Values of 757-200s, 767-200s/-300s, A310-300s and A300-600Rs are now all declining, and some have reached the point where conversion to freighter has become economic. The economic performance of the closest competitors is similar, leaving issues such as range, operating performance, container types and availability as factors in selection.

Selection of 40-60 ton freighters

New generation freighters in the 40-60 ton category are the new stars of the market. The increasing supply of used 757s, 767s, A310-300s and A300-600s has coincided with the progression of several passenger-to-freighter programmes. There are five basic types for freight carriers to chose from, and while the 757-200SF has no direct competition, many carriers with a requirement to fill a 40-60 ton payload capacity may seek mixed fleets. These developments therefore raise the issue of which is the most economic combination of two or more aircraft types.

Demand for new freighters

Global market forecasts for demand for 40-60 ton freighters over the next 20 years vary. While growth forecasts can be approximated, actual numbers of 757Fs that come into operation compared to, for example, the 737-300, will depend on the corporate and fleet development of a small number of large operators. One prediction is that about 300 757Fs will be required over the next 20 years.

Most forecasts predict the reduction of the large narrowbody category (DC-8, 707 and 757), at the expense of the medium widebody category. Some predict the current number of about 300 medium widebodies will increase to about 1,050. Taking into consideration probable retirements of A300B4Fs in service, there will be a demand for at least 800 medium widebodies over the next 20 years.

Markets for freighters

The market roles and potential for the 757, 767-200/-300, A310 and A300-600 are varied.

All types are suited to carrying both general freight and express packages. Express package markets have so far been left to North America and West Europe, but are now also developing in Central & South America, several parts of the Asia Pacific region and China.

The main markets for general freight for 40-60 ton aircraft are between Europe and the Middle East/Africa and between North and Latin America, and to a lesser extent the transatlantic. Like the express package sector, general freight markets which 40-60 ton aircraft could satisfy are also developing within Latin America, and intra Asia Pacific.

The most direct role for 40-60 ton aircraft is DC-8, 707 and A300B4 replacement. Few 707s now operate, since most have already been replaced, some by A300B4s. These in turn will be retired within 20 years.

Both A300B4s and DC-8s have high maintenance costs and are performance and payload limited in many cases. The A300B4 has a notorious high engine maintenance cost problem and is only a medium-range aircraft. Most operators would prefer flexibility. It is also the last type to have a three-man flightdeck.

The DC-8's airframe-related maintenance costs are now rising, faster than expected in many cases. The aircraft is also performance and payload limited from many hot and high airports. Many DC-8s are still operated into Central and South America or Africa. Other remaining fleets are operated in large numbers by US express package carriers. Some DC-8 operators, such as MK Cargo, have fully depreciated fleets and cannot see an economic basis for replacing their aircraft. "While younger types have a cash operating cost advantage, our DC-8s are fully paid for and so our total unit cost cannot be beaten by replacing with younger types," says Steve Anderson, risk and legal manager at MK Cargo.

While the large narrowbody category will diminish at the expense of medium widebody freighters, as forecasts suggest, the medium widebody fleet will grow as a result of several other factors, including freight traffic growth, which may also result in small narrowbody aircraft being replaced with medium widebodies. This has already happened to an extent with FedEx, United Parcel Service (UPS) and DHL.

The corporate development of the three major express package carriers will have the largest influence on all freight aircraft size categories. Reductions in express package volumes in recent years have been supplemented by the carriage of general freight, which has diluted average yields. This is reflected in the poorer profit performance of these carriers in recent years, and has actually caused consolidation among express package carriers, leaving DHL, UPS and FedEx as the three main players.

The problem of lower yields can be overcome in two ways. The first is only to carry express packages and reduce average aircraft size to maintain load factors. The other is to consolidate the air route networks, using turboprops on some routes and widebodies on others. The strategy each airline chooses will strongly effect demand for aircraft in different size categories. For example, the latter strategy would stimulate the market for aircraft in the 40-60 ton category.

