Using containers and ULDs that are interchangeable between different aircraft and making full use their available volume is a complex process. While rarely possible to achieve with 100% success, it is important for freight carriers to save time and achieve the lowest cost per ton-mile.

Interlining ULDs in freighter operations

Freight containers, or unit load devices (ULDs), are a main factor affecting the payload and economic efficiency of freighters. The different main types of ULD have been designed to match the internal dimensions of specific aircraft. Utilising the correct ULD for each aircraft type will therefore affect how much of its internal space and potential payload-carrying volume can be used. The weight and internal capacity for each type of ULD will vary by manufacturer, and further affects the payload capacity of a freighter aircraft. The ability of several aircraft types to interline the same type of main- and lower-deck ULDs between them will maximise the use of freight-carrying space on all types.

ULD types

The size and dimensions of ULDs are affected by aircraft internal dimensions. ULDs are divided between those utilised for widebodies and narrowbodies, and are then further sub-divided between main- and lower-deck containers. The main ULD types in these four categories have been summarised *(see Containers & ULDs for main & lower deck freight, Aircraft Commerce, August/September 2009, page 43)*.

Maindeck ULD dimensions are expressed in terms of base width, depth and height. ULDs are loaded so that the base width is lateral to the aircraft's floor. The ULD's contour and profile needs to match the curved inner wall of the aircraft's main deck. ULDs with base widths wider than the floor clearly cannot be used on the aircraft. Container height obviously has to be less than the inner ceiling height. An optimised ULD will have just a few inches of space between its outer edges and fuselage wall so that the aircraft's internal volume is fully utilised.

Container depth is longitudinal to the fuselage length, and the ULD depth and maindeck length will therefore determine how many ULDs can be loaded on the aircraft.

Several maindeck ULDs are designed to fit half the maindeck width, and so are loaded in pairs to fit the complete fuselage cross-section.

Widebody freighters

Widebody aircraft come in four main categories with respect to maindeck cross-section dimensions: the 767, the A300/A310, DC-10/MD-11, 777 and 747. These determine the type of ULDs that can be used if each aircraft's available maindeck volume is to be fully utilised.

The 767 has the smallest widebody dimensions. Its maindeck has a height of 101 inches and base width of 182 inches. This accommodates a pair of AAX contoured ULDs, which can be used on all other widebodies, but leaves large gaps of unused space between them and the fuselage wall and ceiling, thereby wasting potential payload space. AAX ULDs have a base width of 88 inches, height of 96 inches and an internal volume of 467-532 cubic feet and tare weight of up to 600lbs, depending on manufacturer.

The A330/A310 have a maindeck base width of 202 inches and height of 96 inches. This allows them to have a pair of AMJ/M1 ULDs loaded on the main deck. AMJs have a base width of 96 inches, height of 96 inches and internal volume of about 594 cubic feet and tare weight of up to 800lbs. While these cannot be utilised on the 767, they can be loaded on the larger DC-10/MD-11, 777 and 747 freighters. They would not, however, fully utilise the ceiling height of these larger aircraft.

The DC-10/MD-11 have a base floor width of 216 inches and ceiling height of 126 inches. These dimensions therefore permit larger ULDs to be used that maximise the payload volume on the maindeck.

In addition to using the smaller AMJ/M1s that can also be used on the A300/310, there are two ULDs that can be utilised on the DC-10/MD-11. The first of these is the AMA/M1 which is contoured to better match the DC-10/MD-11 inner wall contour. This has the same base and height dimensions as the AMJ/M1 but a larger volume of 600-620 cubic feet.

The second ULD is the AMD/M5, which has the same base width and depth as the AMJ/M1, but a greater ceiling height of 117 inches. The AMD/M5 therefore each have an overall greater volume of 760 cubic feet: 140 cubic feet more than the AMA/M1; and 160 cubic feet more than the AMJ/M1.

The 777 has an 11-inch wider base width than the DC-10/MD-11 maindeck, but the 777's ceiling height is eight inches shorter at 118 inches. The 777 can still just accommodate the AMD/M5 containers, and maximise the utilisation of maindeck volume. There is also the AMX which has a base width of 96 inches, depth of 125 inches and height and 118 inches. It has an internal volume of 704 cubic feet.

