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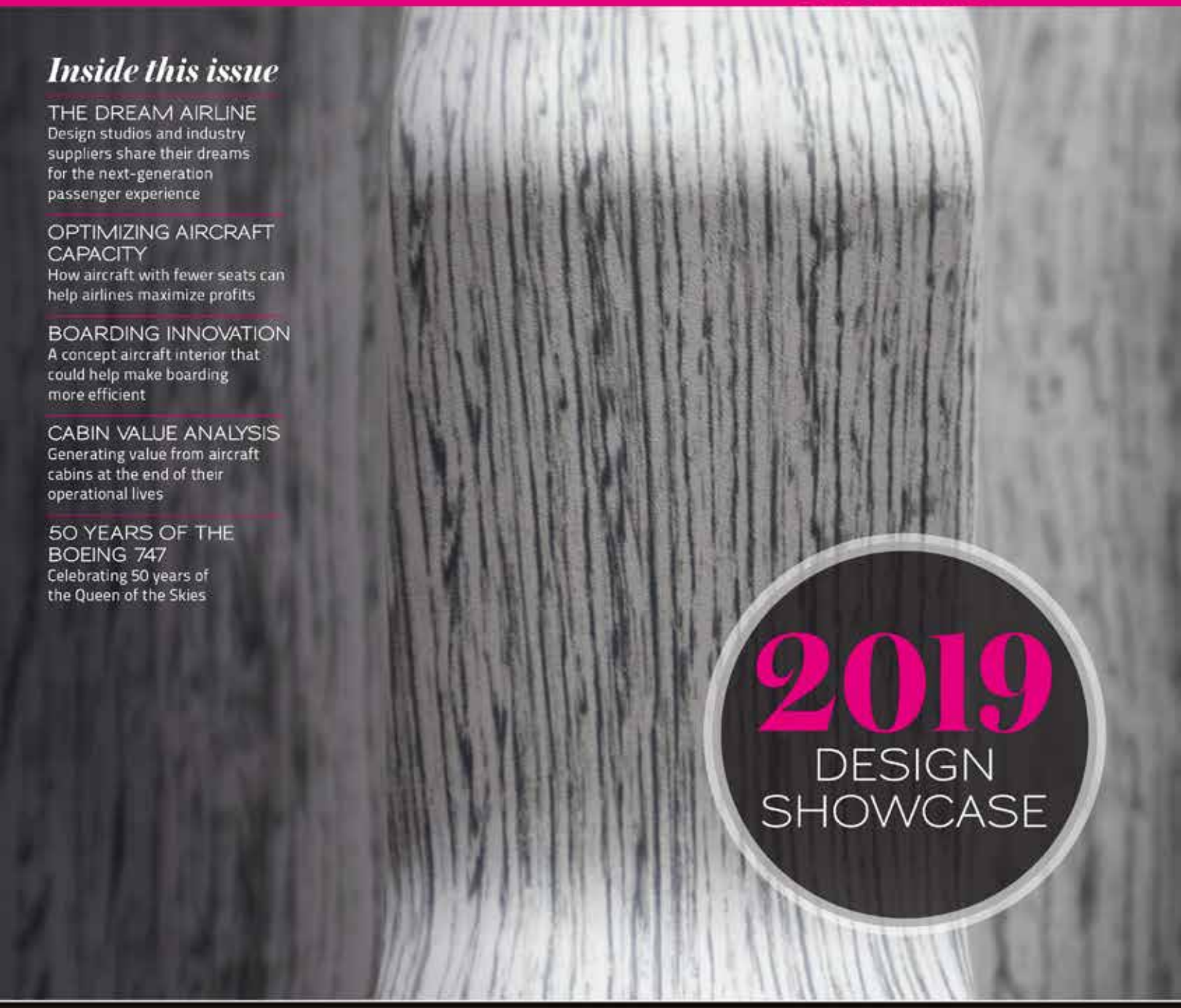

