Regional airlines continue to shun turboprops and place orders for regional jets because of their passenger appeal. Turboprops still hold an advantage of superior field performance, but only on runways shorter than 4,500 feet. Is this enough to maintain a market for turboprop manufacturers?

Can field performance save the turboprop?

Economics are the overriding aircraft evaluation criteria for any airline. Several recent articles in *Aircraft Commerce* have highlighted the similarity in direct operating costs between regional jets and turboprops. This suggests that the manufacturers of regional turboprops face a limited future.

The one remaining intrinsic advantage of turboprops may be their superior airfield performance and the inability of regional jets to access all of the market.

Turboprop vs jets

Chart A *(see page 39)* shows the variation in field length required (most limiting effect of take-off and landing at maximum take-off weight [MTOW] and maximum landing weight [MLW] respectively) with seating capacity for regional turboprops and jets.

This shows that there is no such thing as a 'typical' turboprop as far as airfield performance is concerned. The range of performance capabilities encompasses everything from the short take-off and landing (STOL)-capable de Havilland Canada Dash 7 to the poor British Aerospace J32. For the purposes of this analysis the turboprops are grouped into four levels of capability. The fifth group is of regional jets:

- STOL turboprops

The de Havilland Canada Dash 7, Dash 8-100/-200 and the Dornier 228 which can operate into airfields of less than 3,000ft.

- High performance turboprops

The de Havilland Canada Dash 8-300, Fokker 50 and Dornier 328-130. These require 3,000–3,500ft of runway.

- Mid-performance turboprops

The ATR42 series, ATR72-500, Beech 1900D, BAe ATP, Dornier 328-110, Saab 340Bplus and Saab 2000. These require 3,500–4,000ft of runway (as do the 146-100 and RJ70 regional jets).

- Low performance turboprops

The ATR72-200, BAe Jetstream 31/32/41, de Havilland Canada Dash 8-400, Embraer Brasilia, Fairchild Metro, Saab 340A and 340B. These require 4,000–4,500ft of runway (as does the Fokker 70 jet).

- Regional jets

The Canadair RJ Series 200, RJ Series 700 and the Embraer ERJ-135 and ERJ-145 all require in excess of 4,500ft of runway.

These groupings illustrate how wide the spread of turboprop performance really is. Some aircraft appear in more than one category. This occurs where continuous development of the basic aircraft has improved its capability. Examples include the ATR72, which has been developed through the –200, -210 and now the –500 series, and the Saab 340, which has progressed through A, B and Bplus models.

For simplicity, only ISA, sea-level conditions have been considered in this



Regional jets require runways longer than 4,500ft, allowing them to operate from 62% of airports. Regional jets can also operate from 73% of airfields that most turboprops can. These airfields also cater for the majority of traffic. This fact will mean jets will undermine turboprops as a niche aircraft in many cases.



The ATR72 offers good take-off and landing performance and so is a threat to the Dash 8-400. The best prospects for the ATR72 and Dash 8-400 are in Europe, where congestion and high airport user charges put regional jets at a disadvantage in several markets. The ATR72 is also lighter than the Dash 8-400.

article, but airfield performance is also limited by airport temperature and altitude. Under extremes of these conditions even the turboprops are not immune to limitations. This has led to the development of high-performance variants of many different aircraft.

The overall message is that turboprops under sea-level ISA conditions are capable of operations from airfields less than 4,500ft in length and the existing 50-seat regional jets are not. A 4,500ft runway is thus the dividing point between turboprops and jets as far as performance is concerned.

The ability of turboprops to outperform regional jets is simply a function of their design. Turboprops, without exception, feature straight wings, which are a compromise between the need for speed and the need for good airfield performance.

The Canadair and Embraer regional jets have no such pretension. They are designed with small, highly swept wings which result in less drag for high speed, but also in less lift for take-off and landing.

Airfield performance is not simply a function of aircraft size. Observers might assume that larger aircraft require longer runways.

At the upper end of the size scale the BAe 146-100 and Avro RJ70 offer a level of airfield performance capability in excess of that provided by the same manufacturer's Jetstream 32 aircraft.

