Developing aircraft families with extensive flightdeck, component and engine commonality has been central to Airbus' and Boeing's product definition over the past 20 years. Now product lines are complete, what savings can actually be derived from these benefits?

What savings can be expected from commonality benefits?

Many airlines are evolving their fleets with a minimum number of aircraft types to increase commonality between types and reduce costs relating to pilots, spare engines, and inventories of rotables and spare parts. In the case of most airlines it is estimated that about two-thirds of savings derived from commonality between aircraft types are related to flight crew costs.

What savings can new aircraft offer, compared with other types, which do not share flightdeck, engine and rotable commonality?

Flight crew commonality

Lower total flight-crew employment costs have partly been realised by standardising all aircraft types to a two-man flightdeck. The second main contribution to lowered crew cost has been commonality of flightdecks of aircraft types. This has reduced training costs and increased annual pilot productivity; thereby reducing crew numbers employed per aircraft.

Under traditional airline operations, separate pools of pilots held type ratings for each aircraft type operated. This is because different aircraft types have different flightdecks and operating procedures, and pilots were only legally permitted to have a single type rating.

Keeping pilots to a single type rating has several limitations. Crew and aircraft have to be in the same place according to the aircraft operating schedule. This makes it difficult for airlines to respond to varying traffic demand by changing aircraft type. Varying aircraft size would allow supply to be matched more closely to passenger demand.

Annual flight hours achieved by pilots in single-type operations are also limited for other reasons, including legal limitations on a crew's operating hours, schedules and periods of rest so they avoid fatigue. Rest periods are longer for crew type rated on long-haul aircraft. In parallel to regular operations, crew have recurrent training, which requires downtime, at regular intervals, to maintain their type ratings.

Most airlines also transfer pilots from one type to another, in some cases every three to five years, and in others less frequently. Some airlines which operate only a single type, or variants of a single type like the 737-300 and 737-800, only transfer pilots between types when an old aircraft variant or type is retired from the fleet. Transfer between different aircraft types requires transition training.

Transition training requires longer downtime than recurrent training and also incurs high costs because of the extensive amount of simulator training time. Pilots in some airlines will transition between pools four to six times in their careers.

Mixed fleet flying (MFF) is the modern practice of pilots having ratings for two aircraft types. This is permitted, and economically possible, where two aircraft types have similar or identical flightdecks and operational procedures. These features reduce the time and cost of transition training to get a second type rating. If it is economic for pilots to hold two type ratings, it transforms an airline's ability to schedule different aircraft sizes in accordance with passenger demand, while maintaining or even increasing flight crew productivity.

Swiss is one airline which practices mixed fleet flying, and has pools of pilots with A320 and A330 ratings, and with A330 and A340 ratings. "Once pilots are in a dual rating pool they seldom need to change ratings," explains Captain Conrad Stefan, head of A330/340 training at Swiss.

Despite the possibility for MFF, not all airlines take advantage of commonality between aircraft types. For example, although Iberia operates the A319/20/21 and A340, it still has single type ratings for its pilots, and transitions pilots between types every four to six years.

Pilot productivity will be increased where crew rest periods between flights can be reduced on mixed short-haul and long-haul operations: following a long-haul flight pilots can operate a short-haul flight sooner than they would be permitted to operate another long-haul flight.

Rostering pilots on to another type also allows more pilots and aircraft to be scheduled at short notice.

These benefits can only be exploited if getting a second type rating requires minimal additional training. This, in turn, is only possible if there is extensive commonality between the two types. In some cases a rating on two types can be achieved using the same simulator.

Flightcrew commonality therefore raises two questions: do aircraft types offered by either manufacturer have

Flightdeck commonality between modern aircraft types and the advent of aircraft families have provided airlines with an opportunity to reduce transition training costs for pilots, irrespective of whether the airline operator practices mixed fleet flying.

enough commonality between them to make it economic for pilots to have two type ratings; and what are the potential savings compared to traditional systems of single type rating operations?

Type ratings

Under traditional and modern systems, newly recruited First Officers usually gain their initial type rating usually on one of the smallest narrowbody types in the fleet, such as a 737 or A320.

Initial type rating training involves groundschool classroom, system trainers, full motion simulator training and actual flight training, or line check training, on the aircraft type in question.

"Transition training for a new rating now takes about 23 days for pilots with cathode ray tube (CRT) flightdeck experience and about 25 days for those without," says John Blanchfield, director of technical marketing at Airbus Industrie. "This time would allow a First Officer to get an A320 rating, for example, and for slightly longer training an A320 family type rating." The amount of time spent by pilots transitioning from older aircraft to modern Boeing types is similar.