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2019 DESIGN SHOWCASE

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BOARDING INNOVATION

Quick thinking

A COLLABORATION BETWEEN ACADEMIA AND INDUSTRY BELIEVES IT HAS CREATED AN INNOVATIVE WAY FOR AIRCRAFT INTERIOR DESIGN TO CONTRIBUTE TO FASTER BOARDING

Words by Peter Vink and S Hiemstra-van Mastrigt, TU-Delft; André Castro, Almadesign; and Antonello Nardini, Optimares

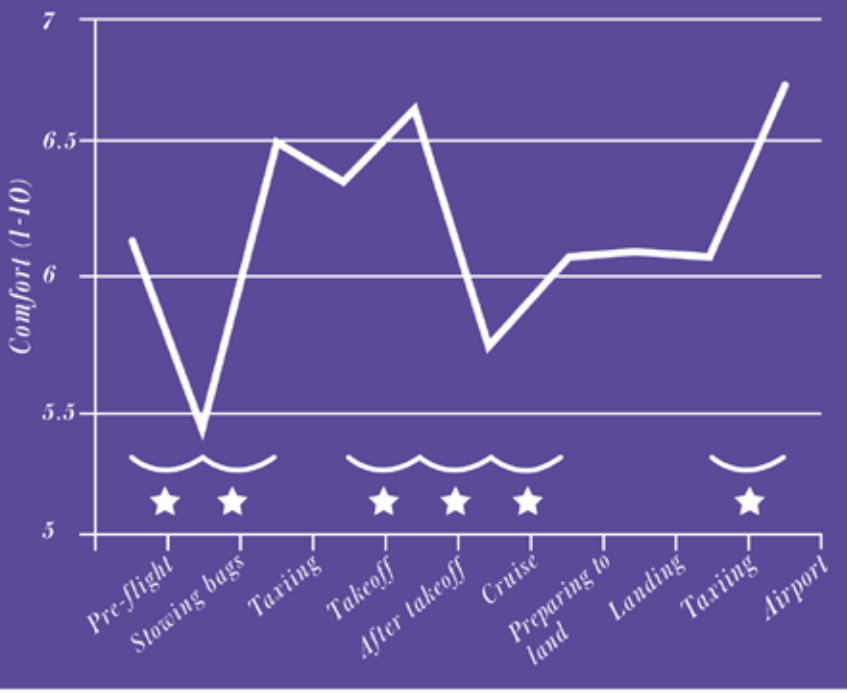


FIGURE 1 (LEFT): COMFORT DURING THE FLIGHT, WITH LOW PEAKS AT LUGGAGE STOWING AND DURING CRUISE FLIGHT

FIGURE 2 (BELOW): THE SEAT PAN IS RAISED DURING THE BOARDING PROCESS (LEFT) AND LOWERED FOR TAKE-OFF (RIGHT)

The PASSME Innovative Aircraft Seat was shortlisted for the 2018 Crystal Cabin Awards

Research has found that passenger comfort is at its lowest during the boarding phase of flight[1] (see Figure 1). Therefore improvements to the boarding process are welcome, including ways to ease the placing of carry-on luggage into the overhead bins.

Many of us have experience of boarding and de-boarding not being optimally organized – a feeling that has been backed up by research (e.g. Nyquist and McFadden[5]). For instance, aisle blocking by passengers hinders others getting to their seats. Computer simulations indicate that there are more efficient boarding methods than those currently in use (e.g. Van Landeghem and Beuselinck[3]). However, the implementation of such optimal boarding schemes can present practical challenges (Steffen[6]).

Boarding influences the passenger experience and can also influence airline income. Boarding times have a direct relationship with aircraft turnaround times. Slow boarding can cause an airplane to lose its slot, which results in delays – reason enough to strive for faster boarding.