Chart A *(see page 43)* also shows that the 19–50-seat market lacks high-performance jets. The only manufacturer that is currently paying much attention to this market niche is Fairchild with the 328Jet/428Jet family.

Demand for performance

To predict the future market for turboprops based on superior airfield performance, it is necessary to investigate the airports from which they will operate.

Taking a sample of over 5,500 airports from around the world, the distribution of runway length is shown in Chart B *(see page 39)*. What is clear is that 62% of the airport runways examined are more than 4,500ft long.

Chart B groups runway lengths into the different performance classifications used earlier. It demonstrates very clearly why the dedicated high-performance turboprops have been so unpopular commercially. Only 4% of the airports examined were limited to runways of less than 3,000ft, which is where these aircraft would be required.

The next segment for runways of between 3,000–3,500ft accounts for 11% of the total runways available. A total of 15% of runways are excluded to the majority of turboprops. The exceptions are STOL aircraft; the Dash 7, Dash 8-100/-200, Dornier 228 and Fokker 50.

The total percentage of runways, and thus market, excluded to 50-seat regional jets is 38%.

Jets can operate from 62% and most turboprops from 85% of most airports. Jets can therefore use 73% of the fields that most turboprops can.

This suggests regional jets will outsell turboprops by a factor of three to one. Unfortunately for turboprops this simplistic examination takes no account of frequency of service to these smaller airports. The majority of airports with a well-developed route network will already have their runways extended to allow operations with non-STOL aircraft. The remainder are either special cases, such as London City Airport, which are limited by political/environmental concerns, or do not have the traffic to support extensive scheduled operations. Demand for aircraft to serve these destinations is therefore likely to be less than the 26% suggested here.

High-performance jets

Some demand could also be lost to a later generation of high-performance jets. What needs to be asked is how good will these aircraft be, and can they serve as a

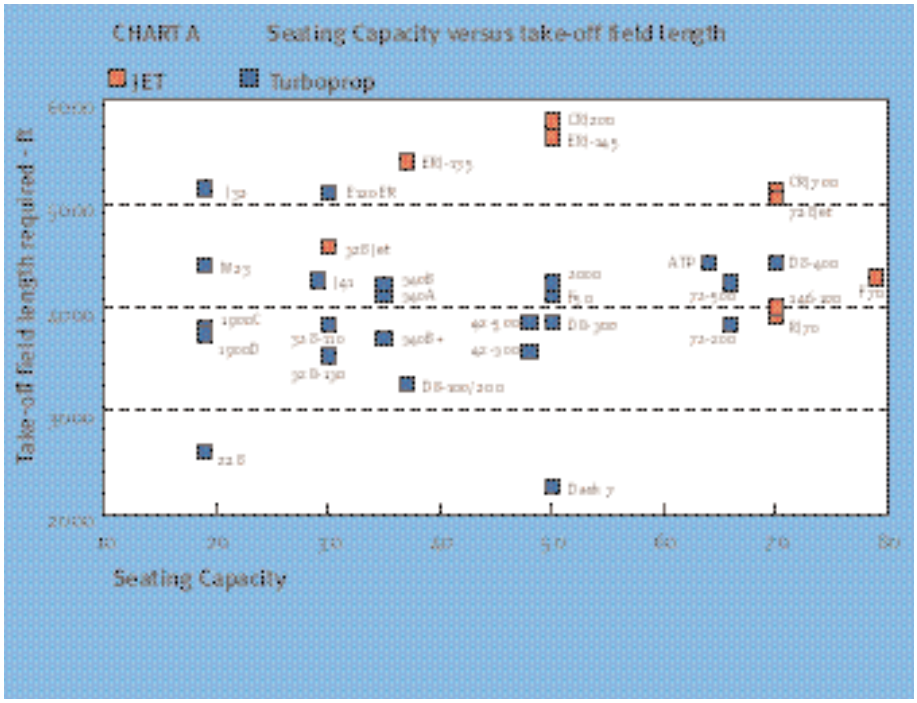
complete replacement or alternative to the turboprop?

