Chaise Longue: Passenger perception of more spacious economy class seats in the same pitch

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ABSTRACT

Usually, the economy class has limited space and limited recline possibilities causing discomfort, especially on long haul flights. In this paper, a seat was developed creating more space by using the vertical space in the aircraft. The design is described and 59% preferred this seat based on visual impression, which is promising. Further prototyping, certification studies and manufacturability research is needed to check the feasibility further.

KEYWORDS

Seat pitch, Passenger Density, Passenger Comfort, Spacious Aircraft Seats

Introduction

To increase the income airlines want as much passengers on board as possible. However, if space is too limited it could mean that passengers choose for another airline with more space. Depending on the length of the flight, 20-40% of passengers mention the cabin interior as the most important factor in their choice of an airline (Brauer, 2004). Vink et al. (2012) also found a strong correlation (r=0.73) between aircraft interior comfort and "fly again with the same airline". Ahmadpour et al. (2014) found that the seat is an important aspect in relation to aircraft passengers' comfort perception. Rankin et al. (2000) suggested that seat comfort is the best predictor of overall flight comfort (r=0.77, n=3630, $p<0.01$). Bouwens (2018) studied which seat related elements are important for passengers from Asia, Europe and the USA. The top five of most important seat related elements was the same in all three regions, only the order differs slightly. These were Legroom, Foot space, Hygiene, Bottom Cushion and Overall Space. Three of the five elements concern space and are influenced by the pitch if traditional seats are used. Seat pitch is the distance from any point on one seat to the exact same point on the seat in front or behind it (Vink, 2017). Anjani et al. (2020) found that comfort increases significantly when the seat pitch increases. Some airlines try to create space by developing a thin backrest (Vink, 2017) and some have a curved seatback instead of a flat one and if the passenger splays his legs (https://www.sfgate.com/travel/article/Spirit-Airlines-new-seat-pitch-14426008.php) a bit, the knees will have more room than before. Another possibility is to use the vertical space. This principle is applied in the Flying V (see fig.1). In a study among 1692 participants visiting the interior of the Flying V (Vink et al., 2020) it was shown that, the majority (36%) preferred this 'chaise longue' out of 4 possibilities. This seat (see fig. 1) uses the vertical space in the airplane and creates more legroom, more foot space and more overall space within the 32" seat pitch. A problem in aircraft seats is the limited variation of posture. In this 'chaise longue', it is possible to change the position of the human body. There is an upright position for eating and working with the laptop and a more reclined or lounge position for relaxing and sleeping.

Figure 1: The chaise longue seat of the Flying V using the vertical space in the aircraft cabin.

However, this seat needs further development. It was now made in a 1:1 mock-up and passengers could not sit on it. In addition, the moving mechanism was not functioning and was not designed in detail yet. The question remains whether this type of seat is feasible and accepted by passengers. In this paper, the seat is further engineered to see how the structure of this seat can be made and renderings are made of a more detailed aircraft seat and shown to potential travellers to get an impression on whether passengers are able to see the advantages and disadvantages. The research question of the paper is: 'are potential future aircraft seat users able to see advantages and disadvantages of the 'chaise longue' of a more detailed design?'

Engineering and detailed design

In detailing the design of the current 'lounge seat' of figure 1, it became clear that the construction will be heavy and hanging the construction on the ceiling is not feasible. Therefore, an alternative design was made and detailed. To make this seat as comfortable and minimalistic each piece of the Chaise Longue Design was engineered separately and optimised to reduce its weight while trying to keep comfort. The intention of the design is to keep the shape of the top and bottom rows as similar as possible so that in case of manufacturing those, the same moulds and machines could be used.

Figure 2: Exploded view of 6 seats indicating its modularity. The seat pan of the lower row can disappear under the back rest enabling in- and egress.

The design is modular, and pieces can easily be replaced without having to disassemble the whole seat structure (see fig.2). The headrests and the backrest are almost equal, except for an extra feature that enables the seat pan to be hidden under the backrest to improve in- and egress.

Figure 3: The headrest in the position with neck support and in the position with freedom for the neck.

Figure 4: the design of the back rest

The headrest has a U-shaped chin/neck rest that can rotate and has soft foam (see fig. 3). Franz et al. (2012) showed the importance of a difference between a neck rest and a headrest. The headrest is of harder foam. The length of the backrest (see figure 4) can be changed to create free shoulder space, which is important according to Goossens et al., (2003). The contour is based on the ideal shape found of Nijholt et al. (2016).

Figure 5: the seat pan

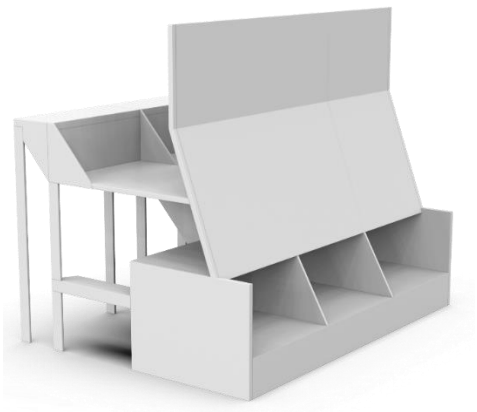

Figure 6: the basic structure

The seat pan was designed taking into account the human contour (Hiemstra-van Mastrigt, 2015). It has a soft front, which is inflatable as behind the knees the human is very sensitive (Vink & Lips, 2016) and because this area has the most variation if we overlay the various 3d scans of different humans (Hiemstra-van Mastrigt, 2015). For this reason the seat has a convex dent right at the back. Having designed the headrest, backrest and seat pan a supporting construction had to be designed.

