

The 90-105 seat jet market is wide ranging with strong competition between five manufacturers. Trip costs and seat capacities vary, providing a wide choice for mission requirements. It is, however, the least defined market for aircraft.

# Large or small? The array of options in 90-105 seat regional aircraft selection

**T**he large regional jet market is the border between mainline and regional operators. It is being contested by Bombardier offering a stretched regional jet, Airbus and Boeing with shortened developments of mainline jets and Embraer and Fairchild Dornier offering purpose designed aircraft. With a wide choice of types to choose from, which are the most cost efficient?

This analysis of the '90-105 seaters' follows the analysis of 70-seat jets (see *Purchase price & financing determine fate of 70-seat jets, Aircraft Commerce, August/September 2001, page 41*). This earlier article analysed the Avro RJX70 and RJX85, Bombardier CRJ700 and CRJ900, Embraer ERJ170-100/-200 and Fairchild Dornier 728Jet.

Each of these four manufacturers were also offering aircraft in the larger category; the Avro RJX85 and RJX100, Bombardier CRJ900, Embraer ERJ190-100/-200 and the Fairchild Dornier 928Jet. The Avro RJX is now cancelled, so not included in this analysis. Although slightly outside the 90-105 seat category, the A318 and 717 have been included.

This market is the least easily defined and should be considered as a series of markets. None of these aircraft would be allowed into the fleets of major regional operators, due to the scope clauses. This is demonstrated by the current US customers for these aircraft; America West and Frontier Airlines (A318s), Airtran, Hawaiian Airlines and TWA (717) and Mesa Air Group (CRJ900). Mesa is the only 'regional' operator among them. Mesa is an exception, since it is an independent operator and not tightly constrained as other regional operators. The market in the US is therefore largely the mainline carriers, until such time as scope clause limitations

are removed. The result is a bias towards the larger products from Airbus and Boeing, and an artificial gap between approximately 80-110 seats where demand will be limited.

In Europe flag carriers Air France and British Airways have ordered the A318, but their regional affiliates Regional and CityExpress are also evaluating the dedicated regional jet designs. The new Embraer and Fairchild Dornier families were launched by European regional carriers, Crossair and Lufthansa Cityline respectively. The only other airline customer for 728/928Jets is CSA, with an order for eight 728Jets and an option for two to be converted to the 928Jet.

The European market is more diverse, with demand for these aircraft from both the smaller mainline operators and the larger regionals.

The presence of the A318 and 717 is an important consideration for 100-seat regional jet manufacturers. Although the more efficient regional jets offer lower direct operating costs, the important issue is whether these savings are enough to justify introducing a new type or manufacturer into a large airline's fleet.

Cost differences between regional jets are not the only consideration. So too are their cost advantages over their mainline jet derived competitors.

As well as BAE Systems' cancellation of the Avro RJX, rumours continue that Boeing is about to close the 717 line. Boeing has already confirmed it is evaluating the 717's future. The type is retained in this analysis despite this.

Since the 70-seat article analysis, Embraer has re-named the ERJ-170 and ERJ-190. The ERJ-170-100 becomes the EMB170, the ERJ-170-200 becomes the EMB175, the ERJ-190-100 becomes the EMB190 and the ERJ-190-200 becomes the EMB195.

## Seat capacity

In order to 'equalise' the seat capacities of the aircraft, similar guidelines to the 70-seat analysis have been used. A comparison of technical data summarises the aircraft (see *table, page 36*).

Five of the aircraft are configured with 32-inch pitch. The only aircraft with a 31-inch pitch as standard is the CRJ900. This is assumed to be re-configured with a forward cabin at 33-inch pitch, and the aft cabin at 31-inch. This results in a reduction in seat numbers to 82. The remaining aircraft retain their standard configurations: A320 with 117 seats, 717 with 117 seats in a mix of 31/32-inch pitch, EMB 190/195 with 98 and 110 seats, and Fairchild Dornier 928Jet with 100 seats.

All the aircraft are fitted with two toilets as standard, with the exception of the A318 which has three.

The A318 inherits the standard galley configuration of the A320, with a capacity for eight full sized trolleys. This capacity per seat, which is typical of European operators, is matched by the EMB190/195 and 928Jet. The standard CRJ900, fitted with a single forward galley, will only accommodate five half-sized trolleys. In order to accommodate an equivalent number of trolleys to its competitors it requires an additional forward galley. This results in a further reduction in the number of seats fitted to the aircraft from 82 to 80. Similarly, the 717 requires an additional forward galley, reducing capacity to 115 seats.

