Large turboprops & RJs have developed to the point where they can offer cabin service levels close to or on a par with small jetliners. The operating performance and economics of large turboprops and RJs is superior to types such as the 737-600 & A318.

Large turboprops & RJs take on jetliners

The advent of large turboprops and regional jets (RJs) or 'right-sized' jets has provided airlines with greater flexibility in fleet planning. The introduction of 75- to 110-seat jets and 65- to 78-seat turboprops is allowing airlines to adopt new fleet-planning and corporate strategies.

The lack of aircraft between 50-seat turboprops or RJs and 105-seat airliners like the 737-500/-600 and A318 has forced airlines to make the traditional distinction between regional and mainline services. Regional aircraft naturally have high costs per seat and per available seat-mile (ASM), so they need high average net passenger yields to make them economic. This has led to regional subsidiaries and partners serving shorter and thinner routes for major carriers.

The smallest jetliner types, the 737-500/-600 and A318, are heavy and also have high costs per seat relative to the larger variants of the same families. This forces some airlines to limit their use to business routes so that yields are enough to cover costs, or to operate larger variants to achieve lower unit cost per ASM (CASM). This can have the effect of diluting yields. Airlines were also prevented from operating at optimum frequencies or capacity levels on many routes.

In the most extreme cases, the absence of economic jets or turboprops in the 70- to 115-seat category has also led to airlines choosing not to operate routes.

Right-sized aircraft

The CRJ-900, CRJ-1000 and Embraer E-Jets offer 70- to 115-seat aircraft with operating and economic performance and technologies that allow them to offer attractive CASM performance despite their size. This allows airlines to take a new approach to fleet planning. The noticeable change in fleet-planning strategies by some airlines has been to use these large RJs and 'right-sized' jets as alternatives to jetliners on routes with smaller traffic volumes. Since their introduction, other strategies that have been adopted by airlines include their operation together with jetliners, and the opening of new routes.

There have been several aircraft in the 70- to 115-seat category, including the Fokker 70 & 100, and BAE146/Avro RJ. These do not have low enough CASM performance, however, to justify their operation in the case of most airlines.

The current generation of jet aircraft in the 70- to 115-seat category comprises the Bombardier CRJ-700, CRJ-900, CRJ-1000 and four members of the Embraer E-Jet family *(see table, page 32)*. These aircraft have already had an effect on airline fleet planning, but several new types are coming available. The first of these are two variants of the Sukhoi Superjet 100, which provide 78 and 98 seats, and will enter service in 2010.

The first of two other new families is the Mitsubishi RJ. This will enter service in 2013, and its two variants will provide 70-80 and 86-96 seats, similar to the SSJ100 variants and smaller E-Jets.

The Bombardier C Series is the largest family of the new generation of right-sized jets, and the two models provide 110-125 and 130-145 seats. The larger aircraft, the CS300, is clearly a direct replacement option for jetliners such as the 737-700 and A319. The smaller CS100 is an alternative to the E-195.

Airline right-sizing

The three larger CRJ models and the Embraer E-Jets have attracted about 640 and 890 firm orders respectively. The aircraft are used in a variety of roles, including traditional regional feeder services. Some have clearly been acquired as more economic alternatives to mainline jets, rather than for use by regional subsidiaries or affiliates.

Airlines in North and Central America that have done this with the Embraer E-Jets include jetBlue, Air Canada and COPA. A larger number of European carriers have followed this strategy, including Finnair, LOT Polish Airlines and Flybe. Egyptair, Royal Jordanian and Virgin Blue have also used the E-Jets in this way.

Most airlines operating the CRJ-700, -900 and -1000 are regional affiliates and subsidiaries of major airlines. Pluna in Uruguay and Adria Airways use the CRJ-900 on thinner routes.

