Freighter conversion programmes have been in development for several aircraft types over the past three to four years. The recent fall in values has brought many aircraft closer to the economic zone of convertibility. Airlines and lessors should consider all costs to make an aircraft serviceable.

Are aircraft values low enough to trigger a wave of conversions?

Current market values of all aircraft have fallen in the past 18 months. A large number of passenger-to-freighter programmes are under development. Since a low current market value is paramount for conversions to proceed, is the fall in values enough to trigger conversions of several aircraft types?

Replacement fundamentals

The economic prerequisite for replacing older freighters is that younger alternatives offer lower unit available ton-mile (ATM) costs. Younger freighters all have two-man flight crews and, in many cases, fewer engines and lower cash operating costs. These include the 747-400, A300-600, A310-300, 767-200/-300, 757-200 and 737-300/-400.

While these types offer low cash operating costs, a newly converted freighter must have a low lease rate for its unit ATM costs to be low enough for it to displace an older type.

Lessors converting aircraft to freighter have to consider the long-term lease rates they can sustain. These have to be compared to the cost of acquiring passenger aircraft, converting them and putting them on the ramp ready for service, as well as the probable residual value and expected, or required, return on investment.

Sufficient airline demand; and lessors' or airlines' ability to acquire them at low enough values will trigger conversions.

Investment returns

Lessors will use debt to fund about 80% of the cost of making an aircraft serviceable as a freighter. The remaining investment will come from equity. The ability of lessors to negotiate debt repayment terms will determine the attractiveness of the project. Debt balloons, repaid from residual value or refinancing of the aircraft, result in smaller monthly debt repayments. Lessors will aim for lease rentals to meet debt repayments, cover overheads and provide the targeted return on equity. Resale value is a further source of potential return, but also high risk.

Lease rentals required to meet these financial targets must be compared with the actual lease rentals the aircraft type is likely to command in the marketplace. Conversion only becomes viable when the acquisition cost has dropped below a critical level.

Lease rates expressed as a percentage of total to make the aircraft serviceable as a freighter will need to be in the region of 1.5% per month (a lease rate factor of 1.5% is generally high enough to meet lessors' financial targets). Younger aircraft, which have a longer remaining life to repay debt or depreciate total cost of acquisition, can sustain a financial case of a lease rate factor of about 1.25%.

Since lease lease rates are determined by what operators are prepared to pay, a lease rate factor of 1.25-1.5% puts a ceiling on the cost of making an aircraft serviceable as a freighter. This therefore limits cost of aircraft acquisition, possible weight upgrades and maintenance. The cost of converting and installing a freight-handling system is invariable.

A balance needs to be struck regarding aircraft values, weight specification and maintenance status. Aircraft with lower weight specifications and poorer maintenance status will have low acquisition costs than those in better condition with higher specification.

Used aircraft require maintenance in many areas, including: airframe check; weight upgrades; engine shop visits; landing gear exchanges or even upgrades; auxiliary power unit (APU) shop visit; and component changes or upgrades.

Generally, two aircraft acquired with different specification and maintenance condition incur similar total costs for acquisition, weight upgrades and maintenance.

New generation freighters

New generation freighters include the 747-400, MD-11, 767-200/-300, A300-600R, A310-300, 757-200 and 737-300/-400.

The first factor to consider for each type is its payload characteristics: a good maximum structural payload; upper and lower decks that accommodate containers which efficiently utilise the aircraft's interior and also interline efficiently with other types; and a high enough maximum packing density to allow a variety of cargoes to be carried. Maximum packing density is maximum structural payload divided by total containerised volume. Volumetric payload is a specific packing density multiplied by containerised volume.

Small and express packages have relatively low packing densities of about 7lbs per cubic foot. All types should have a maximum packing density higher than this if they are to be candidates for small/express package operations.

The structural payloads, container configurations, containerised volumes and maximum packing densities of new generation freighters is summarised *(see table, page 42)*.

