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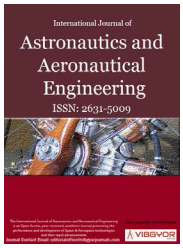
An Aircraft Interior Change to Improve the Passenger Safety Perception



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Abstract

In fact, the aircraft interior is rather safe with respect to viral safety. However, the perception of passengers is different. Passengers might be afraid of catching the COVID-19 virus or another virus while traveling. This study shows that especially the phase of eating without a facemask and the phase of disembarking with passengers rushing to the exit is experienced as unsafe. For the disembarking solutions are available, but solutions for eating next to other passengers in economy class are scarce. Therefore, solutions were developed and 24 potential passengers evaluated four concepts. Eighteen out of the 24 passengers preferred the 'roller blind', which is a kind of roller screen, which can be rolled out and can be attached to the seat in front of you. This separates your seat from the adjacent seat. Future research is needed whether it is accepted and whether the potential advantage is beneficial enough for airlines.

Keywords

COVID-19, Aircraft interior, Passenger perception, Design, Safety

Introduction

The coronavirus, which emerged worldwide in 2020, has raised concerns about viral safety in air travel. (2.) "According to the WHO (www.who.int), the virus spreads mainly between people who are in close contact with each other, typically within 1 metre (short-range). A person can be infected when aerosols or droplets containing the virus are inhaled or come directly into contact with the eyes, nose, or mouth. The virus can also spread in poorly ventilated and/or crowded indoor settings, where people tend to spend longer periods of time. This is because aerosols remain suspended in the air or travel farther than 1 metre (long-range). People may also become infected by touching surfaces that have been contaminated by the virus when touching their eyes, nose or mouth without cleaning their hands. (1.) However, the rates of infection inside an aircraft are extremely low due to high ventilation rates, the universal use of face masks and High Efficiency Particulate Air (HEPA) filters that remove at least 99.9% of virus aerosols inside an air cabin (Silcott, et al. 2020; Harvard APHI, 2020)." In addition, research by Harvard School of Public Health and US Transportation Command point to a low risk of transmission [1]. Aerosol contamination of an aircraft cabin by infectious passengers is anyhow a concern of passengers, aircrew and the aviation industry [2]. Today it is COVID-19, but in the future another virus might pop-

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up. International air travel has decreased by two-thirds, or nearly 1.5 billion passengers in 2020 only [3], due to ubiquitous travel restrictions, quarantine obligations or low willingness to fly related to the COVID-19 pandemic. Passengers also fly less due to the fear of catching the virus while traveling. There is a difference between the factual spread of the disease in aircrafts and the perceived safety of passengers. "Perceptions of threat are crucial and culturally uniform determinants of protective behavior". Humans often make decisions based on perceived threats that have not necessarily been materialized, or even completely understood [4].

(3.+7.) There are many ideas available to reduce the transmission of the virus. For instance, Vision Systems developed a lightweight transparent barrier to separate passengers (https://skiesmag.com/press-releases/vision-systems-unveils-a-fast-and-easy-barrier-solution-against-covid-19/), Lufthansa Technik developed a head protector that is installed in the middle seat (https://runwaygirlnetwork.com/2020/06/16/inside-the-agile-certification-of-covid-19-cabin-additions/) and Factory design proposes using the middle seat as the convertible space for ensuring social distancing (https://www.factorydesign.co.uk/aviation/isolate-a-social-distancing-travel-screen/).

This study focuses on improvement of the perception by changing the aircraft interior with COVID-19 measures.

Method to Selecting Unsafe Phases in the Flight

To get an impression on the phases during the flight that are experienced as unsafe interviews were used. Ten participants (6 passengers and 4 pursers) who flew recently (within 6 months before the interview) were interviewed. The semi-structured interview consisted of questions like: Which activities are the most important to address for increasing the perceived viral safety? what undesired on-board behaviours are present among passengers when flying during a pandemic?, and what aspects of the journey inside the cabin decrease passengers' perceived viral safety? Transcripts were analysed using Reflexive Thematic Analysis [5], which allows for identifying meaning patterns in qualitative data. To facilitate the process Quirkos software was used, allowing coding and grouping the interview transcripts into topics. Text fragments identified as important for the research were selected and succinct labels (codes) were assigned.

