFM56-5B3
Range nm-with maximum payload	1,000	2,400	2,120	1,900
Range nm-with full passenger load	2,000	3,500	2,900	2,650

possible proportion to traffic and revenue. The existing traffic can still make a gross profit contribution to overheads, despite there being an additional aircraft on the sector. The larger aircraft, the A321 in this case, can be used on another route in the network.

This family concept works best when all aircraft types are variants of the same basic model. Although differing in fuselage capacity and weight, variants of a family have similar performance and trip costs.

The differences in operating costs between members of the A320 and 737 families are fuel burn, weight-related charges, cabin crew and finance and insurance charges.

Variants of aircraft families have similar maintenance, spare parts and inventory costs and can, depending on airline policy, have equal flight crew costs. Because some costs are equal, use of a larger aircraft incurs a smaller increase in costs.

An increase in traffic with existing capacity leads to a rise in gross profit. This gross profit then falls because an additional aircraft has to be added once traffic has grown beyond existing capacity.

Gross profit therefore continues to rise and fall in a sawtooth pattern as traffic grows and capacity increases in increments. The recovery of gross profit will be fastest every time capacity is added for the aircraft family that has the smallest increase in seat size between family members and the smallest rise in trip costs. This is where introducing larger, different types can cause too high an increase in costs. The manufacturer that can offer the widest spread of seat numbers in the same aircraft family should therefore have a greater advantage.

The 757 gives Boeing an advantage, since traffic can grow from the 737-900 to the 757's 201 seat capacity. This requires a change in aircraft type, however, In the Airbus alternative an A318 or A319 would be required after traffic outgrew the A321's 186-seat capacity.

Since the 757 is larger and heavier than the 737, it will have relatively high fuel burn per seat, higher maintenance costs, user charges and finance and insurance costs and a different pilot salary scale. The 757 will also require its own inventory and supply of spare parts.

The 717 has some of the same disadvantages against the 737-600. The lighter 717 will have lower fuel burn, engine-related maintenance charges, weight-related user charges and flight crew and finance costs than the 737-600. Despite all of this, many airlines will seek to maintain a common 737 fleet.

Fuel economy

The combination of operating costs will determine which aircraft family or mix of types will provide the most economic solution for an airline.

Fuel burns for the A319, A320, A321, 737-700, 737-800 and 757-200 were compared on return sectors from Chicago O'Hare to Detroit (261nm) and Denver (789nm). The aircraft and engine variants were as indicated in the tables.

On both routes the A319 and A320 had 5.5% and 10.5% higher fuel burns per seat than the 737-700 and -800. With typical fuel costs of 55 cents per US Gallon, the A319 and A320 are 0.07 cents and 0.11 cents per available seat-mile (ASM) more expensive to operate than their counterparts on the shorter route and 0.07 cents more expensive per ASM on the longer sector.

The difference between the 757-200 and A321 is 0.09 cents on the shorter sector and 0.03 cents on the longer route.

These differences in fuel economies are put in perspective by the fact that the fuel costs are 0.75–1.25 cents per ASM and airlines in the west have cost targets of 7.0–10.0 cents per ASM. Carriers in less developed regions of the world have costs of 4.0–6.0 cents per ASM.

These small differences in fuel burn will give an overall advantage to the Boeing option, but can be counterbalanced by larger and more flexible costs, such as finance charges.

Maintenance costs

Maintenance is difficult to quantify for most airlines; it will be equally hard to estimate for the new 737NG.

The A320 has a system of equalised A and C checks, performed every 500 and 4,000 flight hours (FH). These checks consume about 135 and 1,530 manhours respectively, although there is variation across the fleet.

The aircraft also has five-year and nine-year structural checks. Most A320 maintenance facilities are beginning to perform their first nine-year checks. The most experienced are Air France and TAP Air Portugal. These two checks consume about 14,000 and 21,000 manhours, including painting, interior work and modifications.

The A320 has a landing gear overhaul every 25,000 flight cycles, which would coincide with the nine-year check. The exchange fee is about $170,000. The average on-aircraft time is about 7,000FH. Wheels and brakes are similar to other aircraft of its size.

