AIRBUS´ Approach to Improve Travel Comfort for Wheelchair Users

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ABSTRACT

This paper introduces concepts and solutions which aim at improving the travel comfort for wheelchair users inside the aircraft. Airbus has historically taken a proactive approach on accessibility working on comfort improvements and solutions for passengers beyond regulation. An outline of this user-centred approach is given showing how the needs and expectations of a high diversity of end-users is considered during product research and development. Exemplary solutions are presented that are dedicated to the accessibility of aircraft lavatories for persons with reduced mobility and to the reliable and damage free transport of wheelchairs in an aircraft.

KEYWORDS

Wheel chair, travel comfort, accessibility

Introduction

The World Health Organisation (WHO) estimates that 15% of the global population – around one billion people – is disabled. A recent survey showed that airlines are seeing a steady increase in passenger demand for wheelchair assistance (IATA, 2019a). Expectations towards airlines to provide travel solutions for persons with reduced mobility are increasing due to a growing number of regulatory work, self-commitments of the aviation industry (e.g. IATA, 2019b) and efforts by advocacy organisations.

Looking at the travel comfort of wheelchair users in-flight, two areas of concern are particularly in focus: the access to lavatories on-board and the damage free transport of wheelchairs in an aircraft. On long-range aircraft the available cabin space allows to provide full accessible lavatories with sufficient space to enter the lavatory sitting on an on-board wheelchair, for manoeuvring with the wheelchair inside and for the transfer from the wheelchair to the toilet seat that allows also seated dependent transfer supported by an assist person. On single-aisle aircraft the limited available space is the main challenge for providing accessible lavatories. No comparable regulation is in place yet concerning the full accessibility of lavatories on such smaller aircraft.

Damages to wheelchairs are identified as a problem in air travel which directly impacts the comfort, trust and well-being of their users and generates costs. According to the US Air Travel Consumer Report (US Department of Transportation 2020a), a significant number of 29 wheelchairs and scooters were mishandled in the US per day in the year 2019 (1.54 % of enplaned wheelchairs and scooters).

The Federal Aviation Administration (FAA) is currently conducting a study to determine the feasibility of in-cabin wheelchair restraint systems and if feasible, the ways in which individuals with significant disabilities using wheelchairs can be accommodated with in-cabin wheelchair restraint systems (The National Academies of Sciences, Engineering, and Medicine, 2020)

Airbus approach

The role of an aircraft manufacturer in terms of accessibility is to design and deliver aircraft that can be operated in compliance to present and future regulation (e.g. accessible lavatories, wheelchair stowage, and space for on-board wheelchairs). Table 1 summarizes such requirements that are relevant in the US.

Table 1: US Requirements for Nondiscrimination on the basis of disability in air travel according to DOT 14 CFR Part 382

	Requirements for Accessibility of Aircraft
§ 382.61	aisle seats must be equipped with movable aisle armrests on at least one-half of the aisle seats proportionately in all classes of service in the cabin
§ 382.63	aircraft with more than one aisle in which lavatories are provided shall include at least one accessible lavatory
§ 382.65	one on-board wheelchair to be offered
§ 382.67	priority space in the cabin of sufficient size to stow at least one typical adult-sized folding passenger wheelchair (13” x 36” x 42”)
§ 382.69	audio-visual displays played on aircraft for safety purposes, or informational purposes are high-contrast captioned

Airbus provides standard lavatory solutions specifically for Persons with Reduced Mobility (PRM) on all platforms, even beyond formal regulations and requirements. Here, Airbus ensures that accessible lavatories are compliant to the regulation. According to the US DOT part 382 regulation aircraft with more than one aisle in which lavatories are provided shall include at least one accessible lavatory. Three criteria are fulfilled for accessible lavatories:

(1) The accessible lavatory must permit a qualified individual with a disability to enter, manoeuvre within as necessary to use all lavatory facilities, and leave, by means of the aircraft’s on-board wheelchair.
(2) The accessible lavatory must afford privacy to persons using the on-board wheelchair equivalent to that afforded ambulatory users.
(3) The lavatory shall provide door locks, accessible call buttons, grab bars, faucets and other controls, and dispensers usable by qualified individuals with a disability, including wheelchair users and persons with manual impairments.

Airbus has historically taken a proactive approach on accessibility in order to find and offer solutions beyond regulation, also to account for trends (e.g. aging population). As a prominent example Airbus developed some years ago the Space-Flex Module - a rear door galley/lavatory module featuring a space efficient fully accessible lavatory. It was the first wheelchair capable lavatory on a Single-Aisle aircraft in the market.

