Technological developments generally diminish the economic appeal of older aircraft. Low cost of funds has enhanced the case for new aircraft. Are low financing costs sustainable beyond the short-term, and do new generation types have a big enough advantage over legacy aircraft?

How is the economic useful life of aircraft changing?

Depending on the point of view, there have been four or five generations of narrowbody and widebody jetliner aircraft. Original equipment manufacturers (OEMs) have focused on reducing aircraft fuel burn and the maintenance burden for each generation to provide airline operators with a reduction in total operating costs, and cost per available seat-mile (ASM).

There is generally, however, a trade-off between the lower cash operating costs of new-generation aircraft and their purchase price and related monthly financing charges, which are higher than for older aircraft.

Financing accounts for a large portion of total aircraft-related costs, so it influences the decision between new and used aircraft. Aircraft lease rates have been relatively low for an extended period, while the past two generations of aircraft have also provided significant reductions in fuel burn and maintenance burdens. This has made the economic case for acquiring new aircraft more attractive than previously. This raises the issue of how the economic life cycle of aircraft has changed, and how the aircraft replacement cycle might be affected by an increase in interest rates and financing charges.

Fleet development

A first-tier airline's decision to replace its fleet with new-generation aircraft is partly influenced by the trade-off between financing charges and lease rentals, and direct operating costs (DOCs) that include flight crew, fuel and maintenance.

Aircraft monthly financing costs, regardless of which of the several financing mechanisms are used, are generally affected by interest rates. Interest rates have been low for an unprecedentedly long period since the 9/11 terrorist attacks in 2001. This period of low interest rates was extended by the financial crisis of 2008.

Until 2001, the market operated on the basis of flag carriers and first-tier airlines acquiring most of their aircraft as new. Many second-tier carriers, freight airlines and flag carriers of poor or third-world countries were the traditional market for used aircraft retired by first-tier airlines.

The past 18 years of low interest rates have kept monthly lease and financing rates low for new aircraft acquired at the same price. In addition, Airbus and Boeing have increased total narrowbody production and delivery rates. Airbus, Boeing and McDonnell Douglas combined delivered an average of 38 units per month in 1990, with Boeing accounting for an average of 21 of these. In 2018, Airbus and Boeing combined delivered about 100 units per month, with Airbus accounting for 55 of these.

Increased production rates have reduced the build cost per unit. This has led to deeper purchase discounts, which in turn have kept operating lease rentals competitive and low.

The extended period of low interest rates, and so low monthly lease rentals, has altered the trade-off between a new aircraft's financing charges and its cash DOCs. This has been a major factor in increasing the proportion of aircraft being acquired new by airlines.

Another factor that has given new aircraft an advantage over used ones is the maximum age limits that many states have imposed on importing used aircraft for passenger operations. Examples are a 15-year age limit for India, Brazil and China.

In addition, the cost per flight hour (FH) that engine OEMs and other industry providers are offering for engine and rotable component provisioning and technical support. This makes new aircraft more attractive, since it allows airlines to avoid large investments in facilities and inventories.

Aircraft generations

Successive generations of aircraft have benefited from design and configuration changes that have reduced cash DOCs and improved operating efficiency. The three major cost categories that have been addressed relate to flightcrew, fuel burn and maintenance requirements.

Flightcrew costs have fallen via a reduction in the crew complement for an aircraft. Aircraft operating long-range missions used to have two pilots, a flight engineer and a navigator. The navigator was made obsolete from the late 1960s/ early 1970s, leaving a crew of three. Long-range aircraft operating with just two pilots become available from the early 1980s. Most short-haul aircraft have always had two-man flightcrews.

Fuel burn has been steadily reduced for generations of aircraft through improvements in engine and airframe technology. The main factor in reducing fuel burn has been the development of the higher bypass ratios of turbofan engines, achieved mainly through wider intake fans. Other factors include higher combustion temperatures made possible through improved materials, and more aerodynamically efficient aircraft and the use of advanced materials to reduce airframe weight.

The change from three and four engines with relatively low thrust ratings, to two engines at higher ratings has also reduced aircraft weight, which in turn has helped to reduce fuel burn.

Maintenance costs have been reduced in several ways. Increased reliability of aircraft components and systems, and more tolerance to damage and corrosion have extended the intervals of airframe maintenance checks. A combination of design factors has also reduced the number of tasks included in each of these checks, and the labour used to perform them.

Improvements in engine design have reduced combustion temperatures and increased their durability, which has lengthened the intervals between removals for shop visits (SVs).

These factors, and other improvements, have reduced overall the cash DOCs paid to operate narrowbody and widebody aircraft over successive generations.