A simple method to budget for line replaceable unit (LRU) spare parts is that they are leased and the operator pays an additional power-by-the-hour (PBH) exchange and repair fee for guaranteed supply of parts from a spare parts supplier.

"The economics of a lease and PBH system is that the lease rates vary between 1.0% and 1.6% per month of capital cost per month," explains Brian Barrett, assistant general manager commercial at Airline Rotables, Stansted, UK. "The current 737s have the cheapest parts. The A320 and 737NG have similar component costs, although the A320 inherently has parts that are 10–15% more expensive than the 737-800."

Despite its success, Airbus is still far less established in the aftermarket than Boeing. The former has caused some resentment in the spare parts aftermarket by controlling the supply of all material. This will not continue with the A320 because of the large numbers of that aircraft in operation. Spare parts should therefore become cheaper in the future.

Airline Rotables and other parts providers lease components and offer exchange and guaranteed supply on a PBH basis for the 737 and A320 families. The PBH cost for the service of providing, exchanging and repairing parts on a guarantee for the A320 is about $165 per FH. Operators would have to budget additionally for the leasing of parts.

At a typical flight hour : flight cycle ratio of 1.45FH, engine reserves for the A320 could be budgeted at about $270 per FH. Overall, aircraft in the A320 family could be expected to have maintenance costs of about $750 per FH, excluding the leasing or purchase of LRU inventory.

The 737NG has a maintenance schedule that has been simplified from the current generation aircraft. The 737NG has introduced a weekly check into its schedule and has reduced the A check multiples from 16 to 10. The number of C check multiples has also been reduced by one to six. The sixth C check is the aircraft's structural check and is performed at 24,000FH, or about every eight to nine years. It is therefore equivalent to the A320's nine-year structural check.

This simplified system has increased the 737NG's overall check intervals. The design of the aircraft has also reduced manhour and material consumption.

Taking routine manhour estimates from the MPD and typical escalation factors and non-routine ratios used by airlines or maintenance providers, the number of manhours needed to complete checks can be calculated. This includes labour for interior refurbishment and cleaning and modifications.

The 737NG could be expected to have very similar FH maintenance costs for line and A checks. The 737NG also has similar manhour consumptions and FH costs for C6 structural checks as the A320's nine-year check.

The 737NG's C check pattern does not have an equivalent to the A320's five-year check. For this reason the 737NG's C check is heavier than the A320's. The A320's five-year check consumes about 14,000 manhours and overall it will use more manhours in its combined C and five-year checks than the 737NG's C checks. This gives the 737NG the advantage.

The 737NG will also have an LRU replacement and repair PBH cost of about $135 – $30 per FH less than the A320. The two differences of LRU and check costs could give the 737NG an overall maintenance cost advantage of up to $70 per FH. This difference is equivalent to about 0.15 cents per ASM between the A320 and 737-800.

The 737NG will have similar FH costs for other components, including landing gear, wheels and brakes and APU, to the A320. The 737NG's engine maintenance reserves are assumed to be similar to the A320's, since the two share the same basic CFM56 engine.

The CFM56-7's more recent design, however, could mean it will take greater benefit from CFMI's vast in-service experience. The CFM56-7 also has a larger exhaust gas temperature (EGT) margin and so could achieve longer on-wing times than the CFM56-5B on the A320.

BOEING NARROWBODY AIRCRAFT SPECIFICATION AND PERFORMANCE DATA

AIRCRAFT TYPE	717-200	737-600	737-700	737-800	737-900	757-200
MTOW lbs	121,000	144,500	154,500	174,200	174,200	255,000
MZFW lbs	100,500	114,500	121,700	138,500	138,500	186,000
OEW lbs	70,790	81,360	83,790	90,560	93,610	127,962
APS lbs	73,640	84,495	87,390	94,765	98,180	132,922
Maximum payload lbs	26,860	30,005	34,310	43,735	40,320	53,078
Seats	106	108	128	162	177	201
Maximum freight payload lbs	5,130	7,865	8,070	10,525	4,035	11,873
Engine types	2 x BR715	2 x CFM56-7B22	2 x CFM56-7B24	2 x CFM56-7B26	2 x CFM56-7B27	2 x RB211-535E4
Range nm-with maximum payload	1,680	2,080	2,080	2,000	2,000	2,725
Range nm-with full passenger load	2,000	2,840	2,860	2,880	2,280	3,600

Flight crew

Flightdeck commonality and the ability to reduce training costs and to operate mixed fleet flying with the larger types can have an influence on the narrowbody family selected.