Improving the accessibility it is not only about integrating new features for special needs into the aircraft. It has to be ensured that the Cabin & Cargo products and services:

- meet the needs and expectations of a high diversity of end-users in the cabin,
- cover the wide scope in anthropometrics, cultural background and special needs, and
- allow a maximum operational efficiency for the airlines.

There are different and sometimes conflicting needs by different users that all have to be considered for an optimized product everybody is satisfied with. It is a must to understand the needs and expectations of a high diversity of end-users. Accordingly, it is key for new concepts and products

that users are involved already in early design phases in order to optimize and validate new concepts by use of mock-ups (e.g. in the Airbus Rapid Architecture Lab) or earlier by means of Virtual Reality.

In the early design phases, Virtual Reality tools and methods are applied. Only if the usability is validated here by use of digital manikins representing the reference persons (children included) a mock-up will be built to further analyse the ergonomics and operational aspects. As soon as a mock-up is available the team tests it with real users including tall and short persons, passengers of size and persons with reduced mobility.

The main advantages of this approach are, that with this analysis, concepts can be analysed, developed and compared very early and that it is possible to analyse the design for the "critical" cases: e.g. small manikins can be used for the reachability of a handle and the tall manikin for clearances and postures where the space is very limited. At the end the best balance between different user groups with different needs and at the same time to design for operational efficiency will be realized. There is not necessarily a conflict between different needs but very often it is the case.

Onboard improvements

In this chapter exemplary solutions are presented that are dedicated to the accessibility of aircraft lavatories for persons with reduced mobility and to the reliable and damage-preventing transport of wheelchairs in an aircraft.

An increase of the space for the footprint of lavatories on single-aisle aircraft is due to the limited space in the aircraft not easily feasible. A lot of constraints are there, e.g. not to protrude in escape paths required for emergency evacuations or to ensure sufficient space for efficient cabin operations.

The US DOT published a Notice of Proposed Rulemaking (NPRM) that provides future guidance (US Department of Transportation 2020b). It is planned to be applicable for new aircraft with more than 125 seats being delivered three years after the legislation has been passed (which has not happened yet) that fly to/from airports in the United States of America. According to the NPRM at least one lavatory per aircraft will be required that fulfils the following requirements for wheelchair users:

- Grab bars inside the lavatory.
- Accessible attendants call buttons and door locks from a seated position inside the lavatory.
- Door sill / threshold with minimum obstruction to an on-board wheelchair.
- No reduction of toe clearance vs. today's lavatories
- Visual barrier to afford privacy with an open lavatory door.

The provision of full accessible lavatories on new single-aisle aircraft will be covered in a separate NPRM (part 2) with a time horizon for effectiveness of about 20 years.

With the Space-Flex galley/ lavatory module, Airbus developed the first fully accessible lavatory on a Single Aisle aircraft in the market (Schliwa & Cremers, 2013). The Space-Flex v1 lavatory and the operation is shown in figure 2.

Another concept introduced by Airbus is based on the integration of a foldable transfer-seat within the lavatory, which facilitates independent seated transfer onto the toilet. This seat allows the mobility impaired person to move from the on-board wheelchair to the toilet without entering the lavatory on the wheelchair. This seat was introduced with the Space-Flex v2 lavatory (see figure 3).

The transfer seat is now available also on all regular size lavatories in the new Airspace interior of the A320 Family as an option.