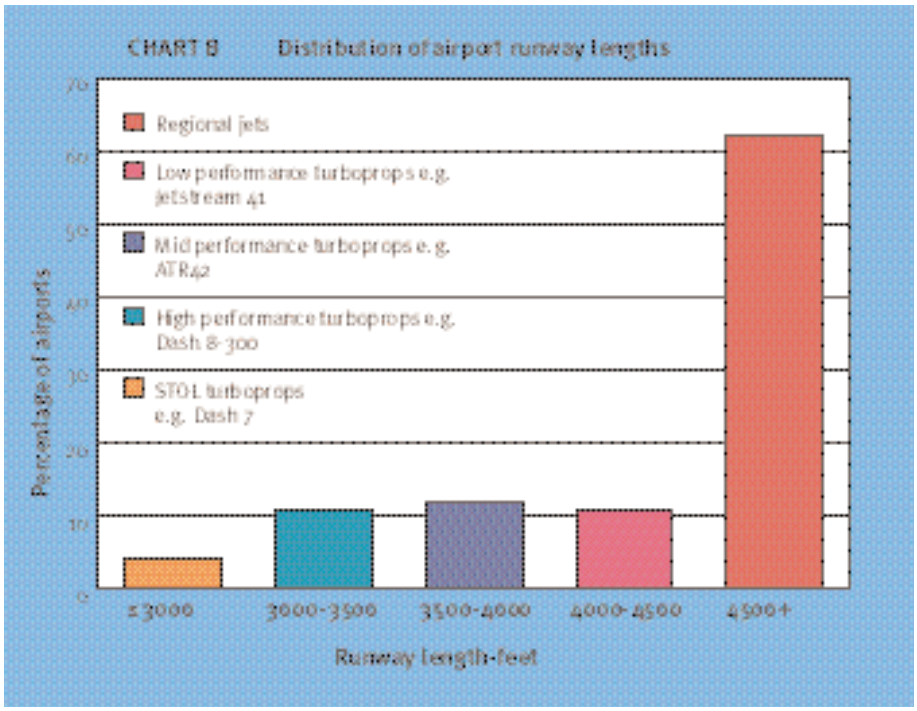
The Fairchild 328Jet was offered as the complete solution for the replacement of the turboprop, offering jet speed with turboprop airfield performance.

Unfortunately since the launch of the project in February 1997 development problems have reduced this advantage. Weight growth to achieve the desired range performance has been substantial and problems caused by the loss of the braking effect of the propellers have resulted in further increased landing distances.

The 328Jet was originally intended to be capable of take-off and landing at maximum weights from runways of 3,950ft. A combination of weight growth and performance shortfalls has seen take-off field length (TOFL) increase to 4,590ft and landing field length (LFL) to 4,300ft. The 328Jet has lost the field performance advantage it would have had over the Embraer ERJ-135/145 family.

Unique attributes of the turboprop will still, therefore, continue to have a role. The next question that needs to be answered is which types will benefit most from this demand?





The 19-seat market

Raytheon continues to be bullish about 19-seat aircraft. British Aerospace was the first player to leave the market. The Dornier 228 and Fairchild Metro have been maintained, but are now effectively out of production.

Fortunately for Beech it has the best-performing turboprop in its class, which makes it suitable for many of the smaller markets that are still taking aircraft from the production line. Whether it is the Beech 1900D's good all-round performance, or the lending power of Raytheon Credit that is maintaining sales is a subject for discussion elsewhere.

The Dornier 228 offered significantly better airfield performance capability than the other 19-seaters but sales were disappointing. Total deliveries amount to 240 aircraft (excluding those built under licence in India by Hindustan Aeronautics).

If there is a continued role for new-production 19-seaters it is unlikely that it will ever be met by a regional jet. Few predicted the success that has followed the 50-seat and 30-seat regional jets. Jet preference factor, aircraft capacity growth and scope clauses all helped the success of these jets.

While passenger preference for jets over turboprops is indisputable, the demand for smaller aircraft is on the decline. The growth in average size of regional aircraft in Europe has almost wiped out the 19-seater market. The only sizeable fleet belongs to Proteus Airlines, which operates 12 Beech 1900Ds.

