Passenger boarding bridges have been around for a long time, but they continue to evolve, thanks to new technologies. *Chris Lewis* reports

World airports: tunnel vision?

The passenger boarding bridge (PBB) is virtually as old as commercial jet aviation – the first examples date back to the late 1950s and early 1960s. There is a clue in one of their alternative names: the jetway. Until then, the main method of getting passengers onto large aircraft was by means of moveable stairs. These remain quite popular, even today. They have the virtue of flexibility, as well as cheapness and simplicity.

Their disadvantages, from the passenger point of view, include exposure to the weather and the noise of the airport, as well as the obvious need to climb stairs up to the aircraft door. Of course, for anyone in a wheelchair, or even on crutches, there is a serious challenge to be faced in such a case. People with significant mobility problems would have to be helped into the aircraft by an ambulift.

PBB manufacturers argue that, for safe and efficient turnarounds, their products currently offer by far the best solution. And global demand from airports for jetways is certainly increasing, due to the general increase in

airline traffic, renewal and upgrading of older equipment, extensions of existing terminals and the construction of entirely new airports. For the footsore passenger, the purpose-built jetway offers the enticing prospect of stair-free access from the waiting-to-board area of the terminal right to the aircraft, protected from the wind, rain or a scorching sun.

Essentially, a PBB is an enclosed, moveable bridge between the terminal and the aircraft door, although many variations on the theme exist. Some are fixed; others are moveable. Some swing radially, others extend and retract. As François Mamert, marketing director of Spain-based manufacturer ADELTE points out, PBBs are today the most commonly used way of routeing passengers between terminals and commercial aircraft (and vice versa) at major gateways. He describes five main types of PBB: the apron drive bridge, A380 apron drive bridge, commuter bridge, nose loader bridge and the T-bridge.

Most PBB types can be moved up and down, or extended and retracted, and possibly pivot, to accommodate different types and sizes of aircraft. Curious passengers waiting to get onto their aircraft may notice the operator's station that allows the bridge to be 'driven' into position.

There is an 'accordion'-type connection that allows the bridge to make a virtually weather-tight seal with the side of the aircraft. A levelling device also makes for a near perfect fit between the floor of the boarding bridge and the aircraft floor – essential for wheelchair users and a highly desirable feature for able-bodied passengers too.

The apron drive bridge is by far the most flexible and popular telescopic boarding bridge worldwide, Mamert says, as it allows a variety of docking heights and ample lateral movement thanks to adjustable handling and lifting mechanisms and 360-degree directional bogies. It employs an electromechanical or hydraulic elevation system and a tunnel structure consisting of two or three bodies depending on the space available on the apron.

A spacious, light and airy ADELTE boarding bridge cabin

INNOVATION

Mamert explains: "These days, PBBs are not just complex ground support equipment that provide access to the plane, but are an extension of the terminal itself. PBBs therefore need to blend in perfectly with the environment and the architecture of the terminal, and to form part of the overall passenger experience."

To the average passenger, one of the most obvious recent innovations is the use of glass-sided walls (as opposed to steel-sided ones). Natural daylight gives a better ambience and visibility for passengers confined in the narrow tunnel spaces. However, PBBs with steel-sided walls are still widely used in airports across the world, especially in the US and Latin America, since they provide more space for advertising and are slightly less expensive.

PBBs are much more than simple metal or glass tubes these days, however. More bridges are being fitted with roof-mounted air conditioning units, for example, "to homogeneously distribute quality air and to maintain an optimum temperature inside the PBB, regardless of outside weather conditions."

PBBs are also now designed to support the extra weight of mounted ground power units (GPUs) and pre-conditioned air (PCA) units that supply electricity and PCA to stationary aircraft. But the largest PCA units can weigh over 4,000kg.

There have been many interesting developments in jetway technology in recent years, especially in the areas of automation, structural design, energy consumption and IT, Mamert observes. Multiple sensors, 'point to go' technology and automated docking systems make docking operations simple and efficient, while minimising any risk to the aircraft or operators on the apron. But there is always still room for improvement

One of the biggest innovations has been in the automation of the docking process. The operator can enter into the system the reference of the aircraft arriving at the gate and the PBB will pre-position itself automatically. "Once the PBB is a few metres from the door of the plane, the operator takes manual control of the manoeuvre until the door of the plane is opened; it is in fact very similar to the automatic pilot of a plane," Mamert informs. "The PBB will then automatically adjust – we call this 'automatic levelling' – to the changes in door height as the plane moves up or down when passengers embark/disembark and luggage is loaded/unloaded."

