The 737 is searching for a secondary market, and can provide the same payload capacity as the 727-100F. Conversion of the 737-400 depends on market values being low enough. Has the 737 yet reached, or is about to reach, the stage where conversion is economically viable?

Are the 737-200 & -300/-400 ready for freight conversion?

The debate about which aircraft will replace the 727-100F and 727-200F continues. Unless traffic growth is high enough to dictate the need for a widebody to replace some 727s, the preferred replacements for the 727 will be those with matching fuselage cross-section. This will allow continued use of the same containers so that existing interlining systems are not disrupted. One candidate for 727 replacement is the 737-300/-400. The viability of the 737 will come down to the lease rate of converted aircraft and total operating cost. This will be determined by current market values being low enough to make a case for conversion.

The second market for the 737-200 and –300 is as a replacement for about 100 DC-9s and 70 older 737-200s in the small narrowbody freighter fleet. This sector is also forecast to expand by 50% over the next 20 years, and so could provide additional potential for the 737-200/-300 where airlines want to open new low-density routes.

737F market

There are more than 200 727-100s and about 290 727-200s in operation. Replacements for these will first depend on their payload characteristics and their operators' payload requirements. The majority of 727s are used in small package operations, which have loads packed at low densities. These have historically been in the region of 7lbs per cubic foot, but in recent years have fallen to about 6.5lbs per cubic foot. Operators carrying small packages therefore have volume, rather than structural payload, as a priority in aircraft selection.

Small package traffic growth rates are high, and so many carriers may have a requirement for aircraft larger than the two 727 models. Network developments, however, continue to see the opening of new routes and frequencies. The 727s are the most popular small narrowbody freighter and, without a need for replacement, would continue to fill this role of providing lift for new and least busy routes. The 737-200 and 737-300/-400 therefore stand not only as a potential 727 replacement, but also as a standalone aircraft that could open new routes with low traffic volumes.

The 727-100's and 727-200's structural and volumetric payload should be compared with that of the 737-300F and 737-400F to determine whether they are suitable replacements for the 727. It is also important to examine the 737-200/-300 in terms of their economic viability as aircraft to open low volume routes and replace DC-9s and older 737-200s.

Payload characteristics

Airlines will use containers for small package operations. In order to preserve continuity of interlining of containers, many 727 operators have striven to keep the aircraft in service for as long as possible. This is one of the biggest hurdles 727 replacement candidates have to overcome. Aircraft that can use the same containers as the 727 will be better placed replacement candidates.

The 727 fuselage can accommodate 125-inch by 88-inch containers. These have an internal volume of 458 cubic feet and tare weight of 250 lbs. The 727-100 can hold nine of these, while the –200 can accommodate 12. This gives the 727-100 and –200 containerised volumes of 4,122 cubic feet and 5,496 cubic feet on their main decks *(see table, page 12)*.

At a packing density of 6.5lbs per cubic foot the 727-100 has a volumetric payload of 26,800lbs, and the –200 a volumetric payload of 35,700lbs.

The 737-400 is the same size as the 727-100, also carrying nine 125-inch by 88-inch containers, and so has a volumetric payload of 26,800lbs. "We regard the 737 as a viable 727-100 replacement," says Rick Smith, vice president of marketing at Pemco. "It is difficult to find a 727-100 replacement. Despite having re-engined aircraft, UPS has announced it will start to retire 727-100s in 2002. There are other airlines which are looking for alternatives to the 727-100."

The 737-300 has a capacity of one less container than the -400, and the 737-200 one less than the –300. This gives the 737-200 and –300 volumetric payloads of 23,800lbs and 20,800lbs, smaller than the 727-100. The DC-9-30 can accommodate eight 108-inch by 88-inch

The 727-100F's low lease rates make it hard for other types to challenge its unit costs per ATM. The 727-100F cannot continue operating for much longer, and so will have to be replaced. The strongest candidates are the 727-200A and 737-400.

containers. These are narrower than those used by the 727 and 737, on account of the DC-9's narrower fuselage cross-section. These give it a volumetric payload of about 21,000lbs when packed 6.5lbs per cubic foot, close to the 737-200's capacity.