Several big fleets remain in the US; in particular the Beech 1900Ds of Commutair, Continental Express, Great Lakes and Mesa and the Jetstream 31/32 fleets of Atlantic Coast, CCAir, Chautauqua, Express Airlines and Trans States. But these are also in decline.

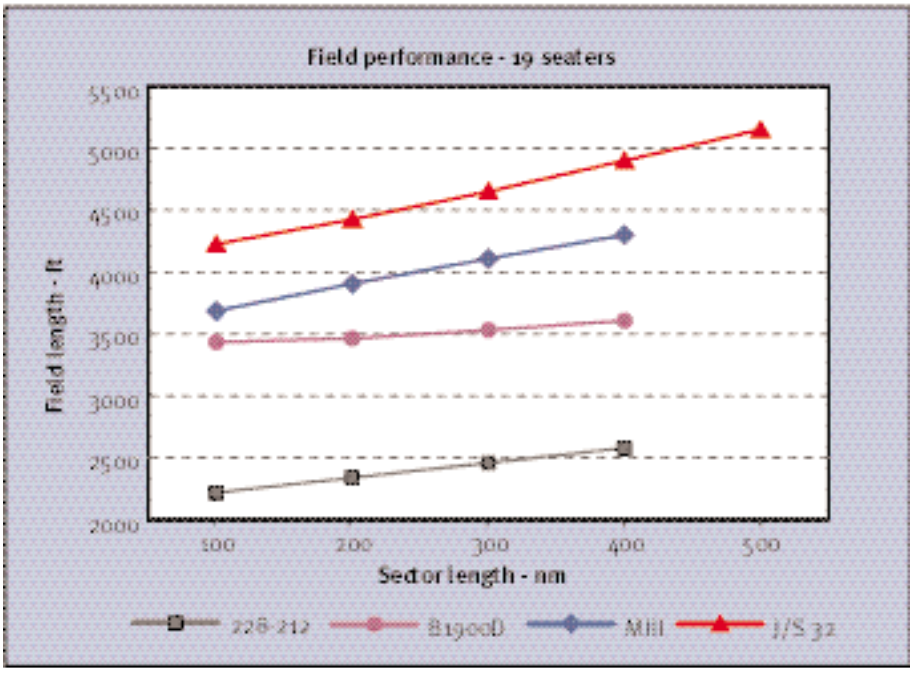
Both ACA and Continental have made public their 19-seat replacement plans, which sees them committed to the 328Jet and Embraer ERJ-135. Mesa meanwhile has stated its 19-seat operations are uneconomic, and has begun to dispose of its Beech 1900Ds.

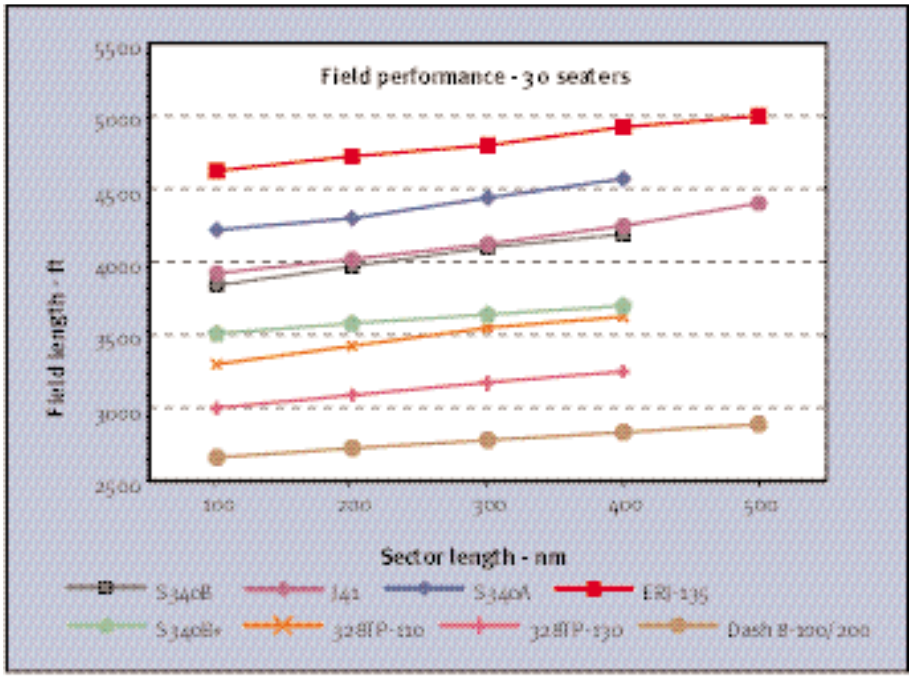
The 30-seat regional jets are gaining market penetration on the back of the scope clause limitations. Next to a 50-seater, the 30-seat jets are the next best thing by virtue of their scope clauses. The same 'logic' does not apply to the 19-seat aircraft.