Results and Discussion to Selecting Unsafe Flight Phases

From the interviews, several phases during the flight were mentioned as unsafe. Figure 1 shows an overview with the phases of a flight that are experienced as most unsafe. Eating next to someone and disembarking seem the situations

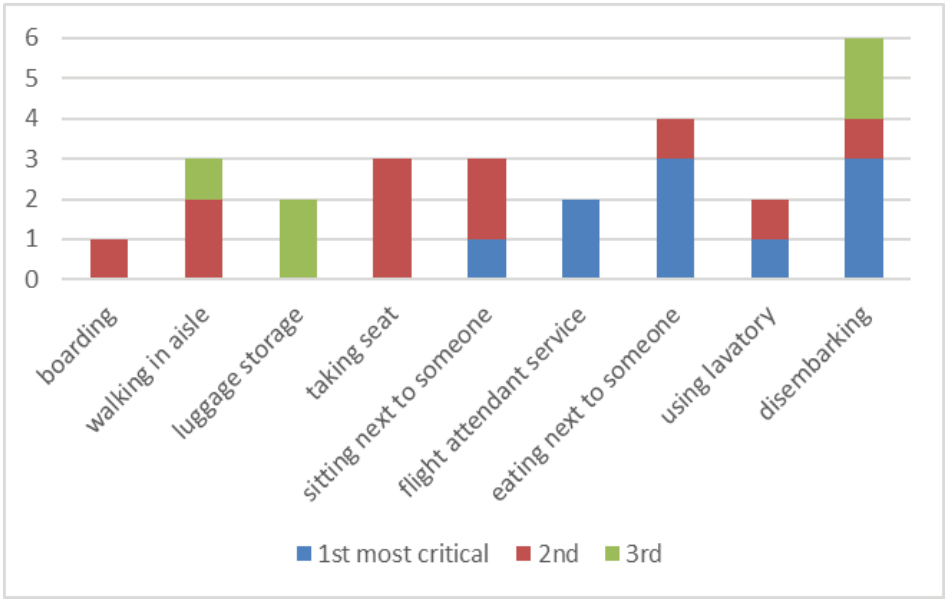

Figure 1: The number of persons mentioning an unsafe situation in an airplane. 1st most critical means the most important unsafe situation, 2nd means second most important and 3rd most important.

that are experienced as most unsafe. In the interviews, having the meal on the plane is seen as unsafe as the covid mouth mask is removed and airflow might be disturbed. This is also reported in other studies. According to Khatib, et al. [6] a main concern during flying stems from eating in proximity to others within an enclosed space. Khatib, et al. [6] also point to a study published by the Centers for Disease Control and Prevention (CDC), which suggests that adults diagnosed with COVID-19 were twice as likely to have dined at a restaurant.

The disembarking is seen as unsafe as passengers want to leave the airplane as soon as possible and there is too much physical contact by people rushing to the exit. This is not a new finding. The fact that the likelihood of passengers coming into contact with each other is high during boarding and disembarking is already described by Mangili, et al. [7]. However, several solutions for boarding and disembarking are described by using for instance the reverse pyramid method for boarding and deboarding enlarging the distance between passengers. Milne, et al. [8] describe six new boarding methods and all new boarding methods reduce the level of the health risk from COVID-19.

For on board eating the number of solutions is still limited and in this paper, the decision was made to develop and test solutions for this phase in the flight. During eating, the feeling of safety is reduced, but it is not only the feeling of safety as there are indications published by CDC that the virus spreads during dining. The research question is: is there an aircraft interior solution aimed at reducing the perception of being infected by the COVID-19 virus while having a meal on the plane?

Method

The design vision was to develop a proof of concept for an economy class interior product, which increases the perceived viral safety when consuming food. The product should be comfortable in use, without impeding the existing viral and emergency safety. The product should be optimized for low environmental impact and a retrofittable design is preferred for greater versatility. In order to facilitate the development of a solution a brainstorm session with aviation experts was organized, current existing solutions were studied and prototypes were developed and tested with travellers using virtual reality to define solutions that evoke a sense of safety. After rapid prototyping nine potential solutions that are shown in Figure 2, the decision was made to develop four promising ideas further that could be tested in VR with test subjects.

Four concepts are chosen using the selection criteria: Perceived safety, virus safety, interior safety, sustainability, maintenance (including cleaning), convenience and cost. The selected concepts are a (see Figure 3):