The 737-200 and –300 are potential candidates for providing economic lift in a capacity class smaller than the 727-100 if airlines require it, or to replace the DC-9 and older 737-200s.

Unit cost performance

The four cost categories that are determined by aircraft type are fuel, maintenance, flight crew and finance or lease charges. Other operating cost categories will be the same or almost the same per unit of freight, irrespective of aircraft type. Unit costs are trip costs per available ton-mile (ATM) generated on an average trip.

Most small package operations generate low utilisations. In many cases airlines operate with only one return flight per day, and only five days per week. On this basis aircraft will only generate about 500 flight cycles (FC) per year. Sector lengths for 727 operations are in the 600-1,100nm region, but an average route of 800nm is typical. Block times for these routes are in the order of 2.3-2.6 block hours (BH), so aircraft can only generate about 1,200BH per year.

With an annual utilisation of 500FCs, the 727-200 will generate about 6.5 million ATMs per year, and the 727-100 about 4.9 million ATMs. The 737-400, with the same volumetric payload of 26,800lbs, will generate the same number of ATMs if it operates under the same utilisation pattern as the 727-100. The 737-300 will produce about 4.3 million ATMs and the 737-200 and DC-9-30 about 3.8 million ATMs annually on the same basis.

These utilisations will limit the extent to which aircraft finance and lease charges can be diluted per ATM. Low acquisition cost and lease rate are therefore imperative for the 737 models if they are to generate a unit cost performance comparable to the 727-100 and -200.

The 737 variants will have to generate competitive unit costs on two fronts. First, 727 and DC-9 operators will be unwilling to increase their unit costs and so will only accept the 737 or other aircraft if they have similar unit costs to their existing aircraft. Second, the 727-100 and older 727-200s can be replaced by the 727-200A, since there are more than 200 passenger-configured aircraft still in operation. The 727-200A can offer additional capacity to the 727-100 to accommodate traffic growth, if required.

There are wide variations in the lease or depreciation charges paid by operators of the 727-100Fs and 727-200Fs in operation. It will be harder to justify replacing fully depreciated aircraft. Market lease rates for the 727-100F are in the region of $50,000-80,000 per month, and about $85,000 a month for the 727-200. "Although 727-100 lease rates are low and fluctuate, they cannot be that high," says Smith. "Although this gives them a cost advantage, their age has to be taken into consideration."

If a passenger-configured 727-200 is bought now and converted, the resulting lease rate will be higher. The youngest –200s are now about 26 years old, and remaining life for build costs to be amortised means lease rate factors will be at least 1.5% per month and, in many cases, closer to 2.0%. An acquisition cost of about $3.0 million for a hushkitted –200 will result in a total build cost of about $6.0 million, and a corresponding monthly lease rate of $90,000-120,000.

The 727-200A has the advantage of being younger than the 727-200, although the –200As are now 19-25 years old. Because of its youth and better operating performance the build cost of a converted 727-200A will be in the region of $8.5-10.5 million. A maximum remaining life of 15 years for the youngest –200As, means lease rate factors will still have to be 1.5-2.0% if lessors are to recover their investment. This will result in lease rates of about $150,000 per month.

The 727's lease rates then have to be taken in consideration together with its

737-200/-300/-400 FREIGHTER SPECIFICATIONS & BUILD COSTS

Aircraft type	737-400	737-300	737-200
Container type	125 x88 x 82	125 x 88 x82	125 x 88 x82
Container numbers	9	8	7
Container volume-cu ft	4,122	3,664	3,206
Volumetric payload @ 6.5lbs/cu ft	26,793	23,816	20,839
Freighter build cost ($ million)			
Current market value	19.0	14.5	4.2
Pemco conversion	2.2	2.2	2.2
Airframe maintenance	0.3	0.3	0.3
Engine maintenance	2.0	1.5	0.7
Components & other	0.2	0.2	0.2
Total build cost	**23.2**	**18.7**	**7.6**

fuel burn, maintenance and flight crew charges on an 800nm sector length. A fuel price of 65 cents per US gallon has been used. Maintenance costs for the 727 are hard to pinpoint, since airlines have a variety of options for acquiring spare parts, the quality of aircraft is variable, and engine shop visit costs can be avoided by swapping modules. Aircraft are also affected by a wide range of ageing aircraft costs. A rate of $900 per BH for all line, airframe and component costs has been used. In addition to this, an engine reserve of $120 per BH has been applied. This takes total costs to $1,260 per BH, although they could be $900-1,500 per BH.