30-seat market

This is probably the most important market of all, due to a combination of the large number of aircraft and the importance of the US market.

The average 27-seat size in the US regional fleet, the recent introduction of two 30-seat regional jets and the strength of scope clauses are almost certain to see a dramatic round of orders for 30-seat regional jets.





Turboprops in this category also share a lack of airfield performance. With the exception of the Dash 8-100/-200 and the -130 variant of the Dornier 328, the remaining aircraft, the BAe J41, Embraer Emb-120 Brasilia, Fairchild 328 (-110 and -120) and Saab 340 all suffer from at best poor airfield performance.

The Embraer Emb-120 Brasilia is the worst of all, being restricted to runways exceeding 4,500ft. Since the Embraer ERJ-135 and Fairchild 328Jet are largely able to match the airfield performance of most turboprops, their market is minimised.

This forecast is borne out by the decisions of the various manufacturers to cease production. The British Aerospace Jetstream 41 was the first in May 1997, and was followed later that year by Saab with the 340.

Skywest's order for 20 Emb-120s in 1998 is the only significant order for the Brasilia in recent years. Embraer's recent announcement that it will increase the production rate of the ERJ-135/-145 family to 16 aircraft per month assumes the closure of the Brasilia line.

Fairchild appears to be placing most of its marketing efforts with the 328Jet, rather than the turboprop. This leaves the de Havilland Canada Dash 8-100 and -200, which easily outperform the other aircraft. Sales into Europe were stifled by their high weight design, but they have been successful in North America.

The Dash 8-100 and -200 provide a level of capability between the true STOL aircraft, such as the Dornier 228 and Dash 7, and the more typical performance capabilities of the Jetstream 41, Dornier 328 turboprop, Embraer Emb-120 Brasilia and the Saab 340. This will undoubtedly help maintain the residual values of the Dash 8, since it is by far the most flexible of aircraft on offer. There have been 20 orders for the Dash 8-100 and –200 since 1 January 1998.

The Dash 8-100/-200's unique performance capability is confirmed by an examination of where some of their recent customers intend to operate their aircraft. Amakusa Airlines, a Japanese start-up, is being formed specially to operate from a newly constructed 1,000m (3,280ft) runway on the island of Amakusa.

UNI Airways has ordered a single Dash 8-200 to operate between Taiwan and neighbouring Matsu Island. Two of the other recent customers, Sunstate Airlines and Ryuku, will also operate their newly ordered aircraft into island destinations.

The 30-seat market is definitely not going to be the salvation of the turboprop, but it could become a big enough niche for the Dash 8-100/-200. The smallest member of the Dash 8 family will satisfy the majority of the demand for difficult airfields.

50-seat market

The performance gap between the turboprops and regional jets is at its widest in the 50-seat market. Whereas the Canadair RJ and Embraer ERJ-145 realistically require field lengths of at least 5,000ft for operations, the turboprops can support realistic payloads out of airfields of less than 4,000ft in length.

Unfortunately despite the large number of airports that could benefit from high-performance turboprop aircraft, the lack of commercial success with such aircraft again highlights the limited real demand.

