It is commonly accepted that young freighters have no place in low utilisation operations. While older aircraft still provide the most competitive unit costs at the lowest utilisations, younger converted and new factory-built freighters can be surprisingly economical at medium levels of aircraft productivity.

Freighters for low utilisation operations

Low aircraft utilisation is a characteristic of many freight operations. This fact has made the freight sector adopt a strategy of using older aircraft types to obtain the lowest unit operating cost. There are several types of freight operation. So what are the most economic aircraft types for each style of operation under a low utilisation regime?

Economic principles

Aircraft operating costs are generally split between finance charges and all cash operating costs.

Finance charges per flight hour (FH) reduce as utilisation increases, while all other costs are perceived as being constant per FH irrespective of utilisation. As utilisation increases cash operating costs account for a larger portion of unit costs.

For this reason high levels of utilisation are regarded as suitable for younger types with low cash operating costs. This factor coupled with their high efficiency is generally perceived as making little impact against their disadvantageous finance charges at low levels of utilisation.

Older aircraft with low finance charges are more suited to low levels of utilisation. Operating efficiency and high cash costs are not expected to put them at a disadvantage against younger types at low utilisations.

Utilisation has an impact on unit operating cost in several respects. The most direct influence is on aircraft depreciation or lease finance charges. These are fixed on an annual basis and so the amortised rate per FH is reduced as utilisation is increased. Because these charges are the highest of all operating costs they can have the largest influence when selecting between new and used equipment.

Other cost elements are also affected by utilisation. Many airframe checks have both FH and fixed calendar (FC) intervals. Under a regime of low utilisation airframe check FH intervals are not reached before calendar intervals and so the resulting amortised cost per FH is raised.

Heavy components, such as landing gears, also have FC and calendar inspection intervals. Again, they rarely achieve their full FC intervals and so cost per FH and FC is raised. Low levels of utilisation will therefore raise maintenance cost per FH for all aircraft types.

While low levels of utilisation favour older types in terms of finance charges, the raised FH maintenance charges as a result of low utilisation act more against the older types that have higher maintenance costs.

Operating cost elements that are unaffected by levels of aircraft utilisation are user charges and fuel. Flight crew costs are marginally affected by rates of utilisation, but more by the style of operation. Freight operations at night will impose longer rest periods on crew and so will achieve fewer FH per year than would otherwise be possible with a short-haul daytime operation.

With unit values of A300-600s, A310-300s and 767s falling, their operating costs should be low enough to make them competitive against the DC-8s. The DC-8 fleet is expected to give way to smaller widebodies in the next 20 years.

FREIGHT AIRCRAFT LEASE RATE, FH MAINTENANCE, ANNUAL FLIGHT CREW AND NET PAYLOAD CAPACITY

Aircraft type	Monthly lease rate	FH maintenance charge	Annual flight crew employment cost	Net payload lbs
727-100FH	45,000	1,450	235,000	40,580
727-200FH (-7/-9)	60,000	1,350	248,000	55,300
727-200FH (-15/-17)	125,000	1,350	248,000	55,300
757PF	500,000	1,225	210,000	82,920
707-320H	99,000	1,300	285,000	90,420
DC-8-55F	70,000	1,350	285,000	91,000
DC-8-63H	90,000	1,350	285,000	110,730
DC-8-73F	220,000	1,350	285,000	104,730
A310-300F	280,000	1,525	220,000	75,252
A300B4-200F	200,000	1,700	300,000	85,350
A300-600F	650,000	1,375	220,000	93,350
767-300PF	700,000	1,375	220,000	115,750
L-1011-200F	200,000	1,950	315,000	92,300
DC-10-10CF	250,000	2,000	315,000	93,970
DC-10-30CF	280,000	1,750	330,000	133,470
MD-11CF	660,000	1,400	250,000	183,350
747-100SF	200,000	2,800	355,000	183,830
747-200SF	400,000	2,575	355,000	198,830
747-400F	1,000,000	1,800	270,000	232,970

Airline operations

The most common scenarios in which fleets achieve low levels of aircraft utilisation are with small package and *ad hoc* charter operations.