A First Officer might then maintain their type rating for a few years while gaining experience and hours.

Older aircraft types each have a single type rating, but commonality between modern aircraft types means that groups share single type ratings.

In the case of Airbus products, the older A300B2/4 has one type rating. The next generation A300-600 is also a single type rating, but shares a common type rating with the A310-200/-300 series. A common type rating is a single pilot type rating given to two different type certificated aircraft. The A300-600 and A310-300 have different type certificates, but a pilot has the same ratting for both aircraft.

There are just four type ratings of the modern Airbus models: the four variants of the A320 family; the A330-200/-300; the A340-200/-300/-500/-600; and the A380.

Older Boeing types each had a single type rating. The 737-300/-400/-500 series have a single type rating, as do the 757-200/-300 and 767-200/-300/-400. Like the A300-600 and A310-300, the 757 and 767 families have a common type rating.

Besides the 757 and 767, the remaining aircraft in the current Boeing product line are split between three single type ratings. These are the 737-600/-700/-800/-900 (NG) family, the 777-200/-300 and the 747-400.

In terms of single type ratings, the current Airbus and Boeing product lines can therefore each be split into five groups of aircraft.

Both manufacturers have reduced the number of single type ratings by developing families of aircraft to cover the same range of seat capacities that were matched by several older aircraft types. The A320 family, for example, provides between 107 and 185 seats in a dual-class arrangement, and the 737NG series offers 108 to 177 seats. Prior to their existence, airlines would have had to operate three or even four types to have the same spread of seat capacities.

The advent of aircraft families therefore allows airlines to operate a range of seat capacities while incurring costs reflective of a single aircraft type rather than several aircraft types.

Iberia is a typical example. Ten years ago the airline had five different narrowbody types; now it has three basic types, including older MD-80s.

Recurrent training

Once pilots have attained a type rating they are required to have recurrent training to keep it valid, which involves several days out of line operations. Kelly Bush, flightdeck and & crew scheduling in Boeing marketing, explains that recurrent training is required every six months by both the Joint Airworthiness Authority (JAA) and Federal Aviation Administration (FAA) where a single type rating is held.

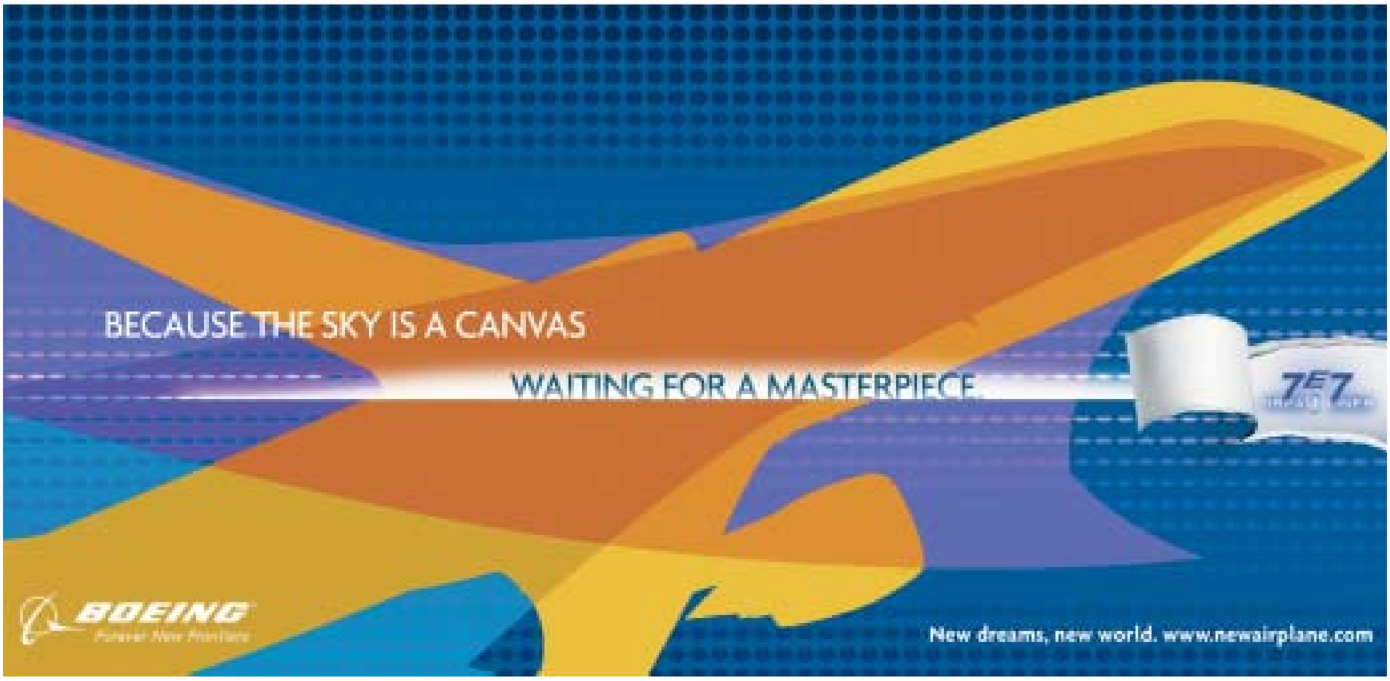
"Recurrent training programmes vary by airline and regulatory authority, but they generally last 1-3 days (2-6 days per year), including one day's simulator refresher training in each session, and an annual line check of one or two flights on the aircraft.