Besides the E-Jets and CRJ family, other large RJs have been selected by airlines opting to follow the same strategy. These include Malev of Hungary and Aeroflot, which have firm orders for 15 and 30 Sukhoi SSJ100s. All Nippon Airways has 15 firm orders for the MRJ90, and Swiss has 30 firm orders for the CS100.

The advent of large RJs has also increased fleet-planning flexibility for airlines operating in conjunction with their regional feeders. Austrian Airlines, for example, operates aircraft with more than 110 seats, including the A319. Its regional subsidiary Austrian Arrows operates Q400s, Fokker 70s and Fokker 100s. There is no clear distinction between the two in terms of route networks, as is traditionally the case with major and regional airlines. Austrian Arrows operates on routes during lower periods of passenger demand.

While the large ATR72 and Q400 turboprops have been acquired by many airlines to operate regional routes, they have still provided airlines with more fleet-planning flexibility. Airlines were forced to operate either smaller RJs or turboprops, jetliners or a combination of the two. Large turboprops filled the same seat gap as the larger CRJ models and E-

LARGE TURBOPROP, LARGE RJ & SMALL JETLINER CHARACTERISTICS

Aircraft type	ATR72-500	Q400	CRJ-900	CRJ-1000	E-170	E-175	E-190	E-195	737-600	A318
Seats - single class	72	78	86-90	95-100	70-80	78-88	98-114	108-122	120-130	120-130
Max lavatories	1	1	3	2	2	2	2	2	3	3
Max galleys	1	1	2	1.5	1-2	1-2	1-2	1-2	3	3
Engine	PW127F	PW150A	CF34-8C5	CF34-8C5A1	CF34-8E	CF34-8E	CF34-10E	CF34-10E	CFM56-7B	CFM56-5B/ PW6000A
MTOW lbs	49,604	65,200	90,000	91,800	85,098	89,000	114,199	115,279	144,500	149,900
OEW lbs	28,550	38,986	50,700	50,700	46,385	47,664	61,112	63,603	80,200	86,650
Range nm		1,457	1,758	1,691	2,100	2,100	2,400	2,200	2,800	3,200
Cruise speed	276 kts	360 kts	M 0.83	M 0.82	M 0.82	M 0.82	M 0.82	M 0.82	M 0.785	M 0.82
Take-off field length - ft	4,290	4,600	6,486	6,549	5,394	7,362	6,745	7,149	5,500-8,200	4,471
List price - $m	20.5	22.0	38.0	42.0	432.9	35.5	39.4	41.6	55.0	59.0

Jets, but the turboprops provide lower CASM than jets, and similar flight and block times on shorter routes. The ATR72 and Q400 typically offer 65-78 seats, and the Q400 with a cruise speed of 360 knots has similar flight times to jets on routes of up to 250nm. Turboprops also often have quicker turn times than jets. Passengers are not inconvenienced by them, and their rates of utilisation are comparable with jets.

Turboprops' lower trip costs therefore result in lower CASM. "The Q400's economics and seat numbers mean we can operate at more attractive frequencies on UK domestic routes than mainline jets. For example, two Q400 operations can provide similar seat counts to a single A319 service at a similar trip cost," says John Palmer, director of aircraft operations at Flybe. "The Q400 is the overall better option because of higher service frequency, and we use it on our shorter UK domestic routes where there is limited competition from other modes of transport. Other airlines using jets are economically challenged because of their higher operating costs, and larger seat numbers which will dilute yields if they find them hard to fill."

Passenger demand

The prime appeal of large turboprops and RJs is their combination of seat capacity, operating performance and competitive CASM performance. The seat capacities of large turboprops and large RJs, in a single-class configuration, range from 65 to 122, which allows airlines to better match capacity with demand.

The ATR72 is configured at 65-70 seats, while the larger Q400 has 72-78 seats in most cases.

The large RJs can be viewed in four size groups. The first group includes the CRJ-700, Avro RJ70, Fokker 70 and E-170, which offer 72-80 seats in a single-class layout.

