AMSE Association for the Advancement of Modelling & Simulation Techniques in Enterprises
IIETA International Information and Engineering Technology Association
Advancing the World of Information and Engineering

Modelling, Measurement and Control C
Vol. 79, No. 4, December, 2018, pp. 212-215
Journal homepage: http://iieta.org/Journals/MMC/MMC_C

Influences of aircraft seat adaptations on wheelchair user perceptions when transferring into and out of the seat: A pilot study

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https://doi.org/10.18280/mmc_c.790411

Received: 15 September 2018
Accepted: 31 October 2018

Keywords:
ergonomic, aircraft seat, adaptation, accessibility, wheelchair user perceptions

ABSTRACT

Aircraft seat accessibility for wheelchair users is very complicated. The distance between two seats is very small which creates accommodation deficiencies. Improving air travel experience, and more specifically egress and ingress of aircraft seat could be associated with development of some adaptations. An experimental study was made to propose three removal adaptations on aircraft seat and to collect perceptions of wheelchair users. According to the results the adaptation the most appreciate was when surfaces of the boarding chair and of the aircraft seat were fixed at the same level. The results of this study give perspectives for further researches on the impact of some adaptations which could be provided on aircraft seat. Results might also be used to design products and service to improve sitting transfer.

1. INTRODUCTION

The World Health Organization [1] reported that about 15% of the world's population is estimated to live with some form of disability. People with disability have adequate resources to travel several times per year, especially for the purpose of family visits, vacations and medical care [2].

According to 2005 Open Doors Organization [3], 31% of adults with disabilities traveled by air. They approximately take 2 flights every two years and they would take 2 more flights per year if their needs as a disabled person were considered by airlines [3]. Among adults with disabilities who have traveled by air, 72% said they encountered major obstacles with airlines [4]. The most reported complaints were the physical obstacles and cramped seating areas [3].

Aware of difficulties encountered by disabled person the tourism literature is increasing turning its attention to tourist with disabilities [5-9]. Some studies identified problems and the difficulties encountered by all profile of disabled people. They show that travelers with physical disabilities encounter barriers during their air travel. The facilities are not physically accessible, especially the on board aircraft. Concerning the aircraft design, distance between two seats is very small which creates accommodation deficiencies. A pitch, smaller than 71 cm, makes the space between seats very small. Then the accessibility for wheelchair users is very complicated [9].

Furthermore, standard wheelchairs are too wide for airplane aisles. Thus wheelchair users transfer on a boarding chair to be taken to their allocated aircraft seat. The boarding chair is reported to be very uncomfortable and to limit movements, especially in wheelchair users with sensorimotor impairments at the lower extremities and trunk [5]. Furthermore, the transfers between the boarding chair and the aircraft seat is challenging due to a small seat pitch [9]. In fact, among many things, many wheelchair users have reported an increased risk of skin integrity alteration during the transfer, which could alter their health-related quality of life [5].

The aim of this pilot study is to investigate adaptations aiming to improve aircraft seat access for wheelchair users.

2. METHOD

A simulated custom build aircraft cabin with real cabin seats was constructed for this experiment [10]. In brief, two rows of three economic aircraft seat are positioned, one in front of the other separated by a pitch of 80 cm [11]. Four experienced manual wheelchair users with a chronic spinal cord injury who use a manual wheelchair were recruited (table 1). The questionnaire was approved by a local ethic committee. The recruited participants give their full consent before starting the experiments.

Table 1. Characteristic of recruited participants

	Sex	Age	Trunk size	Weight	Pathology
1	Male	52	88	75	Paraplegic T12
2	Male	34	82	80	Paraplegic T6
3	Male	32	99	90	Quadriplegic C7
4	Male	30	80	73	Paraplegic T2 on the right side and T4 on the left side

When transferring between the boarding chair and aircraft seat, three adaptations were proposed: 1) surfaces of the boarding chair and aircraft seat adjusted (Fig.1.A), 2) backrest vertical seat inclination (Fig.1.B) and 3) a transfer handle was made available (Fig.1.C).