There are several maximum structural payload configurations of each type, since for each one there are different maximum zero fuel weight (MZFW) and operating empty weight (OEW) configurations. Earlier production line numbers of each

PAYLOAD SPECIFICATION & CHARACTERISTICS OF NEW GENERATION FREIGHTERS

Aircraft	747-400	MD-11	A300-600R	A310-300	767-300	767-200	757-200	737-400	737-300
MTOW lbs	875,000	630,500	375,900	361,500	362,000	335,000	230,000	150,000	139,000
MZFW lbs		461,000	286,600	251,300			188,000		
OEW lbs		261,000	176,900	162,900					
Payload lbs-HIGH	230,000	200,000	109,700	88,400	121,000	95,000	70,000	51,769	44,860
Payload lbs-LOW	225,000	190,000	107,370	86,200			68,000		
Maindeck Container Volume-cu ft		15,444	10,500	8,000	9,660	7,980	6,600	4,122	3,664
Lower deck Container volume-cu ft		4,672	3,212	2,044	3,600	2,640	1,680		
Total volume-cu ft	25,800	20,116	13,712	10,044	13,260	10,620	8,280	4,122	3,664
Maximum packing density-lbs/cu ft	8.9	9.9	8.0	8.8	9.1	8.9	8.5	6.5	6.5

aircraft are lower maximum take-off weight (MTOW) and MZFW variants. They have smaller payload-range performances, when converted, than later production aircraft. Earlier aircraft can have their MTOWs and MZFWs increased during conversion to freighter to varying degrees by incorporating modifications under service bulletins (SBs). Smaller increases in MTOW and MZFW sometimes only require paper changes or minor structural modifications. Larger increases may require the installation of higher weight specification landing gears. Airlines and lessors therefore have to consider the cost of weight specification increases and the resulting improvement in payload and performance. Also, it is impossible for all line numbers of a type to have weight increases to the maximum specification.

The new generation of freighters will provide payloads across the whole spectrum of possible weight and volume requirements. These types must be considered against the probable lease rates the market will bear for them.

Conversions & lease rates

747-400

Several companies are considering the development of a conversion programme for the 747-400. One is Bedek Aviation. The main problem with the 747-400 is that floor beams of its longer passenger deck protrude into the cabin below. A converted freighter could have a main deck of limited height at the front, resulting in an aircraft with container volume of about 25,800 cubic feet, a few hundred cubic feet less than the 747-200SF.

The upper deck floor beams could be raised, allowing containers of the same height throughout the maindeck of a converted aircraft. Such a conversion would provide a higher containerised volume of about 26,500 cubic feet. Bedek Aviation of Israel is in the process of developing a supplemental type certificate for the 747-400 passenger-to-freighter conversion, and will launch the programme early in 2003.

The estimated cost of the various conversion programmes that could come onto the market are bout $20 million, including freight handling system. A converted 747-400 will have a structural payload of 225,000-230,000lbs.

The 747-400SF's economic advantage is that it has a similar containerised volume and higher structural payload than the 747-200SF, combined with the efficiencies of a -400. The 747-400SF will have shorter range and higher maintenance costs than the -400F, but the -400SF is targeted at -200SF replacement.

The 747-400SF is expected to command lease rates in the region of $550,000-650,000 per month.

MD-11

The MD-11 is already an established freighter. There are several MTOW variants, and possible MZFWs for converted aircraft. Maximum structural payload is 190,000-200,000lbs *(see table, this page)*, making the MD-11 slightly smaller than the 747-100SF and -200SF.

Container volume is 20,116 cubic feet, which allows a maximum packing density of 9.9lbs per cubic foot.

The majority of MD-11s have been converted or earmarked for conversion. Only 95 remain unconverted, and some of those are already reserved for modification. A few major passenger fleets remain as potential candidates, such as VARIG, KLM, Finnair and Delta.

The passenger-to-freighter conversion STC is an original equipment manufacturer (OEM) one, but modifications are completed by Aeronavali, Singapore Technologies and Bedek Aviation. Conversion cost is $8 million, with a further $0.5-1.0 million for the freight handling system.

The MD-11F is targeted at 747 replacement and growth for DC-10 operators. The MD-11 can command lease rates in the region of $450,000-500,000, and has the dual advantages of a durable airframe and young age. The oldest aircraft are 12 years old, and most could operate for another 25 years.

A300-600 & A310-300

The A300-600R and A310-300 programmes are relatively young, with only a few of each type so far converted. EADS-EFW is the only conversion facility that holds an STC for the types. Flight Structures Inc (FSI) recently bought the work progress for development of an STC to convert the A300-600 from BAE Systems Services. FSI intends to continue with development of this STC.

The A300-600F/-600RF has a structural payload of 109,700lbs and container volume of 13,700 cubic feet, while the A310-300 has a payload of 86,200-88,400lbs payload and volume of 10,000 cubic feet *(see table, this page)*.