In addition, reductions in DOC per ASM have been achieved through greater cash cost dilution realised by fuselage 'stretches' and increases in seat numbers, with less than proportionate increase in cash operating costs. Examples of initial and 'stretched' variants of a type are the DC-9 and MD-80, 767-200 and 767-300, 737-300 and 737-400, A320 and A321, 777-200ER and 777-300ER, and A350-900 and A350-1000.

First generation

The first generation of jetliners emerged in the 1960s. Boeing and Douglas dominated the market with the 707 and DC-8. These were closely followed by the 727. These aircraft were three- and four-engine designs, and had four- and three-man flightcrews. The 707, DC-8 and 727 could all be regarded as two different generations, since the first variants were powered by turbojets with zero bypass ratios, while later variants were equipped with Pratt & Whitney JT3D engines. These later-variant engines were more fuel-efficient because they were turbofans, albeit with low bypass ratios.

Similar factors applied to the first-generation widebodies that entered service from 1969 to 1972: the 747-100, DC-10 and L-1011. These aircraft were three- and four-engined designs, and had three-man flightcrews. They were the first to be equipped with large-thrust engines with relatively low bypass ratios.

These were followed in 1974 by the first Airbus, the A300B2, which had similar capacity to the initial DC-10 and L-1011 variants, but was the first widebody to feature a twin-engine configuration. In addition, it was the last all-new aircraft to have a three-man flightdeck.

The first generation of smaller narrowbodies was followed by the 737-100/-200 and DC-9, equipped with JT8D engines with bypass ratios of 1.05-1.1:1. These had two-man flightcrews and a twin-engine configuration.

Second generation

The second generation of aircraft initially entered service in the early and mid-1980s. These all-new aircraft had two-man flightcrews, a twin-engined design, and a high fuel capacity for long-range missions.

This generation of aircraft included the 767, A310 and A300-600R. Their engines had increased bypass ratios of 4.6-5.3:1.

Another new feature was extended-range twin-engine operations (ETOPS) missions. This permits aircraft to operate the same tracks as the larger previous generation three- and four-engined widebodies.

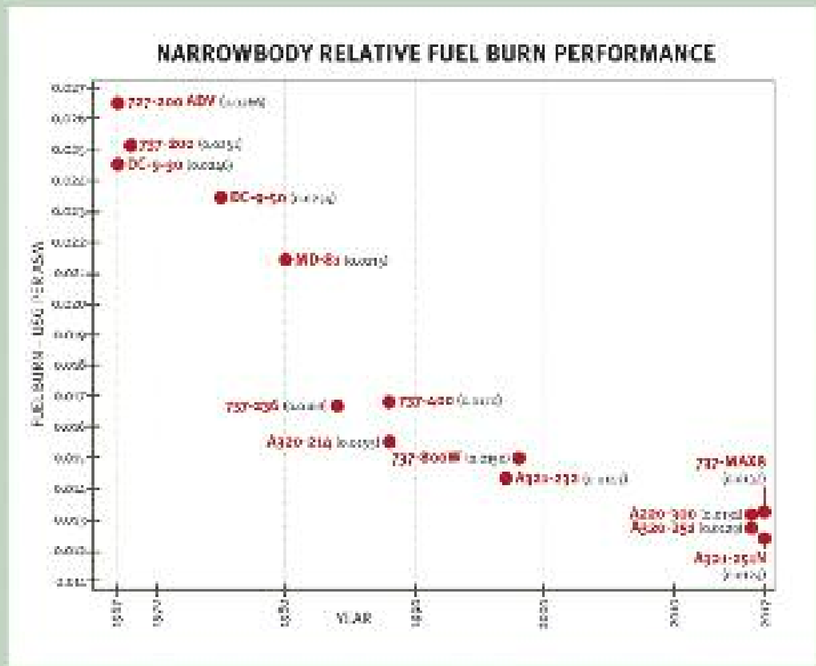
Other widebodies included derivatives of first-generation aircraft: the 747-400 and MD-11. These both had two-man flightcrews, higher bypass ratio engines, and higher seat capacities.

In the case of narrowbodies, the MD-80, a 140-seat, stretched derivative of the DC-9, was launched in 1980. The 737-300/-400/-500 were a second generation of the 737 that followed the -200 series.

All-new aircraft included the large 757 and the A320.