- Foldable headrest, a headrest that allows for

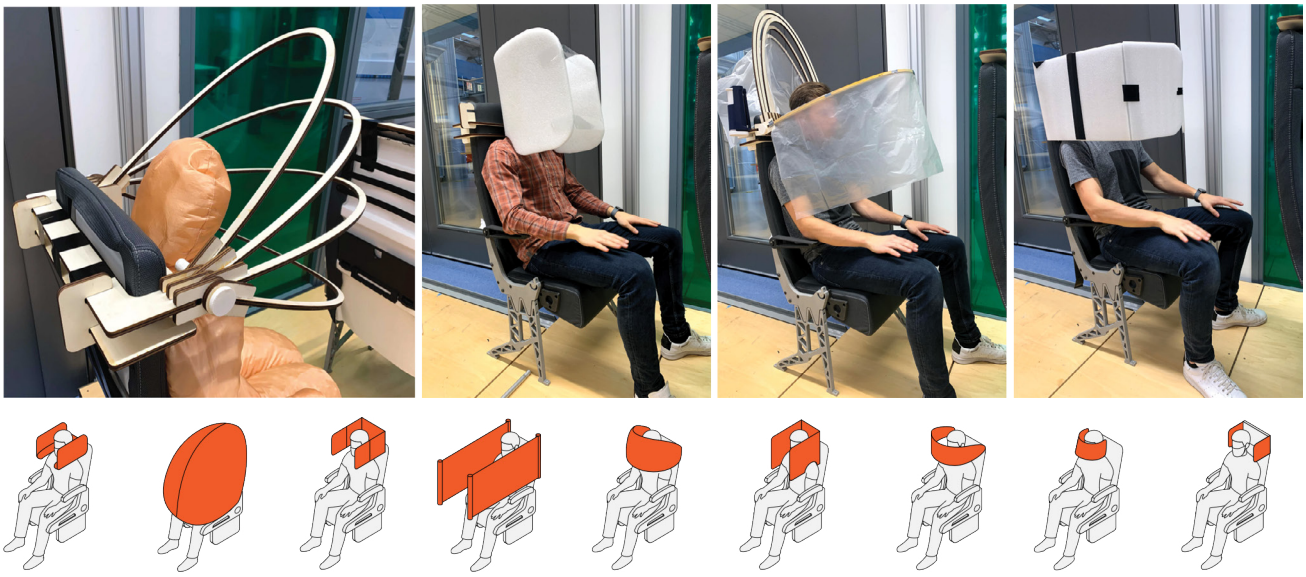

Figure 2: Nine rapid prototyped ideas (lower row) to explore possibilities for safe eating in an aircraft. Four examples of prototypes are shown in the upper row.

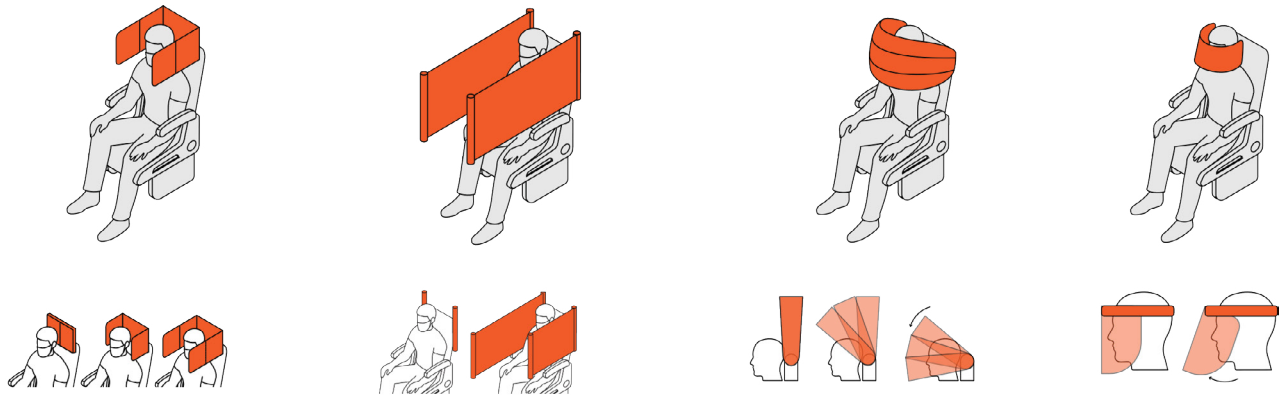

Figure 3: The four concepts that were developed further. From left to right: Foldable headrest; Roller blind; Head cover; Visor.

flexible separation. Side flaps can be expanded to provide different levels of privacy.

- Roller blind, a semi-transparent roller blind that gives privacy and protection by rolling out the fabric.
- Head cover, a cover that protects the head, additionally limits the access of light.
- Visor, an on-head visor that can be expanded to provide protection when eating.

As the experiment was performed during the COVID-19 pandemic, the test participants could not come to the Boeing 737 where the prototypes were built. Therefore, tests were done using VR. Four prototypes were made and from inside the prototype a movie while eating was made that could be shown in VR to participants. Omni-directional videos were used, created in the cabin of a Boeing 737, using an Insta360 Nano S camera (Arashi Vision Inc.) connected to a smartphone (Apple inc) and attached to the head of the recording person.