Small package operations that are characteristic of the domestic US typically work on the basis that the majority of the fleet operates just one return flight from and to the carrier's hub per night, five or six days a week for 50 weeks per year. Only 500–600 cycles are generated per year. FH utilisations will depend on the aircraft types operated on the routes. The 727 has been the mainstay of the shorter routes in these operations and so normally flies between one and two-and-a-half hour sectors. Larger types, such as the DC-8, and more recently the 757, A300, 767 and DC-10, operate longer routes of up to four or five hours. Average sectors of 2FH for the 727 will therefore only generate utilisations of 1,200FH per year, while the A300 or DC-10 may generate nearer 2,000–2,500FH per annum.

Airlines that operate new types, such as the 757 and 767, will ensure that their aircraft operate at higher rates of utilisation. United Parcel Service (UPS), the only airline to operate substantial fleets of new 757PFs and 767PFs, operates them on two return flights a day, compared to one per day for its older aircraft. The aircraft are also operated on longer sectors where possible. This will double the rates of utilisation achieved by the older types.

Ad hoc and charter freight operations also generate low rates of aircraft utilisation. The nature of these operations often means aircraft range is less of a problem and flights can operate with fuelling stops. This allows older types to be used that have lower lease rates than their younger counterparts. For example, the DC-8-50 can be used as an alternative to the DC-8-70, or the 747-100 in preference to the higher-value CF6-powered 747-200 series.

Also, types such as the 707 can still operate competitively against the A310-300, which is trying to break into the market *(see Can the 707 and DC-8 justify another life extension programme?, page 42, Aircraft Commerce, November/December 1998)*.

Economic comparison

The unit costs of freight aircraft are minimised when full payloads are carried. Unlike passenger types, there is a higher degree of variance between the structural payloads of competing types. Variance also occurs between the available volumes of competing aircraft.

This makes it harder to place aircraft in competitive groups. Each freighter type can almost serve its own market according to traffic density. There are several examples, including the 727, 707, DC-10-30 and 747-400, each with exclusivity in their respective payload capabilities.

However, there are still some broad groups that several of the freighter types will fit into and this is where these types compete or are used for similar styles of operation.

To compare the unit costs of old and younger types under a low utilisation operation regime, freighters have been divided into four broad groups. These involve aircraft of similar sizes or younger types that have been pitched as a replacement for older aircraft.

The first group includes the 727-100, 727-200 and 757-200PF. These are compared in a small package operation scenario flying short sectors of 500nm and 1,000nm with annual utilisations of 600FCs. The 757PF is considerably larger than the 727-200. Small package airlines are experiencing fast growth and could conceivably require the 757's capacity on some routes.

Because it is likely that the 757PF will be operated at higher rates of utilisation than the 727, the 757PF has been analysed at twice the rates of FC utilisation to see the effect on unit costs.

The second group looks at older long-range freighters, the 707 and DC-8-50/-60 & -70 series and how they compare with younger aircraft that have been pitched as their replacements. This includes the 757, A310-300, A300B4-200, A300-600F and 767-300PF. Group two is compared on 1,500nm and 2,000nm sectors with 1,500FH and 2,000FH utilisations.

The 707 and DC-50/-60 series aircraft are often used on *ad hoc* and low-yield operations, although the DC-8-60 series is also used by small package carriers, as is the DC-8-70 series.

The A310-300F and A300-600F have yet to enter the market with launch customers for a passenger-to-freighter conversion. The A300-600F has already entered the market as a factory-built aircraft. The A300B4-200 now operates in a few fleets, but not in any for small package airlines. The 757PF and 767PF are exclusively operated by UPS, but at a high rate of utilisation. The 767PF complements the airline's DC-8-70 fleet.

The third group looks at the medium-sized L-1011-200 and DC-10-10, which are used on short- and medium-range routes, mainly in the domestic US. The younger A300-600F and 767PF compete with these older types. The A300-600F recently won an order from UPS in competition with the L-1011-200.

The L-1011-200 has not achieved success in the freight market, although it is operated in small numbers by a few carriers. Much of its work involves *ad hoc* operations that result in low utilisations. The DC-10-10 has been highly successful, with FedEx acquiring the majority of the

existing fleet. Its comparison with the A300-600F and 767-300PF on a low utilisation regime is therefore appropriate.

These four aircraft have been compared on 1,500nm and 2,000nm routes at annual utilisations of 1,500FH and 2,000FH, typical of what they might achieve on a small package operation.