CHARACTERISTICS OF NARROWBODY AIRCRAFT

Aircraft type	Engine type	Bypass ratio	Year EIS	Typical seat capacity
727-200	JT8D-9/-11/-15/-17	1.05:1	1967	145
DC-9-30	JT8D-7/-9	1.1:1	1967	100
737-200	JT8D-9/-15	1.04:1	1968	108
DC-9-50	JT8D-15	1.04:1	1975	122
MD-81	JT8D-209/-217	1.78:1	1980	140
757-200	RB211-535E4	4.3:1	1984	192
A320	CFM56-5A1, -5B4	5.7-6.0:1	1988	153
737-400	CFM56-3C1	5.0:1	1988	145
A321-200	V2533-A5	4.5:1	1997	184
737-800	CFM56-7B26	5.1:1	1998	158
A320-251N	LEAP-1A26	11.0:1	2016	161
A220-300	PW1521G	12.0:1	2016	145
737 MAX 8	LEAP-1B28	9.0:1	2017	158
A321-251N	LEAP-1A32	11.0:1	2017	192



Third generation

Third-generation aircraft entered service in the 1990s. The two main widebody families were the A330/340 and 777. These all had the long-range performance, and higher bypass ratio engines, and lower maintenance requirements of their predecessors. These aircraft could complete missions traditionally operated by the 747, but had fewer seats. They could be operated at competitive rates per ASM. The largest variant of the 777 was the 777-300ER. This has almost the same seat capacity as the 747-400, but 20-30% lower cash operating costs.

Third-generation narrowbodies were the 737 Next Generation (NG) family. These had various improvements to reduce costs per ASM compared to the 737-300/-400. The 777-200LR was an ultra-long-range aircraft with a performance of 8,800nm with about 250 passengers.

Fourth generation

Fourth-generation aircraft entered service in the 1990s. Widebodies included the derivative A340-500 and -600 which were stretches of the A340-300. These aircraft are heavy.

All-new aircraft include the 787 family, the A350XWB, and the ultra-large A380. They all have engines with increased bypass ratios, and reduced maintenance requirements.

The 787 family was the first to feature a high portion of carbon fibre in its structure. The three main 787 series had different fuselage capacities, and they are alternatives to the earlier A330, A340-300 and 777-200ER.

The A350-900 and -1000 have tri-class seat counts of about 330 and 375. These are other alternatives to previous generation aircraft.

The A380 and 747-8 were launched to supply the ultra-large market with 510 and 410-415 seats respectively.

The two main narrowbody programmes are the A320neo and 737 MAX families. These have ultra-high bypass ratio engines that deliver a 15% fuel burn reduction over their earlier counterparts.

Fuel efficiency

A key objective of airframe and engine OEMs when introducing new aircraft and engine types, is the continual reduction in aircraft cash operating costs. Improved fuel efficiency has been a feature of every aircraft and engine generation, and further reductions are still possible.

As described, a main factor in an aircraft's fuel efficiency is the bypass ratio of its engines, as well as other design features. Several improvements in airframe design and technology have contributed to aerodynamic efficiency and reduced aircraft weight.

The use of all these technological developments is reflected by the A320neo's, A321neo's, 737 MAX 8's, 787's and A350's fuel burn performance per ASM relative to older types *(see charts, this page & page 10)*.

Examples of aircraft types that have relatively high fuel burns per seat, compared to their counterparts in the same generation, are the A340-600 and A380 *(see chart, page 10)*.

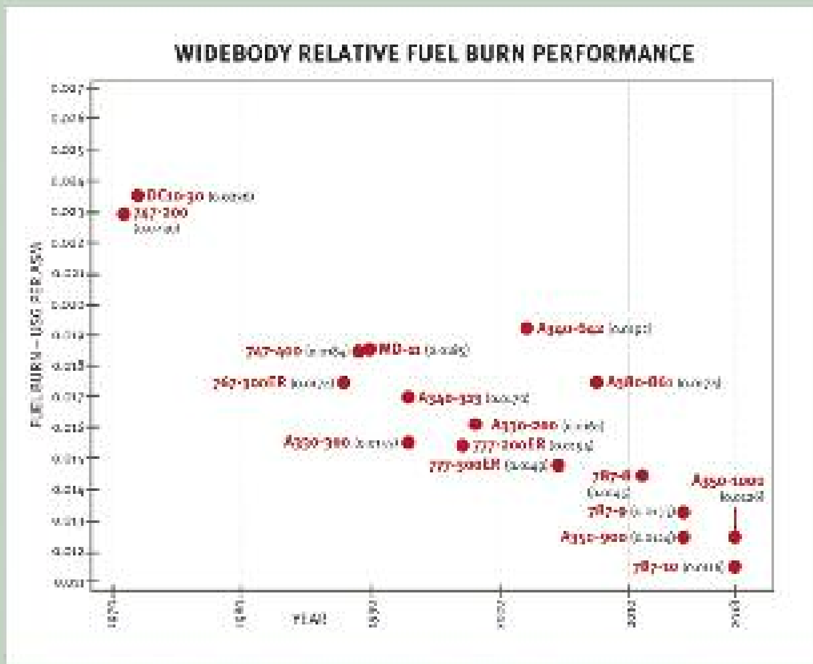
The continual general downward trend in fuel burn per seat and per ASM for a group of aircraft in the same generation, and between different generations of aircraft, can be illustrated by analysing aircraft fuel burn for a flight plus taxi-in and -out on a typical airline route.