The 747 maindeck has similar dimensions to the 777. The 747 can also use the AMD/M5 and AMX profiled ULDs when maximising maindeck internal space and volume.

It is therefore clear that these four groups of widebodies need to use their own type of ULD if they are to maximise

Several operators are prepared to use double contoured ULDs for interlining between narrowbody and widebody aircraft types. While this does not fully utilise the aircraft's available volume, it does save time. There is a trade between saving time and using ULDs that make complete use of the volume in all the aircraft types being used in freight operations.

the use of their maindeck space internal volume.

Narrowbody freighters

Narrowbody jet freighters fall into three distinct categories in terms of fuselage cross-section dimensions and the types of ULD that should be used to maximise main deck space.

While widebody maindeck freighters have ULDs loaded in contoured pairs, narrowbody aircraft can either have containers in pairs, or as a single contoured unit to the inner fuselage profile of the aircraft.

Narrowbody jet freighters include the BAE 146/Avro RJ, DC-9, 707, 727, 737, 757, DC-8 and A320/321.

The first category includes the BAE 146 and DC-9. These aircraft have the narrowest fuselage cross-section of all jet freighters, and can only accommodate a ULD with a 108-inch base width. The 108-inch wide, 88-inch deep and 63-inch high narrowbody main deck ULD, termed the ABC by Satco, makes optimum use of the DC-9's and BAE 146's main deck space.

The second category comprises the Boeing aircraft, which have similar maindeck fuselage dimensions, and the DC-8. The Boeing aircraft have a base width of 125-135 inches and ceiling height of 83-85 inches. The DC-8 has a base width of 133 inches and height of 83 inches. This group of aircraft therefore utilises the same maindeck ULD. The standard ULD in this case is the SAA or AAA container. Both are a full-width container for narrowbodies, and have a base width of 125 inches, depth of 88 inches and height of 79 or 80 inches. These provide an internal volume of 430-450 cubic feet.

An alternative to this is a pair of contoured ULDs that occupy the same dimensions in the aircraft. These are known as the AAY-demi ULDs, and have a base width of 62 inches. These each provide an internal volume of 202 cubic feet, so a pair has a volume of 404 cubic feet, about 40 cubic feet less than the single contoured container.

The A320/321 have a wider maindeck base width and ceiling height, but their dimensions are only a few inches more than those of the previous group of aircraft. The A320/321 will therefore utilise the same SAA, AAA and AAY-demi ULDs as the Boeing narrowbodies and DC-8.

There are a few hybrid ULDs that can be used on both narrowbodies and widebodies. One example is the AAY-demi. This ULD has a 62-inch base, and is loaded in pairs on narrowbody maindecks, but it is used on widebody maindecks by FedEx, which loads it three abreast on the A300/310 and DC-10/MD-11. However, this arrangement does not completely utilise maindeck space and volume, since the ULDs are only 79 inches in height, compared to the maindeck height of 126 inches. As a result, up to 47 inches of space is wasted above the tops of the ULDs. The profile of the AAY-demi containers also means that space is wasted around the sides on the widebodies.

Other hybrid ULDs are the dual-contoured AAC and AAY-A2N, which are used by DHL. These have a height of almost 81 inches, and base dimensions of 88 and 125 inches. The ULD can therefore be loaded on to the maindeck of Boeing narrowbody, DC-8 and A320/321 freighters with the 125-inch base side of the ULD across the width of the fuselage. The ULD is contoured on both sides, however, so that when it is turned through 90 degrees and its 88-inch base side is across the fuselage width, it can be loaded in pairs in any widebody. This ULD has a lower height than a regular AAX, AMJ/M1 or AMD/M5, and is also double contoured. The AAC therefore has a comparatively low internal volume of 420 cubic feet. Its dimensions and double contour, however, allow it to interline between narrowbodies and widebodies.