In summary, the manufacturer's standard seating capacities have been assumed for all aircraft, with the exception of the CRJ900 which is reduced from 86 to 80 seats, and the 717 which is reduced from 117 to 115 seats.

## 90-105 SEAT JETS SPECIFICATION DATA

Aircraft type	CRJ900	EMB190	EMB195	928Jet	A318	717
Standard seats	86	98	110	100	117	117
Sat pitch (inches)	31	32	32	32	32	31/32
Standard trolleys	2.5	5.5	7.5	7	8	4.5
Standard toilets	2	2	2	2	3	2
Equalised seats	80	98	110	100	117	115
Equalised seat pitch	31/33	32	32	32	32	31/32
Equalised trolleys	4	5.5	7.5	7	8	6.5
Equalised toilets	2	2	2	2	3	2
List price \$m	30.0	28.0	29.6	34.0	35.0	35.0
Price per seat \$	375,000	286,000	270,000	340,000	299,000	304,000
Standard MTOW kg	32,995	45,990	46,990	47,870	59,000	49,845

## Price

List price and the price per seat of the aircraft are given (*see table, this page*). Boeing quotes a range of prices for the 717 from \$35.0-39.5 million. The lower value has been assumed for this analysis, which puts it level with the A318. The A318 and 717 set a mid-price of approximately \$300,000 per seat.

In comparison, the CRJ900 and 928Jet appear to be expensive options at \$375,000 and \$340,000 per seat. The CRJ900 has 18 less seats, but a \$2 million higher list price than the EMB190. The 928Jet, the highest priced of the new designs, has a list price almost the same as the A318 and 717.

With list prices per seat of \$286,000 and \$270,000, the EMB190 and EMB195 stand out as offering a noticeably lower price per seat than all other aircraft offered.

## Financing

The on-going dispute between Brazil and Canada over financing appears to have stabilised, with both sides offering financing at the Organisation for Economic Co-operation and Developments (OECD) Commercial Interest Reference Rate (CIRR). This is the minimum interest rate allowed under the OECD's guidelines. The CIRR is calculated by adding 100 basis points (one percentage point) to the cost of fixed interest rate finance (US Treasury bonds). The advantage of such financing is that it does not account of the operator's own credit risk.

Both Bombardier and Embraer benefit from strong support from their respective governments. For Airbus and Boeing the very strength of the companies puts them

in a good position. It is doubtful whether Fairchild Dornier will ever be able to command the same level of support from the US or German governments. The ability to provide attractive financing is a big advantage for Embraer and Bombardier, but for the purposes of this analysis it has been assumed each of the aircraft will be financed at the same rate. The CIRR rate over a 15 year term to a 25% residual value which approximates to a lease rate factor of 0.75%.

## En-route & landing charges

The most significant cost difference between the US market and Europe is the lack of en-route charges in the US. Whereas Europe has Eurocontrol, the cost of providing the air traffic system, in the US it is met by central government funding. Landing charges in the US are also a fraction of those in Europe. The result is that where European operators have a fundamental interest in lighter aircraft, the same does not apply in the US. The A318, and to a lesser extent the 717, are heavier than the regional jet designs.

It has been assumed the majority of airlines would select the highest available MTOW, except for the A318. This is because the 61,500kg MTOW option still provides a 2,000nm range capability. All other types require their highest MTOW option to provide an equivalent range.

## Fuel

The CRJ900 offers the lowest fuel burn of the regional jets. This is not surprising, since this is largely a function of airframe drag and engine efficiency. Since all three regional jet designs are powered by variants of the same engine,

the difference is the result of different fuselage cross-sections and wing design. Using the CRJ900 as the base case, then over a 500nm sector the other aircraft will consume the following additional fuel: EMB 190 21%, EMB 195 28%, 928Jet 21%, A318 37% and 717 38%.

## Crew

While the regional jets are likely to have the same crew costs, it is not necessarily the same for the A318 and 717.

One of the A318's attractions is the crew commonality across the A320 family. This can, however, create problems when adding the A318. Take, for example, two mainline carriers which have delegated the operation of 70-100 seat jets to their regional affiliates, Sabena/DAT and Swissair/Crossair. In both cases the aircraft types operated by the regional carriers were different to those operated by the mainline carrier. This, together with the 'independent' nature of the regional operators, allowed them to have a different cost structure. In particular, pilot costs are 35% lower than their mainline partners. The higher cost structures of both mainline carriers is one of the reasons why their regional partners have outlived and effectively replaced them.