PBBs have also been optimised according to expected service loads and GSE integration that, together with more efficient engines, allow for a more efficient bridge with reduced energy consumption. The latter is important, not only for environmental reasons but because airports often have limited electric power capacity and need to decrease consumption of existing equipment before adding new infrastructure and equipment. As Mamert says, "We occasionally had airports that wanted to acquire PCA equipment but, after analysis, realised they didn't have the electrical resources to operate it."

(As an aside, this is one of the reasons why a new generation of PCA units, designed around full inverter technology, is arriving on the market. Mamert states: "Currently, only ADELTE and one of its competitors offer

this innovative technology which can provide increased efficiency of up to 35% using two inverter compressors. (Spanish airport operator) AENA is the first airport operator to purchase this technology. ADELTE will install 20 units at the airport of Palma de Mallorca in Spain.")

BRIDGE MANAGEMENT

More airports are demanding advanced bridge management systems (BMSs). A BMS provides better integration between the PBB and other systems such as the visual docking guidance system (DGS), PCA and GPU. It also allows the airport to monitor unwanted incidents or the number of service hours worked by each piece of equipment, useful information for an operator to develop a more inclusive understanding of gate equipment operation.

ADELTE has developed Webgate, an IT feature that allows the manufacturer to connect remotely to the PBB's 'human-machine interface' and to see the exact same data as the on-site operator. It is especially useful for resolving any doubts or issues as quickly as possible.

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>
> *François Mamert*

Gates at busier airports may have two bridges, either to allow faster loading and unloading of larger aircraft such as the B747, or possibly to allow first and business class passengers to be embarked and disembarked separately from those in economy. And multiple bridges are of course essential for the huge A380, the super jumbo.

Again, the apron drive offers a wide range of operations and can dock a multitude of different classes of aircraft, notably C, D, E and F types. Class F aircraft, such as the A380, usually connect with two or three PBBs. For the super jumbo, standard apron drives are already quite suitable for the lower deck, where a double PBB gate is normally used, but to reach the upper deck, a specific apron drive is needed, owing to the height difference between the door of the upper deck and the door of the lower deck (8m compared to 5m, respectively).

The lifting system requires a higher range and therefore has to be reinforced and supported by a double bogie system. Moreover, due to the angle of the fuselage shape at both the lower and upper decks, the canopies are slightly different to those of the standard apron drive.

(However, it should be pointed out that the difficulties of servicing larger aircraft pale into insignificance in comparison with the needs of the cruise and ferry industry, in which ADELTE considers itself the world leader. Here, PBBs can sometimes comprise five tunnels with an elevation capacity of over 12m.)

Boarding bridges are also, arguably, one of the few pieces of airside equipment that are at least partially self-funding. Many of their insides feature large amounts of commercial advertising.

As with most technical solutions, boarding bridges do reduce flexibility somewhat. Obviously, they are no use for parking stands away from the terminal building. For airports handling large numbers of regional jets, only one aircraft can use the gate at a time.

ADELTE apron drive PBBs

But as Mamert points out, modern PBBs are "more flexible, allowing airports to service a wider range of airplanes, which is an important factor for increasing traffic and attracting more airline companies".

Of course, this flexibility has its limits, he warns, especially with regard to regional or smaller jets that require a much longer PBB than class C to F aircraft in order not to exceed stipulated maximum gradients.

REGULATIONS

There have been one or two boarding bridge collapses over the years, involving injury to passengers and/or damage to aircraft – although, arguably, moveable stairs present far greater risks to life and limb than bridges. Millions of people use PBBs every day and serious injury is rare, but numerous safety improvements continue to be made, whether in technologies, processes or training to drastically reduce jetway-related accidents.

The design of the PBB is well codified and regulated; the main European standard is EN12312-4, as part of which PBBs must be equipped with a series of safety features. Typical features include anti-collision technology to minimise any risk of contact between two PBBs; anti-shear sensors installed inside the PBB to detect the presence of a person at the junction of two tunnels and to prevent injury while operating telescopic movements; sensitive bands integrated into the bogie bumpers to stop the movement of the PBB in case of contact with any equipment or person; and non-slip pavements that guarantee optimum adherence for passengers, including those with reduced mobility, at maximum slope.

Aviramp offers a fresh angle

AN INTERESTING VARIATION on the PBB theme is the Aviramp offering, which uses a unique zig zag ramp design. Providing the flexibility of mobile stairs, but without steps, it consists of three separate interconnected ramps and incorporates two 180-degree turns to offer a gentle 7-8 degree slope from ground to aircraft door.