THE PASSME PROJECT

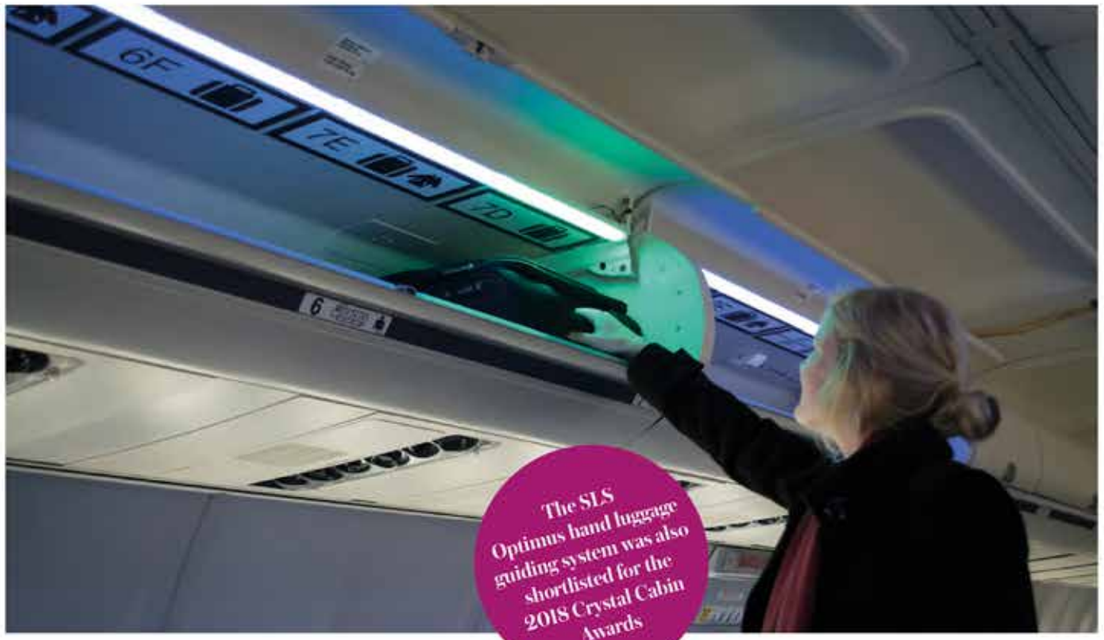
Improvements to the boarding process form part of the PASSME (Personalised Airport Systems for Seamless Mobility and Experience) project. The aims of the project are to reduce door-to-door travel time by 60 minutes and enhance the travel experience.

The project focuses on four major breakthroughs: a real-time, passenger-centric monitoring and forecasting system; a passenger-independent system for managing luggage flows; radically redesigned airports, aircraft processes and interiors; and a personalized, contextually and emotionally aware device and smartphone app. The project partners included TU-Delft, Optimares, Almadesign and DLR.

"Boarding influences the passenger experience and can influence airline income"

As part of the redesign elements of the project, the potential for aircraft interior design to decrease boarding times and improve the passenger experience was studied. The team found 46 scientific papers that experimented with boarding processes. Most reported on simulations, while six contained observations of alternative boarding processes.

Four procedures are supported by the papers. The first is that boarding using two doors and two sets of steps is faster than using one door. Marelli *et al*[4] even reported time savings of five minutes for a B757-200 using two left doors at the front, which usually takes between 22 and 26 minutes.



The SLS Optimus hand luggage guiding system was also shortlisted for the 2018 Crystal Cabin Awards

"Some methods ask much from the organizational efficiency of an airline"

The second – reported by several papers – is that block boarding is slower than random boarding, as shown by Coppens *et al*[2]. It may seem logical to have the rear board first, then the middle rear, the middle front and finally the front. However, aisle blocking happens when passengers load their hand luggage in the overhead bins and results in congestion when passengers are close to each other. With random boarding, passengers are more spread around while putting their luggage in bins, which reduces the likelihood of an aisle being blocked.