The fourth and final group considers the largest widebodies: the DC-10-30, MD-11 and 747-100, -200 and -400 series. This involves two sub-groups of old and new counterparts: the DC-10-30 and MD-11 and the three 747 variants. The MD-11, however, is also an alternative to the 747-100 and older -200 models since they have similar structural payloads.

These five aircraft are analysed on 2,500nm, 3,500nm and 4,500nm sectors at annual utilisations of 3,000FH per year.

The aircraft

Although aircraft types compete for airline selection on the same routes and could therefore carry the same payload, airlines will always try to maximise payload on every aircraft type.

In all cases, therefore, the unit costs of aircraft have been analysed for a full structural payload. Cost elements included in this analysis were: fuel, maintenance, flight crew and typical industry operating lease rentals.

The net structural payload, after taking into account container and pallet tare and crew weights, are shown *(see table, page 44)*.

The lease rates for the 757PF, 767PF, A300-600F and 747-400F are for new aircraft. The rates for all other types are typical for converted aircraft. The MD-11 has only been converted from passenger to freighter in limited quantities, but more are now expected to be converted as market values fall. The lease rate of $660,000 per month is about what the industry can bear.

The A310-300 freight conversion programme has not yet been launched. With few A300B4s remaining the first A310-300s could start to be converted in the next few years. The $280,000 lease rate is the level assumed for an early converted model.

The 747-100 is an old JT9D-7A-powered model with a maximum take-off weight (MTOW) of 734,000lbs. The 747-200 is a CF6-powered model with the highest MTOW of 833,000lbs. The difference between monthly lease rates for the two reflects their performance capabilities and age. High gross weight 747-200s are unlikely to be operated in low utilisation operations, but the comparison with the -100 illustrates the difference in economics of the two.

FH maintenance rates used are also shown in the table. Taking into consideration the probable way in which many freight carriers organise their maintenance, the FH rates for maintenance used take into account the relatively short cycles these aircraft are assumed to operate in the analysis and the low level of utilisation achieved.

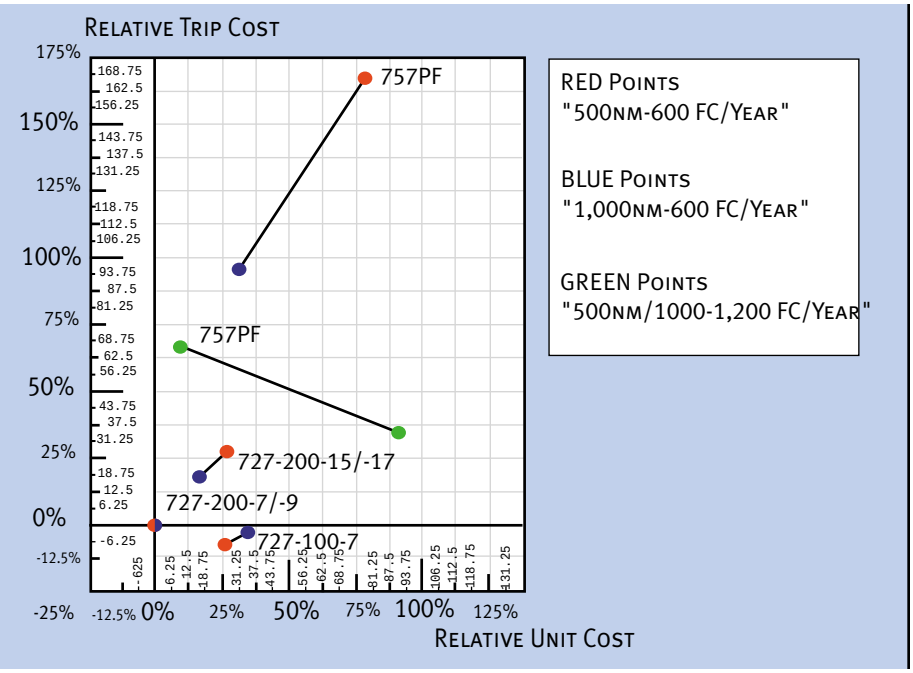
Flight crew costs assume an annual productivity of 550FH per year. This takes into consideration the crew rest periods when flying just at night in the case of the small package operations and the logistical problems of crew rostering for short cycles and low aircraft utilisation of the larger types. In all cases aircraft are assumed not to require supernumerary crew.

