

The operating cost performance of 70-seat regional jets are close. Each manufacturer has its own set of circumstances which determine the level of price discounting and sales finance support it is able to provide. These will determine sales performance.

# Purchase price & financing determine fate of 70-seat jets

**W**ith two new generation twinjets and developments of the Avro RJ and Canadair RJs available, there is certainly no shortage of 70-seat regional jets for airlines to choose from. Which is the most economic?

This article examines the gross profit generating performance of 70-seat jets in North American and European markets. Each of the traditional direct operating cost (DOC) elements of ownership/lease, maintenance, crew, fuel, en-route and landing charges are examined in detail, and are compared with passenger revenue over a range of demand to illustrate gross profit generating performance (see charts, pages 45 & 46). These are based on 500nm mission lengths, at annual utilisations of 2,150 flight hours (FH) for North America and 2,000FH for Europe.

## Seat capacity

It is necessary to 'equalise' seat capacities. A minimum seat pitch of 31 inches matches that provided by the RJX and CRJ700. The ERJ170-100/200 gain no benefit from additional seats by reducing their standard 32-inch pitch, and so remain at 70 and 78 seats respectively. The 75-seat layout of the 728Jet at 33 inches can be re-configured to 80 seats at a 31-inch pitch.

The CRJ700 is the only aircraft fitted with a single toilet, and accommodates a second one only by losing two seats. All other aircraft have two toilets as standard.

The standard CRJ700, fitted with a single galley, will not accommodate the same number of trolleys as its competitors. With two forward galleys and an additional toilet, the CRJ700's configuration is reduced from 70 to 66 seats. Taking the same adjustments, the CRJ900's seat configuration is reduced

82, and so also included in this analysis.

Since the majority of AVRO RJ operators configure their aircraft 5-abreast, the 6-abreast option for the RJX has been excluded. The Avro RJ85 has been included because of its 85-seat capacity. The Avro RJX85 is included, because the RJX70 is less popular. The 728Jet is also included because it is an 80-seat aircraft, and so similar in size to the ERJ170-200, CRJ900 and the Avro RJX85.

The types included in the analyses and their seat capacities are summarised (see tables, pages 45 & 46).

## Ownership/lease

The list price and the price per seat of the individual aircraft are summarised (see tables, page 45 & 46), highlighting a significant variation of \$325,000-400,000 per seat. The lowest-cost aircraft are the Avro RJX85 and the ERJ170s.

In reality the discount available to customers is more important than list pricing. The level of discounting is dependent on many criteria but, assuming that each manufacturer is seeking a commercial return on its investment, the biggest drivers are actual cost of manufacture and write-off of development cost. BAE Systems and Bombardier have an advantage on both counts, since they are offering derivatives. They are therefore well down the production learning curve, and investment in their aircraft is quite limited.

The portion of purchase price that is attributable to development cost amortisation is simply a function of the development cost of the aircraft and the number of sold units over which this cost can be spread. Embraer has projected total deliveries for the ERJ170/190 at 650 aircraft. This equates to a 22.8% share of

its projected market for aircraft in the next 10 years. If Embraer's estimated development cost of \$850 million is to be regained at a commercial rate of return, (for example, 15% per annum) then the average development cost write-off per aircraft is about \$2.25 million.

If the development costs of the remaining aircraft are amortised over a 23% share of their predicted market at a rate of return of 15% per annum on the initial investment, the development cost write-off ranges from \$1.95 million per aircraft for the CRJ700/900, to \$2.25 million for the ERJ170 family, and up to \$3.85 million for the 728/928Jet.

In comparison, BAE Systems has announced that the total investment in the RJX is less than \$100 million, and that the majority of this has been provided by the engine supplier Honeywell.

These analyses assume that a 20% discount on the purchase price is allowed for each aircraft. All aircraft are assumed to be financed to a 25% residual value after 15 years. This may not be available, however, for all the aircraft and their customers, since financial institutions may take a different view of their residual value prospects. They are looking in particular for wide market penetration. This is already the case with the CRJ700/900, with 225 aircraft ordered by 10 different operators. When this is added to the large market base for the CRJ100/200, the CRJ700/900 have an advantage.

The situation is less clear for the ERJ170, since the aircraft is not a direct development of Embraer's 50-seater. However, since the ERJ145 has been so popular, financial organisations will probably take a positive view. Embraer and Bombardier will also have the advantage of PROEX and Canadian subsidies.