The second group includes the Avro RJ85, CRJ-900 and E-175 providing 85-95 seats. The E-175 configured in two classes has 73-75 seats, about 30 seats fewer than the 737-500/-600 in a similar layout.

The third group, which includes the Fokker 100, Avro RJ100 and E-190, provides 97-112 seats in single-class mode, and 93-97 seats in dual-class layout. The CRJ-1000 will fall into this group with typical airline configurations.

The fourth group includes just the E-195, although it will be joined by the CS100. The E-195 offers 116-122 seats in a single class. Dual-class layout is closer to 105-110 seats.

This fourth group offers similar seat capacity to the A318 and 737-500/-600. The A318 provides 118-126 seats in a single class and 105-115 in two classes, a similar number to the 737-500/-600. The larger A319 and 737-300/-700 have 120-145 seats depending on configuration. This is similar to the likely configuration of the CS300.

The first three groups of large RJs therefore fill the market between 50-seat RJs and the smallest jetliners, offering smaller seat numbers than the 737-500/-600 and A318 according to airline requirements.

The fourth group of large RJs offers direct alternatives to the 737-500/-600 and A318.

Several airlines operate the E-Jets and other large RJs together with mainline jets to provide a range of seat capacities. Brussels Airlines, for example, operates the Avro RJ100 with 97 seats and the A319 with 132.

Austrian Arrows and KLM Cityhopper both have the Fokker 100 with 100 seats. Austrian also has the 737-600 with 111 seats, and the 737-700 and A319 with 132 seats. KLM has the 737-300/-700 with 127-129 seats.

Egyptair has 11 E-170s, and also operates the 737-500 and A320. LOT Polish has the E-170 and -175 with 70 and 82 seats respectively, and operates them together with 737-500s configured with 108 seats. The fleet mixes of other airlines operating large RJs and small jetliners are listed *(see table, page 34)*.

Airline strategies

While large RJs clearly offer a range of seat capacities to suit particular demand levels, there is a variety of strategic reasons why airlines utilise them. Fleet-planning criteria fall into three broad categories.

The first of these is commercial. Airlines may wish to offer equal seat numbers via higher rates of service frequency, and so use smaller aircraft. Airlines may also want to reduce capacity on some routes to improve load factors and strengthen passenger yields. This can be because of over-capacity with jetliners, or because they only want to cater to higher-yield business travellers. Airlines may also use the aircraft's size and competitive CASM to open and develop new routes prior to upgrading to jetliners.

A second reason for using large RJs is that they may also be able to operate from airports with smaller runways, and so through operating performance make a group of routes feasible that cannot be operated with jetliners.

Commercial considerations are therefore influenced by aircraft performance. The E-Jets, for example, all have range of at least 2,000nm, which means that they can operate two-hour sectors without any performance limitations. The Sukhoi SSJ100 variants will also have a range of up to 2,460nm, and the MRJ family a range of up to

FLEET OF AIRLINES UTILISING LARGE RJS

Airline	70-80 seats	81-90 seats	91-100 seats	101-120 seats	120-140 seats
Air Canada	E-175		E-190		A319/A320
jetBlue Airways			E-190		A320*
Brussels Airlines			AvroRJ100		A319
Finnair	E-170		E-190	A319	A319/320
LOT Polish	E-170	E-175		737-500	
Egyptair	E-170			737-500	
Kenya Airways	E-170			737-300	
Virgin Blue	E-170			E-190	737-700**

**150 seats*

***144 seats*

1,800nm *(see Large regional jets; the C Series, MRJ, Superjet 100 & E-Jet families, Aircraft Commerce, April/May 2009, page 24)*. The C Series will have a range of up to 2,950nm.

These aircraft also have short take-off field lengths, which adds to their operational and fleet-planning flexibility. The smaller large RJs have take-off field lengths of up to 5,500 feet. The exception is the E-175, which has a take-off field length of 7,400 feet. The larger RJs have take-off field lengths of 5,000-7,200 feet.