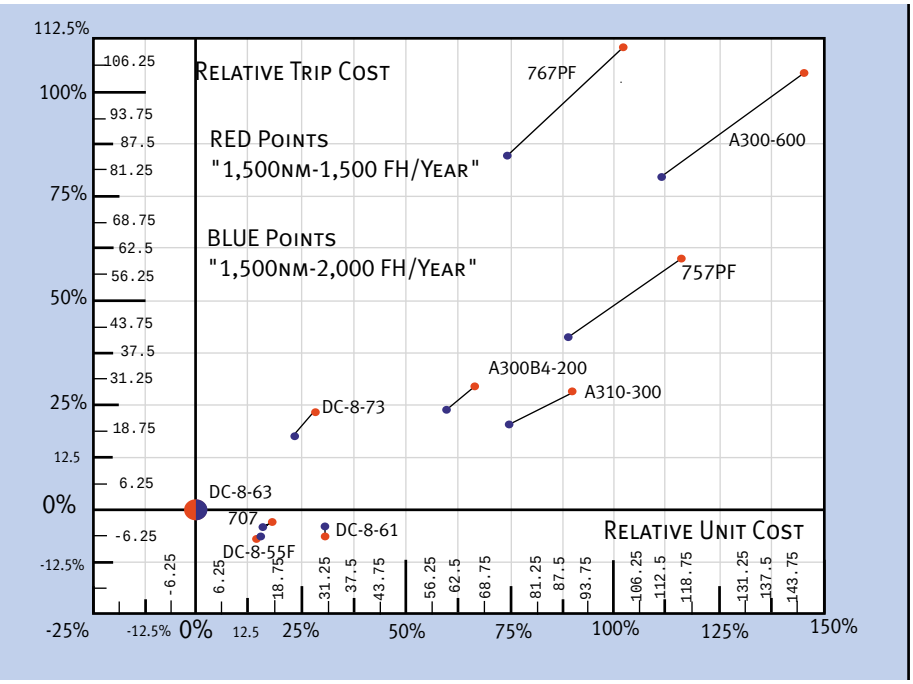
The annual cost of employing a full flight crew complement for each aircraft is also shown *(see table, page 44)*. This considers salaries, benefits, employer's insurance, training, subsistence and other costs.

Group one

The first group produces some surprising results. Despite the 757PF having a much higher lease rate and unit costs than the 727-200, the former's costs are compensated by its lower cash operating costs.

The 757PF has an uneconomical unit cost per lb of payload at the same pattern





of utilisation practised by small package operators operating the 727 *(see chart, this page)*. A doubling of flights, something that is practised by UPS, brings the 757's unit costs closer in line with those of the 727-100 and -200. This is only achieved, however, when the aircraft carries a full payload. A doubling of frequency and carriage of a higher payload will only be possible with significant traffic growth and expansion or with re-organisation of a route network and operation.

The 727 is therefore still able to compete against new 757PFs. The analysis indicates, however, that converted 757s with lease rates significantly lower than those of a new aircraft could provide an attractive alternative to the 727. Recent speculation that BA's 757s may be acquired by Boeing for freight conversion to be operated by DHL suggests that the aircraft's values are now approaching a level at which freight conversion will be economic.

The analysis also illustrates that the 727-100 is still competitive against the -200 and can also keep competition from younger similar-sized types at bay for several more years.

Group two

The second group reveals larger differences in unit costs between the more economic older types and the younger converted or new aircraft *(see chart, this page)*. Unlike in Group one, there is less variance between the payloads of aircraft in this group. The difference in unit costs is explained by the higher lease rates of the younger and new aircraft.

The differences between the two broad groups are widest for the shorter sector length and are reduced with the higher level of utilisation of 2,000FH per year.

One exception in the older group of low lease rates is the DC-8-70 series. Although the DC-8-70 is unlikely to be operated at low utilisations, its payload and lower fuel and maintenance charges compensate for this and unit costs are similar for other DC-8s.

The DC-8-70's lease rate is nevertheless low compared to the 757PF, and the DC-8-70 achieves up to 40% lower unit costs. This shows how the finance charges of older aircraft have the largest influence over unit costs.

Even at the extreme of 2,000nm and 2,000FH per year, the older aircraft are still able to achieve lower unit costs than younger widebodies and 757PF with similar net structural payloads. The younger aircraft have unit costs about 20–30% higher than their older counterparts. This compares to up to 130% higher costs of younger aircraft when operating 1,500nm sectors at 1,500FH per year.