If the 'regional' aircraft operated by regional affiliates are replaced by the A318, then pilot differentiation, and so pilot salary scale differences between mainline and regional will be lost. The airline will want to maximise the benefits of commonality with the regional pilots flying all A320 family types within the airline, both mainline and regional. But then how can the airline justify different pay scales for pilots flying basically the



same aircraft? This is unlikely, and the regional affiliate will have to pay the higher pay scales for the A318. The same logic does not apply to the 717, since it is not a member of a family. The simple fact that it is a large aircraft, however, produced by Boeing will still encourage many pilot unions to see it as a mainline aircraft.

To allow direct comparison between each of the aircraft our analysis assumes identical crew costs for all the types based on regional airline salary levels.

### Airframe maintenance

With common engines across the regional jet designs, and in the case of the EMB190/195 and 928Jet common avionics, the maintenance cost variation between these three aircraft will be small. The important issue is to determine the difference in maintenance cost between the A318 and 717, versus the regional jets.

*Aircraft Commerce* analysed the maintenance costs of the A320 family in some depth in an earlier issue (see *A320 maintenance cost analysis, May/June 1999, page 38*). Although this did not specifically address the A318, it concluded that the differences across the family, between the A319 and A321, amounted to just a few dollars per flight hour (FH).

The cost of line maintenance is largely independent of the type selected, since it requires the provision of mechanics at line stations across the network. The analysis assumes equal costs for all aircraft, with a line maintenance labour requirement of 0.50 man-hours (MH) per FH.

Rather than comparing aircraft of comparable size and complexity, this analysis has to cover aircraft ranging from the Challenger derived CRJ900 to the A318.

This analysis uses the methodology in the A320 maintenance costs analysis. For the A320, the average MH for a C check (except the C8 check) was 2,400MH. Of this total 700MH were allocated to the incorporation of service bulletins (SBs) and airworthiness directives (ADs), and a further 100MH were for cleaning. The C-check interval is limited to 18 months/4,000FH. A regional operator flying 2,000FH per year will be limited by the calendar limit at 3,000FH. A labour requirement of 2,400 MH equates to 0.80MH per FH.

Based on its experience with the CRJ100/200, Bombardier estimates the equivalent requirement for inspection and defect rectification at 800MH for a C check. Adding back in the same allowances for cleaning and SBs and ADs results in a total of 1,600MH. With a C-check interval of 4,000FH, this equates to 0.40MH per FH.

The MH requirement for the higher structural inspections depends to a large extent on the amount of additional work, interior refurbishment, modifications and SB/AD incorporations. The analysis for the A320 concluded a labour consumption 2.5 times that for a C-check. That is, about 2.00MH per FH. To be consistent, we have therefore added assumed an equivalent factor for the CRJ900, that is 1.0MH per FH.

Limited data on the 717, which has a C-check interval limited to 15 months/3,600FH, suggests a MH requirement of 1,500 MH. Again adding

The 90-105 seat jets are limited in their appeal, since they fall between the size requirements of many regional and major airlines. Only independent regionals and second tier airlines have indicated a requirement for these aircraft. The difference in size and trip costs between the contestants in this market also suggests it is ill-defined. Relaxation of scope clauses would bring clarity to the market, as well as increased demand.

in 100 MH for cleaning and 700 MH for SBs and ADs results in a total of 2,300MH which equates to 0.92MH per FH. The equivalent figure for the higher structural inspections being 2.3MH per FH. The difference relative to the A318 is based on the extensive operational history with the DC9, together with its noted structure and the simpler systems employed on the Boeing aircraft.

This analysis suggests the hourly cost for base maintenance labour on the A318 will be double that of the CRJ900, with the 717 even higher. In the absence of equivalent in-service based data for the EMB190/195 and 928Jet, the rate for the CRJ900 is applied to these aircraft. To avoid disadvantaging the 717, based on the limited data available, it is assumed to have the same check costs as the A318.

### Consumables

These are also largely independent of the aircraft type, since all aircraft require the regular replacement of seals and lubricants. A total allowance of \$25 per FH has been included for miscellaneous consumables. Another big cost driver under this section of maintenance costs is wheels, tyres and brakes. Experience with the steel brake equipped CRJ suggests an allowance of \$40 per flight cycle (FC). This is close to the figure provided by Boeing for the similarly equipped 717. The previous analysis for the A320 family indicated a total cost for wheels, tyres and carbon brakes of \$60 per cycle, which will equally apply to the A318.