Cost of conversion under EADS-EFW

United Airlines is one carrier that has an excess of 747-400 capacity. Others carriers have reduced their utilisation. This excess of 747-400s has led to reduced market values, which brings the aircraft close to the economic zone of convertibility.

for the A300-600 is $8 million, and $7.6 million for the A310-300. The A300-600RF is expected to attract lease rates of $220,000-300,000. There is a wide variation in weight specification and range capability in the A310-300 fleet, and aircraft are expected to command monthly rates of $150,000-220,000, depending on age and MTOW.

767-200/-300

There are two major providers of 767 passenger-to-freighter conversions. Bedek Aviation is developing a STC, and will convert the first aircraft in early 2003. Engineering for Boeing's conversion has been completed, and certification will be done in Italy by Aeronavali. the STC will be Boeing's but Aeronavali will be the exclusive license holder.

Cost of conversion is expected to be $8-9 million, including freight handling system. There is a wide variation in MTOWs, range capabilities and the ages of the 767-200 and -300.

The oldest 767-200s are 20 years old, with MTOW varying between 302,000-396,000lbs. The oldest 767-300s are 16 years old, and MTOWs range from 352,000lbs and 413,000lbs.

The 767-300 and 767-200 compete directly with the A300-600 and A310-300. The 767-300 and -200 are thus expected to attract similar lease rates to their Airbus counterparts. The 767-200 is expected to be able to command similar lease rates to the A310-300, while the 767-300 should have similar market lease rates to the A300-600.

757-200

Boeing already has a conversion programme for the 757-200 with a list price of $8 million. There are also several independent STCs under development. The leading two are from Precision Conversions and Structural Integrity Engineering (SIE), and both have conversion prices of about $4.5 million.

Aircraft converted with the Boeing modification can accommodate 14 88-inch X 125-inch containers, while both independent programmes allow 15 containers, which with belly volume totals 8,280 cubic feet. The aircraft's maximum structural payload of 68,000-70,000lbs allows a maximum packing density of 8.5 lbs per cubic foot.

The oldest 757s are 20 years, and MTOW varies between 220,000lbs and 255,000lbs. The 757-200SF is targeted at 727-200, DC-8, 707 and A300B4 replacement. The 757-200SF is expected to command lease rates in the region of 170,000-225,000, depending on age, MTOW and operating role.

737-300/-400

There are several passenger-to-freighter modification STCs for the 737-300 and -400, some of which are currently under development. These include PEMCO (completed), AEI, and Bedek Aviation (under development).

The 737-300 can use eight 88-inch X 125-inch containers, providing 3,664 cubic feet of container volume. The aircraft has a structural payload of 44,860lbs, and a packing density of 14.1lbs per cubic foot *(see table, page 42)*.

The 737-400 can carry nine containers, which is the same as the 727-100. This gives the aircraft a containerised volume of 4,122 cubic feet and with a maximum structural payload of 51,800lbs allows a maximum packing density of 10.9lbs per cubic foot *(see table, page 42)*.

The 737 is placed and targeted for 727-100, 737-200 and DC-9 replacement, as well as growth and replacement of large turboprop freighters and overall market expansion. There are more than 1,400 737-300s/-400s available for conversion. Modification, including freight handling system costs $1.7-2.2 million, depending on conversion agency.

The 737-300 is expected to attract rates of $125,000-150,000 per month, while the 737-400 attract rates of $150,000-170,00 per month.

Conversion & maintenance

The costs of converting each aircraft and possible additions for a freight handling system, have been discussed. Other costs incurred to make an aircraft serviceable relate to maintenance.

Maintenance costs include airframe check, weight increases, component repairs and engine shop visits. Most aircraft will have to transfer to a new maintenance programme, and have a major airframe check and landing gear exchange performed. The same will apply to some components. The cost of these elements will be reflected in the purchase cost of the aircraft.

747-400

Current market values of the oldest 747-400s, like many of the types under study here, are theoretical, since there have been no transactions. There is, however, a surplus of 747-400s, and several passenger operators have parked a few aircraft or are under-utilising them in operation. The lack of a passenger-to-freighter programme may have delayed disposal of aircraft to date.

Values are thought to be in the region of $40-50 million *(see table, page 46)*. Most 747-400s have a MTOW of 870,000lbs, which would be maintained, but MZFW would need to be increased at a cost of up to $500,000.