By comparison, Fairchild Dornier lacks a market base. BAE Systems has a better established market base and product support, but the financial community has been wary of the BAE 146/Avro RJ and the few wholly independent transactions that have taken place.

## Financing

The latest chapter in the on-going dispute between Brazil and Canada over the PROEX subsidy has seen Canada offering financing to both Air Wisconsin and Northwest. Canada claims that this is equivalent to the latest version of PROEX. Financing by Canada is offered at the Organisation for Economic Co-operation and Development (OECD) Commercial Interest Reference Rate (CIRR), which 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). As we go to press, the US CIRR is 6.24% for terms in excess of eight years.

The advantage of such financing is that it does not take into account the operators' own credit risk. The rate would be the same whether it was American Airlines or TWA.

Fairchild Dornier has announced that it will follow Bombardier's example, and seek backing for equivalent financing support from the US and German governments. BAE Systems, meanwhile, maintains its interest in sales to good-quality credits only, which by definition will have good financing sources of their own.

For the purposes of this analysis it has been assumed that the discounted price for each of the aircraft will be financed at the CIRR rate over a 15-year term to a 25% residual value. This approximates to a lease-rate factor of 0.75% of actual purchase price.

## ATC and Landing Charges

The largest cost difference between the US and Europe markets is the lack of en-route charges in the US. While Europe has Eurocontrol, the cost of providing the air-traffic system in the US is met by central government funding through the Federal Aviation Administration. Landing charges in the US are a fraction of those in Europe. The result is that European operators have a fundamental interest in lighter aircraft.

One of the difficulties in comparing the different aircraft lies in deciding which maximum take-off weight (MTOW) option to use. It has been assumed that the majority of airlines will select the highest available in the expectation that even higher weights will be developed. The ATC and landing charges used are summarised (*see tables, pages 45 & 46*).

## Fuel

The CRJ700 offers the lowest fuel consumption. This is not surprising, since it benefits from a combination of airframe drag and engine efficiency. All three twinjets are powered by variants of the same engine. The Canadair CRJ700/900 has the smallest, most highly swept-wing. The ERJ170 and 728Jet are designed for better airfield performance.

The RJX offers a 10-15%

*Ignoring the possible negative effects of lower passenger demand and revenue because of a narrow cabin, the CRJ700/900 have the most attractive gross-profit-generating potential. This is partially because of their low fuel burn and maintenance costs. Bombardier also enjoys Canadian financing subsidies, as does Embraer. Fairchild Dornier will be asking the US and German governments for similar assistance.*

improvement in fuel consumption over the Avro RJ, but this is still an area of weakness compared to the twinjets. Using the CRJ700 as the base case, other aircraft over a 500nm sector will consume the following additional fuel: RJX70 20%, RJX85 30%, CRJ900 10%, ERJ170-100 11%, ERJ170-200 15% and 728Jet 12%. Each of the twinjets cruises at Mach 0.78, while the RJX will be slower at Mach 0.70. In broad terms, the new generation twinjets are midway between the CRJ700 and the RJX. The fuel price used is 80 cents per US Gallon.

## Crew

This cost element will be identical for all the aircraft considered, since they all require two flight crew and a minimum of two cabin attendants.

There are indirect benefits to the operators of BAE 146/Avro RJ and Bombardier CRJ100/200s, since both the RJX and the CRJ700/900 will have the same pilot type ratings as their predecessors. As well as the direct saving in training costs, there is also a significant saving in pilot productivity, since flight crew will not be required to undertake weeks of training.

Salaries are far higher for European pilots, who accumulate on average 25% fewer flying hours per year. Pilot salaries and annual flight hour (FH) productivities are summarised (*see tables, pages 45 & 46*).

## Maintenance

The cost of line maintenance is largely independent of type, since it requires mechanics at line stations across the network. A popular type may increase the ability to outsource such work, since more organisations will be able to provide the service required. This analysis assumes that all types are equal with a line-maintenance labour requirement of 0.5 man-hours (MH) per FH.

The inspection labour requirement for the existing Avro RJ is estimated at 0.35MH per FH, compared with 0.25 for the CRJ200. These rates are therefore applied to their developments, while, in the absence of data for the ERJ170 and 728Jet, the Avro RJ's higher rate is assumed.