### Component maintenance

This cost element is a function of the reliability and cost to overhaul of hundreds of components. However, in today's era of fixed price maintenance agreements the comparison is far simpler. An analysis of data for such programs on the CRJ200 (with additions for the APU and landing gear, which are normally excluded) highlights costs of \$125per FH. In the absence of comparable data for the CRJ900, EMB190/195 and 928Jet it has been assumed that their cost will be identical to that of the CRJ200.

The previous analysis for the A320 family indicated a cost of \$135 per FH,

which will equally apply to the A318 and also the 717. This figure excluded the APU and landing gear, which incur an additional \$15 per FH and \$7 per FC. In addition there is a further cost of about \$70 per FH to lease the on-site stock, which is assumed to be the same for all the aircraft considered.

The difference between the regional jets and the larger mainline designs can be attributed to several factors. A particularly high cost area is avionics. Regional jets also use smaller APUs.

## Engine maintenance

The analysis of the 100-seaters with respect to engine maintenance is complicated by the number of engines powering each of the aircraft on offer. As well as the General Electric CF34, there is the CFM56-5, Pratt & Whitney PW6000 and Rolls-Royce BR715.

For the BR715 engine that powers the 717, Rolls-Royce has offered fleet hour agreement (FHA) rates of the order of \$80 per engine flight hour (EFH), with an additional \$30 per engine flight cycle (EFC) for life limited parts. This suggests Pratt & Whitney will have to offer equivalent maintenance cost programmes for the PW6000, at rates in the order of \$80 per EFH to match its claim for 30% lower costs.

The CF34-8C5/8D/8E was developed for the CRJ900, 728Jet and EMB170/175. To meet the higher thrust requirements of the 928Jet and EMB190/195, General Electric (GE) is developing the -10D/10E variants with thrust up to 18,500lb.

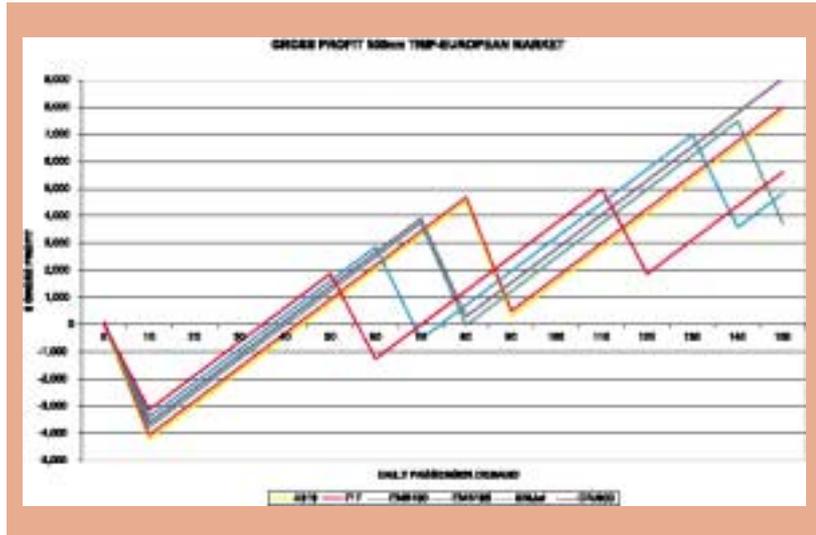
GE is offering power-by-the-hour programs at rates in the order of \$80 per EFH for the -8C1, \$90 per EFH for the -8C5 through to \$110 per EFH for the -10 variants.

Total maintenance costs range from about \$525 per FH for the CRJ900, through \$565 per FH for the new regional jet designs, \$615 per FH for the A318 (largely as a result of the engine) and \$660 per FH for the 717.

## Commonality savings

The advantages of commonality are going to benefit Airbus and Bombardier, at the expense of the other three manufacturers. In the case of the A318 are they enough to overcome the inherent economic penalties in its design?

The introduction of a new type into a fleet requires investment in pilot and engineer training, spares, ground support equipment and tooling. For training, as well as the costs of the courses themselves, there is the cost of covering their absence, hotels and transport. These one-off costs need to be paid at the start of a new operation. These costs will be



## OPERATING COST ASSUMPTIONS FOR 90-105 SEAT JETS ON EUROPEAN 500NM ROUTE

Annual utilisation: 2,000FH

Fuel price: 80 cents per US Gallon

Maintenance costs: CRJ900 \$525 per FH, EMB190/195 & 928Jet \$565 per FH, A318 \$615 per FH and 717 \$660 per FH.