The video and VR goggles were sent to the participants testing the four solutions. The test began with the instructions on how to set the VR mode on the smartphone and install it in the VR goggles. A short introduction was then presented to familiarize the user with the aircraft interior by VR. This was followed by an "introductory flight" where users could get used to the immersive experience. This part concluded with completing the first part of the survey with general questions (like age, number of flights etc.). Then prototypes were presented to the participants in a systematically varied way. After each concept, the screen asked the user to complete the corresponding part of the questionnaire, which was activated by scanning a QR code.

A In this part of the questionnaire questions like

- How safe from viruses would this concept make you feel during eating? Please explain your choice. (5-p Likert)
- Do you consider this concept convenient to use? (5-p Likert)
- Would you be willing to pay more for the flight with such a solution? Please indicate what would be your maximum (%) amount of a ticket price. (5-p Likert)
- Would this solution make you more willing to fly during pandemic? (5-p Likert)

were asked. In the final part of the survey, participants could select their preferred concept and give general feedback on the study. The participants were asked to sign an informed consent and the ethical committee of the Delft University of Technology approved the protocol of the study.

Results

Twenty four participants were willing to participate in the study (age 20 to 55; Took a flight in the last 2 years). An example of the VR view the participants had is shown in the snapshots of (Figure 4). Three of the four solutions improved the feeling of viral safety when eating (see Figure 5). Only the foldable headrest created a lower feeling of safety (on average). The roller blind had the highest score. The preferred solution was also the roller blind as 18 out 24 participants chose it. In the roller blind, there was a general appreciation of the fact that a large area is covered. Most respondents

Figure 4: Two snapshots of the video seen by the test participants.

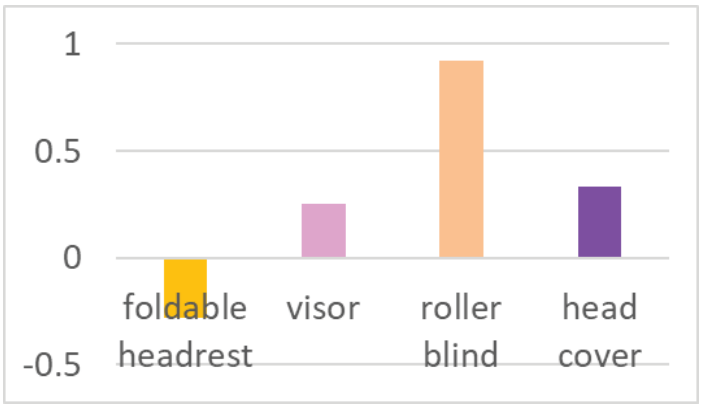

Figure 5: Average score for the feeling of viral safety when eating (participants could score -2= Very unsafe to +2= Very safe; 0 = neutral).

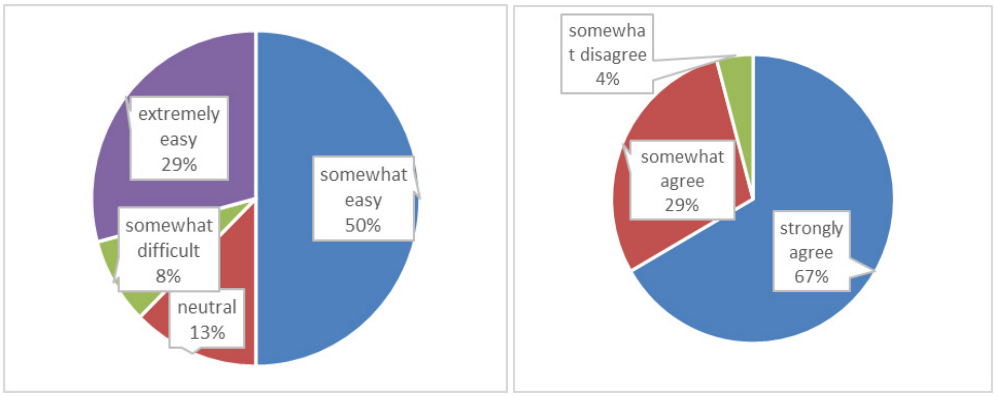

Figure 6: General comments on using VR. Left: The answer to the question: How easy/difficult was it to complete the test? Right: Was there enough information to evaluate the concepts?

believe that this area provides protection and privacy. One out of four participants felt that the food was protected and one participant pointed to the good use of the ventilation system. In terms of convenience, respondents said it is easy to use and it provides a secluded space. (4) There was a relatively low feeling of claustrophobia, with most responses ranging from “not at all” to “a little”. There were concerns that the solution could be a nuisance when a fellow passenger had to leave the seat. Participants reported also that using it might seem rude or annoying to co-passengers, but it might also prevent awkward conversations. One third said that they would pay up to 10% more for

the ticket. One out of six claimed that they would be definitely more motivated to do so. Nine out of 24, about 37% claimed that they would be probably more willing to fly during a pandemic with this solution and 4 out of 24 chose “definitely more”, which means that they would be definitely more motivated to do so.