The surface of the boarding chair and of the aircraft seat adjusted means that both surfaces were fixed at the same level. The boarding chair adjustment requested to modify the mechanical system of the chair. Instead of modifying the boarding chair, the row of the aircraft seat was elevated from 4cm. With this head up to 4cm, surfaces of the boarding chair and of the aircraft seat are at the level.

The backrest of the seat in the front row was inclined vertically to obtain an angle of 90° with the base of the seat. The backseat adjustment enables to increase the space between both seats. The original spacing between both backrest seats is 78.5 cm (Fig.1.B). After adjustment, spacing between both backrest seats is 84 cm (Fig.1.B).

The transfer handle is placed overhead and in the middle of the target seat. The target seat is the seat where participants are transferring. The transfer handle is fixed to a gantry and can be displaced on a sliding rail overhead the three seats of the row. The transfer handle is positioned in average at 142,8 cm from the ground (Fig.1.C).

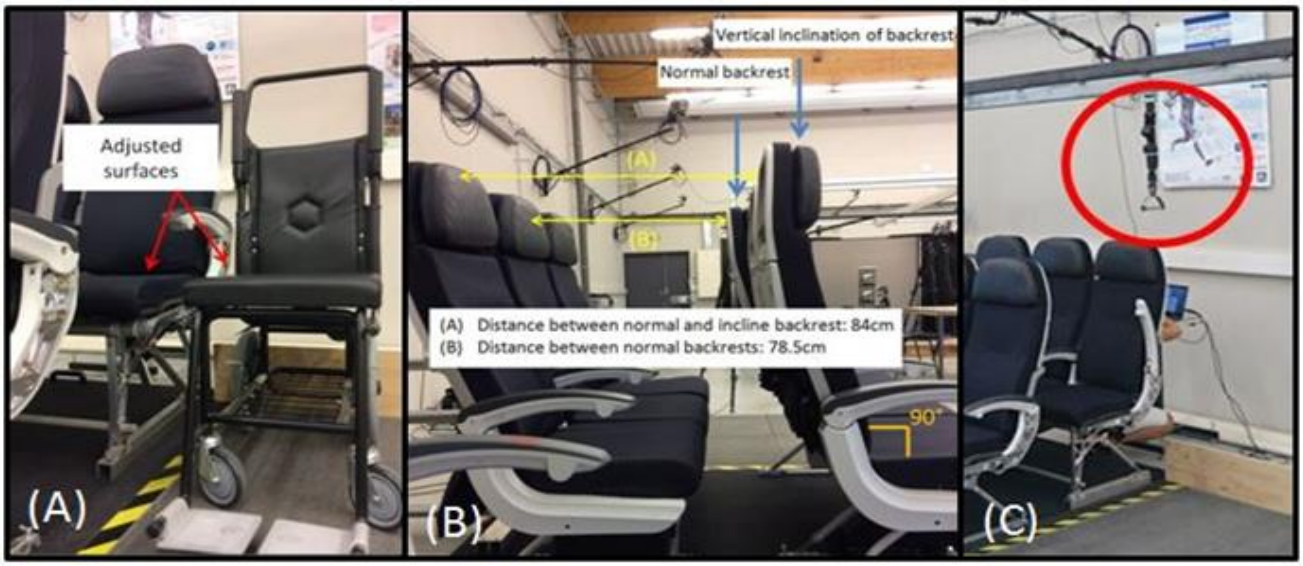

Figure 1. Adaptations on the aircraft seat and on the boarding chair

For each adaptation, participants performed a total of 8 transfers from the right side of the aisle and 8 transfers from the left side, using self-selected movement strategies. These transfers were performed only into and out of the aisle seat, as people will embark or disembark the aircraft.