Crew salaries: Captain: \$75,000; First officer: \$50,000; Cabin attendant: \$25,000, 3 attendants for the CRJ900, EMB190 and 928Jet, 4 attendants for the EMB195, A318 and 717.

Pilot annual productivity: 600FH.

Landing charges: \$9 per ton MTOW

ATC charges: \$0.95 x distance x (MTOW tons/50) ^ 0.5

Finance: Monthly lease rate factor of 0.75% of manufacturer's list price.

substantially reduced for an operator adding A318s to an A319/20/21 fleet.

To put the economic benefit into perspective, take an existing European operator that is looking to add 10 100-seater aircraft, either A318s or 928Jets, to a fleet of A320s. The DOC analysis of the two replacement options suggests the 928Jet will save \$710,000 per aircraft per year. Assuming a useful life with the operator of 15 years, this is equivalent to a total saving of \$10.65 million. However discounting this at 5% per annum reduces this advantage to \$7.75 million. The equivalent figure for a US operator, with an inherently lower cost structure, is \$4.50 million.

To achieve these operating cost savings, the 928Jet operator will have to incur the consequent initial start-up costs:

Initial pilot training costs	\$300,000
Engineer training costs	\$ 75,000
Loss of value in spares	\$500,000
Investment in GSE	\$ 10,000
TOTAL	\$885,000

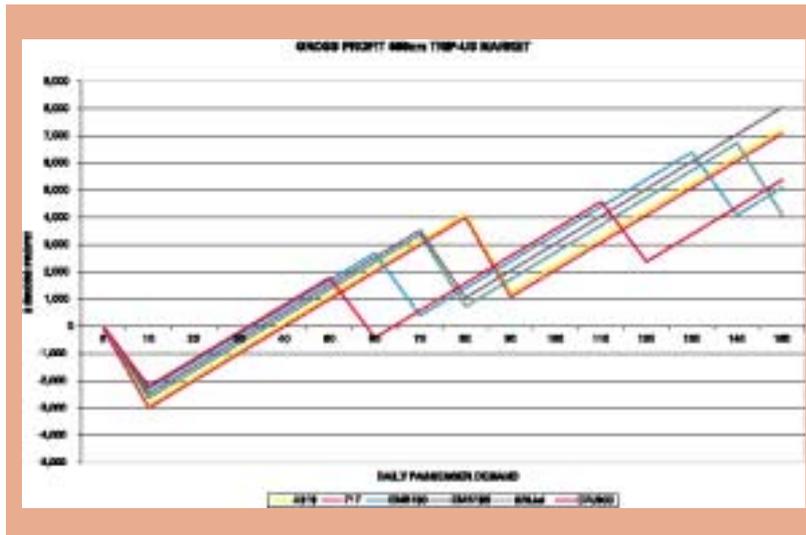
Pilot training cost, including both classroom and simulator instruction, is typically in the region of \$25,000 per pilot. Assuming five crews per aircraft, captain and first officer, then the total

direct cost of the training per aircraft will be of the order of \$250,000. The provision of air fares and hotel accommodation for three or four weeks can add a further \$5,000 per pilot for a total cost per aircraft of \$300,000.

Mechanic training is cheaper, since it does not require expensive simulator time, but still takes mechanics off line for extended periods while they are in the classroom. Again typical costs per engineer of \$10,000 for the course and \$5,000 of additional costs are assumed together with five mechanics per aircraft.

Spares can be a particularly heavy source of loss, since while airlines buy spares at perhaps 75% of the manufacturer's list price, when they then come to sell them later they will probably only achieve 25% of list. Assuming a 10 aircraft fleet justifies a spares investment of \$7 million, the lost value could amount to \$5 million. When spread across the fleet of 10 aircraft it amounts to \$500,000. Type specific ground support equipment typically requires an investment of perhaps \$100,000, equivalent to \$10,000 per aircraft.