The UK-based supplier says that other boarding ramps have far steeper slopes and, with increasing demand for a better, more inclusive passenger experience, "The industry is looking at moving towards a step-free experience which will mean more ramps and boarding bridges."

The company adds that its design also has safety features that ensure that if the system is not operated properly, overrides kick in to remind users of the correct procedures. Furthermore, the materials used are of the highest specifications – a galvanised steel and aluminium structure covered with a serrated non-slip floor that works well in all weather conditions. With its motorised hydraulics and easy steering: "It is perfect for a one-man operation and is incredibly simple to use," Aviramp insists.

DIGNITY

Recent legislation in Norway and Sweden is demanding "greater dignity" for disabled passengers than that afforded by hoisting them into the aircraft by a lift, and is now specifying that ramps should be available wherever possible. Newquay in the UK, one of the airports using the Aviramp, has reported that since introducing the equipment around a year and a half ago, it has reduced the number of physical 'lift-ons' by around 80%. This takes a lot of workload off ramp staff, says the airport's head of training and compliance, Steve Delaney.

Aviramp has five products in its current portfolio – Lite, Domestic, Regional, Continental and International – capable of serving anything from a regional aircraft to an A380. Different kinds of roofing, sensors and lighting are available to cope with all climates, with products from completely open to fully enclosed designs.

The company notes that while there have been accidents involving stairs, stair climbers and lifts, "There have never been any incidents involving Aviramps, and the equipment has been through tough airport and airline risk and safety assessments to ensure maximum safety."

Moreover, it says: "Airlines love the fact that there is nothing on the Aviramp to harm the aircraft exterior." Airports and passengers are also enthused by the safer and more inclusive, non-segregated passenger experience.

The Aviramp could also be a solution for the ever cost-conscious budget airlines. The company says that low-cost carriers "are very keen to use boarding bridges because of the constraints they have to work with regarding turnaround, and the fact that ramps can deliver these kind of times. There is no need for other GSE in the boarding process."

Aviramp is in fact about to run several trials with two low-cost airlines at two different UK airports. As low-cost airlines typically operate through remote stands, the Aviramp could help cut costs while yet ensuring quick turnaround times. ●

An Aviramp boarding bridge serves an A380 super jumbo at Dallas/Fort Worth International Airport

Frankfurt's newer bridges feature a new 'point to go system', which can be operated by a joystick. This system ensures more precise manoeuvring

Fraport provides three bridges for simultaneous boarding and unloading from both decks of an A380 at Frankfurt; credit: Fraport

In addition to the stringent standards and regulations that manufacturers and their equipment must comply with, there are very well defined protocols that operators must follow in order to operate and properly maintain their bridges, and thus prevent accidents on and around the platform.

Careless bridge handling or aircraft taxiing can damage aircraft, and care needs to be taken in very cold places to ensure that the connector does not become frozen to the aircraft and damage it when the two are prised apart. Other local climatic conditions can also affect boarding bridge design. For tropical climates it is recommended to use special engines for improved humidity resistance and – for very low temperatures – ADELTE adds a resistor for heating the oil inside the hydraulic power unit, especially for hydraulic elevation systems. Plus: "Of course we recommend the optional rooftop equipment in order to provide passengers with a pleasant temperature inside the PBB regardless of outside weather," Mamert adds.

FRANKFURT'S BUSY BRIDGES

Frankfurt-Main International Airport's owner and operator, Fraport, currently has 120 boarding bridges in operation at its passenger terminals. Five main bridge manufacturers and 13 different models are represented at Frankfurt.

The gateway has 120 boarding bridge operators, with up to 33 drivers on duty at peak periods. Bridges are first staffed from 04.45 and, after 23.00 – when the night-time curfew begins – two drivers remain on duty to handle possible late-arriving lights. The airport operations centre co-ordinates 2,000 bridge operations per day.

Most of Frankfurt's bridges are of the glass-wall design. A few older models originating from the inauguration of Terminal 1 in 1972 are still in use, but they will be phased out as *Airside* goes to press (September 2015), the operator confirms.

Older models are operated in a conventional manner; as soon as the aircraft docks at its designated parking position, the bridge operator aligns the wheel carriage unit, including the bridge head, in the right direction. The boarding bridge is then completely extended. Frankfurt's newer bridges feature a new 'point to go system', which can be operated by a joystick. This system ensures more precise manoeuvring, especially when the operator has to deal with difficult positioning and has less space to play with – for example, for different aircraft heights.