The tested configurations were divided in two parts. For the first part, surfaces of boarding chair and of aircraft seat were not in the same level. For the second part, surfaces of boarding chair and of aircraft seat were in the same level. In each part, three parameters where studied: access to the seat (left and right), backrest adjustment (with or without), transfer handle (with or without). Various configurations were tested with changes on previous three parameters. A reference configuration was tested with backrest seat without adjustment, without transfer handle and without seat surface adjustment. A random selection of each configuration and parts before each experimentation was realized in order to avoid the order effect. The list of configurations is given by the table 2. All transfers were filmed using 4 synchronized digital cameras and, later, videos were analyzed to describe movement strategies during transfers.

After each configuration, all participants completed a numerical survey. Questions were presented on a digital tablet and perceptions of participants were collected with a visual analog scale (table 3).

Table 2. Configurations on accessibility test

PART 1					
1	Aisle seat	Normal seat surface	Normal backrest seat	Right side	Without transfer handle
2	Aisle seat	Normal seat surface	Normal backrest seat	Right side	With transfer handle
3	Aisle seat	Normal seat surface	Normal backrest seat	Left side	Without transfer handle
4	Aisle seat	Normal seat surface	Normal backrest seat	Left side	With transfer handle
5	Aisle seat	Normal seat surface	Backrest seat adjusted	Right side	Without transfer handle
6	Aisle seat	Normal seat surface	Backrest seat adjusted	Right side	With transfer handle
7	Aisle seat	Normal seat surface	Backrest seat adjusted	Left side	Without transfer handle
8	Aisle seat	Normal seat surface	Backrest seat adjusted	Left side	With transfer handle
PART 2					
9	Aisle seat	Adjusted seat surface	Normal backrest seat	Right side	Without transfer handle
10	Aisle seat	Adjusted seat surface	Normal backrest seat	Right side	With transfer handle
11	Aisle seat	Adjusted seat surface	Normal backrest seat	Left side	Without transfer handle
12	Aisle seat	Adjusted seat surface	Normal backrest seat	Left side	With transfer handle

13	Aisle seat	Adjusted seat surface	Backrest seat adjusted	Right side	Without transfer handle
14	Aisle seat	Adjusted seat surface	Backrest seat adjusted	Right side	With transfer handle
15	Aisle seat	Adjusted seat surface	Backrest seat adjusted	Left side	Without transfer handle
16	Aisle seat	Adjusted seat surface	Backrest seat adjusted	Left side	With transfer handle

Table 3. Question ask during the experiment

1	How do you estimate the difficulty before transferring on the seat?
2	How do you feel the difficulty for transferring on the seat?
3	The experience has been painful?
4	The adaptation has been useful?
5	Using the adaptation facilitated the transfer?
6	The use of the adaptation was easy?

At the end of the experiment when all configurations were tested, participants were subject to a semi-directive interview. This interview collected the global perception on the aircraft seat access, the difficulties encountered and on the adaptations. During the interview each participant had to fill a questionnaire that asked specific question about the adaptations.

3. RESULTS

3.1 Analysis of questionnaire during experiments

Table 4. Configuration: backrest adjusted, without transfer handle, without adjusted seat

	Useful?	Transfer facilitated?
Subject 1	no	no
Subject 2	no	no
Subject 3	no	no
Subject 4	no	no

In configuration with backrest seat adjusted, transfer was mentioned to be not easy for the whole participants (table 4). When transfer handle is added to the reference configuration, only one subject mentioned that this adaptation was useful and facilitated the transfer (table 5). When surface of both seats was adjusted, all participant mentioned that this adaptation was useful and facilitated the transfer (table 6).

Table 5. Configuration: backrest non adjusted, with transfer handle, without adjusted seat

	Useful?	Transfer facilitated?
Subject 1	no	no
Subject 2	yes	yes
Subject 3	no	no
Subject 4	no	no

Table 6. Configuration: backrest non adjusted, without transfer handle, with adjusted seat

	Useful?	Transfer facilitated?
Subject 1	yes	yes
Subject 2	yes	yes
Subject 3	yes	yes
Subject 4	yes	yes

3.2 Video analysis

When the seat surfaces were adjusted to the same height, all users made, regarding the number, less pelvis displacement than for the original configuration (table 7). Also with this modification the quadriplegic subject did not use his transfer board. Using the backrest vertical inclination of the front seat does not influence the number of pelvis displacements. When the transfer handle was used, the transfer required a single long pelvis displacement to land on the target seat. However, this adaptation could not be used by participant with tetraplegia.