Aircraft characteristics

The payload capabilities of each 40-60 ton aircraft are already well documented. There are several container and pallet configurations for each type, and thus several different cubic feet

PAYLOAD CHARACTERISTICS OF 40-60 TON FREIGHTERS

Aircraft type	A300-600RF	A310-300F	757-200SF	767-200SF	767-300SF
MTOW-lbs	375,900	361,554	240,000	352,200	412,000
Structural payload-lbs	109,740	86,300	86,500	93,600	113,900
Range with structural payload-nm	2,650	3,350	2,650	3,300	3,250
Containerised volume-cu ft	14,000	10,350	8,430	10,830	15,900
Maximum packing density-lbs/cu ft	7.8	8.3	10.3	8.6	7.1
Volumetric payload 6.5lbs/cu ft	89,130	65,286	54,795	69,000	102,000
Volumetric payload 7.olbs/cu ft	98,100	72,440	59,000	75,840	111,370

freight capacities.

The structural payload, net of container tare weight, is shown for each type *(see table, this page)*.

The total internal container volume and bulk volume in addition is the maximum space that can be used, and thus defines the maximum packing density (structural payload divided by total containerised volume). The containerised volume of each type also depends on the conversion programme used.

In the case of the 757-200, there are several options. Boeing's own programme offers an aircraft with 14 maindeck containers, while modifications offered by Precision Conversions and SIE-Alcoa have 15 maindeck container positions. These have higher internal container volumes, and are those shown *(see table, this page)*.

Bedek Aviation is in the process of developing a programme for the 767-200 and -300, and the volumes offered by this programme are shown *(see table, this page)*.

The containerised volumes for the A300-600R and A310-300 *(see table, this page)* are for aircraft converted under the EADS-EFW programme.

The maximum packing density of each type is shown *(see table, this page)*.

This shows that each type will have no limitations when carrying most freight types. Express package freight now has a packing density in the region of 6.5lbs per cubic foot, while general freight has a packing density of about 7lbs per cubic foot. This means that all types will be able to use all their available freight volume.

Volumetric payload is a product of packing density and volume. The volumetric payloads for express package freight at 6.5lbs per cubic foot and general freight at 7lbs per cubic foot are shown for each type *(see table, this page)*.

Build costs

Since most freight operations generate low aircraft utilisations, competitive operating cost performance is dependent on low lease rates, or financing charges, which in turn rely on low build costs. The largest element of build cost is aircraft acquisition. Market values of all five types have reduced in the past two years.

Values of 757-200s are variable, between $10-16 million. Supply is high and could rise if major carriers, such as United, reduce their fleets under restructuring programmes. In addition to aircraft purchase and freight conversion, lessors or freight carriers have to consider bridging airframe checks, possible component repairs and engine shop visits. The cost depends on the maintenance status of individual aircraft, but is expected to be about $4 million. List price for conversion offered by Precision is $4.5 million. Total acquisition, conversion and build cost for a 757-200SF can therefore be in the region of $18-20 million. Most operators are only likely to consider leasing 757-200SFs at a monthly rate of $200,000.

A310-300s can be acquired for market values similar to the 757-200. EADS-EFW's conversion list price is $7.5 million. Bridging maintenance, which is likely to require either an IL or D check, component maintenance and possible engine maintenance can total about $4.5 million, taking total build cost to about $22 million. The likely accepted market lease rate for an A310-300F will be in the region of $225,000. This suggests that market values of A310-300s will have to drop below $10 million for lessors to acquire these aircraft and convert them.

Current market values of A300-600Rs have now reduced to about $20 million. Conversion list price at $9 million and a probable additional maintenance cost of $4.5 million takes total build cost up to about $33 million. This is too high compared to a market lease rate of $260,000, indicating that total build costs will have to be reduced by about $7million. While supply of A300-600Rs has been limited in recent years, the retirement by China Airlines and fleet restructuring of other airlines may increase supply and therefore reduce values.

Supply of 767-200s has increased rapidly in recent years. Varig, for example, has retired its 767-200ERs, four of which are the first to be converted under Bedek Aviation's programme and will be leased by GECAS to Tampa Airlines Cargo. Values of 767-200s have dropped to as low as $8.5 million. Bedek Aviation's conversion list price is about $8.5 million, and additional maintenance, because of an equalised maintenance programme, may total about $4 million. Total build cost will thus reach about $21 million, while the aircraft can probably achieve a lease rate of $225,000. The 767-200 is therefore at the right market value to justify conversion.