This Double Decker Structure design took a long time because the calculation process was complicated. It should be safe and strong enough to withstand 15G (see fig 6).

How it works

The functioning of the Chaise Longue concept is divided into two main parts. The top row has a recline mechanism that is currently in use for the recline of aircraft seats (see figure 7). The backrest can be tilted backwards without taking knee space from the passenger behind it. The lower row mechanism is composed by two different mechanisms that have not been used yet in travel seats.

Figure 7: the top recline mechanism

Figure 8: The lower row sliding mechanism

Figure 8 shows the lower row seat sliding mechanism. For the seat pan, a telescopic or sliding mechanism is chosen that acts as a drawer. The passenger can change the position of the seat pan by pressing a button while pushing or pulling the seat to take it into the next position.

Method

To check the impression of passengers on these lounge seats an online questionnaire was sent to 49 participants. The participants had to rate the comfort of the lower and upper seat on a scale from 1-9, the impression for the in- and egress and the neck rest on the same scale. Additionally, they were asked to compare this seat to the current economy class seats (which was shown in a picture) and mention positive and negative points of the seats. A t-test was used to check statistical differences ($p<.05$).

Results

The comfort scores are not that high. The unreclined lower row scores on average 5.02 (stdv 1.70) and the unreclined upper row 5.46 (stdv 1.90). The difference is not significant ($p=0.23$). Both reclining positions score rather good. The reclined lower row scores on average 5.98 (stdv 2.22) and the reclined upper row 6.73 (stdv 1.45). The difference is significant ($p=0.05$). The difference between the lower row upright and reclined is significant ($p=0.018$; $t=2.40$) and for the upper row as well ($p=0.0004$; $t=3.68$). The in- and egress also show score that are not that high (5.02, stdv 1.74). The questionnaire also showed that 59.2% of the public would choose the Chaise Longue design while 32.7% would still prefer the current economy class seats. Others did not score a preference. The top row is chosen by most participants above the lower row (79.6%). This was surprising as the lower position has a more comfortable position for sleeping (see fig. 9), which is beneficial for a long haul flight.

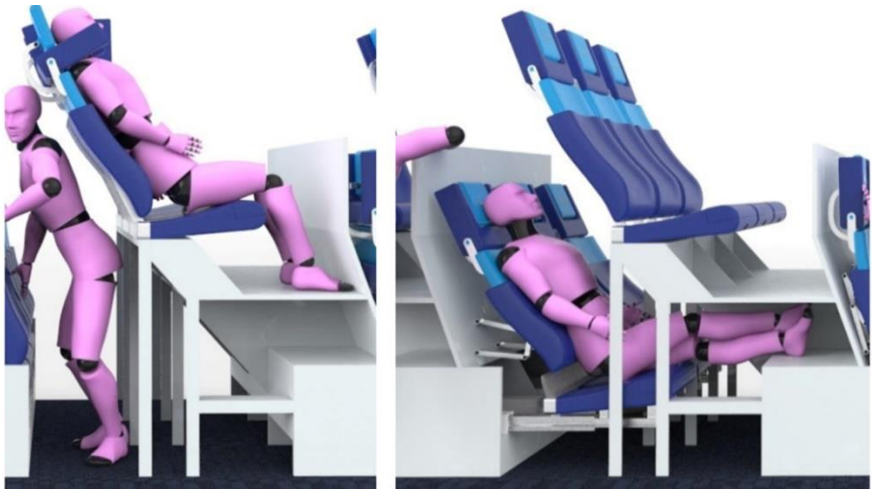

Figure 9: the reclined position in the top row (left) and lower row (right)

Discussion

This study indicates that the majority of end users did see the advantage of this new type of seat. In a previous version of the seat (Vink et al., 2020) the reactions were also positive. Although that version was hard to realize. The idea of using the vertical space is not new. An interior developed by Skift (2020) and one by Jacobs (2020) also use this space. These ideas are all conceptual and not flying. In this project, also, mechanisms and dimensions are defined, and calculations are made on strength and safety and human models are placed into the seats to check the anthropometric fit. However, also, in this case, further development is needed and prototypes are needed to check its feasibility. In addition, the passengers now rated the comfort based on visual impression. A working mock-up, which passengers could feel and experience, might give other outcomes and is in preparation.

The concept has new ideas that should be studied further, but they could have impact in the future of aircraft interior designs and comfort experience of passengers. Another advantage of this new modular concept where elements could be taken out, could be that passenger cabins could be used as small and medium cargo storage compartments (which is relevant in pandemic times). Although the modularity indicates an efficient manufacturing process, further prototyping is needed to check its manufacturability. Additionally, certification studies and research with participants is needed to check the feasibility further. Perhaps the main advantage and reason why this seat needs to be further developed is that the seat has been designed for the economy class on long-haul flights, which are more spacious, but take the same space as current economy class seats.

Conclusion

A seat using the vertical space in an aircraft has been developed, which seems to have potential. The first engineering step shows that it is still possible to make the seats. 59% of passengers preferred this seat based on visual impression. However, further prototyping is needed to check its feasibility

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