These take-off field lengths compare to 8,000-11,000 feet for the 737-500, and 6,000-9,000 feet for the 737-600, depending on engine thrust rating and operating conditions.

The ability to access smaller airports, with their usually small and uncongested terminals, will appeal to passengers and reduce ground delays. The aircraft are also capable of faster turnaround times than jetliners. "The E-Jet's four-abreast configuration allows relatively fast loading and unloading, which is aided by its integral airstairs," says Palmer. "These contribute to more efficient utilisation. The four-abreast cabin and low interior noise also have passenger appeal. The aircraft also has lavatories and galleys at both ends of the cabin, which means that we can offer a full service with the aircraft."

The third main category is aircraft operating economics. The main direct operating cost (DOC) categories that vary between aircraft types are fuel, maintenance, flightcrew, navigation charges, and airport user fees. There is also the issue of aircraft acquisition and financing costs.

The relative operating and financial performance of large turboprops, large RJs and small jetliners is considered later.

Airline fleet plans

Flybe in the UK is an example of a carrier that uses the E-195 as a direct substitute for same-sized jetliners. "While we use the Q400 on our shorter and less dense routes, we use the E-195 on longer and more popular sectors," says Palmer. "We have 14 E-195s with 118 seats, and the 737-600 is probably closest to this on a seat number basis. There is a large difference, however, between the E-195, and the A318, 737-500 or -600. Airlines with these jetliners are challenged. The 737-600 and A318, for example, are 10,000-30,000lbs heavier, and we would use them to do the same job as the E-195. The A318's weight gives higher fuel burn, and is one example of the inefficiency of small jetliners. The A318 also has bigger engines that incur higher maintenance and spare-inventory-related costs. We had 737-300s in the past, and had to dilute fares and yields to fill seats and get a decent load factor."

Egyptair has operated a fleet of 11 E-170s since 2007. The aircraft are operated on eight domestic city-pairs at high frequency that have flight times of 50-60 minutes. These aircraft have been used to replace larger jets, and the E-170s are proving popular with passengers. The forward and rear galleys and lavatories mean that Egyptair, like Flybe, is able to offer a full cabin service. The aircraft also has an average turnaround time of about 45 minutes, which allows the aircraft to achieve an annual utilisation of about 2,400FH and 2,700FC per year. This is equal to an average of more than seven operations per day.

jetBlue started operations in 2000 with a single fleet type, the A320. It needed an aircraft to operate in off-peak periods alongside the A320 and provide flexibility in operating frequency. "The E-190 provides us with 100 seats, 50 fewer than the A320, and the two together provide a seamless service in terms of comfort and passenger experience," says Mark Powers, treasurer at jetBlue. "We are very sensitive to customer experience, and the E-190 has a four-abreast layout, good seat pitch and live TV in the seatback. We also use the aircraft on a variety of route lengths, the longest being Boston-Austin, Texas which is about 1,500nm. The aircraft provides the right capacity during periods of lower demand while not being an RJ. We have identified a lot of routes with demand too small for the A320, and we have done well with the E-190."

Aircraft performance

The main economic concern against using older generations of large RJs and turboprops is that they generally have been perceived to have higher costs per seat than jetliners, because smaller aircraft do not have the economies of scale of larger types.

The current generation of large turboprops, such as the CRJ-900/-1000 and E-Jets, is able to deliver similar or even lower costs per seat than the 737-600 and A318 on short-range missions. The economic performance of these eight jets and the ATR72-500 and Q400 can be examined on 200nm and 500nm missions to illustrate their relative trip costs and CASM performance. The relative difference in overall performance depends on seat number configurations and aircraft utilisation, as well as operating cost performance.