Figure 2: Airbus Space-Flex v1: PRM capability with removable wall

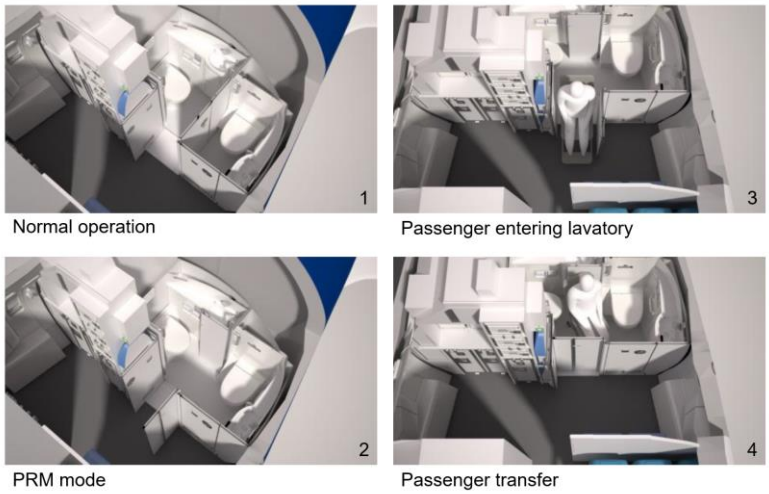
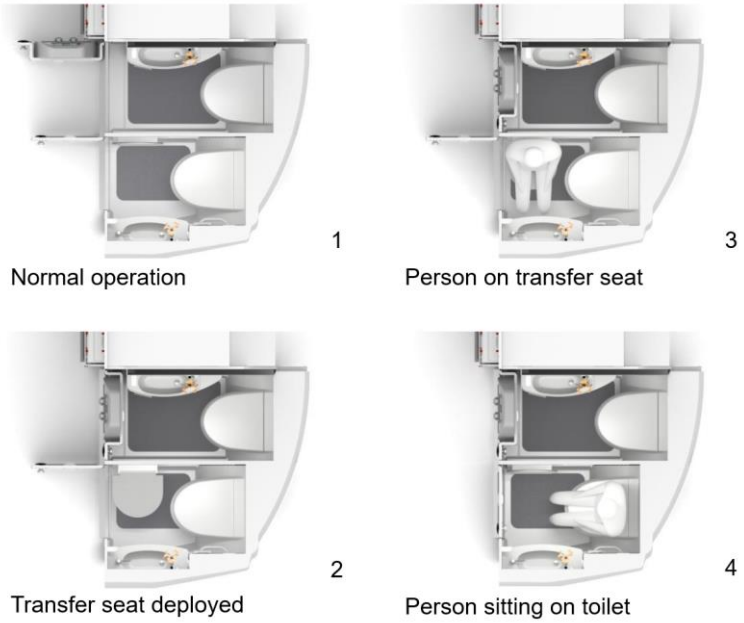


Figure 3: Airbus Space-Flex 2: PRM capability with transfer seat



New approaches

Students at Hamburg University of Applied Sciences developed a concept for a new type of on-board wheelchair that was based on a cantilever structure that allows the person on the wheelchair to remain on the wheelchair that can be positioned over the toilet lid (see figure 4). The passenger can enter the lavatory, use the facilities in privacy, and exit the lavatory without standing up. Accordingly the space needed for the transfer would not be required with such a wheelchair. The idea of the so-called Hamburg wheelchair became with the support from Airbus a reference for the new Advisory Guidelines for Aircraft On-board Wheelchairs which the Department of Transportation (DOT) expects to establish in a forthcoming rulemaking under the Air Carrier Access Act. The US Department of Transportation has defined new requirements to improve the usability to accomplish non-toileting personal hygiene and medically needed tasks in private for wheelchair users.

Figure 4: Hamburg On-board Wheelchair Prototype in A320 lavatory

Currently there are longer-term solutions under discussion that would enable wheelchair users to travel in their own wheelchair on an aircraft. The Federal Aviation Administration is currently conducting a study to determine the feasibility of in-cabin wheelchair restraint systems and if feasible, the ways in which individuals with significant disabilities using wheelchairs can be accommodated with in-cabin wheelchair restraint systems (The National Academies of Sciences, Engineering, and Medicine, 2020)

In 2018 the Canadian Transportation Agency initiated activities on issues related to storing and transporting mobility devices that grow in size and complexity. Wheelchairs are “as diverse as the population and therefore it is difficult to develop standard maximum design envelopes (height, width, length, weight) of mobility aids” (Hunter-Zaworski, 2019).

The integration of the huge variety of individual wheelchairs personal wheelchairs would require a reutilization of cabin areas and new solutions for technical integration and especially certification and qualification and also bears new operational challenges (Giesa & Schliwa, 2020).

Important targets for the integration of personal wheelchairs are:

- Safety for the wheelchair user and other passengers and crew
- Space efficiency (minimum loss of seats and cabin monuments), especially when the area is not in use for wheelchairs
- Minimum additional weight, especially when not in use for wheelchairs
- Low impact on operational efficiency during turnaround and during flight
- No changes of aircraft structure - the integration should work with standard interfaces (seat tracks or upper attachments for monuments)

Figure 5 shows various variables that have an impact on these targets and need to be considered for the definition of a design envelope.