To demonstrate this, all narrowbodies have been compared on New York JFK to Chicago O'Hare (ORD), which has a tracked distance of 682nm; and all widebodies have been compared on London Heathrow (LHR) to ORD, which has a tracked distance of 3,551nm. Aircraft on both routes would encounter headwinds, so JFK-ORD would have an equivalent still air distance (ESAD) of 790nm, while LHR-ORD would have an ESAD of 3,925nm.

The narrowbodies have been compared on the basis of a two-class cabin, while a three-class cabin has been used to compare widebodies. Typical seat numbers for these configurations and the engine used for each aircraft type are listed *(see tables, this page & page 10)*. Flight and taxi fuel burns were obtained using flight plans provided by Lufthansa Systems' LIDO/Flight

CHARACTERISTICS OF WIDEBODY AIRCRAFT

Aircraft type	Engine type	Bypass ratio	Year EIS	Typical seat capacity
747-200	JT9D-7A/-7F	5.1:1	1971	375
DC-10-30	CF6-50C	4.3:1	1972	252
767-300ER	CF6-80C2B6	5.06:1	1988	216
747-400	PW4056	4.9:1	1989	387
MD-11	PW4460	4.8:1	1990	274
A340-300	CFM56-5C4	6.4:1	1993	267
A330-300	Trent 772B	5.0:1	1993	274
777-200ER	GE90-94B	8.7:1	1997	304
A330-200	Trent 772C	5.0:1	1998	248
A340-600	Trent 556-61	7.6:1	2002	311
777-300ER	GE90-115BL	9.0:1	2004	367
A380-800	GP7270	8.8:1	2007	505
787-8	GEnx-1B64	9.0:1	2011	237
787-9	GEnx-1B74/75	8.8:1	2014	279
A350-900	Trent XWB-84	9.6:1	2014	328
787-10	GEnx-1B474/75	8.8:1	2018	325
A350-1000	Trent XWB-97	9.6:1	2018	375



flightplanningsystem. These flight plans have used standard rules with respect to fuel reserves, cruise speeds, winds and operating procedures.

Narrowbodies

The analysis of narrowbodies clearly illustrates the effects of technological development on the progressive improvement in fuel efficiency. The first-generation aircraft included are the 727-200, 737-200, DC-9-30, DC-9-50 and MD-81. These are all JT8D-powered aircraft *(see table, page 8)*.

The MD-80 is arguably a second-generation aircraft, or at least half a generation later than the 727-200, DC-9 and 737-200. This is because the MD-80 was developed in the 1970s, and used later-generation JT8D-209/-217/-219 engines, and a glass cockpit; the other types were 1960s developments.

In the 1980s, the second generation narrowbodies started with the 757-200, which is equipped with RB211-535E4 engines, and was then followed by the 737-400, A320-200ceo, and later by the A321-200. The engine types and seat configurations are listed *(see table, page 8)*. The aircraft types included in the analysis illustrate relative differences between similar-sized types.

The third generation of aircraft includes the 737NG family, which entered service in the late 1990s, about nine years after the A320 entered service. The 737NG is also the third generation of the 737 family. Third-generation narrowbodies could arguably include the A321-200, since it entered service in the late 1990s, and the lower-weight variant, the A321-100, which entered service in the early 1990s. This is despite the A321-100/-200 being a simple stretch of the A320.

Fourth-generation narrowbodies include the A320neo, A321neo, 737 MAX 8 and the all-new A220-300. The MAX 8 has been included because it is close in size to the A320neo, while the A321-200neo illustrates the effects of higher seat numbers and a stretched fuselage on fuel burn per ASM performance.

The A220-300 is configured by airlines with 140-145 seats, putting it close to the MD-80 and 737-400. This shows the A220's lower fuel burn relative to older generation types.

The relative fuel efficiency of aircraft types is illustrated by the chart that shows fuel burn per ASM compared to the year that the aircraft entered service *(see chart, page 8)*. The 727-200 clearly has the highest burn per ASM, which is expected given its three-engine configuration. The burn per ASM of all other types is compared with the 727-200.