Supply of younger and more capable 767-300s is tighter than the -200, although supply of -300s has increased, reducing values. This has been further exacerbated in recent years by the presence of the A330-200. Values of older 767-300s are in the region of $25 million, and are expected to fall further as more examples come onto the market. Conversion list price is $9 million and additional maintenance of about $4 million will take the total to about $38 million. An acceptable market lease rate is about $275,000, making the 767-300 clearly too expensive at its current value. Total build cost will have to fall by about $12 million before lessors can justify conversion.

Aircraft in operation

There are two basic roles these five types can have in operation: express packages and general freight. There are

Tampa Colombia is one freight carrier that has elected to replace its DC-8s with a younger type that has superior operating performance and higher payload and revenue generating ability as a result. Tampa Colombia has a special requirement for operating out of hot and high airports and a need to carry a 40 ton payload for more than three hours. All younger aircraft in the 40-60 ton category will find an adequate market, since a market for up to 800 medium widebodies and 300 large narrowbodies is forecast over the next 20 years.

many areas of the world for either type of operation, each with its own cost structure. While fuel price will be the most consistent cost, maintenance costs will vary mainly due to labour rates and flightcrew remuneration and employment costs will have one of the largest variances. Flightcrew charges will be highest in North America, followed by West Europe. Other cash operating costs that vary will be airport user charges.

Lease rates will also vary, according to airline creditworthiness. One major influence, however, on overall costs will be aircraft utilisation, which is affected by type of operation and average route length.

Express package integrators will deploy these aircraft on the longer routes and operators will aim to achieve a higher number of sectors per day than, for example, fully depreciated 727Fs flying shorter routes. The ability to maximise utilisation on these operations will nevertheless be limited. Longer routes will mean these aircraft have an average route length in the region of 900nm, equal to a flying time of about 130 minutes. Most airlines only operate five days per week, or 300 days per year. In many cases aircraft will only achieve about 600 flight cycles (FC) per year, generating about 1,450 flight hours (FH) per annum.

Route lengths for express package operations in Europe will be shorter, and so annual FH utilisations are also likely to be lower.

In many cases, new generation 40-60 ton freighters will be used on medium- and long-haul operations. One example is Tampa Airlines Cargo which has selected the 767-200ER to supplement and replace its DC-8-70s. The carrier is leasing four 767-200ERs from GECAS, with the first aircraft being delivered in July 2004. "The 767-200 will be used to operate from the hot and high airports we fly from in Central and South America," explains Mauricio Londono, vice president of operations and maintenance at Tampa Airlines Cargo. "These airports include Bogota, which has an elevation of 8,362 feet, and Medina, which has an elevation of 7,028 feet. Both of these can have ambient temperatures exceeding 20 degrees celsius. We generate about 8.6FH per day utilisation with our DC-8s. The DC-8-70 and 767-200 have almost the same structural payload, but the 767-200SF has about 15% more volumetric capacity. The 767-200, powered with the CF6-80C2, also has a performance advantage on our network, since few other aircraft can manage 40 tons of freight for missions longer than three hours from hot and high airports."

The 767-200's higher performance will also allow Tampa to change its route structure. "We average routes of three hours with the DC-8-70 and the 767-200SF will allow us to operate certain routes that the DC-8-70 could not operate on. Also, the 767 will provide us with better payload capacity than the DC-8 across our network because of operating performance," says Londono. "We also think the 767 would have better performance than the A300-600 or A310-300 operating from hot and high airports on long routes."

General freight operations will include north-south markets between North and Central/South America and between Europe and Africa/the Middle East. Average route lengths will vary, but could be as long as 2,500-3,000nm. A route length of 2,500nm will have a flight time of about 6.5FH. Annual utilisations will be higher than express package operations. They will be limited for some operators because of ad-hoc operations. Many general freight operations have low frequencies, despite some routes being long.

Economic performance

Although there are many permutations of operation type, average route length, annual utilisation and cost structure that could apply to these aircraft, two examples can be used to demonstrate the relative economic performance of these five aircraft.

These are a North American express package operation and a long-haul general freight operation, similar to those previously described. Because each type has different payload characteristics, the differences in economic performance between types will depend on payload carried. A payload of 95,000lbs, for example, can be carried in a single frequency by a 767-300, but would require two flights by either an A310-300, 757-200 or 767-200. A smaller payload of 60,000lbs could be carried by all types in a single frequency, provided that packing density was not too low. This would put smaller types, with a high load factor, at an advantage over larger

types, which would operate with empty capacity and have a higher trip cost. Simple analysis of unit cost performance will also put the larger types at an advantage without revealing the relative differences between similar sized smaller types.