The options for the location of an accommodation of a passenger on a personal wheelchair are physically restricted by the geometries and particularly by the relatively narrow aisles. Accordingly the location in the cabin seems to be preferably feasible close to a passenger door forward or at the rear. There is a wide range of different types of wheelchairs regarding size, weight and fixation interfaces. For an analysis of potential locations a design envelope incl. requirements regarding accommodable wheelchair dimensions, the acceptable loads and structural adaptations and a definition of maximum weight for wheelchairs is required, as they have a major impact on the space needed. The handling of lithium batteries and the related risk of lithium battery fires requires particular attention. The type of restraint systems for the wheelchair and the occupant need to be

defined and a standard of the related interfaces is required. In order to minimize any safety risks for the wheelchair user or other passengers or crew a concept for the qualification and certification of the wheelchairs and restraint system need to be defined.

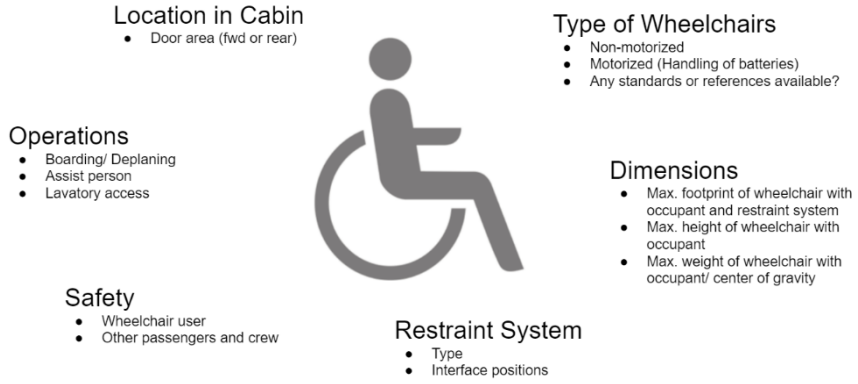


Figure 5: Engineering Design Envelope for Personal Wheelchairs (Giesa & Schliwa, 2020)

Also operational aspects will have an impact on the integration. The boarding and deplaning of a passenger on the wheelchair need to be manageable within the limits of the aircraft turnaround at the airport. Furthermore, interfaces and space allocations could be designed differently if an assist person would obligatorily be available, e.g. for the access to cabin functions as the In-flight Entertainment System, the transfer to a lavatory and for assistance for oxygen mask or life vest use.

The high complexity of the integration into the cabin and the unavailability of an engineering design envelope are reasons to pay attention also to complementary and simpler solutions to improve air travel with wheelchairs in a much shorter time-frame. Most mobility aids are not designed for air travel, and as a result, they cannot be easily modified (Hunter-Zaworski, 2019).

Currently Airbus is working on a new "cargo box" – called Airportainer. This semi-rigid container bag that can be used to protect wheelchairs and other assistive devices during transport in the cargo area.

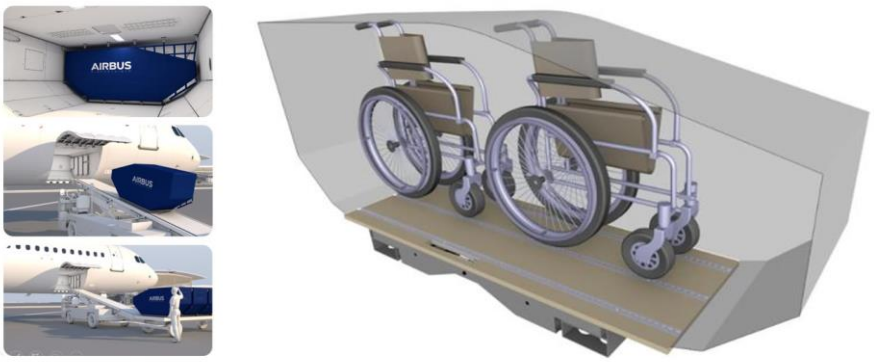


Figure 6: The Wheelchair Airportainer as innovative approach for reliable and damage preventing transportation of the wheel chairs

Outlook

Going forward, the aviation industry needs to take into consideration that the travelling public includes people who have a wide spectrum of disabilities and challenges, such as hearing or visual impairments, hidden or intellectual disabilities, all of which need to be supported when they fly. With cabin design, the aircraft manufacturer has often to focus on the use of space but digitisation

brings new opportunities to improve travel for everyone. Here Airbus will act as an integrator and push new ideas.

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