Despite having fewer seats, the 737-200 has 5.7% lower burn per ASM, while the DC-9-30 is slightly better at 7.7% lower per ASM, despite being smaller. The DC-9-50 benefits from its additional seat capacity, and so is 12.2% lower *(see chart, page 8)*. These lower burns are mainly because of their two-engine configuration.

The MD-81, which entered service in 1980, has a 19.30% lower burn per ASM than the 727-200. This is explained by the MD-80's use of two engines compared to three, while both aircraft have similar seat capacities. The MD-81 also has later-generation JT8D-209/-217s with a higher bypass ratio. The MD-80 is also overall lighter on a per seat basis.

The 757-200, which first entered service in 1982 with PW2037 and RB211-535C engines, and later in 1984 with -535E4 engines, has a 36.9% lower burn per ASM than the 727-200 *(see chart, page 8)*. This is an impressive drop, and is partly explained by the 757-200's 47 higher seat capacity.

The A320-100, which entered service in 1988, was powered with CFM56-5A1 or V2500-A1 engines. The CFM56-5B4-powered -200 series aircraft came in 1995, but this variant has been included on a 1988 timescale. The fuel burn difference between the two is a few per cent. The A320-200's burn per ASM is 41.9% lower than the 727-200. The 737-400, which was introduced the same year as the A320-100, is 36.3% lower per ASM than the 727-200 *(see chart, page 8)*.

The third-generation narrowbodies provide a further generational improvement. The A321, which entered service in 1992, in particular has a 46.3% lower burn per ASM than the 727-200. The A320's and A321's fuel burn per ASM is mainly influenced by engine type, and other factors, such as weight variant.

The 737-800 has a bigger reduction of 43.5% compared to the 727-200 *(see chart, page 8)*.

The fourth-generation aircraft include the A320neo, A321neo, 737 MAX 8 and A220-300. These all entered service in 2016 and 2017, and have a 50.4-53.3% reduction in fuel burn per ASM compared to the 727-200 *(see chart, page 8)*.

These successive and steady reductions in fuel consumption per ASM clearly show how at least one major cash operating cost has reduced with each aircraft generation.

The burns per ASM at current fuel prices of $2 per US Gallon are equal to fuel cost per ASM of 5.3 cents for the least efficient 727-200 and 2.60-2.75 cents for the A320neo, A321neo and 737 MAX 8. This is equal to a trip cost difference per seat of $21-22 on this 650-700nm route.

Widebodies

The analysis of widebodies on LHR-ORD shows the same rate of improvement over first-generation aircraft. The DC-10-30, which entered service in 1972, has the highest burn per ASM of the aircraft compared. The burn per ASM of all other types is compared to the DC-10-30's.

The only other first generation widebody examined is the 747-200, which entered service a year before. This has a 2.2% lower burn per ASM than the DC-10-30 *(see chart, page 10)*. The 747's four-engined configuration is less efficient, but having 123 more seats gives it economies of scale.

The L-1011 and lighter DC-10-10 would also have lower burn per ASM. The A300B4 would have a more efficient performance due to its being the first twin-engined widebody.

The second-generation aircraft show a 21.3-26.2% reduction. The examples used are aircraft that entered service relatively late with the benefit of a twin-engine configuration: the A310, 767-200 and A300-600. The 767-300ER, which entered service in 1988, has 26% lower burn per ASM, despite being 36 seats smaller than the DC-10-30. This illustrates the efficiency of a twin-engined configuration.

The 747-400 and MD-11 show a 21.3-21.9% reduction *(see chart, page 10)*. This is partly because of increased seat counts, but mainly due to powerplant advancements. The efficiency of twin-engined configurations over three- and four-engined designs is illustrated by the 767-300ER having lower burn per ASM, despite being about half the size of the 767-300ER.

The third-generation widebodies included here are aircraft that entered service from 1993 to 1998. The four-engined A340-300 has 27-28% lower burn per ASM than the DC-10-30. Twin-engined efficiency is demonstrated by the A330-300 having a 6.5-7.0% lower trip burn, despite carrying more passengers, and 34.5% lower burn per ASM *(see chart, page 10)*. The 777-200ER also has a 34.5% reduction compared to the DC-10-30, while the A330-200 is 31.5% lower than the DC-10-30. The absolute fuel burns of the A340-300 and 777-200ER are close, but the latter benefits from a higher seat count.