Belly freight

The issue of belly freight containers is simpler than maindeck ULDs. All belly ULDs are contoured with wings to fit the cross-sections of lower decks. ULDs are either half units loaded in pairs, or single devices that fit across the full belly width. A third option is a box-profile ULD, which is not contoured with wings, and therefore does not use the full space available.

Widebodies fall into three groups in terms of the belly containers they use. The first is the 767 which has the narrowest lower deck, and uses a pair of LD-2 containers. These have a top width of 61.5 inches and, depending on manufacturer, an internal volume of 124 cubic feet.

The 767 belly can also use a full-width winged container, the LD-8, which has an internal volume of 258 cubic feet. This takes the place of two LD-2s.

The second group of aircraft is the A300/310, DC-10/MD-11 and 777. These all have the same belly space dimensions, and so utilise the same LD-3 half-container. These aircraft also have the choice of several full-width belly ULDs provided by Nordisk, which have varying depths of 60 to 96 inches. These aircraft can clearly also use the LD-2 and LD-8 ULDs that are used on the 767, but not all belly space is used. In contrast, the narrower 767 can accommodate a single LD-3 in its belly, therefore not fully utilising all belly space. There is also the LD-6, which is a single-width container and takes the place of two LD-2s.

The 747 has a unique belly space, which is wider than that of other widebodies, and uses larger belly containers. These are the half-width LD-1 with a top width of 92 inches, and the full-width LD-29 which has a top width of 186 inches.

The only narrowbody types to use ULDs in their belly spaces are the A320/321. The belly container for this aircraft is the Nordisk AKH/LD3-45. It is a full-width, winged container that has a top width of 96 inches and base width of 61.5 inches.

Interlining ULDs in operation

Interlining of ULDs in freight operations takes two forms, and both concern the interchangeability of containers between aircraft.

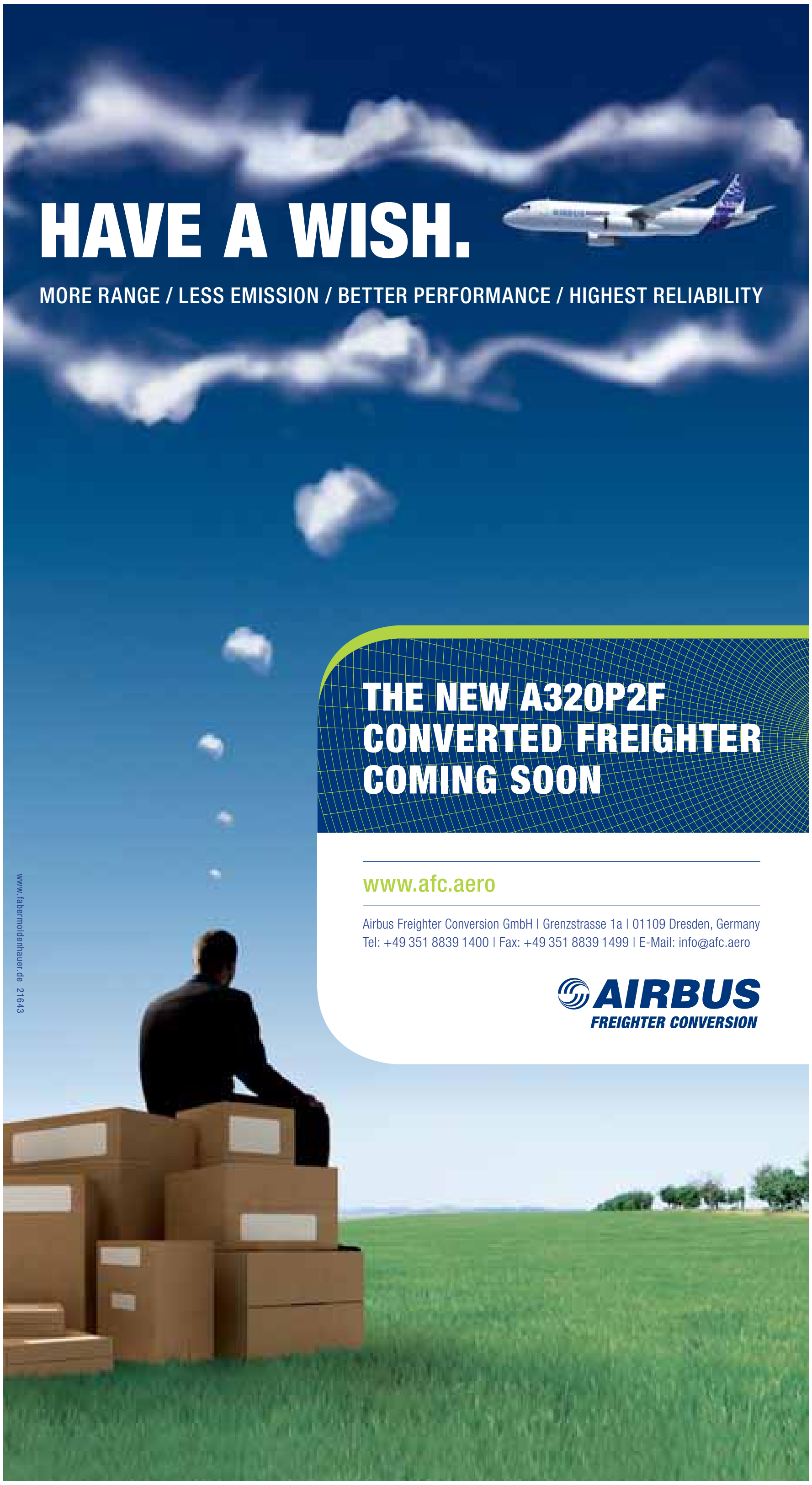
The first is the general ability to use ULDs across several aircraft types. Many freight carriers operate with several aircraft types, and so have to consider the logistics of operations. With turn times and other operational issues to consider, aircraft have their ULDs unloaded after arrival, and have new ULDs packed with freight loaded prior to departing on the next leg. Since aircraft are not on the ground long enough for the same ULDs to be unpacked and reloaded, this means that airlines need to have ULDs on the ground at airports all over their route networks. One main management issue for airlines in this respect is tracking ULDs and monitoring their position across a network. Some airlines have developed software solutions to track ULDs, but these will be superseded by radio frequency identification (RFID) tags.