Rather than being considered for regional feeder services, the large turboprops and large RJs are being considered instead as substitutes for small jetliners in mainline service on short-haul routes. Airlines have different service standards on short-haul routes. Some, such as Flybe, BMI baby and jetBlue offer a single-class service, while others, like Air Canada, offer dual-class service. A dual-class service with first- or business-class seating reduces seat counts on the E-190, for example, by up to 10 seats. Air Canada's E-190s have nine executive-class and 84 economy-class seats. This compares with 100 seats on KLM Cityhopper's aircraft and 104 on Virgin Blue's fleet.

Virgin Blue has a modern approach, and a premium economy service. This has a minimal impact on reducing seat numbers, with 104 on the aircraft.

Turboprops and smaller RJs, such as the CRJ-900 and E-170 are unlikely to be used in a dual-class layout. A single-class configuration has therefore been used for all types. Seat numbers range from 68 for the ATR72-500 up to 122 for the 737-600 and A318 *(see table, page 32)*. The E-Jet seat numbers range from 76 to 118.

Aircraft utilisation is a crucial factor in relative economics. Turboprops and large RJs are likely to have a shorter taxi time than jetliners, so a five-minute difference has been applied.

Routes of about 200nm and 500nm are typical of some shorter routes operated by several categories of airlines, and have a wide range of traffic volumes.

A growing number of airlines are utilising large RJs like the CRJ-900, CRJ-1000 and E-190/-195 for mainline operations in favour of the smaller jetliner models.

Routes can be between large, medium or small airports. This has an impact on aircraft turnaround times, taxi times, in-flight delays and overall aircraft utilisation. The assumptions of aircraft utilisation are described *(see box, page 37)*.

The primary appeal of the CRJ-900/-1000's and E-Jet is their similar fuel burns per seat compared to jetliners *(see table, page 37)*. Both turboprops, the CRJ models and the three largest E-Jet types have equal or lower fuel cost per seat than the 737 and A318.

Although the large RJs are smaller aircraft and have similar standards of engine technology, they have a lower weight per seat than jetliners. The CF34-8C5, CF34-8E/-10 and SaM146 engines powering the CRJ-900, E-Jets and SSJ100 have similar technology and performance to the CFM56-7B and PW2000 powering the 737NG and A318/19. The bypass ratios, which are an indication of fuel burn efficiency, for these five engines are all 4.4-5.5:1.0.

The new generation PW1000G geared fan engine powering the MRJ and C Series is expected to give bypass ratios of 8.4:1.0 and 12.1:1.0. This will contribute to lower fuel burn per seat compared to current large RJs and the 737-600 and A318/19. The MRJ and C Series will therefore have lower burns and fuel cost per seat.

Large turboprops, the ATR72-500 and Q400, have similar or lower fuel burns per seat than the small jetliners, despite being slower and having longer flight times than jets *(see table, page 37)*.

The PW1000G is also designed to have fewer parts, and so have longer intervals between shop visits and lower shop-visit costs than current generation engines. The C Series and MRJ will also benefit from having lower costs in other parts of their total maintenance.

The large RJs have several benefits over the jetliners in maintenance costs. In engine-related costs the CFM56-5B/-7B and other engines powering the A318 and 737-600 have higher costs for life limited parts. Shop-visit costs are also higher than the CF34-8C5, -8E and -10E variants powering the CRJ-900/-1000 and E-Jets. Shop-visit costs for the CFM56 models are $1.4-2.0 million, depending on workscope. This compares to $0.7-1.4 million for the CF34 models.

The large RJs and large turboprops clearly have lower airframe and component costs than the jetliners. The overall difference is that the Q400, CRJ models and three larger E-Jets have lower maintenance costs per seat than the 737 and A318 *(see table, page 37)*. The design and maintenance standards of the four main jet types are similar, so differences in maintenance cost per seat are therefore not significant.

The E-190 and -195 have a particular advantage in that they have a lower maintenance cost per seat than the 737-600 and A318.