The point to go bridges are also equipped with cameras which enable the driver to look at the situation from all angles. For enhanced safety, the ground-level wheel carriage unit is surrounded by a protective safety ring. Should this ring come into contact with a foreign object, or a person, the wheel carriage is shut off instantaneously.

Fraport has consistently looked to the challenges of handling newer and ever-larger generations of aircraft on the ground. It hosted the world's

PBB at Munich International Airport

first airport compatibility tests for the A380 in 2005 and the aircraft's first route-proving flights in 2007; its ground handling equipment and terminals as well as bridges were also quickly adapted for the world's largest passenger airliner. Frankfurt's A380 docking positions are all equipped with three bridges, two for the main deck and one for the upper deck. Another special case is the B777, which is fitted with a 1.2m diameter passenger door, so the bridge head must be able to accommodate a door of this size.

Aircraft change their height during the loading and unloading process, and modern boarding bridges can adapt to these barely noticeable movements due to their modern/flexible construction.

Frankfurt's boarding bridges are not air-conditioned or heated, as it considers that large amounts of energy would be lost when different doors of the aircraft are opened and closed by cleaning and catering personnel. The climatic airflow originating in the terminal itself is sufficient to supply the airport's air bridge with the necessary climate for changing seasons and daytime fluctuation, it argues. A normal ventilation system guarantees the necessary air supply. In any case, passengers generally spend only a very short time passing through the bridges when boarding or disembarking their aircraft, the operator points out, and northern Germany has a temperate climate.

Fraport has a designated health and occupational safety department that oversees standard operating procedures, as well as suggesting continuous improvements to standards. Operators receive comprehensive training and are updated on new procedures and systems to ensure safe and responsible operations. To prevent accidents, it is prohibited for any person, other than the operator, to be in the bridge head while it is moving – whether when docking or undocking. Separately, an alarm system is installed that warns all personnel in the equipment and on the apron by the aircraft of immediate bridge movement. To ensure the reliable function of the boarding bridges, regular cleaning, maintenance (three times per year) and checks are carried out, including worthiness inspections by TüV, the German Technical Inspection Agency, Fraport notes.

Moreover, the modern boarding bridges at Frankfurt feature a bumper mounted on the bridge head floor and movable floors within the bridge for more flexibility. Both features function as buffers to minimise potential damage. A new aircraft docking system (AVDGS or Advanced Visual Docking Guidance System) helps to optimise the process, guiding the aircraft to the exact docking position. A handheld computer shows the bridge driver where he/she has to go for his/her next job and provides all essential information on aircraft type, terminal position and bridge configuration.

LAX AND MUNICH – THE VIEW FROM THE BRIDGE

Roger Johnson, deputy executive director of the Airport Development Group, Los Angeles World Airports (LAWA), emphasises what we have already seen from the above: boarding bridges, like so much mechanical equipment today, are becoming increasingly automated. "New bridges are capable of automated operations, with the bridge movement per aircraft type programmed into the controls. The operator's job is primarily to choose the aircraft type and then monitor the movement and override the controls in the event of a problem."

The introduction of new and/or larger aircraft has necessitated new designs at Los Angeles International Airport (LAX) as it has at many of the world's other big hubs, such as Frankfurt, he continues. "The new generation of aircraft utilise three bridges (one upper and two lower). On the A380, the front upper and lower doors are in close proximity. The bridges operate in very close proximity to each other, increasing the chance of accidental collisions but the new bridges have very sophisticated anti-collision devices in place."

Munich International Airport in Bavaria, Germany, sees a trend towards more glass tunnel designs – regarding them as more comfortable and stress-free for passengers boarding or leaving their aircraft. Operator Flughafen München GmbH (FMG) considers itself to be leading the field in Germany in regard to the installation of USS bridges that feature larger cabin heads and interfaces. USS stands for Universalschnittstelle, or 'universal interface' – bridges with a larger front area for docking onto different aircraft door sizes.

Interestingly, while Frankfurt has not worried about the weather in regards to its PBB acquisition, in the colder southern part of Germany, local climatic conditions have affected boarding bridge technology strategies. To meet more challenging local conditions, including rain, snow and frost, Munich Airport has introduced rain fenders, heating, a tunnel ventilation system, roller gates and heated rain gutters on its jetways. ■

"New bridges are capable of automated operations, with the bridge movement per aircraft type programmed into the controls"

Roger Johnson

Fraport has standardised on glass-walled bridges to improve the passenger experience; credit: Fraport