The best performers in the 50-seat market are the Dash 8-300 and the Fokker 50. Close behind are the ATR42 models. The latest –500 model, despite having greater engine power, also suffers from a large amount of weight growth. This causes slightly inferior performance in the newer model.

The Saab 2000 is the only high-speed aircraft to come close to matching the performance of conventional turboprops. The type has carved itself a niche as the only high performance high-speed 50-seater capable of operating at London City Airport. The Saab 2000's commercial failure confirms how low the demand for high performance really is.

As with the 30-seat market and Dash 8-100/-200, the future market for high-performance turboprops is going to be limited. Where such capability is required the Dash 8-300 and ATR42-500 are available.

70-seat market

The Dash 8-400 is the natural successor to the ATR72, and to a lesser extent the ATP, in terms of capacity and passenger attractiveness. How well does the Dash 8-400 compare in terms of its ability to match its competitors' airfield performance? Despite its higher weight and superior speed capability the vastly greater engine power relative to the ATR72-500 ensures that the Dash 8-400 is able to match the ATR's overall take-off performance.

The Dash 8-400's heavier weight contributes to a relatively poor landing performance capability for a turboprop, which limits it to runways in excess of 4,000ft.

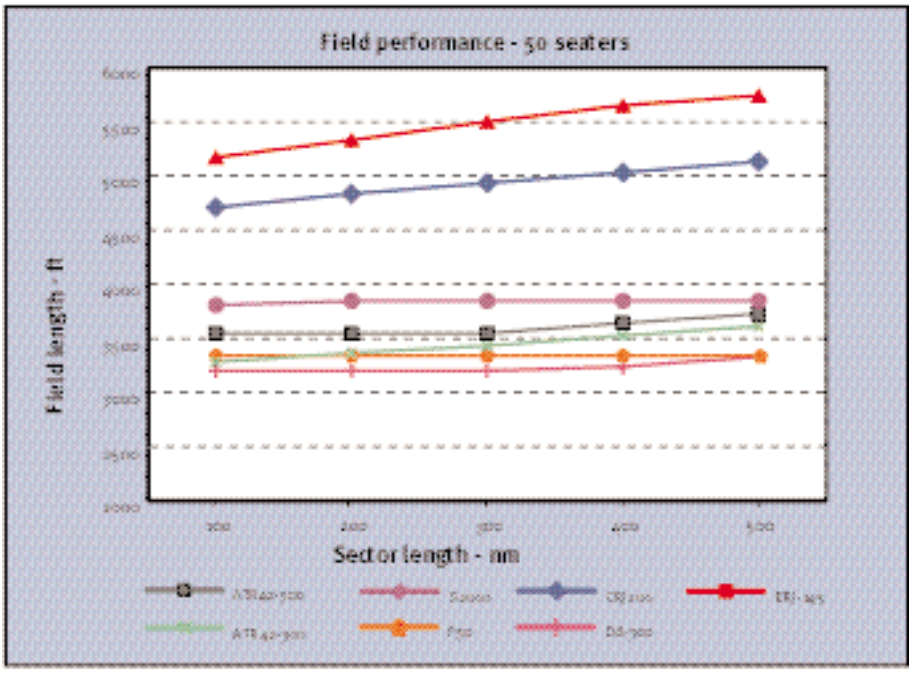
The ATR72-500 is the latest development of the ATR72. It offers far superior airfield performance to the earlier, lower powered, -200 variant. Despite the introduction of the Dash 8-400, there could therefore still be a role for the ATR72 family.