Flightcrew costs are complicated by some airlines having two salary scales for regional feeders and mainline operations. In this case a single salary scale is used. The assumptions for crew costs are described *(see box, page 37)*. The larger aircraft benefit from their size, in that pilot salaries do not increase in proportion with aircraft size.

Flight attendants are another issue, particularly the number used on each aircraft. Crew numbers are more or less in proportion with seat numbers, ranging from two to four, and so cost per ASM varies little between types.

Of these four main cash operating cost categories, fuel and maintenance account for 75-80% of the total cash DOCs. Total cash DOC per ASM is similar for the turboprops and jetliners on the 200nm missions, despite the turboprops' slower speed. The ATR72's slow speed is more detrimental on the longer missions of 500nm, and it consequently has a higher cash DOC per ASM. The Q400 still manages to maintain a similar performance to the jetliners.

The E-Jets have varying degrees of cost per ASM compared to the jetliners. The E-195, benefiting from its larger size, has a 13-17% lower cost than the A318 *(see table, page 37)*. The E-190's cost is closer to the jetliners on the 200nm route, but is the same on the longer route as the jetliners become more efficient. The E-170 and -175 have 9.7% and 4.5% higher costs respectively than the A318 on the 200nm route. These differences increase to 12.8% and 7.7% on the 500nm route.

The higher cost of fuel means that fuel burn efficiency has a higher importance, a factor that will benefit the MRJ and C Series.

Aircraft financing costs are 29-33% of the total CASM for the turboprops and large RJs, but higher at 40% for the jetliners on 200nm routes. This reduces to 35% for the jetliners on the longer routes as they become more efficient. These differences in financing costs illustrate the high costs associated with acquiring an aircraft with higher weight and payload and longer-range capability. The turboprops and large RJs are optimised for shorter missions and route networks with lower traffic densities. Larger 737 and A320 family models would offer better costs per seat where their higher capacities are required, or on longer routes.

Overall performance

The total CASMs of the turboprops are 1.5-3.25 cents lower than the jetliners *(see table, page 37)*. This illustrates the inefficiency of using large, heavy jets on short routes. The ATR72-500 and Q400 also have $3-6 lower cost per seat than

LARGE TURBOPROP, LARGE RJ & SMALL JETLINER CHARACTERISTICS

Aircraft type	ATR72-500	Q400	CRJ-900	CRJ-1000	E-170	E-175	E-190	E-195	737-600	A318
Seats - single class	68	76	90	98	76	82	98	118	122	122
200nm average route length										
Fuel-c/ASM	4.1	4.6	4.1	4.1	5.4	5.2	5.2	4.5	5.1	4.7
Maintenance-c/ASM	4.8	3.9	2.8	2.6	3.6	3.6	2.7	2.3	3.8	4.5
Flight crew-c/ASM	1.9	1.6	1.3	1.4	1.5	1.4	1.4	1.3	1.4	1.4
Flight attendants-c/ASM	0.7	0.6	0.6	0.7	0.7	0.7	0.7	0.6	0.7	0.7
Cash DOC-c/ASM	11.6	10.8	8.8	8.7	11.2	10.9	10.9	8.8	11.0	11.3
Finance-c/ASM	4.7	4.8	5.7	5.8	5.8	5.8	5.4	4.8	7.0	7.5
Total-c/ASM	16.4	15.6	14.5	14.5	17.0	16.7	15.4	13.5	17.9	18.7
Trip cost-$	33	31	29	29	34	33	31	27	36	37
500nm average route length										
Fuel-c/ASM	3.4	3.3	3.8	3.8	4.0	3.9	3.8	3.3	3.9	3.7
Maintenance-c/ASM	3.6	2.6	2.0	1.9	2.6	2.6	2.0	1.8	2.2	2.6
Flight crew-c/ASM	1.5	1.1	1.0	1.0	1.1	1.1	1.0	1.0	1.0	1.0
Flight attendants-c/ASM	0.6	0.4	0.4	0.5	0.5	0.5	0.6	0.5	0.5	0.5
Cash DOC-c/ASM	9.1	7.4	7.3	7.2	8.3	8.1	7.4	6.5	7.6	7.8
Finance-c/ASM	3.3	3.1	3.4	3.5	3.4	3.4	3.2	2.8	4.1	4.4
Total-c/ASM	12.4	10.5	10.7	10.7	11.7	11.5	10.6	9.3	11.7	12.2
Trip cost-$	62	53	54	54	59	57	53	46	59	61