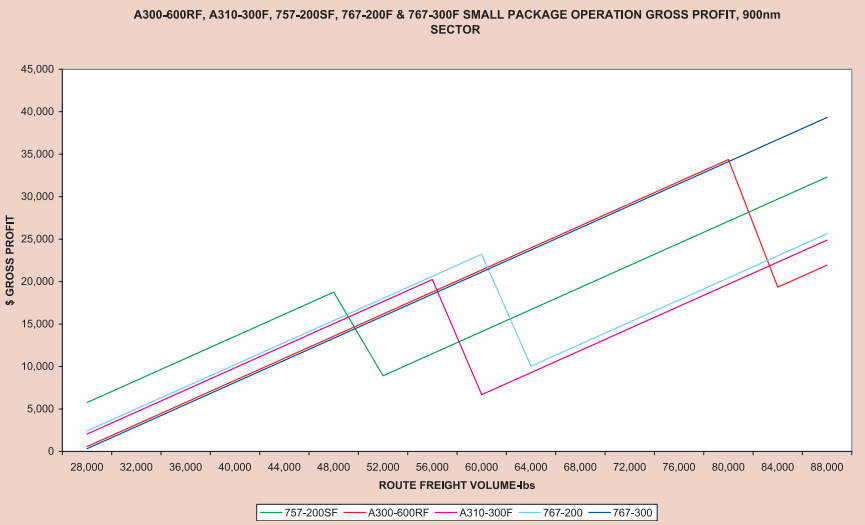
Each aircraft's gross profit performance should therefore be analysed over a range of freight volumes on a route representing an average sector length in both types of operation. The relative difference in operating efficiency will therefore be revealed for a given freight volume, and therefore revenue, of all five types. Different types will have a different relative economic performance to other types at different freight volumes, however.

This will illustrate which of the smaller types is best suited to lower volumes and which of the larger types has the best performance at higher volumes. Furthermore, it will reveal if any particular combination of aircraft groups (for example the 757/767-200/767-300 or A310-300/A300-600R) offers a better overall economic solution for an airline's route network.

The first of the two scenarios analysed is the express package operation, with an average route length of 900nm, and an annual utilisation of 600FC and 1,450FH with a North American cost structure. This assumes a freight packing density of 6.5lbs per cubic foot, thus using the maximum volumetric payloads as described *(see table, page 44)*.

The second scenario is a long-haul general freight operation of 2,500nm average stage length, with aircraft utilisations of 2,750FH and 500FC and a packing density of 7.0lbs per cubic foot: Maximum volumetric payloads are as described *(see table, page 44)*.

In each case all aircraft types are assumed not to be performance and payload limited at departure airport. While this is likely for all cases in the 900nm route length analysis, there may actually be cases where aircraft are performance and payload limited on routes of 2,500nm. The range capabilities of each aircraft type *(see table, page 44)* all exceed 2,500nm for maximum structural payload. Volumetric payloads at a 7lbs per cubic foot packing density are all less than maximum structural payloads, and all aircraft will have longer range performance for these payloads. Where there are no limits imposed on maximum take-off weight because of operating conditions, all aircraft will therefore be able to carry a full volumetric payload on a 2,500nm route. Certain routes will be between hot and, in some cases, high airports, reducing take-off and landing weights. Some aircraft may not be able to carry a full volumetric payload on certain routes with a still-air distance of about 2,500nm.



OPERATING COST ASSUMPTIONS FOR AIRCRAFT ON NORTH AMERICAN EXPRESS PACKAGE OPERATION, 900NM ROUTE

Annual utilisation: 1,450FH, 600FC
Fuel price: 80 cents per US Gallon
Maintenance costs: A300-600RF: $ 1,620/FH; A310-300F: $ 1,620; 757-200SF: $,1070; 767-200: $ 1,670; 767-300: $ 1,670
Annual crew costs: A300-600RF: $ 300,000; A310-300F: $ 275,000; 757-200SF: $ 250,000; 767-200: $ 275,000; 767-300: $ 300,000
Annual crew productivity: 700FH
Annual engine inventory costs: A300-600RF: $ 165,000; A310-300F: $ 120,000; 757-200SF: $ 69,000; 767-200: $ 167,000; 767-300: $ 167,000
Monthly lease rentals: A300-600RF: $ 260,000; A310-300F: $ 225,000; 757-200SF: $ 200,000; 767-200: $ 225,000; 767-300: $ 275,000
Annual insurance cost: A300-600RF: $ 390,000; A310-300F: $ 280,000; 757-200SF: $ 290,000; 767-200: $ 270,000; 767-300: $ 440,000