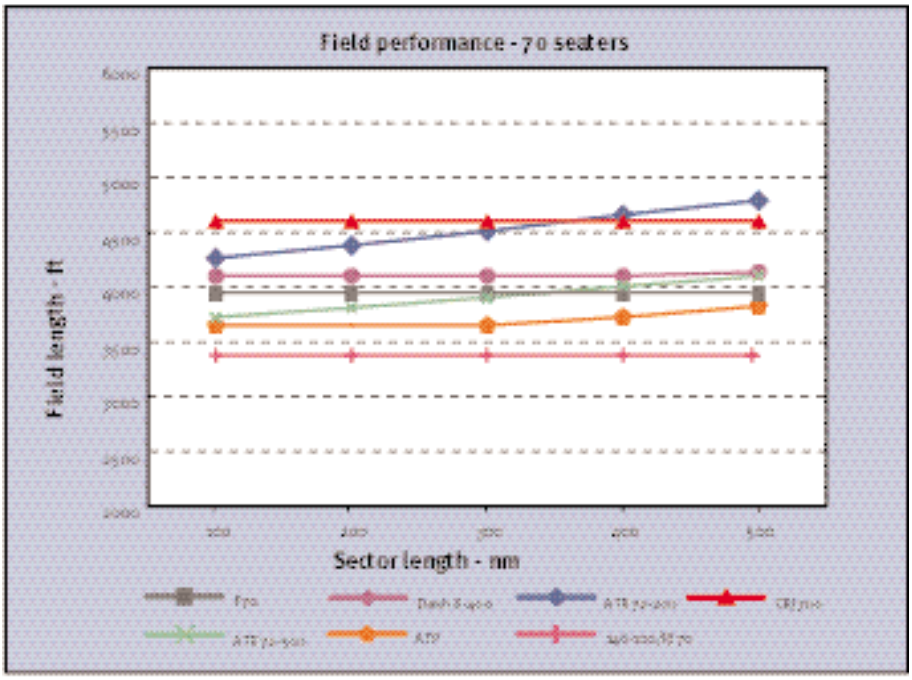
As well as the Dash 8-400, Bombardier can also offer the CRJ Series 700. By incorporating leading edge devices, the CRJ 700 offers comparable performance with the 50-seat regional jets, requiring a field length in excess of 4,500ft.

An alternative high-performance 70-seat regional jet has existed for nearly 20 years which easily outperforms the 70-seat turboprops. The BAe 146-100 and its successor the RJ70 were hardly great commercial successes though. Total sales of the 146-100 were limited to 34 and the RJ70 sold 12 units out of the 371 Avro RJs and BAe 146s ordered to date. The RJ70 is the Avro RJ variant that is built to order and is not readily available.

Turboprops are finding it harder to offer advantages over regional jets. The Dash 8-400 and the ATR72-500 offer a significant cost advantage over the CRJ700 *(see Dash 8-400: the right economics for Europe, Aircraft Commerce March/April 1999, page 47)*.

The real debate is that with the availability of the Dash 8-400 will the ATR72 be able to compete in a limited market?





Conclusion

It is an undisputed fact that (with the exception of the 146-100/RJ70 in the 70-seat market) the turboprop aircraft available today offer superior airfield performance to regional jets.

The only questions that remain are how important is this capability (and therefore how big a market does it create) and can the jets be improved further to meet it?

History shows that demand for ultra-high performance aircraft, such as the Dash 7 and the Dornier 228, is always going to be limited. Future demand from many parts of the world will be met by the large number of used examples that are coming on to the market.

There will always be operators that require high-performance aircraft, but the majority of turboprop operators have never fully utilised their aircraft's full capability.

The analysis of over 5,500 airports highlights that performance of regional jets meets the majority of airlines' needs. This is simply because turboprops only hold a field performance advantage over jets on runways shorter than 4,500ft. The fact that 62% of airfields have runways longer than this and that they are also the majority of airfields served by regional carriers, means turboprops do not hold a strong competitive advantage over jets in terms of performance.

Fairchild is attempting to make inroads into much of the remaining potential demand with the introduction of the 328Jet/428Jet. Its experience, together with a brief look at an older generation of regional jet, the VFW 614, demonstrates how difficult it has been to reconcile the opposing requirements of high speed and good airfield performance.

De Havilland Canada has found itself in the position of a niche turboprop supplier in a market otherwise dedicated to regional jets. Both the Dash 8-200 and -300 are likely to remain in continued, probably limited, production. Competition remains, in the shape of ATR which can provide similar levels of capability with its ATR42-500 and the ATR72-500. The latter is a particular threat to sales of the Dash 8-400, which does not benefit from the superb landing performance of its predecessors. AC