the 737-600 and A318, highlighting some of the appeal of large turboprops to airlines. As Palmer explains, the Q400 has the same seat cost as the A319, and two Q400 trips provide a similar number of seats as one A319 service. The Q400 can operate at higher frequency while maintaining cost per seat.

Even on a longer 500nm mission the turboprops have lower or similar costs per seat than the 737 and A318, despite flight time being up to 40 minutes longer for the ATR72. The Q400 still has a lower overall cost per seat and CASM, mainly due to its low capital cost per seat *(see table, this page)*. Turboprops are unlikely to be used on routes with flight times of more than one hour, however.

The CRJ-900 and -1000 offer the best performance on both route lengths. With the exception of the E-195, the CRJ-900 and -1000 have the best CASM performance of all large RJs. On the 200nm route, the CRJ-1000's performance is 0.9 cents better its closest competitor, the E-190 *(see table, this page)*. The CRJ-900 also has lower costs than the E-175. The CRJ-900 and -1000 are, however, used less as right-sized jetliners and more as large RJs.

On the 200nm route the three larger E-Jets have a 0.50-4.75 cents lower CASM than the jetliners *(see table, this page)*, due to a combination of the RJs' lower cash operating cost and financing charges. This translates to lower costs per seat. Moreover, the E-170's performance is between the 737's and A318's.

On the longer 500nm route the E-Jets' performance relative to the jetliners is similar to that on the 200nm route. This again is due to the E-Jets' better cash operating and finance costs.

This clearly illustrates that larger turboprops and RJs are more economic than jetliners on shorter routes where smaller aircraft are required. The similar or lower costs per seat offered by the turboprops and large RJs mean that airlines can utilise them to lower capacity, offer higher frequency of service, improve load factors, and possibly raise average yields. AC

200nm mission

The large turboprops have flight times of 51 and 54 minutes, and achieve the shortest turnaround times of about 30 minutes. They are assumed to have utilisations of 2,300-2,400 flight cycles (FC) per year.

Large RJs have flight times of about 35 minutes, and turnaround times of 45 minutes. Annual utilisations of about 2,800FC are used.

The 737& A318 have similar flight times, but longer turnaround times and utilisations of about 2,450FC.

500nm mission

Turboprops have flight times of 94 and 119 minutes. They are assumed to have utilisations of 1,400 flight cycles (FC) per year. Large RJs have flight times of 77-79 minutes, and turnaround times of 45 minutes. Annual utilisations of about 1,850FC are used.

The 737& A318 have similar flight times, but longer turnaround times and utilisations of about 1,650FC.

200nm & 500nm mission

A gradual increase of annual salaries for a single crew of two of $105,000 per year for the turboprops up to $174,000 per year for the 737-600/A318 is used. Salaries are escalated by 40% to reflect the full cost of employment. Pilots are assumed to complete 650 block hours per year.

The turboprops are assumed to use two flight attendants, while the CRJ-900, E-170 & E-175 are assumed to use three. All other aircraft use four. Flight attendant salaries are $28,500, and are escalated by 15% for the full cost of employment. Annual productivity is 750 block hours.

Financing charges are based on current list prices *(see table, page 32)*, with a 30% discount applied. Monthly lease rate is based on a lease rate factor of 0.9% of net purchase price.