This requirement is one factor limiting the number of block hours (BH) pilots can achieve each year. Recurrent training will therefore be double for pilots with two type ratings where there is no commonality between aircraft types. This is one factor that makes it uneconomic to have multiple type ratings on older aircraft. The time required for recurrent training is little increased, however, where there is commonality between two types.

"A pilot with an A320 and A340 rating, for example, still only requires 4-6 days per year recurrent training and can alternate recurrent training on each type," explains Blanchfield. "That is, the pilot can have recurrent training on the A320 after the first six months and then recurrent training on the A340 six months later, and maintain both ratings." The same applies to a combination of the A320 with the A330 and to the A330/340.

Stefan estimates pilots with dual ratings on the A320/330 and A330/340 have about 6-7 days of recurrent training per year.

"The higher the level of commonality between types, the higher the chance that



there would be no increase in annual recurrent training requirements for a dual type rating over a single type rating," explains Bush. "Therefore, recurrent training is 2-6 days per year for a single type, but would be 4-12 days for two types with no commonality. A dual rating with the 757 and 767, for example, would only require 2-6 days per year. The same is true of the 767/777, 777/747-400 and 737/757 combinations."

In addition to recurrent training, pilots are also required to maintain recency or currency on their ratings. "This requires three take-offs or landings every 90 days for each rating held," explains Blanchfield. "Recency for dual ratings can also be easier to maintain where there is commonality between types. In the case of an A320/330, A320/340 or A330/340 combination, one of these three landings or take-offs can account for either of the type ratings held. One has to be on the A320, one on the A340, but the third can be on either." In some long-haul operations it may not be possible to reach the required number of take-offs and landings in the 90 day period, especially on routes where supernumerary crew are used. Simulator time would be required to maintain currency: This increases costs, but can be avoided where commonality allows these three take-offs and landings to be shared between the two types.

Transition training

Transition training is required for pilots when acquiring a new rating. As described, acquiring an initial type rating takes 21-25 days.

Under a system of single type ratings, transition training requires a similar amount of time where there is little or no commonality between the type currently held and the new aircraft. An A320 rated pilot would thus require 21-25 days of training when getting a 777 rating. The length and cost of this transition training have an economic impact on the airline, especially if pilots transition between aircraft types every 3-5 years. "We have five fleet types: the 737; the 757-200/-300; the 767-200/-400; the 777-200; and the MD-80," says Jay Elzey, senior director of safety and flight standards at Continental Airlines. "We will phase out the MD-80 by 2005, taking us down to four types. We have changed our pilot salary structure to one where higher salaries are paid for flying larger types, and so pilots change ratings to larger types every three years when the industry is doing well, but less frequently when the economy is weaker. Senior First Officers on larger types also have transition training to smaller types when promoted to Captain."

Transition training is reduced where there is a level of commonality between the two aircraft types in question. If the commonality is sufficiently extensive, the transition training to get a new rating can be small enough to make it economic for the pilots to hold two ratings. In this case 'differences' training is required to get a second rating. The recurrent training to maintain both ratings also has to be considered.

Four groups of Airbus types also have fly-by-wire (FBW) flight control systems, and therefore can be programmed to have similar handling characteristics. Combined with identical flightdecks, this allows cross-crew qualification (CCQ) between these four types. CCQ reduces the differences training required for pilots to get a rating on a second FBW Airbus type when a rating on another FBW type is already held.