Third, the Steffen method of pyramid boarding[6] is claimed to be faster than random boarding. The pyramid starts with the boarding of window seat passengers in the rear, followed by window passengers in the middle, then the middle seats in the rear and so on. The Steffen method follows this procedure, but first the even-numbered window seats are boarded, followed by uneven ones, giving more space for passengers during boarding. In practice, these methods ask much from the organizational efficiency of the airline. Positive effects have been proved in practice (Vincent[7]), but only in highly efficient organizations.

Finally, it has been found that good preparation can lead to faster boarding. Delays in boarding are often caused by passengers having difficulty finding their seats and by passengers blocking the aisle while they retrieve items from their hand luggage before placing it in the overhead lockers. Such delays can be prevented through good preparation. The PASSME tests also found that when passengers boarded a second time, they were always faster still, even when a different seat was assigned.

Three interior changes were tested in the PASSME project: a seat-locating light, a guiding luggage bin and a widening seat.

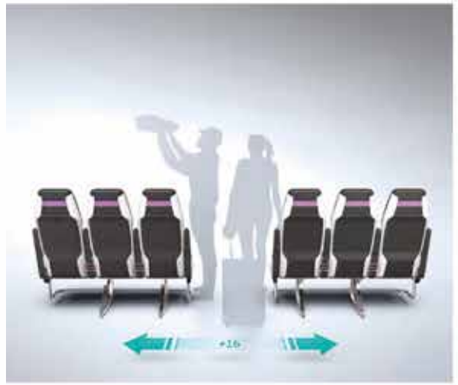
FIGURE 3 (ABOVE): A GREEN LIGHT SHOWS IN THE BIN WHEN THE HAND LUGGAGE IS PLACED CORRECTLY – AND RED WHEN IT IS NOT

FIGURE 4 (BELOW): AS THE TICKET HOLDER GETS CLOSER TO THE SEAT, THE LIGHT BECOMES BRIGHTER (DESIGN: S AKKERMAN)

SEAT-LOCATING LIGHT

The seat-locating light, fitted above each aircraft seat, becomes brighter as the ticket holder approaches (see Figure 4). This guidance system, which uses Bluetooth technology, reduces passenger stress and helps airlines to structure the aircraft boarding process.

A prototype of this lighting system was made and tested to see how it helped people to find their seats. In a trial, 10 passengers boarded an aircraft with the light and then another 10 without the light. The boarding times were recorded and a questionnaire issued to gain insight on the experience. Boarding with the light was found to be approximately two seconds faster than without, but the experience data was difficult to interpret as some of the participants were not aware that there was a light. The study shows that there is potential in using the light, but further research is needed to study the effect on a flight where many passengers board at the same time, and to verify the effect on boarding time.



GUIDING LUGGAGE BIN

If all passengers take their full hand luggage allowance on board, there will generally not be enough space in the bins. The guiding luggage bin is a system intended to help by guiding passengers toward the optimal space to stow their bags, given the available space.

This system begins with a little preparation at home before the flight, where passengers measure the size of their carry-on luggage size using an app. They simply scan their luggage with a smartphone by placing a sheet of A4 paper next to the carry-on bag and taking a picture. The app then records its size, using the sheet of paper as a reference.

