There are now about 600 active MD-80s. Large numbers of aircraft have been phased out of operation over the past six years or so, and more aircraft are set to retire. While the MD-80 is seen to represent old technology, it has competitive maintenance costs and can be acquired at known-down values on the used market.

The investment & used market potential of MD-80s

The MD-80 is now clearly a secondary market aircraft, and is considered to be old technology. About half the manufactured fleet remains in active service, with the number of stored or scrapped aircraft growing each month. This process has been hastened by the fuel-thirsty nature of its JT8D-200 engines. Nevertheless McDonnell Douglas aircraft have a reputation for durability. MD-80s are now so cheap to acquire that the type should not be prematurely written off. This is certainly the case as large airworthiness directives (ADs) loom for the 737-300/-400/-500 regarding the replacement of window belt skins and inspections of fuselage stringers *(see Assessing the 737 Classic's ageing maintenance, page 36).* Certain niche MD-80 operators are likely to remain so for years to come.

MD-80 variants

Unlike the 737 or A320, the MD-80 was never developed as a family. With the exception of the shorter MD-87, which is 5.8 metres (18 feet) shorter, the other four variants are the same size. Of a total production run of nearly 1,200 aircraft, only 62 MD-87s were manufactured.

The MD-80 was not a new aircraft, but an upgraded derivative of the DC-9-51. In terms of certification all variants continued to be DC-9 models, but were marketed as MD-80s. The first was the MD-81, which was designated as a DC-9-81, and was delivered to launch customer Swissair in 1980. It featured the upgraded JT8D-200 series engine, with a higher by-pass ratio than its smaller predecessor.

The first MD-80 variant had a typical two-class layout of 143 seats, but could have up to 172 single-class seats in a high-density configuration. This makes it similar in size to the 737-400.

The MD-82 was first produced a year later in 1981, featuring the upgraded -217 engine. Some later deliveries came with the -219 engine, which offered improved specific fuel consumption. The MD-82 was initially intended as a 'hot and high' performance aircraft, but had increased payload and a 400nm range advantage over its predecessor at standard airports. Its passenger capacity is identical to the MD-81.

In 1985 the first delivery of the MD-83 followed to Alaska Airlines. This aircraft offered the upgraded -219 engine as standard, and an almost 1,000nm longer range over the MD-81. The MD-83 has higher operating weights, and offers the longer range through the installation of two additional centre fuel tanks which could carry extra fuel of 1,130 US gallons (USG). It has the same interior configuration as the MD-81/-82.

While the next variant might have been the MD-84, the shorter MD-87 was designated to represent the year of its first delivery to Austrian Airlines in 1987. This shortened variant features a lower seat capacity of 117 in a typical two-class configuration, and up to 139 seats in a single-class high-density layout. It also has the longest range at 2,750nm.

The MD-88 was developed at about the same time as the MD-87, primarily to Delta Airlines' specifications. It had the same configuration as earlier variants and the same range as the MD-83. The MD-88's main difference over other variants is its glass cockpit.

ACTIVE MD-80 FLEET

MD-80 variant	Number in active	Age range (years)	Major operators
MD-81	7	18-31	Laser, Orient Thai & Olympia Aviation
MD-82	220	14-30	American Airlines (104), SAS (23), Alitalia (11), Meridiana Fly & Bulgaria Air Charter
MD-83	211	12-27	American Airlines (85), Allegiant Air (45), & Ryan International (8)
MD-88	124	15-25	Delta Airlines (115), Allegiant Air (5) & Bukovyna Airlines
MD-87	25	20-25	SAS, Air Mali, Allegiant Air & Air Uganda

American Airlines remains one of the largest remaining MD-80 operators. The airline is due to phase out its fleet over the coming years, and this will release nearly 200 aircraft onto the market.

Active fleet

It is difficult to accurately estimate the number of aircraft that remain in service, since aircraft continue to be parked and retired at a rapid rate. As at the end of the first quarter of 2012, the number of aircraft in service dipped below 600 units. Among the variants, only seven of the original MD-81s are still in service with three operators. Of the newest MD-88 variant, most of the 124 aircraft listed as active on the ACAS database are with Delta Airlines *(see table, page 9)*, and about half of all 58 MD-87s built are listed as active. The remainder of the active fleet is divided roughly equally between the MD-82 and MD-83 variants.

Distribution

Of the active fleet, the type is highly concentrated among a small number of carriers. According to ACAS, 368 aircraft are at just three North American carriers, including some 200 aircraft at American and over 100 at Delta.