Differences training takes eight days for an A340 or A330 rating when an A320 rating is already held. When an A330 rating is already held, just a further three days are required to get an A340 rating. When an A340 rating is already held only one day is required to get an A330 rating.

Although it is not yet clear what the length of differences training between the A380 and other types will be, Blanchfield expects it to be 8-10 days where an A340 rating is already held. Blanchfield also thinks that airlines could go for a system of three type ratings with the A330, A340 and A380.

The length of time for differences training is similar for combinations of Boeing aircraft with extensive commonality. The length is longer for pilots with experience on aircraft with non-CRT flightdecks going to aircraft with CRT flightdecks and flight management systems.

"Differences training is required between variants of the same type, for example, going from the 737-300 to the 737-800," explains Bush. "We offer shortened transition (STAR) courses between different types that have a high level of commonality. The length of these is four hours to 15 days, depending on the two types.

"The 757 to 767 takes four hours, while the 737-100/-200 to 737NG takes nine days," explains Bush. "The time for all other combinations of the four main aircraft types is 13 to 15 days."

The commonality of parts and components between aircraft modern types allows economies of scale to be achieved in the inventories required for LRU and rotable components. This can reduce the investment in inventory per aircraft by about $1 million.

Continental Airlines, which operates the 737-800, 757, 767 and 777-200, also maintains a policy of single type ratings. "We do not consider it advantageous for pilots to have a 737 and 777 rating," says Elzey. "We do, however, try to take advantage of commonality between the Boeing types by minimising the transition training from the 737NG and the 757, 767 or 777. This requires about 18 days, compared to 25 for transition training between two types with no commonality. The problem with mixed fleet flying is that, in a large operation like ours, forming pilot schedules on two types so they can maintain currency on both ratings is complex, and the pilots also prefer to have a higher degree of currency on one type. Moreover, our fleet sizes are so large that there is little benefit from mixed fleet flying."

Stefan at Swiss comments that the real benefit of mixed fleet flying is not with a reduction in recurrent training, but in lower transition training, which is realised once a pilot has got their first rating on an Airbus type. "It only takes about two weeks to get a second type rating in this case."

Economic benefits

Flightdeck commonality therefore provides airlines with the opportunity to make savings on the costs of flightcrew.

First, families of aircraft like the A320 or 737NG reduce the number of types and so the amount of transition training required in the average year. The A318/19/20 and 737-600/-700/-800 both provide between about 107 and 160 seats and each have a single type rating. Prior to their availability, an airline will have been forced to operate the DC-9-30 or 737-200, DC-9-50, MD-87 or 737-300 and 727-200 or MD-80 to offer three different aircraft types of similar seat capacities. Transition training from and to each of these three older types would therefore be required, but not between the three members of the A320 or 737 families. This not only eliminates the cost of transition training within modern aircraft families, but also saves time and allows pilot productivity to be increased.

The reduction in transition training includes a possible reduction in the number of simulators required, since either the A320 family or the 737NG family only require one simulator, whereas a simulator is required for each older aircraft type. This is a serious consideration, since a simulator has a capital cost in the region of $12-15 million. Blanchfield estimates that one simulator is required for 25-30 short-haul aircraft and for 15-20 long-haul aircraft, with most simulators operating for 20 hours per day.

Bush makes the point that the number of aircraft or crew per simulator depends on how often pilots go through transition training. "Transition training includes 9-10 days in the simulator. The more frequent transition to a new rating, the fewer crew per simulator," says Bush. "Once pilots have two ratings, airlines are less likely to move them between aircraft types as often as in a traditional system."

Mixed fleet flying with different aircraft types that have a high level of commonality provides a further possibility for airlines to make savings and gain efficiencies. A fleet of older types may have, for example, included the A300B4, MD-11 and 747-200. Similar seat capacities and range capabilities can be offered by the A330-200, A340-500 and A340-600, for example, or the 767-300/-400, 777-200/-300 and 747-400. Either choice of modern aircraft groups will have reduced costs of transition/differences and recurrent training and higher pilot productivity where mixed fleet flying is practiced.

In some cases, savings can again be made in the number of simulators required by the airline. The A330 and A340, for example, can have a common simulator.

The same savings and efficiencies will also be extended where mixed fleet flying is practiced between narrowbody and widebody fleets.