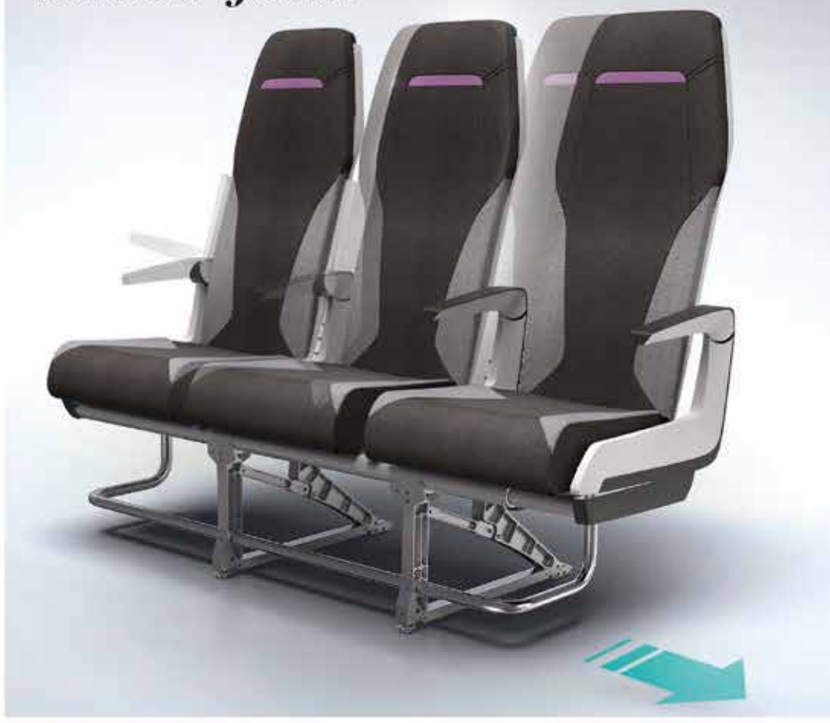
If the app deems the hand luggage to be too large for the overhead bins it will warn the passenger, who will be prepared to have the bag stowed in the hold.

However, passengers with luggage sized within the applicable limits will be allowed to board first and be certain that there will be space for their luggage in the cabin. An algorithm calculates the best luggage distribution in the overhead bins, and users receive the recommended location to stow their hand luggage via the airline app, email or text message before boarding.

Key to the system is that at the gate passengers receive a boarding pass with a printed RFID tag inside, which is read by cabin systems. When each passenger enters the aircraft, they can see their seat number illuminated in the overhead bin, and the luggage stowage space is shown on electronic paper displays inside the bins. As a passenger approaches their bin, their presence is sensed via one of the RFID antenna in the aircraft and the LED starts flashing to indicate when to stop.

BOARDING INNOVATION

"It proves the ability of the system to save between three and five minutes of time"



FIGURES 5 AND 6 (ABOVE AND ABOVE LEFT): THE PASSME SEATS CAN BE NARROWED TO WIDEN THE AISLE DURING BOARDING, AND EXPANDED AGAIN AFTER BOARDING HAS BEEN COMPLETED

LED strips mounted directly beside the screens (see Figures 3 and 7) are activated by the RFID and will give a guiding light effect until the passenger has reached the correct bin. The LEDs will flash more brightly as they get closer. When the luggage is placed correctly, a green light will confirm the correct location and the passenger can then go to their seat, which will be close by.

A user test with 24 participants was conducted in a real fuselage with a working prototype of the system, to test the boarding experience and the interaction with the lights. The results were compared with a boarding situation without a light guiding system, and if the boarding times from the test are extrapolated to reflect a Boeing 737-8 with 189 passengers, it proves the ability of the system to save between three and five minutes of time and to improve the overall experience considerably. Of the participating passengers, 63% indicated that they preferred the new way of boarding, while the other 37% said they did not mind.

The reduced boarding time can be partly explained by the fact that passengers first look for a place to put their luggage and then once stowed, look for their seat. Without such a system, passengers first look for their seat, then try