While American is accelerating its retirement programme, Delta will continue to operate its MD-88s for a number of years. By contrast, Allegiant's fleet of 64 aircraft may grow further.

The only remaining significant European carrier is SAS, with over 20 aircraft, although its fleet has greatly reduced in recent years. Alitalia still has 12, which are likely to be phased out.

Stored aircraft & availability

According to Ascend, 276 aircraft were in storage in April 2012, of which 153 are MD-82 variants and 65 are MD-83s. This suggests that the slightly younger and higher performance MD-83 is faring better than earlier derivatives, since this represents only 24% of all MD-83s remaining.

The aircraft in storage include 48 from American Airlines. Some 24 stored aircraft, however, are due to return to service with carriers including: Allegiant; Aserca; GMG; Hewa Bora; and Khors Aircompany.

During the first quarter of 2012 there were, according to Ascend, five aircraft retirements and 20 lease returns (seven from American). This trend is expected to continue with more phase-outs from Alitalia, American and SAS. Aerolineas Argentinas and Austral will also shortly complete phasing out the type.

Aircraft available for sale or lease are also increasing. In May 2012 Airfax advertised 37 aircraft available, including 19 MD-82s, 16 MD-83s and three MD-87s. Some are being offered without engines. The number of offered aircraft is increasing every month, with six additional units advertised in May 2012.

Current values & lease rates

As with most ageing types, the main value driver is the aircraft's maintenance condition, affected mainly by remaining engine times to the next major shop visits.

The IBA Group estimates that a -219 engine in at least a mid-life condition has a value of $700,000-750,000, so the two engines alone could be worth $1.5 million. Since the average cost of an engine overhaul can exceed $1 million, engines with life remaining in the secondary market are attractive to existing operators with aircraft that otherwise have a minimal core value.

Other components such as landing gears in mid-time condition may be worth an additional $200,000.

The appraisal community is more divided about half-life aircraft values. Avitas believes a mid-life MD-83 with the -219 engine has a current market value (CMV) of $1.5 million. The above engine values suggest the airframe is worth close to zero. Unusually, Avitas now believes that a typical aircraft, irrespective of age, would have about the same value, so younger models no longer command a premium.

Since there are now a large number of aircraft in storage or for sale, Avitas believes there is no longer any point in discriminating between aircraft according to their age.

In contrast, Ascend still uses the traditional age-based approach, and has ascribed the same CMV of $1.5 million to older 1984 vintage aircraft. More recent models have a CMV closer to $2.5 million.

The MD-82 and the few remaining earlier MD-81 models have even lower values. According to Avitas these range from $0.5 million for both models to $0.8 million for the -217C-powered MD-82. Ascend ascribes similar values to the MD-81, but believes that the MD-82 has market values of $1.0-1.7 million.

Avitas ascribes a typical value of $1.0 million to the MD-87 and $1.5 million to the MD-88. Ascend values the MD-87 at $1.8 million for all years of build, and the MD-88 at $1.6-2.3 million, depending on age.

This means that the value of younger variants has declined somewhat in recent years, while older vintages have remained more stable.

The value of all MD-80 variants, according to Ascend, had declined so much by 2010 that further declines were possible. Ascend points out that since 2010 the MD-80 is the cheapest 150-seater around and that values remained broadly at these low levels through to the end of the first quarter 2012.

Since there have been relatively few leases compared to sales in the last year, lease rate trends are more difficult to track. Ascend recorded only a single new lease transaction so far in 2012 to Medallion Air.

With so few MD-81s in service, a current lease rate for the type is not meaningful. There is some anecdotal

Allegiant Air has taken advantage of the MD-80's low acquisition costs of steadily built up a fleet to 50 aircraft.

evidence that MD-82 lease rates have fallen to $25,000 per month. According to Ascend this could range up to $45,000 for a 1997-build aircraft.

MD-83 rates appear a little higher and could reach $60,000 at the top end. MD-87 lease rates, meanwhile, are about $30,000, according to Ascend. Since there are few MD-88s outside Delta, *Aircraft Commerce* believes a market lease rental for this variant is not meaningful.

All appraisers agree that the MD-80's values will never recover, since it is a past design and many aircraft are perceived to be near the end of their economic life. Although fuel prices have recently declined, any new rises will only serve to accelerate the type's retirement.