Mixed aircraft operations are more efficient if the ULDs can be used by several types, without wasting too much of the available volume in any of them. The 747 can clearly accommodate a pair of AMJ/M1 containers on its maindeck, but because these are optimised for use on the A300/310, they do not fully utilise the space on the 747, so its potential payload volume is restricted. ULDs that fully utilise the space on freighter aircraft can therefore influence fleet planning decisions.

Some express-package operations have been organised to make full interlining of ULDs between aircraft types possible. The 727 and DC-8 were selected by several carriers because of their almost identical fuselage cross-sections and their common use of AAY-demi and AAA main deck ULDs. This meant that not only could the airline use a single type of maindeck ULD, but both aircraft types used all the space on their maindecks.

Emery was a 727 and DC-8 operator, which used the 125-inch wide and 88-inch deep AAA container for its overnight, express-package operation. Emery subsequently acquired another operator, Purlolator, which had a fleet of DC-9 freighters that used the 108-inch wide container because of its narrower fuselage. While these could also be used on the 727 and DC-8, they did not make full use of their volume. The 108-inch container was also incompatible with Emery's hub-handling equipment, and the two different container types created transload requirements, which had the effect of slowing down the operation. Emery therefore quickly removed the DC-9s from service.

The major express-package operators today include FedEx, UPS, TNT and various carriers that fly for DHL Express.



Using containers and ULDs that maximise the utilisation of each aircraft type's available volume ensures that the lowest cost per ton-mile is achieved.