The aircraft are analysed across a daily route freight volume of 28,000-88,000lbs, which is commensurate for single daily operations at light loads for the 757-200SF and high loads for the 767-300SF and A300-600RF.

While freight carriers do not experience traffic spill like passenger operators, the break point at which a larger aircraft would have to be used or a frequency added for the same aircraft is a load factor of 90%. A second frequency for the 757-200SF is therefore added on the express package operation when traffic volume reaches 49,000lbs; equal to 90% of its 54,795lbs volumetric payload.

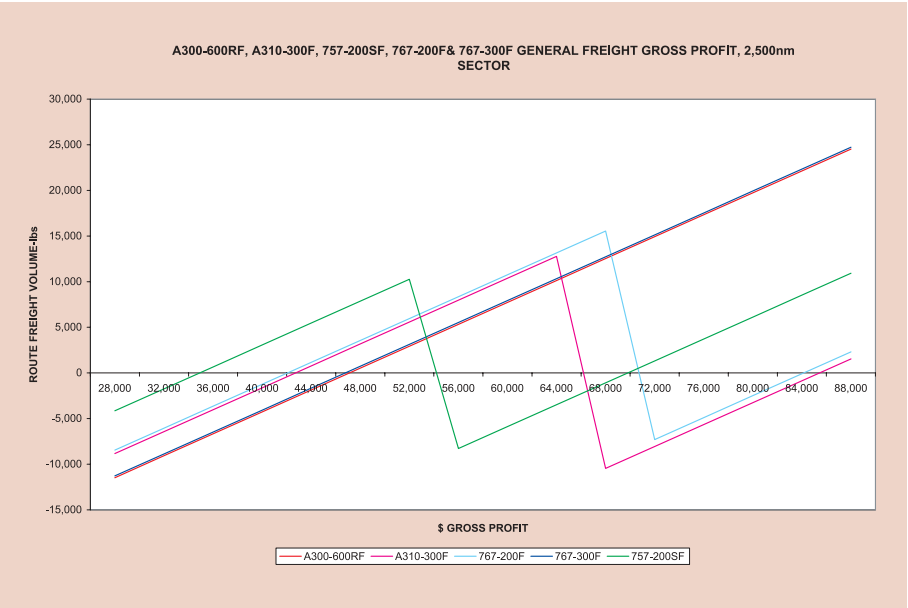
Gross profit performance of the aircraft illustrates their relative differences, since revenue for all types is the same at the same daily traffic volume. Unit revenue used is thus arbitrary, and not reflective of market conditions. Unit revenue used for express packages is 65 cents per lb, while 35 cents per lb is used for general freight.

Operating cost parameters

Fuel burns for each aircraft in both analyses have been charged at a price of 80 cents per US Gallon.

Maintenance charges include airframe- and engine-, and component and inventory-related costs. Rates are higher for aircraft operating shorter average route lengths because of shorter cycle times and removal intervals. Engine inventory costs are also included. These are based on a fleet of 10 aircraft for each type, typical removal intervals commensurate with average FC times and a shop turn time of 50 days. In each case, one engine is owned and depreciated at 10% per year and at an interest rate of 6.5%. Short-term leases are used for all other spare engine requirements, with lease rentals and maintenance reserves charged at market rates.