Passenger economics

The most appropriate comparison benchmark for the MD-80 are the 737 and, in particular, the -400. The 737-400 is closest in size and seat capacity to the MD-81/-82/-83/-88.

The critical cost elements where both aircraft are likely to differ are fuel consumption and burn rates, ownership costs and maintenance. Another major operating cost element is flight crew, but for the purposes of this analysis this will be excluded since it is not materially different for the two types.

Other costs such as navigation charges, handling, airport charges, cabin crew, catering and insurance are a smaller part of the total and are broadly similar, and so can be excluded.

When both aircraft are compared, fuel and maintenance costs make the MD-80 look unattractive, but this is partly offset by its lower ownership costs.

In terms of fuel burn, the cost of fuel, at current prices of $2.72 per US gallon (USG), for an MD-82 or MD83 on a typical 1,050nm two-hour sector will be $5,262; equal to a burn of 1,940USG.

This compares with $4,455 on a 737-400 or $4,220 for the 737-300, with fuel burns of 1,740USG and 1,550USG respectively.

On this basis, the MD-80 costs almost 20% more to operate than the 737-400, reflected largely by the CFM56-3C1's fuel burn efficiency over the JT8D-200's.

Maintenance costs favour the MD-80, mainly because its engine shop visit and overhaul costs are lower than the 737-400's CFM56-3C1s.

The JT8D-200 has total maintenance costs of $150-190 per engine flight hour (EFH), including a reserve for life-limited parts (LLPs). The JT8D-200 is a simple engine to maintain and manage. Its LLPs have a uniform life of 20,000 engine flight cycles (EFC). This compares to typical removal intervals of 4,000-6,000EFC, equal to 6,000-8,000EFH at typical rates of operation.

The engine can follow a simple shop visit pattern of alternating hot section inspections or performance restorations, with overhauls. It can therefore go through four shop visits before the LLPs are due for replacement at the fourth.

LLP reserves can therefore be $70 per EFC, equal to $50 per EFH at an operating ratio of 1.4EFH per EFC. Owners and operators of MD-80s should be able to avoid buying new LLPs for the JT8D-200, however, because of the plentiful supply of time-continued engines on the market.

Typical shop visit costs, excluding LLPs, are $600,000 for a lighter input and $1.1-1.2 million for an overhaul. This would result in a reserve of $145 per EFH. With LLP reserves added, the total reserve would be $195 per EFH for engines managed by operators with a long-term view and not using time-continued modules and LLPs.

In contrast, the CFM56-3B2/-3C1 on the 737-400 is more complex to manage in terms of optimising a shop visit pattern. Its LLPs have varying lives. Those in the high pressure modules have lives of 15,000-20,000EFC, those in the low pressure turbine are at 25,000EFC, and parts in the fan and low pressure compressor are at 30,000EFC. This means the engine cannot conform to a simple alternating shop-visit pattern of core performance and restoration followed by a full engine overhaul in the same way that the JT8D-200 can.

The higher-rated -3C1 engines have mature scheduled shop visit intervals of about 4,000EFC, while the lower-rated -3B2 engines have mature planned intervals of 5,000-6,000EFC.

The LPT and fan/LPC modules will probably need a full shop visit on average once every third shop visit for mature engines, and have their LLPs replaced once every fifth or sixth shop visit. A core and performance restoration will be required at every shop visit, and LLPs will be replaced every third or fourth visit in the case of most engines.

A full set of LLPs for the CFM56-3B2/-3C1 has a list price of $1.8 million. Based on the likely LLP replacement schedule described, LLP reserves will be $90-100 per EFC.

The cost of core performance restoration or overhaul is $1.0-1.2 million, while workscopes in the Fan/LPC and LPT modules, excluding LLPs, are $150,000 and $300,000 respectively.

These shop-visit reserves will be $290 per EFC for the -3C1 and $250 per EFC for the lower rated -3B2. With reserves for LLPs added, the totals will be $380-390 per EFC for the -3C1, equal to $270-280 per EFH; and $350-360 per EFC for the -3B2, equal to $250-260 per EFH.

The CFM56-3B2/-3C1's reserves are therefore $55-85 per EFH higher than the JT8D-200; equal to $110-170 per FH for both engines.

Reserves for base checks will also have possible differences between the MD-80 and 737-400. Despite its age, the

The large number of retired and parked MD-80s means that their values and lease rates have collapsed to all-time lows. Market values of older models are estimated at about $0.5 million, while the youngest MD-88s are thought to have a value of $1.6-2.3 million.