There were also general comments on the use of VR for this type of research (see Figure 6). Two third mentioned that there was enough information to evaluate the concepts. There were also comments like that the materials provided were clear and that the use of virtual reality allowed for a proper assessment of concepts. It was also mentioned that physical concepts are preferable for more thorough testing.

Discussion

As was mentioned before, eating in the airplane during the COVID-19 is perceived as unsafe. It is not only the feeling of safety as there are indications by the CDC that the virus spreads during dining. Out of four concepts, a promising solution selected by 24 potential passengers was the roller blind, (1) which may increase the perceived safety among passengers, by providing a separation from other passengers, additionally being an ad hoc antimicrobial barrier limiting droplet exchange in the lateral direction. This is especially relevant when eating, when the feeling of safety is among the lowest. It could also fit within the current airflow in the airplane, which was mentioned by a participant as well. The airflow in the seat area is vertical and in the downward direction [9,10], but proper testing needs to be done to test this hypothesis. A separation screen is not new. The use of a separation screen is also used in surgery to reduce droplet spread during the surgey [11].

This project did lead to a further embodiment of the chosen concept as is shown in Figure 7. Of course, further research is needed, whether this concept really reduced the spread of viruses while eating in an airplane and whether it would stimulate more passengers to fly again, also when

Figure 7: The embodiment of the by 18 out of 24 participants chosen concept. It is applied to the Rebel seat of the Flying V [12].

the COVID-19 pandemic reduces in size [12].

During a pandemic, when the perception of safety is influencing the choice of whether you will fly, the roller blind could influence this choice. Providing a roller blind for every flyer may improve the airline's image as a safe carrier. However, as the confidence in flying is likely to increase after the pandemic, there might be less demand for virus protection on the future flights and an option is to only install the roller blind in a number of seats. This idea is supported by a study of Inmarsat [13,14] in which 27% of the respondents showed confidence in flying again six months after the pandemic subsides. Furthermore, one out of five participants stated that they are very satisfied with the current airlines' response to the pandemic. This indicates that not all passengers will need a divider to feel safe in the aircraft cabin. This is important for the implementation strategy, as optimizing the number of dividers saves costs and limits the CO_2 emissions.

A potential benefit for an airline by introducing such a product is an increased willingness to fly among customers. As was stated, one out of three test participants claimed that they would be probably more willing to fly during a pandemic with this solution. This indicates that airlines implementing this solution in the aircraft may contribute to restoring confidence in flying, and in consequence, support the recovery of the aviation industry.

Limitations

(4,B) The limitation of this study is that participants might have had insufficient sensory input to assess the concepts thoroughly. In the VR test, passengers do not feel the limited space and might have the perception of more freedom of movement. Further tests with physical prototypes may reveal additional data regarding comfort, freedom of movement and claustrophobia.

(5,6) Safety concerns - emergency

Assessing a product's compliance with safety requirements requires a series of extensive tests that would have to prove that the concept is reliable and intuitive in everyday use, and also safe during an evacuation or in the unlikely event of an accident. As the product is fixed to a seat, several regulations have been identified by an expert as crucial for implementing such a product: Static load test (25.561), Dynamic Load Test (25.562), Physical Injury test (25.785).

(3) Airflow

Air circulation in commercial planes is tightly controlled and this type of product may cause disruption to the airflow. This may prove either beneficial or deteriorating for the viral safety of the cabin. No assumptions can be made about the advantageous droplet propagation properties of the device without thorough testing with particle generators and/or CFD simulations. These may indicate possible product design improvements or an adaptation of the airflow in the aircraft cabin to work effectively with the product.

Conclusion

This study shows that the phase of having a meal and disembarking is perceived as unsafe regarding the COVID-19 virus. Eating without a mouth mask close to the neighbour feels unsafe as well as disembarking with passengers rushing to the exit. For the disembarking solutions are available, but solutions for eating next to another passenger in economy class are scarce. Several solutions are developed in this paper. Among these solution the 'roller blind' the perception of passengers id most safe. This is a screen, which can be rolled forward and attached to the seat in front of you. This separates you from the eating neighbour. To see whether the potential advantage is beneficial enough for airlines future studies are needed.

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