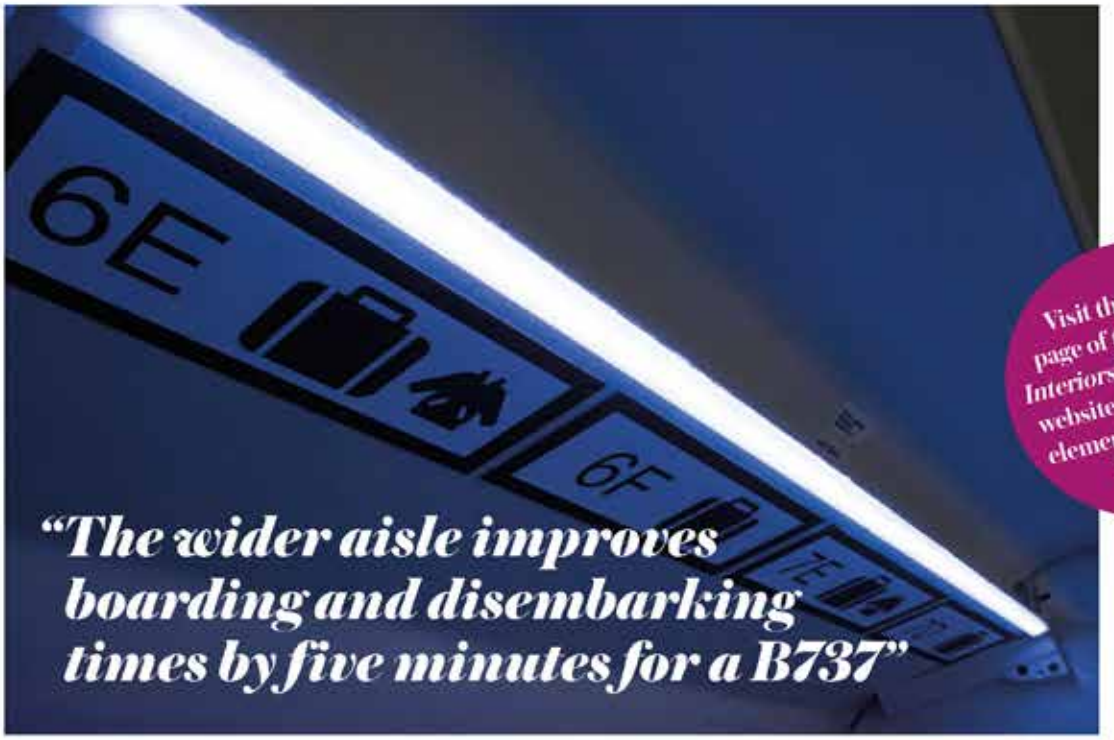


FIGURE 7 (LEFT): LIGHTS IN THE BINS INDICATE TO EACH PASSENGER WHERE THEY SHOULD STOW THEIR CARRY-ON LUGGAGE

"The wider aisle improves boarding and disembarking times by five minutes for a B737"

Visit the Videos page of the Aircraft Interiors International website to see various elements of PASSME in action

to find a place for their hand luggage, and then look for their seat again.

THE WIDENING SEAT

The widening seat is a concept triple economy seat that is contracted during boarding, which doubles aisle width to 32in, allowing passengers to pass each other and enabling use of normal wheelchairs in the aisle. Passengers take a – briefly uncomfortable – seat, and when boarding is completed, the crew indicate that the seat triples can be expanded to normal width for take-off and cruise, by using the mechanical actuator found on each row. Tests have shown that the wider aisle improves boarding and disembarking times by five minutes for a B737-800.

A similar system is available from Molon Labe Seating in the USA, whereby when passengers get off the aircraft they slide the seat across to make the aisle wider. The aisle seat slides over the middle seat, and during flight the middle seat is larger.

The system tested in the PASSME project and considered here does not slide laterally; instead passengers are seated at a higher position while boarding to enable the seat to contract. When the seats are widened, they also lower (see Figure 2). It is a mechanical system featuring the same mechanisms used in seat recline systems, and no electronics are used. The lowering action of the seats simply uses the weight of the passengers. When passengers stand up, the system can be unlocked and moved upward.

In conclusion, boarding time can be reduced and the experience of passengers improved by using a combination of ideas such as using pyramid boarding, light guiding, preparation and a wider aisle.

ACKNOWLEDGEMENT

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