MD-80 has base check reserves of $185 per FH. This is close to the 737-400's reserves of $175 per FH.

The other maintenance elements are line and A checks, heavy components, and rotable component inventory support. These are likely to be similar for the two types.

The biggest difference between the MD-80 and 737-400 is therefore in engine reserves. The MD-80 has an overall advantage in maintenance costs.

Since there have been relatively few recent leases of MD-80s and more direct purchases, *Aircraft Commerce* believes that an aircraft comparison based on an acquisition cost financed on a full pay-out basis over five years is a better reflection of relative aircraft operating costs.

If MD-80 ownership costs are based on a mid-life aircraft of $1-1.5 million, an interest rate of 8% and a term of 5 years, the monthly cost would be $20,000-30,000, equal to $133-200 per FH based on an aircraft operating at a utilisation of 150FH per month.

In contrast, if a 737-400 has a value of $4 million, the equivalent ownership cost would be $550 per FH; a premium over the MD-80 of $400 per FH.

On a two-hour sector, the 737-400's higher finance charge would cancel out its higher fuel burn and cost. Only the maintenance cost difference between the two types would therefore remain.

On this basis the economics of the MD-80 are a bit more favourable, because its engine-related maintenance costs are lower. It can also be acquired for low capital costs, which is beneficial to some owners particularly if utilisation is low or highly seasonal.

Although the 737-400 is younger, and is being retired at a slower rate than the MD-80, there are now higher risks of continued operation. An AD is expected to be issued late in 2012 that will cover repairs to delaminated skins along the window belts. There is also an AD that requires a detailed inspection of a fuselage stringer. Inspection could result in an expensive repair *(see Assessing the 737 Classic's ageing maintenance, page 36)*. This is likely to require compliance by 40,000FC. Since the AD will require a high level of labour and material inputs it could represent a retirement watershed for the aircraft.

Used applications

Since the MD-80's market values are so low, it is of interest to operators with low utilisation and/or a strong level of seasonality in their operation. They also make buying the MD-80 attractive to cannibalise it for rotable components to maintain existing fleets.

Early 2012 saw evidence of both types of strategy with available aircraft. Seven aircraft, which are now in active service, were delivered to new operators up to June 2012, according to ACAS.

This includes aircraft acquired by Zagros Air, Tango (Equatorial Guinea), Dana Air and ATA. This was prior to the recent crash in Nigeria, which may cut this limited element of the market.

Other aircraft have been acquired and subsequently parked by Allegiant and GA-Telesis, which suggests they were purchased for spares. Indeed GA-Telesis is now offering a number of aircraft for sale without engines, which implies that they were principally bought for their powerplants.

In 2011, 49 aircraft were delivered to active service, including: 12 to four operators in Iran; six to two Venezuelan operators; five to Orient Thai; and several to Khors Aircompany in Ukraine.

This continued the trend set in 2010, but apart from two further deliveries to Zagros in 2012, these carriers have not acquired additional aircraft in 2012. In 2011 Allegiant, Aserca and others bought and parked aircraft, which implies that they are to be used for spares.

During the rest of 2012, Ascend notes that Allegiant is to acquire a further four former SAS aircraft and Aserca plans to lease in two further MD-82s.

Freighter conversion

As with many ageing aircraft, a passenger-to-freighter conversion programme would seem to be an obvious use for used MD-80s, so it is perhaps surprising that such a programme is only now about to come to market.

Robert Convey, vice president sales & marketing at Aeronautical Engineers Inc (AEI), says that while its conversion of the first aircraft is marginally behind schedule, the flight test programme should be complete by the end of July 2012, and the supplemental type certificate (STC) should be issued by the end of August 2012.

Convey explains that the MD-80 can be an attractive freighter by comparison to the similar sized 737-400. *(See AEI's MD-80SF payload specifications described in Issue 72, October/November 2010)*. This is based not only on the MD-80's capacity and range capabilities, but also on the capital required. The cost of acquiring the aircraft to convert is one-quarter of its closest 737-400 competitor. This includes the cost of the airframe with a reasonable 2,000-3,000 flight cycles remaining on its engines.

Given the conversion's published price of $2.3 million, and the cost of buying an aircraft, which Convey says can be less than $1 million, the completed product comes in at $3.0-3.5 million. This makes compelling economics, despite the aircraft's higher fuel burn but lower maintenance costs.