A flight crew complement of three will have a total annual employment cost to an operator of $248,000. The actual cost incurred by an operator will depend on basic salaries, allowances, training, pension schemes and subsistence. The final cost will therefore vary widely for each operator. FedEx, for example, has some of the highest pay scales in the US, while other freight carriers pay lower salaries for flight crew than passenger operators do.

Flight crew productivity for overnight small package carriers is lower than those achieved by passenger airlines with mainly daytime operations. Using 550 BH per year, each aircraft will need just over two crews.

With a lease rate of $150,000, the 727-200A will have a unit cost of 0.75 cents per ATM. The 727-200 will have a marginally lower unit cost of 0.69 cents per ATM, which is largely attributable to its lower lease rate of $120,000. Despite a monthly lease rate of $60,000, the 727-100 will have the same unit cost performance as the 727-200A.

These unit cost performance levels reflect what can probably be achieved at current conditions. The 727's position, however, is becoming less secure for several reasons. The first of these is the impending issue of Stage 4 noise compliance. The 727 is probably capable of meeting the target reduction in noise emissions from Stage 3 to Stage 4. This will, however, require additional modifications to be made. These include a proposed combination of the FedEx hushkit with Duganair's quiet wing system. This additional cost will have to be borne by the lease rate, which will therefore have to be raised. European rulings may also make the 727's ability to meet Stage 4 noise requirements academic, since the European market for 727s will be closed.

The 727 has also had to challenge structural airworthiness directives (ADs), which have threatened to limit its payload to the point of making the aircraft uneconomic to operate. Several specialist companies have developed finite element modelling systems to overcome these threats. The aircraft also continues to face rising maintenance costs, mainly as a result of higher man-hour inputs into airframe checks.

These issues, coupled with increasing age and a reduction in the number of years left to amortise and recoup investments, will raise depreciation and lease rates. Overall, the 727 is beginning to enter the period where it represents a higher risk option than it previously did.

737 & DC-9 unit costs

The three 737 models all benefit from lower fuel burn, maintenance costs and flight crew charges than the 727 variants. These advantages will be offset by the fact that the 737's lease rate charges are higher than the 727's. The difference will therefore determine each of the 737's overall ATM unit costs and competitiveness.

The 737 models all benefit from lower fuel burn and mature but stable airframe and component charges. The 737-300/-400 have higher engine shop visit costs than the JT8D-powered 727s, although the 737 has the benefit of one less engine. While the 737-200 and DC-9 have higher airframe related costs, their JT8Ds have lower shop visit rates than the CFM56-3. Overall, the 737-200 and DC-9-30 will both have total maintenance cost per BH in the region of $860. Total BH costs for the –300 and –400 will be slightly less at $840.

Flight crew charges will be lower for all four 737 types than the 727's because of the absence of a flight engineer and all associated costs of employment. Total annual cost for a flight crew will be about $180,000 for a 737-400. This will be marginally lower for the 737-300, 737-200 and DC-9-30.

The largest influence on the 737's and DC-9's unit ATM costs will be lease rates, which will in turn be determined by build costs of acquired passenger aircraft converted to freighter. The conversion cost for the 737 depends on the conversion agency. Boeing's modification is the most expensive, at over $3 million. Pemco's conversion for a 737-300/-400 into a pure freighter is in the region of $2.3 million. Its 737 freighter conversion has recently been upgraded with a re-designed door, the first of which has been installed on an aircraft for Bluebird of Iceland. Additional costs will be bridging maintenance. This is likely to include a C check and some component changes and repairs. An engine shop visit and some replacement of life limited parts should also be budgeted for. This could be up to $2 million for a CFM56-3. The largest element of build cost will be aircraft acquisition. Current market values of 737-200s are now about $4 million, while they are higher at $13 million for a 1986-build 737-300 and $18 million for the earliest build 737-400s.