Flight crew costs include market salaries for North American express package carriers in the first analysis, and market salaries for North American and



OPERATING COST ASSUMPTIONS FOR AIRCRAFT ON GENERAL FREIGHT OPERATION, 2,500NM ROUTE

Annual utilisation: 2,750FH, 500FC
Fuel price: 80 cents per US Gallon
Maintenance costs: A300-600RF: $ 1265/FH; A310-300F: $ 1,265; 757-200SF: $,1020; 767-200: $ 1,315; 767-300: $ 1,315
Annual crew costs: A300-600RF: $ 300,000; A310-300F: $ 275,000; 757-200SF: $ 250,000; 767-200: $ 275,000; 767-300: $ 300,000
Annual crew productivity: 700FH
Annual engine inventory costs: A300-600RF: $ 160,000; A310-300F: $ 136,000; 757-200SF: $ 84,000; 767-200: $ 184,000; 767-300: $ 184,000
Monthly lease rentals: A300-600RF: $ 260,000; A310-300F: $ 225,000; 757-200SF: $ 200,000; 767-200: $ 225,000; 767-300: $ 275,000
Annual insurance cost: A300-600RF: $ 390,000; A310-300F: $ 280,000; 757-200SF: $ 290,000; 767-200: $ 270,000; 767-300: $ 440,000

West European operators in the second analysis. These are raised by 25% to account for additional costs of employment, such as training, subsistence, benefits and insurance. Crew members are assumed to achieve 700 block hours per year on both cases.

The annual insurance costs that most airlines must pay is a hull insurance of 1% of book value, which will be higher than the market value. Premium rates will be higher than 1% for airlines operating outside North America and West Europe. Airlines additionally have to pay liability insurance at an annual cost of about $60,000.

The lease rates used in these analyses are the market rates that airlines are expected to be prepared to pay for these aircraft, rather than what would have to be paid to provide an adequate lease rental for current build costs.

Express package operation

Because each aircraft has the same revenue at each level of freight volume on a route, the relative difference between types is equal to differences in aircraft trip costs.

The 757-200SF, unsurprisingly, has the lowest trip cost, and so the best gross profit performance at lower volumes of freight, up to the traffic volume at which it would have to be operated at two daily frequencies *(see chart, page 47)*. This is equal to about 50,000lbs, depending on the load factor at which an individual airline would want to introduce a large aircraft or add frequencies with the 757. Interestingly, the 757-200SF's maximum take-off weight is about two-thirds that of the A310-300, while the two have similar structural payloads. The A310-300 has the advantage of about 2,000 more cubic feet of containerised volume.

For higher volumes, airlines have the four larger types to consider. This may be with a single type, or mixes of the 767-200/-300 or A310-300/A300-600R.

The 767-200 has a higher volumetric payload than the A310-300 and the 767-300 a higher volumetric payload than the A300-600R *(see table, page 44)*. The 767-200/-300 combination allows airlines to operate single frequencies of either 767 variant at a single frequency compared to double frequencies of the A310-300 and A300-600R at certain traffic volumes. That is, one 767-200 frequency can be used for freight volumes above about 64,000lbs (the A310-300's limit) where a A300-600R, with a higher trip cost would have to be operated, at a single frequency or an A310-300F at a double frequency *(see chart, page 47)*.

The 767-200, however, has almost the same trip cost and so gross profit performance for the same frequency of operation as the A310-300. The same is true of the 767-300 and A300-600R.

Besides differences in pure trip costs, airlines will consider several other factors. First, the A300-600 and A310-300 have LD-3 containers for belly freight, which may interline better with other aircraft types for some carriers' operations. The Airbus aircraft and 767 also have different maindeck containers, and their interlining ability with other aircraft types will also influence efficiency of operation with other aircraft. The need to use container types that do not use all available space provided by the aircraft will reduce its revenue earning potential.

The 767-200-300 combination may also be expanded to include the 757-200SF, since the two types have a common type rating, and so could generate some savings in crew training costs.

General freight operation

All five types have the same relative differences as in the first analysis. This is because of similar differences in trip costs between the A310-300 and 767-200, and A300-600R and 767-300, as well as similar differences in volumetric payload.

Since the gross profit performance of the A310-300 and 767-200 are close *(see chart, this page)*, and the same applies to the A300-600R and 767-300, airline selection will be less influenced by aircraft trip costs. Other factors such as operating performance and payload limitations across a route network, the need and ability to interline containers, and other types in the fleet will influence aircraft selection.

Aircraft availability over the short-term will have an effect on the types that airlines select. The first 757-200SFs with 15 maindeck containers positions will be modified within the year. The first 767-200s will be delivered by the end of 2003, and the first 767-300 by the middle of 2004; but a larger number of A310-300s have either been or are due to be converted. Moreover, several A300-600s have also been committed to conversion, and the value of most 767-300s are still too high. AC