Airframe maintenance is most likely

COSTS FOR MAKING NEW GENERATION FREIGHTERS SERVICEABLE & MARKET LEASE RATES

Aircraft	747-400	MD-11	A300-600R	A310-300	767-300	767-200	757-200	737-400	737-300
Costs in $ millions									
Current value-	40-50	25-40	18-20	9.5-13	16-30	5-10	12.5-20	9	6
Conversion cost	20.0	8.0	8.0	7.6	8.5	8.5	4.5	1.7-2.2	1.7-2.2
Freight handling		1.0							
Weight increases	0.5	0.5		0.25-1.0					
Airframe check	4.9	3.0	1.3	1.3	1.2	1.2	1.1	1.5	1.5
Landing gear & components	1.45	1.05	1.05	1.05	0.95	0.95	0.85	0.6	0.6
Engine shop visit	1.7	1.7	1.9	1.8	1.7	1.7		1.1	1.1
Total cost	68-78	40-55	30-32	21-25	28-42	17-22	19-26	14.4	11.4
Probable lease rate ($K)	550-650	450-500	250-330	220	250-300	220-250	200-230	125-150	150-170
Lease rate factor-%	0.82	0.91-1.12	0.83-0.93	0.89-1.04	0.71-0.88	1.12-1.27	0.87-1.05	1.18	1.32

to be a D check, since this will zero maintenance life and bridge the aircraft to a new programme. This will incur a cost of about $4.9 million, and will be accounted for in the purchase price of the aircraft. Most aircraft will also require a landing gear exchange, costing about $750,000 and further component maintenance adding $700,000. An engine shop visit would cost $1.7 million. It could be higher, depending on life limited part (LLP) status.

Total maintenance costs for a 747-400 could be expected to be about $8 million *(see table, this page)*, and will be higher if engine LLPs require replacement.

This will take total cost of making the aircraft serviceable as a freighter to about $68 million *(see table, this page)*.

MD-11

Values of the oldest MD-11s have dropped to about $25 million. Some aircraft can have weight increases at a cost of about $530,000.

A D check will cost about $3 million. Landing gear exchange and component maintenance will cost about $1.05 million. A single engine shop visit will be about $1.7 million.

Total maintenance and conversion costs would therefore be about $14 million *(see table, this page)*. The total cost of making an older MD-11 serviceable as a freighter would be in the region of $40 million.

A300-600 & A310-300

Values of the oldest A300-600s have now fallen to about $18 million, and to about $9-10 million for the oldest A310-300s. Values for younger and higher MTOW specification A310-300s are in the region of $12-13 million.

There were only about 160 A300-600s built, and supply of these remains limited since few passenger operators want to retire their fleets. Unlike the A300-600R, there are A310-300s available for purchase.

The majority of A300-600Rs are long-range variants, and do not require weight upgrades. There are several MTOW variants of the A310-300, and upgrades can cost between $250,000 and $1 million. Higher cost upgrades are uneconomic, since the resulting increased payload and range performance are not enough to offset the cost.

The A300 and A310 have Airbus base maintenance programmes of IL and D checks at four- and eight-year intervals. The IL check could be used in most cases during conversion to freighter to bridge the aircraft onto another maintenance programme. This will cost in the region of $1.3 million for both aircraft.

Landing gear and component maintenance will be about $1 million. Engine shop visits for the two types will high compared to other because the A300 & A310 are used on short cycles. These will be $1.9 million for the A300-600R and $1.8 million for the A310-300.

This will take conversion and maintenance costs to about $12.2 million for the A300-600R and slightly higher for the A310-300 if a weight upgrade is included.

The total cost to make an A300-600R serviceable as a freighter will be in the region of $30 million, and will be about $21.5-23 million of the youngest A310-300s *(see table, this page)*.

767-200/-300

The number of 767s available has increased over the past year, due to several operators ceasing operations and others reducing capacity. The numbers could further rise with United Airlines filing for bankruptcy protection.

Values of older 767-200s are now as low as $5 million, and only $10 million for younger -200ER aircraft. Values of the oldest 767-300s are down to the region of $16 million, and only as much as $30 million for younger aircraft.

The 767 has an equalised airframe check programme, and so is likely to use a C check during conversion to bridge to a new maintenance programme rather than a heavy check. A large C check will cost about $1.2 million, and component repairs and landing gear exchange about $950,000. An engine shop visit will incur about $1.7 million. Like the A310, there are several MTOW variants of the 767-200 and -300 and upgrades vary widely in price. A further complication is that each upgrade is only applicable to a range of line numbers. The total maintenance cost incurred at conversion is about $4 million. Cost of maintenance and conversion will be in the region of $12.5 million.

The cost of preparing a 767-200SF for service will be about $17-22 million, and at least $28 million for an older -300.