DHL Express is not an airline, but an express-package company, and uses 21 different airlines with a combined fleet of 260 aircraft. One carrier is European Air Transport (EAT), now based in Leipzig, Germany after moving from Belgium in June 2010. "We use 21 different airlines around the world because of issues with various traffic rights," says Joerg Andriof, vice president of global network management at DHL Express. "EAT is in DHL colours from Leipzig. It operates a fleet of A300B4s and 757-200s. We also use feeder services from other airlines using the 737. EAT has a hub-and-spoke system whereby the aircraft fly in from outstations to Leipzig, arriving prior to midnight. Containers are unloaded, mail is sorted, repacked into ULDs, and the containers are then loaded onto aircraft bound to one of the European outstations. The first flights leave after 3am, so ULDs have to be sorted and repacked in a three-hour window. There are only a few cases where a container being unloaded from one aircraft has its entire contents going to a single destination and so can be interlined from one aircraft type to another. All containers therefore have to be unpacked and the contents sorted. We do, however, think it is important to use containers in each aircraft type that fully utilise the available space. It is therefore worth spending the time and labour to sort and repack containers because using all available payload is the best way to lower the cost of per ton-mile. Load factor and packing density also have an effect, however. Other express operators may feel that saving time is more important than maximising the use of available payload."

DHL has a wide variety of ULDs and aircraft in its operation. "We use the double-contoured AAC on the 757s and A300B4s," says Diet Uytterhoeven, global ULD control manager at DHL Express. "Another ULD is the LD-7/AAJ, a double-contoured belly container. This can be used in the belly of widebodies or as a narrowbody maindeck container, although the latter is an inefficient use of space.

"On our intercontinental operations, we utilise five 747s that we lease from Polar Air Cargo, and 777s that are operated by Aerologic. The AMD is optimal for the 747. We do not always use it, however, because if the 747 has a technical problem and we need to unload all ULDs and put them on another aircraft, it may be a smaller type, such as a 777. Using smaller containers on the 747 means that we would not have to unload the ULDs, which is an important time-saving issue," continues Uytterhoeven. "We use the AMX on the 777, which is about two inches shorter than the 747, but also fits on the 747. The 747 and 777 fly around the world, so they have to interline with the A300B4s. We can use the AAC on all types, but we avoid this where possible because it does not utilise all the available space. If freight comes in an AMX from a 747 or 777 it has to be unpacked and put on a different ULD. There are, however, the belly LD-3s and LD-7s to consider, which fit well on the A300B4 and 777, and can also be used fairly efficiently on the 747. This avoids cross-loading, unpacking from one ULD and loading in another, and therefore saves times and maximises the use of space. It is extremely important that we maximise the use of available space on the aircraft because our aircraft are almost always full, in particular those that fly from the Asia-Pacific region to Europe."

TNT, another European express carrier, has a similar operation. "We operate a hub-and-spoke network from Liege, Belgium. Our fleet for our European network includes 40 BAE 146s, 737-300s and 757s, as well as some 767s. The 767s are also part of our transatlantic operations. We also use some A300B4s on wet lease from Air Atlanta. The 737 and 757 replaced the 727," says Emile van der Berg, director of network planning at TNT. "Our flights arrive from outstations at Liege between 11:30pm and 1:30am. We use ULDs on our aircraft maindecks, but bulk load the belly space on the aircraft. The packages are sorted, repacked into containers and the aircraft depart for the outstations between 3:30am and 5:30am. The 737 and 757 use the same 125-inch wide ULD, while the BAE 146 uses the smaller 108-inch wide container. We actually use the AAY/AAC, dual-contoured maindeck ULD for our 737s and 757s, since these can also be used on the 767s and A300s when turned through 90 degrees and loaded in pairs. We can also use the 108-inch BAE 146 containers in the 737/757 if we have to, but doing this requires extra locks on the cargo loading system. Using the dual-contoured AAC/AAY container on the narrowbodies and widebodies when interlining means that lots of maindeck volume ends up unused, because of the ULD's short height. Interlining saves a lot of time, and we have to consider the speed of connection in addition to maximising aircraft volume utilisation. It's important for us to achieve a compromise between speed and the efficient use of payload. We also utilise the AAX ULD on the widebodies. This ULD has a greater height that allows it to fully utilise the aircraft's available volume, but of course it has a higher tare weight." AC