One of the advantages for the Avro RJX and the CRJ700/900 is that they can take credit for the experience of their predecessors. For example, the C-check intervals on the Avro RJX will be the same 4,000 flight cycle (FC) interval as they are for all the other BAE 146/Avro RJ variants (projected to extend to 5,000 cycles), and the 4,000FH interval on the CRJ200 is applicable to the CRJ700/900. Embraer is planning for a C check interval of 6,000FH/5,000FC, but this may be unavailable at delivery.

These are also largely independent of the aircraft type, since all aircraft require the regular replacement of seals, lubricants and windows. A total allowance of \$25/FH has been included for miscellaneous consumables. Another big cost driver under maintenance costs, comprises wheels, tyres and brakes. For the twinjets a further \$25/FC has been assumed. The Avro RJX has a higher allowance of \$35/FC, since it lacks a thrust reverser, and its brake costs are known to be an issue.

The overall cost of rotables is a function of reliability and the price of overhauling hundreds of components. In today's era of fixed price maintenance agreements the comparison is far simpler. An analysis of data for such programmes on the Avro RJ and the CRJ200 (with additions for the APU and landing gear, which are normally excluded) highlights costs in the order of \$110/FH and \$125/FH respectively. In the absence of comparable data for the CRJ700/900, ERJ170 and 728Jet, it has been assumed their cost will be identical to the CRJ200's.

The largest individual element of maintenance cost is engine overhaul. This analysis is simplified, since the three twinjet designs are all powered by variants of General Electric's (GE) CF34 engine.

The Avro RJX is powered by four AS977 turbofans. In comparison with the LF507s fitted to the Avro RJX's predecessor, the AS977 powering the Avro RJX is claimed to offer 20% lower maintenance costs with a power-by-the-hour rate of \$58 per engine flight hour (EFH).

Although the AS977 is a considerable improvement on the LF507, the real competition is provided by the CF34. With GE offering equivalent programmes at rates in the order of \$90/EFH, the RJX will still be at a disadvantage with the AS977, since it has an across-the-wing cost of \$232/FH, versus \$180/FH for the twinjets.

The scale of the improvement that is expected with the AS977 over the LF507 is demonstrated by a comparison of the expected on-wing life. While the LF507 can achieve 6,000-8,000EFH between removals, the AS977 is guaranteed to achieve 12,000EFH. The even older ALF502R fitted to the BAE 146 was unable to achieve 5,000EFH. For the first time this will put the quadjet in a superior position, in terms of on-wing life, to its twinjet competition. The first scheduled removal of the CF34-8 is expected to be 8,000-10,000EFH.

Total maintenance cost for the twinjets is estimated at about \$375/FH, compared with \$425/FH for the RJX (see *assumptions tables, pages 45 & 46*).

The Avro RJX has the advantage of a large customer base and small development costs. This last factor may allow BAE to offer deeper price discounts than its competitors.

## Commonality savings

While some of large regional operators may operate more than one of the types considered here (Lufthansa Cityline's current plans for its future involve not only the Avro RJ85 and the CRJ700, but also the 728Jet), smaller carriers will not have this luxury. Many will also already operate examples of the BAE 146/Avro RJ, CRJ100/200 or the ERJ145. It will therefore be easy for them to retain their existing supplier.

An airline's inclination to stay with the same manufacturer is governed by the actual cost of introducing a new type. This substantial cost is often overlooked in a simple analysis of direct operating costs. As well as the cost of pilot and engineer training, there are investments to be made in spares, ground support equipment (GSE) and tooling. For training as well as the costs of the courses themselves, there is the cost of covering personnel's absence, hotels and transport. These one-off costs need to be paid at the start of a new operation. For an operator progressing from either the CRJ100/200 to the CRJ700/900, or from the BAE 146/RJ to the Avro RJX, these costs will be substantially reduced.