An airline which already has the 757 may find the 737NG more economical than the A320. This is because getting a new type rating for pilots transferring from the 737 to the 757 will be cheaper than when going from the A320 to the 757. Training costs will therefore be lower for an airline running the 737 and 757 than for an airline with the A320 and 757. An airline that needs the 757 is therefore more likely to select the 737NG and so become an all-Boeing airline.

The 757 can have an influence in the overall selection of narrowbody type. Delta, which for about 16 years has operated the 757 and 767, had to choose a new narrowbody fleet. "Our marketing department said it required the airline to have the 757, which has a common type rating with the 767," explains Bill Watts, director of flight operations technical support at Delta. "We are keeping our 757s and 767s because they are young. This meant we could consider the A320 with the A330, or the 737NG with the 777".

"The key factor is for crews to move from one aircraft type to another with the least training. Over the years we have been able to very accurately assess training requirements," says Watts. "The key to low training costs is the differences between types. Because of Airbus' very different flightdeck philosophy, the training cost in the mixed A320/757/767/A330 fleet was much higher than the 737/757/767/777 option. The Boeing option means each pilot requires significantly fewer days initial type training across his or her career than with the mixed Airbus/Boeing option. This is a huge saving when taken over thousands of pilots."

Continental Airlines has also operated the 757 for several years and had to consider new narrowbody and widebody fleets. "It is possible to streamline training for all Boeing types when pilots get promoted from one type to another. This is because the operational procedures of Boeing aircraft are very similar," explains Dave Flynn, 737 fleet manager at Continental. "We did analyse the transition training required to go from an A320 to a 757 and this is very significant compared to going from a 737 to a 757. It's too early to say what the reduction in transition training is, since few airlines have enough experience across several types of these modern aircraft."

If an airline does not require the 757, the issue of flight crew costs would be a straight contest between the 737NG and A320 families. The training for additional type ratings within the 737NG and A320 families is similar. An airline that does not need the 757 may then find the cross-crew qualification (CCQ) between the A320 family, A330 and A340, makes the all-Airbus fleet preferable. This will extend to the A3XX if it comes into operation. CCQ minimises differences training between aircraft types so as to make mixed fleet flying with all A320, A330 and A340 family members economical.

Besides training costs, mixed fleet flying can also dilute flight crew costs. Each airline has its own circumstances which determine whether mixed fleet flying is practical and, if so, which narrowbody will be the most economic.

"We have a few pilots who do mixed fleet flying with the A320 and A340. We are still too much in the early stages of this practice to get experience with it," explains Dr Walter Bock, vice-president flight operations at Austrian Airlines. "We operate a system of 14 days rostered on the A320 and then 14 days on the A340. This system has given us very good pilot productivity and we get about 50 block hours per month on long-haul flights and about another 40 block hours on short-haul operations. Taking into account vacation time, the pilots achieve about 700–750 block hours per year. This compares with about 680 block hours per year that the A310 pilots were getting.

"Mixed fleet flying saves training costs because the differences courses for going from an A320 to an A340 rating is less than with other types. It is also easy to get enough landings to maintain currency with this system. The number of standby pilots can also be reduced by up to 60% because of multiple ratings," says Bock.

Not all Airbus operators take

Many existing operators of 757s will find several economic benefits in acquiring all-Boeing fleets. However, there are several exceptions to this, including British Airways, America West, Northwest and US Airways.

advantage of mixed fleet flying. Aer Lingus operates the A320/21 and A330. "Our A320 and A330 operations do not mix because of the difference in sector lengths and size of fleets," explains Captain Donal Foley, director of technical operations at Aer Lingus.