Widebodies introduced in the 2000s are arguably fourth-generation aircraft. These include derivatives: the A340-500 and -600, and the 777-300ER. The A340-600 suffered from a heavy design, with a larger wing and heavier engines than the earlier -300 variant. It is also configured with fewer seats than its nominal or standard tri-class capacity, and has an average seat capacity of 311 passengers. Also influenced by its four-engined design, its fuel performance is 18.5% lower than the DC-10-30's *(see chart, page 10)*. The efficiency of the 777-300ER's twin-engine layout its 56 seat higher capacity is reflected by its fuel burn performance being 34-35% lower than the DC-10-30's.

Similar to the A340-600, the A380 is affected by being relatively heavy for its size. Its burn per ASM is about 26% lower than the DC-10-30's and close to the 767-300ER, which is less than half the A380's size *(see chart, page 10)*.

Aircraft that have entered service from 2011 to 2018 will be regarded as being either fourth or fifth generation. These are members of the 787 and A350 families. These have the largest reductions in fuel per ASM over the DC-10-30, at 38.3% for the smallest 787-8 to 50.9% for the larger 787-10 and 46.6% for the largest A350-1000 *(see chart, page 10)*. Similar to narrowbodies, it has taken 40-45 years and successive generations of development to achieve a 45-50% reduction in burn per ASM.

At today's fuel prices of $2 per USG, these burns per ASM are equal to a trip cost of $175-186 for the 747-200 and DC-10-30, and $90-118 for the 787 and A350 variants. The difference between the 787 and 787-10 is about $20 per seat.

Jet fuel prices

Fuel prices are the second factor that influences the relative cost differences between aircraft generations. High crude oil and, therefore, fuel prices magnify the differences between the operating performance of aircraft types.

The relationship between the price of crude oil and Jet A-1 is chiefly determined by the refining cost or 'crack spread'. This is about $20 added to the $ price of crude oil, divided by 42 gallons provided by a barrel of oil. Thus a crude oil price of $65 per barrel will result in a spot Jet A-1 price of about 202 cents per USG.

Analysis of long-term Jet A-1 spot prices since 1978 shows the sharp climb in prices during several spikes, but also sharp drops that followed as production was increased *(see chart, this page)*.

Despite these peaks and troughs in spot fuel prices, the long-term increase in fuel prices has been a compounded average annual increase of 4.34%. This is higher than the global annual rate of inflation over the same period.

Long-term pressure for aerospace manufacturers to reduce aircraft's fuel consumption has, therefore, been reduce cost per ASM and to offset long-term fuel price inflation.

The 767-300ER was the first widebodied twin to offer very long range performance. Its fuel burn per ASM is 26% lower than the DC-10-30, 21% lower than the 747-400, and was similar to the A340-300.

Aircraft retirement

The age at which first-tier and primary operators retire and phase out different fleets gives some indication of the economic viability and appeal of aircraft types. Factors such as increased rate of aircraft production, low interest and lease rates, and an increased portion of aircraft financed via operating leases may have changed the economical useful life.

A change in retirement age can be examined by analysing the average age at which most first-tier and flag-carrier airlines have retired their aircraft. This issue can be clouded, however, by certain aircraft types or sub-types being retired early by first-tier operators. An example is the 747-100, exclusively powered by low rated variants of the JT9D. These were changed for higher-weight and longer-range variants of the more capable -200 series powered by a variety of higher rated JT9D, CF6 and RB211 engines when they came available.

Another factor that can distort the picture of retirement is the cessation of operations by an airline, and so this is omitted from the analysis.

There is also the issue of 'industry orphans', which are aircraft that have been retired comparatively early by their main customers due to relatively poor sales performance. Examples are the L-1011-500, MD-11 and A340-500/-600.

In the case of narrowbodies and widebodies, it is possible to obtain clarity on the retirement age of first- and second-generation aircraft that were built up to the early and mid-1990s. Third-generation aircraft were built from the early 1990s onwards, so only a few have been retired by most first-tier operators. This provides less information from which to make conclusions.

Narrowbodies

The first generation of narrowbodies is a group of four main types: the 727-200/-200ADV, 737-200/-200ADV, DC-9-30 and DC-9-50.

Most 727-200/-200ADV operators were based in the Americas and Europe. Operators included Air France, American, Continental, Delta, Iberia, Northwest and United. Many airlines operated for an average of more than 20 years.

Major European operators of the 737-200/-200ADV, such as Aer Lingus and British Airways (BA), retired fleets at 13-19 years. North American operators retired their fleets at an average age of 18-22 years.

The DC-9-30 was also operated by several major European and North American airlines. European flag carriers operated their fleets for 18-25 years. North American carriers, including Air Canada and Northwest, retired fleets at averages of more than 27 years.

The same applies to the DC-9-50, which, for example, Finnair operated for up to 23 years.