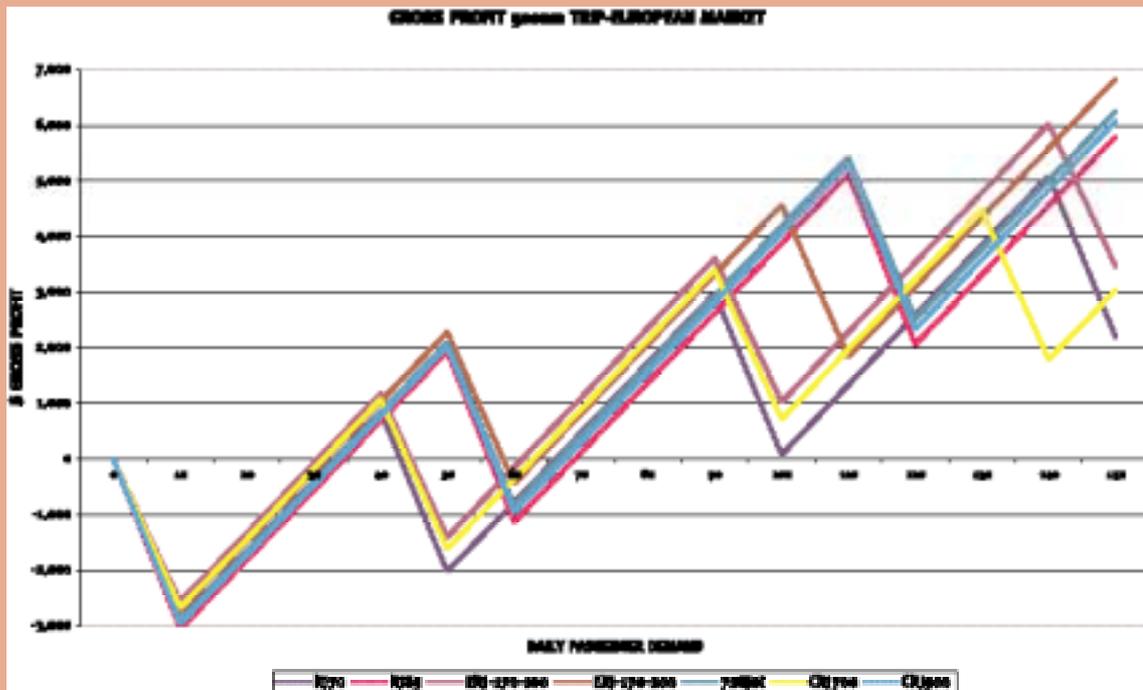
The significance of these costs can be illustrated by the example of an existing European BAE 146-200 looking to replace its fleet of 10 aircraft with either an equal number of RJX85s or ERJ170-200s.

The DOC analysis of the two replacement options suggests that the newer twinjet design will save \$135,000 per year. Assuming a useful life with the operator of 15 years, this is equivalent to a lifetime saving of \$2,025,000 per aircraft. Discounting this at 5% per annum reduces this advantage to less than \$1,500,000.

To achieve this saving from the introduction of a new type, the operator must invest in the following:

● Initial pilot training	\$300,000
● Engineer training	\$75,000
● Loss of value in spares	\$500,000
● Investment in GSE	\$10,000
<b>Total</b>	<b>\$885,000</b>

Initial pilot training cost, including classroom and simulator instruction, is typically in the region of \$25,000 per pilot. Assuming five crews per aircraft, 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 3-4 weeks can add a further \$5,000 per pilot for a total cost per aircraft of \$300,000.

Engineer training is cheaper, since it does not require expensive simulator time, but it still takes engineers 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 for additional costs are assumed, with five engineers per aircraft.

Spares can be a particularly heavy cost. While airlines buy spares at perhaps 75% of the manufacturers' list price, when they come to sell them later they will probably only achieve 25%. A 10-aircraft fleet justifies a spares investment of \$7 million, so the lost value could amount to \$5 million. When spread across the fleet of 10, it amounts to \$500,000 per aircraft. Type-specific GSE typically requires an investment of \$100,000, or \$10,000 per aircraft.

It should be noted this simplistic analysis has not examined all the additional costs of changing types.

## Summary

In terms of cash operating costs, the differences between the three new-generation twinjets are practically zero. In fact, the difference is only 3% between the three aircraft with the closest seat capacities: the CRJ900, ERJ170-200 and 728Jet.