Finance and user charges

Weight related user charges only make an impact on overall economics when rates per unit of weight are high. Overall, the 737NG and 757 have a weight advantage over the A320 family.

The most influential economic factor will be the financing charges for aircraft, spare parts and engines and support equipment. While financing or lease charges for the aircraft will be determined on the price the customer is able to negotiate and on the financing terms, the customer may have an interest in the residual value of the aircraft. This can prove to be a highly subjective figure several decades before the need to retire the aircraft.

To date, the 737 has yet to find as large a secondary market as the 727. The existence of a freight conversion market has made the biggest difference between high and low demand and residual values for most types. By the time the A320 and current and new generation 737s are ready for disposal freight traffic will have grown considerably and will reduce the demand for narrowbodies.

Residual value will also be impacted severely by the influence of new technology. The A320 already has an advantage over the 737NG here because of a perceived image that it has more modern technology.

P&W's PW8000 geared fan engine claims to offer large reductions both in fuel burn and maintenance costs. Its competitors say P&W's claims are exaggerated, since the engine will be heavy and inherently more complex. Nevertheless, if the PW8000 does provide such large savings and is offered on later variants of the A320 family, it will create a huge difference between the economics of the 737NG and A320. This would not only damage the residual value of all other older technology widebodies, but would also force Boeing to consider a replacement for the 737NG.

Summary

Despite the sales it has won in the past few years, the A320 family appears to have some operating cost disadvantages against the 737NG. For example, the A320 is marginally less fuel-efficient, it has a more complex maintenance schedule and the cost of parts make its maintenance costs higher. So why has the A320 family been selling faster in recent years?

There is little difference in flightcrew costs between the 737NG and A320 families when considered on their own. However, Airbus has succeeded in portraying the image that it is cheaper to operate mixed fleet flying between the A320 and its other products than the 737NG is able to do with other Boeing aircraft.

The four members of the A320 family have CCQ with two A330 and four A340 variants. The differences training between the 737NG and 757/767, 777 and 747 is generally viewed as being higher. The A320/340's CCQ and the A340-500's long-range advantage over the 777-200 makes the Airbus option more appealing.

The A320 has also been on the market longer than the 737NG. The A318/19/20/21s cover a wider spread of seat sizes than the 717 and four members of the 737NG. Although the 757 can be offered as a larger alternative to the A321, most airlines appear not to require the 757's capacity and can operate the A320 family alongside Airbus widebodies. Examples of Airlines which have done this are Swissair, Austrian and Air Canada.

Other airlines which already have the 757 have nevertheless ordered the A320 and A321 as well. These include US Airways and British Airways. Many regard the A321 and 757 as serving two markets and so require both aircraft. The costs of serving a separate fleet of 757s is counterbalanced by the advantages of size and commonality with the highly successful 767.

The prospect of the A3XX, which will also have CCQ with the A320 family and A330/340, further strengthens the appeal of the A320 and an all-Airbus fleet.

Overall, the Airbus FBW aircraft family has three basic types, the A320, A330 and A340. This compares with the 717, 737NG, 757/767 and 777 covering the same size brackets. The smaller number of basic types adds to Airbus' advantages and is enough to overcome the A320's marginally higher fuel burn and maintenance costs.

The A320 has the potential for further development and the PW8000 could hold the key to this. The smaller PW6000 is already selected for the A318 and the PW8000 could allow the A319/20/21 to leapfrog by a significant amount any fuel and maintenance cost disadvantages it has with the 737NG.

The PW8000 cannot be installed on the 737NG and the aircraft is now probably developed to its full potential. This adds to the A320's attractiveness.

Residual value and modern technology give airlines further reassurance that the A320 is the right choice. After all considerations have been made, an airline's biggest concern is the bottom line. Purchase price has the largest influence on economic performance. Airbus naturally will have been prepared to make competitive offers to secure strategic orders from large airlines. AC