Blanchfield estimates that airlines which have adopted mixed fleet flying have increased pilot productivity by 5-15%. "Airlines have traditionally got 600-800BH per year from their pilots, and so have experienced an increase of 60-80BH per year as a result of new aircraft types," estimates Blanchfield. "Pilots are not on duty for more days, but do more actual flying because rostering is made more flexible by their having two type ratings; they consequently spend less time on standby. Airlines have a range of five to seven crews per short-haul aircraft and seven to 10 crews per long-haul aircraft. The savings that are possible depends on the disparity in fleet sizes."

If, for example, an airline operates 50 A320 family aircraft and only five A340s, mixed fleet flying will not be practical for most pilots, since the portion of BHs they have each year on the A340 will be too small to justify the cost of having the second rating. The airline would still, however, have reduced costs for transition training compared to operating two older types with no commonality between them.

Parts commonality

With rotable component commonality, savings in the quantity of spares required increase, and their ownership cost per aircraft reduces, as fleet size grows. It is generally held that investment in inventory per aircraft reduces to a minimum and remains constant for a fleet size of 25-35 aircraft and larger.

The sharing of the same parts and part numbers by two aircraft or variants of an aircraft thus allows these economies of scale to be realised when the fleets of the two types are small; for example, when 10 of each type are operated.

Like flightdeck commonality, Airbus and Boeing have developed aircraft families to have a higher level of parts commonality than older types. Thus a fleet of 10 A310s and 10 DC-10s, for example, would have to be supported by a larger inventory than a mixed fleet of 20 A330s and A340s. Similarly, fleets of 10 737-200s and 15 727-200s together would have a larger inventory of parts than 25 A320s or 737NGs.

The objective of parts commonalities is to reduce inventory held per aircraft operated, by effectively having a single aircraft type replace two or three aircraft types. A small airline which requires different sized long-haul types might operate a mixed fleet of A330-200s and 777-200s, but is likely to have an overall lower spares investment if it instead selected a fleet of A330-200s and A340-500s or 767-400s and 777-200s.

This advantage is less significant or even lost in the case of large fleets. An airline is unlikely to realise much of a difference in inventory costs between 75 A320s and 50 757-200s or 125 A320s/321s.

To illustrate the potential savings in investment in inventory, older fleet mixes can be compared to modern Airbus or Boeing fleets of the same size that have a higher degree of parts commonality.

A short-haul fleet of 10 737-200s and 15 727-200s can be compared to 25 A320 family aircraft or 25 737NGs. Similarly, a mixed fleet of 10 A310-300s and DC-10-30s, providing medium-haul and long-haul life for an airline can be compared to 20 A330/340s or a mix of 10 767-300s and 10 777-200s.

The problem with a straightforward comparison is that the cost of inventory for the older types is now actually lower than for modern types, since there is an excess of material for older types on the used market. This continues to be, however, an issue in aircraft selection for airlines when evaluating new fleets.

While the market value of 737-300 and 727 inventory is low, it was higher in previous years. An estimate of the total cost of LRU inventory at 1998 manufacturer's list prices for 10 737-200s is $14.2 million, and a further $35.6 million for 15 727-200s. This total of $49.8 million compares to an investment of $21.5 million for 25 737NGs, or $23.1 million for 25 A320 family aircraft. The modern fleet clearly has an advantage of more than $25 million, or $1 million per aircraft.

The repair and management costs of these different inventories can also be compared using typical rates an airline with these fleet sizes might pay a specialist third party provider. This is estimated at $190 per flight hour (FH) for the 737-200s, $210 per FH for the 727-200s, $141 per FH for the 737NGs and $148 per FH for the A320s. The modern aircraft types clearly have a cost advantage; of up to $60 per FH. When this is considered against annual aircraft utilisations of 2,500-3,000FH per year, this equates to about $3.75 million per year for a fleet of 25 aircraft.

The cost of inventory for 10 A310-300s is estimated at $32.4 million, and $36.4 million for 10 DC-10-30s. This total of $68.8 million compares to an investment of $49 million for a fleet of 20 A330s/340s. A fleet of 10 767-200s and 10 777-200s would require an inventory of $45.7 million, which is interestingly lower despite the level of commonality between the A330 and A340. In either case, the modern aircraft types have an advantage of about $20 million, equal to $1 million per aircraft.