This is hardly surprising, since they are all powered by the same engine, and therefore have similar fuel consumption and engine maintenance costs. They all require two pilots and two cabin attendants to crew the aircraft, so this

## OPERATING COST ASSUMPTIONS FOR 70-SEAT JETS ON EUROPEAN 500NM ROUTE

**Seats:** Avro RJX 70: 70; Avro RJX: 85; CRJ700: 66; CRJ900: 82; ERJ170-100: 70; ERJ170-200: 78; 728Jet: 80.

**Annual utilisation:** 2,000FH

**Fuel price:** 80 cents per US Gallon

**Maintenance costs:** \$375 per FH for twinjets, \$425 per FH for Avro RJX

**Crew salaries:** Captain: \$75,000; First officer: \$50,000; Cabin attendant: \$25,000, 2 attendants.

**Pilot annual productivity:** 600FH.

**Landing charges:** \$9 per ton MTOW

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

**Finance:** 20% discount on manufacturer's list prices of: Avro RJX70: \$25.4 million; Avro RJX85: \$27.4 million; CRJ700: \$26.8 million; CRJ900: \$30 million; ERJ170-100: \$23.5 million; ERJ170-200: \$25.35 million; 728Jet: \$28.75 million. Monthly lease rate factor of 0.75%.

cost will be identical. There is some variation in landing and en-route charges due to the differences in MTOWs.

To make any significant difference the manufacturers will have to rely upon the costs of acquisition/lease.

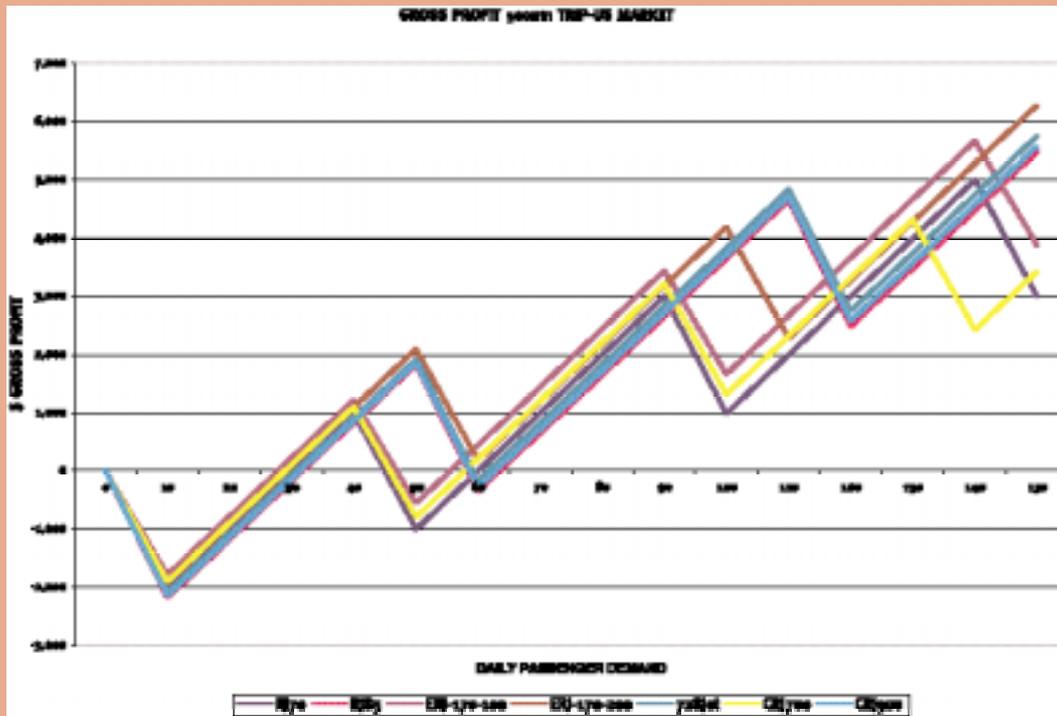
To compare aircraft of different seating capacities, their overall economic performance is shown in terms of their gross-profit potential, (see charts, this page for Europe, and page 46 for the US). This is how the difference in passenger revenue, less direct operating costs, varies with a range of passenger demand on a typical route.

These analyses have used arbitrary fares of \$125 per passenger for the European analysis and \$100 per passenger for the North American. In both cases, load-factor constraints of 70% have been used for all aircraft. That is, once average passenger demand on the route has reached 70%, the operator will have to add another frequency to avoid

passenger 'spill'. This will increase costs equal to the trip cost of an aircraft, while revenue will have increased by an amount equal to one passenger. Each time a frequency is added the gross profit for each aircraft falls by an amount equal to one additional trip, and climbs thereafter as passenger demand and revenue grow.