This rapid closure in unit cost differences with increased utilisation shows that the younger aircraft will be able to out-compete the older types if utilisations of at least 2,500FH per year are achieved. The younger aircraft all have two engines, half the number of the older types and two-man flight crews.

Average sector lengths of 1,500nm would mean just over 700FC would have to be generated each year, or about two flights per day, for 2,500FH to be generated. This level of utilisation is not excessive for the younger aircraft.

With the market values of passenger-configured 757s, A310s, A300-600s and 767s constantly reducing, it should be only a few years before the lease rates of converted aircraft are low enough for aircraft to be attractive to airlines and economic for investors.

Group three

The differences in unit costs are smaller between aircraft in groups three and four than they are between older and younger smaller types groups one and two.

The net payloads of the L-1011, DC-10-10 and A300-600F are similar. The 767PF has about 20,000lbs advantage over the other three.

The A300-600F's and 767PF's lease rates are nearly three times higher than those of the L-1011 or DC-10-10. Despite this, once the aircraft are operating at least 2,000FH per year, the difference in unit costs between the younger and older aircraft is reduced to less than 30% *(see chart, next page)*.

As with the younger and older types in Group two, the A300-600F's and 767PF's unit costs could probably equal those of the L-1011 and DC-10-10 when utilisations in excess of 2,500FH are achieved. This again implies the market value of older passenger-configured A300-600s and 767s are now or will soon be low enough for lease rates of passenger-converted aircraft to be competitive against the older widebodies for low utilisation operations.

Group four

This last group of aircraft is the only one in which some types have payload restrictions on longer routes.

The DC-10-30 is a unique aircraft since it has long-range capability that makes it a good north-south route direction aircraft and a payload size in between the DC-10-10 and 747. The MD-11 is a direct competitor of the 747-100 and -200 because of their similar payloads.

The 747-400's large payload makes it unique just like the DC-10-30. On the first sector length of 2,500nm the DC-10-30 has a small payload restriction because of a limited landing weight. The unit cost for all five types is similar, although is higher for the DC-10-30 because of payload limitation *(see chart, this page)*.

The MD-11's, 747-100's and 747-200's trip costs are similar, resulting in similar unit costs. The MD-11's higher lease costs are easily overcome by lower fuel consumption and small maintenance and crew costs.

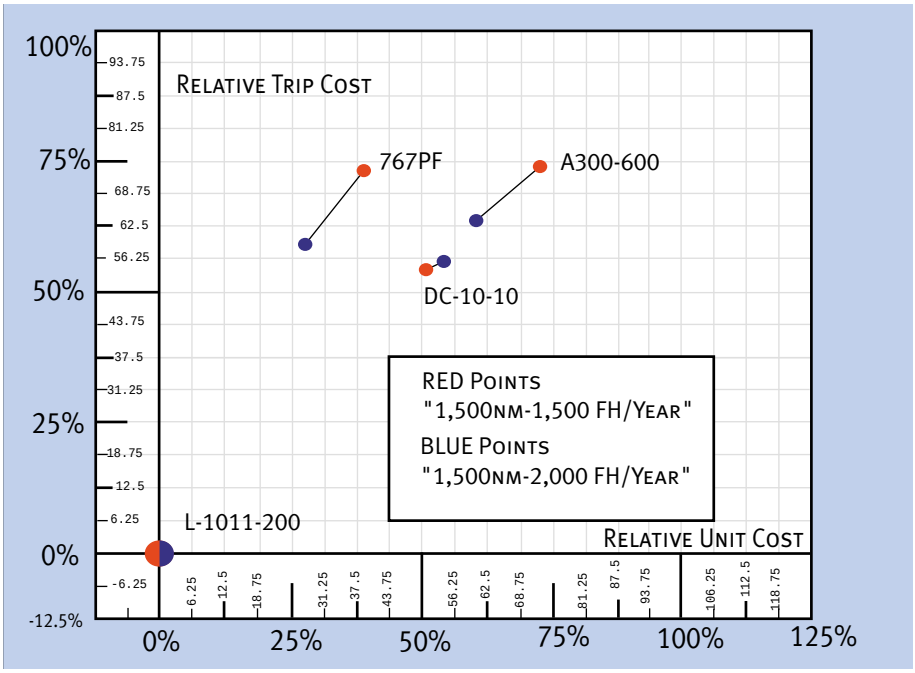
The 747-400's higher trip costs are compensated for by its larger payload. Even at this low level of utilisation for a new aircraft the aircraft is able to offer competitive economics for an airline which requires its capacity.