Similar to the comparison of old and new generation narrowbodies, the repair and management costs of the rotables contrast. The cost for A310-300 material is $270 per FH and $290 per FH for DC-10-30 material. This compares to $163 per FH for the A330, $190 per FH for the A340, $175 per FH for the 767-300 and $180 per FH for the 777-200. The savings between old and new types are thus in the region of $100 per FH, equal to $400,000 per year per aircraft for an annual utilisation of 4,000FH.

Parts commonality clearly provides a saving in inventory investment, but the largest cost reduction comes from the lower repair and management cost of components for modern aircraft. The biggest factor in this saving is the higher reliability of components of the modern aircraft types.

Engine commonality

Engine commonality is a similar issue to spare parts commonality. Like the example above of older versus modern fleets, modern types like the A320 family and 737NG family share the same engine, whereas mixes of older types can have two different engine types. Even the 737-

200 and 727-200, which both use the JT8D, may be equipped with different variants and so each fleet requires its own inventory of engines.

The number of spare engines required for a given confidence level can be predicted if the average removal interval, aircraft utilisation and total engine shop turnaround time are known for a particular fleet size. In the case of the 737-200 and 727-200, the JT8D might have an average removal interval of 7,000 engine flight hours (EFH). This compares to intervals of 12,000-20,000EFH, say an average of 16,000EFH, for the V.2500 and CFM56 powering the A320 and 737NG families. A typical shop turn time might be 70 days for all engine types.

A fleet of 10 737-200s has 20 installed engines, and 15 727-200s have 45 installed engines. In the case where both aircraft generate utilisations of 2,500FH per year, the 737-200 fleet generates 50,000EFH annually, which implies an average of seven engine removals per year and total shop time, or ‘days in progress’, of 500 days. Three or four engines would be required to support this fleet the whole year round to minimise the risk of not having a spare engine available when required, since removals and shop times often coincide and overlap.

The 727-200 fleet generates 112,500EFH each year, and will have an average of 16 removals per year, corresponding to 1,125 days in progress. Five or six engines would probably be required to support this fleet to avoid having no spare engines to support the fleet at all times.

If the two aircraft, or similar older types, used different variants of the JT8D, then the operator would require a total of eight to 10 engines to support its fleet of 25 narrowbodies.

In contrast, 25 A320s or 737NGs would have 50 installed engines and generate 125,000EFH annually. An average removal interval of 16,000EFH would result in eight removals per year on average, and 560 days in progress (not much more than the 10 737-200s). This fleet would thus require only three V.2500 or CFM56 engines to support its operation at a high confidence level, providing a significant saving over the fleet of 10 737-200s and 15 727-200s.

The market value of older engines, however, is far less than those of equivalent new generation powerplants. Even at previously high values of $800,000-1,000,000, a spare fleet of eight to 10 JT8Ds would represent an investment of $7-10 million. In contrast, the V.2500 and CFM56-5B/-7 have market values in the region of $4.5 million. Three engines would therefore have a total investment of about $13.5 million. An airline might therefore attempt to reduce its engine inventory investment by holding two spare engines of its own, reducing investment to $9.0 million, and using short-term leases from specialist engine lessors to provide coverage on occasions when three or more engines are in the shop simultaneously.

In this case the commonality of engines in the fleet, and more importantly the longer average removal time, has reduced the number of spares required, which compensates for their higher capital cost compared to the older generation powerplants.

Summary

Flightdeck commonality can reduce costs for airlines whether or not they practice mixed fleet flying. The biggest contributor flightdeck commonality makes to savings is the reduction in transition training between modern types. Airlines, such as Continental and Iberia, which do not have mixed fleet flying have lower transition training costs with their modern Boeing and Airbus fleets than they did with their older fleet types that shared no flightdeck commonality.

The introduction of aircraft families has meant that pilots transition between types less often, which generates another reduction in transition training costs.

Airlines that do operate mixed fleet flying can realise further savings through improved pilot productivity.

The benefit of LRU and parts commonality between aircraft over types that do have no commonality appear to be in the region of $1million per aircraft. Modern types further have the advantage over older types of higher parts reliability and lower repair costs as a consequence.

Engine commonality has the advantage of airlines requiring fewer sub-fleets of spare engines. More importantly, however, the fewer engines per aircraft and superior on-wing reliability and removal intervals make the biggest contribution to lowering the spares requirement. This, fortunately, offsets their higher capital cost when compared to the older generation engines. Fleets of older aircraft, however, are still likely to have less capital invested in spare engines than fleets of modern aircraft types. The high capital cost of modern engines is overcome by other commonality benefits. AC