These analyses show the CRJ700 and CRJ900 in both regions offering the highest gross profit generating potential. No account is taken of the effect that higher comfort standards may have on passenger demand and load factor. This could favour the other aircraft over the CRJ700/900.

Where airlines select the CRJ because of its cross-section, there is little difference between the remaining aircraft. The ERJ170 variants in Europe have a slight advantage over the RJX85 and the 728Jet. The gross profit profiles of the latter are so close as to appear as one line (see chart, this page).



**OPERATING COST ASSUMPTIONS FOR 70-SEAT JETS ON NORTH AMERICAN 500NM ROUTE**

- Seats:** Avro RJX 70: 70; Avro RJX: 85; CRJ700: 66; CRJ900: 82; ERJ170-100: 70; ERJ170-200: 78; 728Jet: 80.
- Annual utilisation:** 2,150FH
- Fuel price:** 80 cents per US Gallon
- Maintenance costs:** \$375 per FH for twinjets, \$425 per FH for Avro RJX
- Crew salaries:** Captain: \$65,000; First officer: \$35,000; Cabin attendant: \$20,000, 2 attendants.
- Pilot annual productivity:** 800FH.
- Landing charges:** \$2.2 per ton MTOW
- ATC charges:** N/A
- Finance:** 20% discount on manufacturer's list prices of: Avro RJX70: \$25.4 million; Avro RJX85: \$27.4 million; CRJ700: \$26.8 million; CRJ900: \$30 million; ERJ170-100: \$23.5 million; ERJ170-200: \$25.35 million; 728Jet: \$28.75 million. Monthly lease rate factor of 0.75%.

In the US, the RJX85 has the advantage over the ERJ170 variants and the 728Jet. The ERJ170-200 and 728Jet have such close gross profit profiles they appear as one line (see chart, this page).

While the Avro RJX cannot match the cash operating costs of the new generation of twinjets, the total costs of all four can be competitive. In the RJX's favour are some existing operators for whom its start-up costs will be substantially reduced.

The Avro RJX's higher weight and lower fuel efficiency in Europe have an impact on its attractiveness, but this is the same market where its passenger comfort and high performance can command a premium. The significance of these disadvantages is actually reduced in the US market where fuel is cheap and weight related charges are minimal.

As a stretched development of the CRJ200, the CRJ700/900 offers the lowest DOCs of all the types considered,

in both the US and Europe. When this advantage is supported by the success of the CRJ100/200 in North America, it is no surprise that over 150 CRJ700s have already been sold into that market. In Europe, while economic efficiency is an important criterion, it is not the only one and here the type's smaller cabin may count against it.

Following closely behind the CRJ700 in terms of economic efficiency is the ERJ170. Operating costs are a key driver in any evaluation, but the aircraft has to be capable of flying the routes for which it is intended. The biggest difference in this case is that the ERJ170 is claiming a substantially better airfield performance than the other twinjets, with London City and Lugano as design missions.

The 728Jet is the most expensive twinjet, but offers the highest comfort standards (not quite matching those of the 5-abreast RJX). The 728Jet's biggest disadvantage is the lack of market

presence from Fairchild Dornier itself, which in turn damages the 728Jet's financing prospects. Unless support comes from the German and US Governments, it will be difficult for Fairchild Dornier to compete with the support that the Brazilian and Canadian governments provide Embraer and Bombardier.

Modern cost conscious airlines acquire aircraft in order to generate profits. There is no point in manufacturers offering well engineered, super fuel efficient designs if the airline pays for this in higher initial cost or lease rates. BAE Systems and Canadair are offering less glamorous alternatives but, providing the operators accept their shortcomings, they can be highly competitive against the new designs.

With the competitors having such similar operating costs and gross profit generating performance, purchase price and sale financing terms will have the main influence on final sales.

BAE has the advantage of the lowest development cost, but does not have government subsidies to aid financing. However, it has relied on its own financing support to aid airlines.

Embraer has the advantage of the lowest list prices, and PROEX financing.

Bombardier also has financing aid, plus one of the largest levels of market penetration.

Fairchild Dornier has yet to acquire a scheme, similar to Embraer's and Bombardier's, which will subsidise financing and put it on a level playing field with the other twinjet manufacturers. Fairchild Dornier also has the highest list price, but offers one of the largest aircraft with the biggest cabin. 