Second-generation narrowbodies were operated by major carriers for similar periods. The earliest, the MD-80, was operated in large numbers by a few US majors and European flag carriers. American and Delta retired at 24-28 years. Continental and Alaska retired aircraft relatively early at 17 and 14 years.

In Europe, some airlines operated the MD-80 for an average of 19-22 years, while others retired it after 14-16 years; replacing it with the A320. Average length of service was about 20 years.

The 757-200 has been kept in service by many large operators. US majors retired most of their fleets at 19-25 years old.

The 737-300 was operated in large numbers by mainly US carriers. Continental, United and USAirways all had large fleets which were operated to average ages of 19-20 years. Lufthansa and KLM, two of the larger European carriers, operated the 737-300 to a similar age.

Similarly, Alaska Airlines and USAirways operated the 737-400 to 21-22 years old, while BA and KLM used them to a slightly younger age of about 19 years.

The MD-80, 757-200, 737-300 and 737-400 have all been operated to a similar age of close to 20 years by major operators prior to fleet disposal.

Early A320 and A321 models and variants had typical retirement ages of 19-23 years. Later aircraft, with improved engines and delivered from the late 1990s onwards, have had lower retirement ages in many cases. Air France and Alitalia retired A320-200s with CFM56-5B4s at average ages of 12-14 years. Similarly, 737-800s operated by Alaska and American Airlines have scheduled lease expiry at an average age of 13 years. The earlier retirement and fleet disposal of aircraft of more recent generations is partly explained by the increased influence of operating leasing on aircraft return and fleet development strategies. This has given airlines the flexibility to retire aircraft at a younger age.

Widebodies

The average age of 747-200 disposal was 21 years, but up to 25 years for airlines such as KLM and Northwest. A few individual aircraft were operated for 27-29 years.

The lower-weight variants of the L-1011 were operated by BA, Air Canada, All Nippon Airways, Cathay Pacific and Delta for an average of 18 years. Some higher-weight variants were operated for close to 20 years.

The long-range DC-10-30 was

The 777-300ER is a prime example of the benefits of twin-engined configuration and the economies of scale provided by a stretched fuselage. Its fuel burn per ASM is 14% lower than a 747-400 and 5% lowrr than the 777-200ER.

regarded as the only real alternative to the 747. The aircraft was operated by a large number of major North American, European and Asia Pacific airlines. Its average age of disposal was 21.6 years.

The A300B2/B4 achieved widespread geographical acceptance. Its first-tier operators included several European and Asia Pacific flag carriers, plus several other major airlines. The overall average age of disposal was 18 years.

Second-generation widebodies included several types that had poor market acceptance and were prematurely retired. These include the A310-200 and -300 and MD-11.

The A310-200 was low weight and had regional range, and it was operated by mainly European flag carriers. Many retired at an average of 15 years.

The higher-weight and longer-range A310-300 gained wider geographical appeal. Average disposal age was 17 years, only two more than for the A310-200.

The 747-400 was operated to an average age of 20 years by most of its first-tier airlines. These were a large number of flag carriers and major airlines. Most operators have replaced at least some of their fleets with the 777-300ER.

The MD-11 was soon followed by the A330/340 and 777-200ER with better performance. The MD-11 was retired very early by launch customers, most notably by American Airlines. The average retirement age of the 140 passenger-configured aircraft that were built was just over 13 years.

The 767-300ER had a high rate of success, accounting for almost 50% of all variants built. The -300R's appeal lay in its range of up to 6,300nm with a medium load of about 220 passengers, providing the fleet-planning flexibility required by a large number of airlines. Many of its customers operated the aircraft for 22-25 years. Some retirements have been deferred, caused by delayed entry into service of the 787 and A350.

Several second-generation widebodies, therefore, were retired earlier than first-generation aircraft. The 747-400, A300-600R, and 767-300ER have remained in operation with their first-tier carriers for about the same length of time as first-generation widebodies.

Some third-generation widebodies have been retired at a young age. The majority of A340-300 operators retired fleets at 9-17 years old. In contrast, A330-300s were retired by airlines at 18-23 years old. There have been few 777-200ER retirements to date, the first being delivered in 1998.

The A340-500 and -600 were retired at a young age. The oldest A340-500s were retired by first-tier operators at 11-12 years old. Seven of the A340-600's nine major operators retired their aircraft at 6-15 years old. This illustrates their industry orphan status.

Financing & trading

Aircraft financing, monthly financing charges and the aircraft aftermarket have become major factors in determining or influencing the economic useful life of aircraft. While successive aircraft generations have made strides in reducing cash operating costs, changes in aircraft financing and the aftermarket over the past 15-18 years have altered the economics of remarketing used aircraft to the point where disposing of fleets has not only become more challenging, but has also adversely affected the financing of new aircraft.