AEI concedes that since the MD-80 has a narrower fuselage and main deck

AEI's passenger-to-freighter conversion programme for the MD-80 is expected to receive its supplemental type certificate in August 2012. Despite some airlines taking a negative view on the MD-80's fuselage cross-section, its low acquisition costs means the all-up build and production cost of a service-ready freighter could be less than $4 million.

cross-section than the 737, the MD-80 is not suitable for all freight operators as some of the large ones, such as FedEx, need a freight container with interlining capability between its fleet types.

Convey says, however, that most operators do not require interlining of containers between narrowbodies. He adds that the MD-80 conversion programme has had the highest level of initial interest from operators that AEI has ever seen. In terms of firm orders, the prototype aircraft has been pre-sold to Everts Air Cargo. AEI has a backlog of 15 further aircraft from other operators. These are currently undisclosed and cannot be revealed prior to certification of the aircraft later this year.

Convey notes there is considerable global interest for the MD-80 freighter, including emerging markets in Africa and the Middle East.

AEI believes that the level of current interest in the type means that the production run of conversions could exceed 100 aircraft. This would absorb a significant portion of available aircraft, but could also increase the aircraft acquisition cost and so dampen demand somewhat. This would not be due to a lack of available aircraft, but rather a lack of engines with a reasonable amount of LLP lives and on-wing flight hours remaining, so that some engines may have to go through shop visits after all.

Part-out

With an active fleet of 600 aircraft, demand for spares remains. This can be met by overhauling rotable components, or by acquiring those with reasonable remaining lives from parked aircraft.

Since most MD-80 operators now expect to operate it for a few more years only, there is no need to acquire fresh parts with substantial overhaul costs.

An engine overhaul costs $1.0 million but compares, according to The IBA Group, with a mid-life engine which can be acquired for $0.5-0.7 million, depending on the variant. It is also often possible to do an exchange, so the economics of acquiring used engines become compelling.

Lennart Pettersson, head of technical at European Air Spares (EAS), says that an engine with 2,000EFH remaining to a shop visit can be acquired for as little as $250,000-300,000. He warns that this varies considerably according to condition and status. For example, if the first LLP limiter which would prompt a shop visit is 2,000EFC, but the potential of other components remains good, the value can be considerably higher.

EAS believes the demand for spares is such that a number of aircraft can be profitably parted out over the next two to three years. However, as the active fleet continues to shrink, and the number of parted-out aircraft increases, parting out will gradually become less attractive.

Pettersson says that EAS has bought a number of European MD-82s and MD-83s for part-out in recent years, which, in mid-time condition, would now go for $1.0-1.5 million. Since the engines are the main item of value, aircraft without them are now worth $100,000-150,000.

Other components of value include landing gears, the auxiliary power units (APUs) and avionics. A mid-life APU, for example, could sell for about $50,000.

Pettersson says that up to 350 components, including pumps and bleed valves could have some value, but the rest of the aircraft is simply scrap metal.

The parts market is dynamic in both directions, however. If, for example, a US operator decided to park 50-100 aircraft, EAS believes this would flood the parts market and values would drop substantially. But if used engines with time remaining begin to be in short supply prices will rapidly increase. Pettersson agrees with Convey that this could easily arise, since there are only a finite number of engines. If operators continue to buy used engines, rather than overhauling them, there will soon be no used engines with time remaining.

Concluding remarks

The MD-80 series is clearly nearing the end of its useful economic life in passenger mode, so it is highly unlikely to regain anything like its former popularity.

Market values will therefore be permanently impaired. Avitas says that two main issues count against any value recovery: first, a large number of aircraft is concentrated in the hands of a few operators, which will eventually replace them with newer generation aircraft; and second, it has limited freighter potential, because its narrow fuselage prevents it from carrying standard size freight containers. Some freight operators therefore discount it. Nevertheless, AEI believes that there is a significant market for convert MD-80s to freighter.

In the short to medium term some niche opportunities remain. Low values make the MD-80 a cheap alternative to 737-300s/-400s, which now also have two major ADs looming. These require such high labour and material inputs that they could be a retirement watershed.

For carriers with relatively low utilisation, and therefore below average associated variable costs, the MD-80 has an attraction for a few more years. If fuel prices continue to rise, however, and the supply of good quality used engines falls, this attraction could quickly disappear.

Moreover, if one of the three major operators floods the market because of an accelerated retirement programme, the market is likely to decline to little more than scrap value for all but a small number of aircraft. AC