The market lease rate for an existing DC-9 freighter will be in the region of $50,000 per month. Rates for older 737-200 freighters will be close to this.

These values of passenger aircraft would take total build cost to about $7.6 million for a 737-200, which is similar to that for a 727-200A. The 737-200 has a longer remaining life than the 727. A lease rate factor of 1.2% should therefore

The 737's fuel, maintenance and flight crew efficiency allow it to overcome the high lease rates it has compared to older types operating as freighters. The 737-200's and -300's current values are low enough to make them close to matching the DC-9's and 737-200F's unit ATM costs. The 737-400 should be able to match the 727-100F's unit ATM costs within the next five years.

be expected, generating a monthly rental for the 737-200 of about $90,000. Total build costs for the 737-300 and –400 will be about $19 million and $23 million, with corresponding monthly lease rentals of $224,000 and $278,000 for converted aircraft.

At these rentals and the same low rates of utilisation as the 727, a newly converted 737-200 will have a unit cost of 0.82 cents per ATM, 0.06 cents per ATM higher than the 727-100F. Existing DC-9-30 and 737-200 freighters, by comparison, have a unit cost in the region of 0.70 cents per ATM. The 737-300F's unit cost will be 1.02 cents and the –400's 1.07 cents, 0.25-0.30 cents higher than the 727-100F's.

If the 737s' rates of utilisation are doubled, then the unit cost for each model comes down to a level equal to the 727-100F. The 737-300's and –400's unit costs will also be reduced to levels closer to the 727-100F if the 737s can be acquired at lower values.

Freighter fleet

The current fleet of small narrowbody freighters totals about 670 aircraft. More than 230 of these are 727-200s, while the remainder is accounted for by the 727-100 (205), DC-9 (100) and 737-200 (70), plus a small number of other types. The 737's target market will be replacement of the 727-100 and smaller aircraft, as well as growth of this smaller fleet. Boeing's forecast is for this fleet of 670 to grow by about 300 units to 960 over 20 years.

All of the current 670 aircraft in the fleet are likely to retire over this 20 year period, which means that all 960 aircraft in the fleet in 20 years' time will have been added over the same period.

Some of the replacements and fleet growth in this category will be provided by the 727-200A. There are, however, a limited number of 727-200As remaining, and after about another five years it is likely to become economically prohibitive to convert these aircraft because of their remaining age. The best 727-200As are likely to be used to replace some of the oldest 727-200Fs and some 727-100Fs.

This could then leave a market for at least 750 aircraft being replaced by the 737, but also other types such as the A320 in the latter half of this 20 year period.

The 737-400's prime target is 727-100F replacement. The largest 727-100F fleets are operated by UPS, FedEx, DHL and Emery. The fleet plans of these airlines will determine the prospects for large scale 737-400 conversion. The 737-200 and –300 are less likely to cater for 727-100 replacement, but will satisfy demand for smaller aircraft. This will include replacement of 737-200s and DC-9s, plus fleet growth of similar-sized aircraft.

737 availability

There are over 1,000 737-300s and nearly 500 737-400s in operation with passenger carriers. There are also about 640 737-200As in passenger operation.

The oldest 737-300s are 15-16 years old, and will start to be retired in the next five years. Current market values will fall once large fleets are made available. Current market values of the oldest 737-300s are expected to reach levels close to $10 million in three to four years, bringing down unit ATM costs to about 0.90 cents. This will bring the 737-300's operating economics to a competitively acceptable level.

The oldest 737-400s are about 11 years old, and have current market values in the region of $18 million. These will decline to about $15 million in the next four or five years, and bring down unit ATM costs to less than 1.00 cent.

At an acquisition cost of about $4 million, the 737-200's unit ATM costs will be in the region of 0.82 cents, close to the 727-100F's, older 737-200's and DC-9-30's unit costs of 0.70-0.76 cents per ATM. The 737-200's current market value and build cost of about $7.5 million, makes its cost per ATM low enough to be competitive in current market conditions, for airlines that require an aircraft of this capacity. AC