757-200

Availability of 757-200s has increased in the past year, in particular with USAirways filing for Chapter 11 bankruptcy protection and the collapse of National Airlines. This has increased the number of available aircraft to over 50,

The number of 757s and 737 Classics has increased in the past 18 months to the point at which their values have fallen to a level where lessors could make an economic case from converting them. Values of older 757-200s have now fallen a little more than $10 million.

and resulted in market values of the oldest aircraft dropping to the region of $12.5 million. Younger models have a value of about $20 million.

The 757 has an equalised maintenance programme, and can use a C check during conversion to abridge maintenance programmes. This will cost in the region of $1.1 million, while landing gear exchange will require another $350,000 and component repairs about $500,000. Engine maintenance is unique in the case of the 757. Most potential 757-200SF operators have indicated a preference for RB211-powered aircraft. The maintenance of virtually all RB211-535E4s is controlled by Rolls-Royce under fixed rate maintenance programmes. This means buyers will not have to put engines through a shop visit at aircraft acquisition, but take responsibility for paying engine maintenance reserves. This reduces cost of maintenance at acquisition and freighter conversion. Total cost of maintenance for an RB211-powered aircraft will be in the region of $2 million *(see table, page 46)*. The total for conversion and maintenance will be about $6.5 million, while all costs for making the oldest aircraft serviceable as a freighter will be in the region of $19-21 million *(see table, page 46)*.

737-300/-400

More than 1,500 737-300s and -400s could be converted to freighter, including almost 800 aircraft older than 10 years which serve as prime candidates. Many 737-300s and -400s are being made available on the market as a result of their earlier than expected replacement by 737NGs and A320s.

The oldest 737-300s are 14-16 years old and the oldest 737-400s 10-12 years old. The supply of 737-300s/-400s has increased since September 11th with the parking of aircraft, several airline bankruptcies and USAirways filing for Chapter 11 and making capacity reductions. The oldest 737-300s can probably now be acquired at distress values in the region of $6 million, and -400s for $8-10 million.

The 737-300/-400 will probably require a D check to bridge maintenance programmes during conversion, which will be relatively expensive with a cost of about $1.5 million. Landing gear exchange will be about $200,000 and further component maintenance $400,000. An engine shop visit should be expected, with a cost of $1.4 million likely. Total maintenance and conversion costs will be about $5.8 million *(see table, page 46)*. The total cost of making the 737-300 serviceable will amount to about $12 million, and about $15 million for the 737-400 *(see table, page 46)*.

Case for conversion

The drop in value for all these types shows how the total cost of preparing a freighter aircraft for service has fallen in the past 18 months.

These costs of making aircraft serviceable are theoretical, however, since many lessors which own aircraft consider freight conversion as an alternative to leasing aircraft in passenger configuration. This presents a problem, since many aircraft still have book values higher than current market values. This means lessors will have to increase the period over which they finance their aircraft if conversion to freighter is to work financially. Some are reluctant to do this, but may be forced by economic circumstances. Others owners and lessors may face the choice of selling at less than book value, but will resist this and be prepared to continue book depreciation for several years without lease rentals from a passenger operation.

Despite the fall in aircraft values, the lease rentals of the747-400, A300-600 and 767-300 do not generate a high enough lease rate factor to cover the total cost of making these aircraft serviceable as freighters. Values of the A300-600 and 767-300 probably need to drop by about another $6 million, and the 747-400 by another $10-15 million. This could actually be realised if large volumes of aircraft come onto the market and cause sales as distress values.

The MD-11, A310-300, 767-200 757-200 and 737-300/-400 can attract lease rates high enough to make conversion of the older examples economically viable.

This has to be considered against softened lease rates for freight aircraft as a result of the overall air transport downturn. A return of freight traffic growth will see demand for aircraft and lease rates strengthen. Older freighters will also be phased out as operators use up their remaining time on heavy airframe checks and engine LLPs.

The supply and values of aircraft available for conversion will continue to increase, since several fleets of all these types will continue to be retired by primary passenger users. A recovery in the passenger market may in fact hasten the retirement of aircraft as fleet renewal plans are undertaken.

All factors indicate that the fall in values to current theoretical levels is only just beginning to place certain types in the economic zone of convertibility. The total cost of making an aircraft serviceable as a freighter will continue to fall. This will be in parallel with a continuing decline in the book value of these types. The first conversions for many of these types, with the exception of the MD-11, will start in 2003, with higher volumes following in 2004 and 2005. AC