It is important to understand that this simplistic analysis has not examined all the additional costs that arise when changing types. With the difference in



#### OPERATING COST ASSUMPTIONS FOR 90-105 SEAT JETS ON US 500NM ROUTE

Annual utilisation: 2,000FH  
 Fuel price: 80 cents per US Gallon  
 Maintenance costs: CRJ900 \$525 per FH, EMB190/195 & 928Jet \$565 per FH, A318 \$615 per FH and 717 \$660 per FH.  
 Crew salaries: Captain: \$65,000; First officer: \$35,000; Cabin attendant: \$20,000, 2 attendants for the CRJ900, EMB190 and 928Jet, 3 attendants for the EMB195, A318 and 717.  
 Pilot annual productivity: 600FH.  
 Landing charges: \$9 per ton MTOW  
 ATC charges:  $\$0.95 \times \text{distance} \times (\text{MTOW tons}/50)^{0.5}$   
 Finance: Monthly lease rate factor of 0.75% of manufacturer's list price.

direct operating costs and initial start-up costs generating a net saving of nearly \$7 million (\$3.50 million for a US operator) to be attainable over the 15 years of the aircraft life, it would be difficult for the operator to ignore the 928Jet and select the A318 without a thorough investigation and justification of the benefits of a single type fleet.

This analysis suggests the A318's commonality benefits will not overcome the economic penalties inherent in its design. It may be worth an operator, looking to add a few smaller capacity aircraft to a large fleet of A320s, paying this economic penalty simply to avoid the aggravation of introducing a new type. Where the carrier plans to introduce a new large fleet, the economic benefits of the purpose designed aircraft far outweigh the A318's commonality benefits.

Of 60 airline orders for the A318, only one operator, Air China, has selected the type in isolation. The other five are adding the type to complement existing fleets of A320 family aircraft.

## Summary

To compare aircraft of similar but different seating capacities, their overall

economic performance is shown in terms of their profit potential over a typical 500nm sector (see charts, pages 39 & 40). These show that in both Europe (see chart, page 39) and the US (see chart, page 40), the CRJ900 offers the highest profit potential for low traffic volumes. The A318 and 717 have a role where demand is higher. Between these two extremes it is the EMB195 and 928Jet that offer arguably the best combination of capacity versus profitability.

While the CRJ900 in its 'equalised' cabin configuration is outside the seating capacity range intended for this analysis, it is included because Bombardier does not have a larger aircraft. Although the CRJ family covers the capacity range of 44-86 seats (in standard layouts), it does not have an aircraft to compete against the larger members of the Embraer and Fairchild Dornier families. The CRJ900 offers the lowest trip costs of all the aircraft. This is not surprising, since it offers 20% less capacity than the next smallest aircraft, the 98-seat EMB190. The CRJ900 is also the least attractive aircraft in terms of passenger comfort. For operators willing to accept these shortcomings it offers highly competitive economics with the new regional jet designs especially for low demand

markets.

The CRJ900 will be an attractive option for existing CRJ operators, particularly those in North America, which require and can increase capacity, while also attaining lower seat-mile costs. Economic efficiency is not the only important criteria in Europe. Here the CRJ900's cramped cabin and pedestrian performance will limit its attractiveness. The CRJ900 is right for airlines which require a small capacity increase.

As well as more seats, the aircraft from Embraer and Fairchild Dornier are able to offer comfort standards that match those of the mainline jets. The EMB190 and 195 follow closely behind the CRJ900, in terms of economic efficiency, but the 928Jet has the third highest trip costs. The cash operating cost difference between the EMB190 and the 928Jet is negligible at 0.8%. They are powered by the same engine, while fuel consumption and engine maintenance costs are practically the same. Crew cost will be identical and the one tonne difference in MTOW results in a minor difference in landing and en-route charges. Once the 928Jet's \$6 million higher list price is added, the EMB190's advantage increases to 7.4%. This assumes equivalent financing will be available to both manufacturers, a factor that will probably favour the Brazilian aircraft.

For the purposes of comparing their economic efficiency against the smaller aircraft, the A318 and 717 can be considered identical. With the same list price, similar capacity, maintenance cost and fuel consumption the difference in direct operating costs is barely 1%, in favour of the lighter 717. When compared with the EMB195 and Fairchild 928Jet, the difference in trip costs between the A318/717 and regional jets is almost 10%. For existing A320 family operators this difference can be narrowed by the cost savings to be made with a common fleet, but not bridged completely.

The 717 cannot even benefit from similar cost savings and has to stand on its own merits. Caught between the A318 with its appeal to the growing number of A320 family operators and the efficiency of the new designs, it is no surprise the 717 is proving difficult to find customers.

No market for commercial airliners has ever had to sustain eight competing products, and BAE Systems decision to cancel the RJX is a logical move forward to consolidate the industry. Even if the 717 follows the RJX into history, there will still be four competing manufacturers with five aircraft types on offer. Of these the aircraft from Embraer stand out in terms of their cost efficiency and affordability.