There are several main aspects that affect the financing and aircraft ownership cycle. The first aspect is the markets for disposing of aircraft. These include passenger-to-freighter conversion, dismantling for parts salvage and acquiring engines, and sales to second-tier passenger airlines that had difficulty securing financing for new aircraft. These markets only provide an outlet for some of the aircraft operated in first-tier passenger roles, and markets are lacking a high portion of a fleet of each type.

Sales of aircraft for passenger use have been made more difficult in recent years with the introduction by several countries of maximum age limits of 12, 15 and 20 years for aircraft being imported to be used for passenger transport. Countries with a 12-year limit include Algeria and Ethiopia. Countries with a 15-year limit include Mexico, Brazil, Egypt, Turkey, Pakistan, China, India, Bangladesh and Vietnam. Countries such as Indonesia and Russia have imposed a 20-year limit, although this is less restrictive for remarketing used aircraft.

The economics of aircraft disposal and initial financing at acquisition depend heavily on possible residual value. Reduced secondary market prospects have dented residual value prospects.

Other factors that have affected residual value prospects include the use of fleet-hour or fixed-rate-per-hour agreements for engine maintenance from the OEMs. Some generally give airlines less freedom to perform engine maintenance at lower costs. These restrictions have meant airlines have avoided acquiring certain used aircraft or engine types. An example is RR Trent 700-powered A330-300s.

Another factor affecting the overall market is that interest rates have been low over a prolonged period, and have kept the financing terms for new aircraft at attractive rates for airlines. Combined with this has been the steady increase in narrowbody production rates, and so generous purchase discounts. Actual purchase prices have reportedly kept about level for the past 15 years. These two factors combined have not just seen A320ceos and 737NGs being offered to airlines at lease rates of $260,000-320,000 per month, but also to airlines that did not previously acquire new aircraft.

The extended period of low interest rates has pushed lease rate factors for new aircraft from the 1.0-1.1% level per month to 0.9-1.0% for narrowbodies in the first few years after 9/11, and down to 0.6-0.7% per month for narrowbodies, and marginally higher at 0.75-0.8% for widebodies for the past 12-15 years.

A further factor has been the steady increase in the number of Chinese aircraft lessors getting into the market. There are about 20 such companies, compared to just three or four 10 years ago. The subsequent increase in competition between lessors has kept downward pressure on aircraft lease rates.

These attractive financing terms for new aircraft have ultimately led to reduced opportunities for remarketing used aircraft.

All of these factors have potentially serious implications. The first is that lessors have found it steadily more difficult to generate profits. This is often because the residual value forecasts made at the start of the transaction are rarely achieved, and often overstated.

The most serious prospect for lessors is a sudden and steep rise in interest rates. “A spike in interest rates is only likely in the event of a political issue, such as a war,” says Stuart Hatcher, chief operating officer at the IBA Group. “In all other circumstances, interest rates can only be expected to rise slowly, especially over the next few years. A positive effect of this would be the effect of global inflation, which would improve passenger yields. It would also be likely to increase oil and fuel prices, and so should increase demand for new aircraft, helping lessors.”

There are several issues facing the financing community. These include what will happen to oil and fuel prices. They could stay stable, but higher prices favour new aircraft and the accelerated retirement of older aircraft.

“What will be undesirable is if there is a sudden dumping of aircraft on the market,” continues Hatcher. “This will happen if there are several airline failures. We have already seen Jet Airways and Avianca fail so far this year. A few others look possible. The increased risk of airline failures is generally due to an oversupply of airline capacity.”

Another factor affecting volume of aircraft on the market is retirements. “The expected lease return of large numbers of narrowbodies has been delayed by lessees extending leases for up to another six year. These aircraft are now more likely to be returned to lessors, and this could cause a bow wave of retirements,” says Hatcher. “Such a wave would be welcomed by freight airlines that require cheaper feedstock for conversion. Such a wave of retired aircraft would of course not help the situation lessors are.”

Several events could compound to make the situation for lessors more difficult. Hatcher predicts a consolidation of lessors, given the squeezing of profit margins on lease transactions. A consolidation of lessors is ultimately what the industry wants to firm lease rentals up. One result of lessor consolidation is likely to be a reduction in speculative orders being placed by lessors.

Meanwhile, it is economically difficult for OEMs to reduce aircraft production rates quickly to ease supply, since unit production costs would increase. A drop in aircraft production rates can therefore only be achieved slowly.