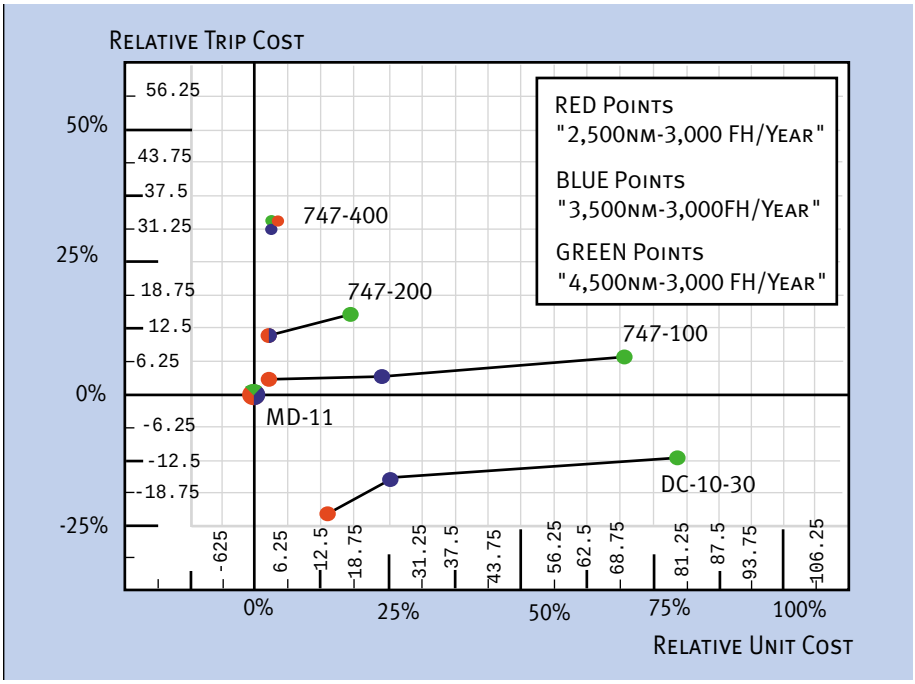
At 3,500nm the DC-10-30 suffers a 10,000lbs payload restriction and so its unit costs start to rise. If more payload capability is required the 747-100 would be more efficient.

The 747-100 also has a payload restriction of almost 30,000lbs, while the MD-11 and 747-200 are unaffected. The 747-100 therefore becomes uncompetitive against the MD-11 and 747-200. The 747-400 has similar unit cost performance to the 747-200 and MD-11.

At 4,500nm the DC-10-30 loses almost 50,000lbs in payload performance. Again the 747-100 would be a more appropriate aircraft than the DC-10-30 for this sector length.

The 747-200 and MD-11 have similar payloads. At this longer route length the MD-11 is able to take more advantage of its operating efficiency and so achieves lower unit costs than the 747-200.





The 747-400's performance is still unaffected and so generates the lowest unit cost despite its much higher lease rate.

Summary

The economic comparisons have, perhaps, surprisingly revealed that younger aircraft can become competitive when achieving only mediocre utilisations compared to older types. However, this only occurs where all aircraft have a maximum payload. In some cases younger aircraft have larger payloads than their older counterparts. One example is the 757PF compared to the 727-200F. For younger types to become acceptable to airlines, therefore, significant traffic growth will be required to both fill the younger aircraft and to stimulate the need for higher utilisations.

There are, however, a number of indications in this analysis that the older passenger-configured converted versions would now or very soon make competitive freighter aircraft when considered against workhorses, such as the 727-200, DC-8 and DC-10. These aircraft include the 757, 767 and A300-600.

This is due to a combination of rising maintenance costs of the current freighters and falling market values and superior performance of aircraft that would result following conversion. This point is best vindicated by speculation that the first 757s, 767s and A300-600s may soon be bought from passenger airlines and converted to freighters.

When this happens it will start the largest upheaval the freight sector has seen for decades, since the first 757s and 767s to be converted will displace the first 727s and DC-8s. AC