Table 7. Number of pelvis displacement from the different configurations

	Number of pelvis displacements			
Configuration	**Subject 1**	**Subject 2**	**Subject 3**	**Subject 4**
Reference	2	2	4	2
backrest adjusted, without transfer handle, without adjusted seat surfaces	2	2	4	2
backrest non adjusted, *with transfer handle*, without adjusted seat surfaces	1	1		1
backrest non adjusted, without transfer handle, *with adjusted seat surfaces*	1	1	2	1

3.3 Semi-directive interview analysis

The subject one mentioned that every transfer was easy. This subject used different strategies even for a single configuration. In daily life he is used to make different transfers in order to be capable of getting out of every difficult situation. If the subject used the transfer handle he rather uses it on the right side because he is right handed. The seated surfaces adjusted are useful.

The second subject apprehended to use the transfer handle because it reminds him the hospital. However, after having used the transfer handle, the subject found that this adaptation is the best among the others. The seated surfaces adjusted helped the transfer when the transfer handle cannot be used. With the transfer handle having different surface seat height is no longer a problem because the transfer handle highly helped him get up.

The third subject did not feel any difference with the backrest adjusted. However, seated surface adjusted were very helpful. The subject didn't even use his transfer board. This subject cannot use the transfer handle because of his disability.

The fourth subject also apprehended to use the transfer handle. Also because this adaptation reminds him the hospital. If the transfer handle will be proposed to him, he won't use it. With the transfer strategies daily used, the subject knows his limits. However with the transfer handle his limits are unknown.

3.4 Analysis of questionnaire after experiments

Summarizing all data from the questionnaire, we found that adjusted backrest seat was mentioned not useful by all participants. The transfer handle was useful for two participants. However the quadriplegic subject could not use the adaptation. Subject all agreed that adjusted seat were useful and that they facilitated the transfer (table 8).

Table 8. Analysis of adaptations and configurations

	Most useful adaptation?	Adaptation that facilitate the most the transfer?	Most useful configuration?	Configuration that facilitate the most the transfer?
Subject 1	Adjusted seat surface	Adjusted seat surface	Adjusted seat surface	Adjusted seat surface
Subject 2	Transfer handle	Transfer handle	Adjusted seat surface + Transfer handle	Adjusted seat surface + Transfer handle
Subject 3	Adjusted seat surface	Adjusted seat surface	Adjusted seat surface	Adjusted seat surface
Subject 4	Adjusted seat surface	Adjusted seat surface	Adjusted seat surface	Adjusted seat surface

4. CONCLUSION

Previous studies [5, 9] have listed the difficulties felt by wheelchair users, inside the aircraft. However, these studies did not focus on what participants would prefer for improving their comfort or their accessibility. The aim of this study was to investigate the influence of some adaptations regarding the accessibility of wheelchair users on aircraft seat. Three adaptations were proposed: 1) surfaces of the boarding chair and aircraft seat were fixed at the same level (adjusted seat surfaces), 2) backrest vertical seat inclination and 3) a transfer handle was made available.

Adjusting the height of the boarding and aircraft seats at the same level represents a useful adaptation to facilitate transfers between these seats while embarking or disembarking the aircraft. This adaptation was considered the most useful and which facilitate the most the transfer. This finding is in adequacy with Quigley [8] who found that the design of seat base was very important for participants getting in or out of their seat easily.

The transfer handle contributes to facilitate the continuous displacement but cannot be adopted by all users. This adaptation contributes to greatly reduce pelvis displacements but is not appreciated by all users, not by a lack of utility but for what it represents. This adaptation could be proposed with a design that would not evoke hospital memories. Vertical inclination was not reported as an advantageous adaptation.

ACKNOWLEDGEMENTS

This research was supported financially by Zodiac Seats France and Direction Générale de l'Aviation Civile (project n 2016930805).

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