

Post-Pandemic Flight: Establishing the Mission of The Aircraft Cabin of the Future from a Passenger's Point of View

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In the scope of InDiCaD (Innovative Digital Cabin Design), a project at German Aerospace Center (DLR), research has been done on the impact of the Covid-19 pandemic on the willingness of the passengers to fly under the given circumstances. The research covers three scenarios; firstly, one where Covid-19 has left no traces, secondly one where the consequences are enormous and thirdly, one where the passengers are still willing to travel, albeit with an extra set of demands concerning their health. These scenarios were used to create a mission definition for the cabin of the future as well as to establish fictional persona's, representing the passengers of the future. To conclude, couple of rough ideas resulting from the research is shown.

Innovation in Cabin Design, Mission definition, Design thinking method, User research, Context research, Human factors

Introduction

On 31st of December, 2019 a new virus was identified by the health authorities in Wuhan, China [1]. At the time this paper is written, a full year later, that same virus, COVID-19 has the whole world in its grip. The death rate is high, just as the infection rate [2]. Scientists from all around the world are working day and night to produce an effective vaccine, and around late autumn 2020, first specimens are approved by various medical boards [3]. Still, due to the production limitations as well as admission limitations, it will take quite a while to vaccinate enough people to eliminate the threat of a new outbreak of the same virus.

However, even if the human population is vaccinated enough to eradicate this particular virus, the previous outbreaks of SARS in 2003 and MERS in 2012 are good indicators that these kinds of pandemics just might reoccur in unpredictable intervals [4]. The fear in the broader public of getting infected or spreading the infection is almost palpable and it affects the daily life of people from all levels of the society [8]. This most certainly has its impact on air travel [5]. Passengers are less willing to sit in a cramped-up space which is what eco class has been until now [6] and even the health and safety regulations have posed certain requirements (social distancing being one of the most stringent) to the cabin space in order to ensure safe travels as possible [7]. At German Aerospace (DLR), Institute of System Architectures in Aeronautics, Department of Cabin and Cargo Systems, the main goal is to develop and design innovative solutions that will increase passengers' comfort and experience in future aircraft

cabins. This is done by means of extensive research and conceptual design, where, following the methodology of Design Thinking [9], the user has a central role. The research and design of the innovative cabin concepts are captured within a constellation of different projects and are currently all governmentally funded. In this particular case, the research has been done within the scope of the project “Innovative Digital Cabin Design (InDiCaD)”, with a team of experts with various backgrounds. The aim of the project is to create an environment which is up to standards of future air travelers. Their needs and wishes are extrapolated from extensive research performed both in-house and with non-DLR participants. Aiming to please the passenger of the future however, also requires taking the current events into account. The consequences of COVID-19 do not fully determine the outcome of the project, but they do play an important role in forming the foundation for the entire road map.

In this paper, the method for the determination of the requirements for a future cabin concept are explained and the results, called cabin mission, are shown. Following that method, during the Empathize phase, research has been done on the current trends in the ways of and reasons for travelling. In the Define phase, the scope and the focus of the design space are determined. This paper concludes with a brief look into the Ideate phase, where first ideas are generated which could solve the identified problems. To wrap up, an outlook into future work within the project will be given.

Determining the cabin mission

Design approach

Within DLR's Institute of System Architectures in Aeronautics, the authors of this paper form a design group called “the Cage”. Currently, the group holds expertise in Product Design, Cabin Design, Context- and User Research and Ergonomics. The central goal of the design group is to enable progress in the field of cabin design by focusing principally on its main users, being passengers and the crew [10]. The main driving force behind the design process is the Design Thinking Method, adapted to the specific requirements of aircraft cabin design. By following the steps described by this method, the user and his/her needs are kept central throughout the whole process. In this chapter, the first two steps of the method will be described as they are adapted to this particular project, together with the outcome. To begin, the Empathize phase will be discussed, where the user context will be determined. Here, questions concerning the reason for travelling and reasoning behind choosing the means of transportation will be answered. In addition, the societal developments and trends will be observed, as well as their potential influence on air travel. Furthermore, the recent development of the aircraft cabins as such will be considered to provide a full basis for defining a cabin mission. The outcome of these three components of the user context will result in a cabin mission definition matrix. The matrix will serve as a direct input into the Define phase, where the design space will be determined. This is necessary to achieve the so-called point-of-view (POV). The POV narrows down the problem and defines the right challenge to address [9]. With the POV, the dispersed data gathered during the Empathize phase gets directed into insights needed to tackle the given challenge.

Who, why and how of travelling: The Empathize phase

From a research conducted among over 5000 passengers over the course of 3 years, design experts from SeymourPowell were able to distill three new passenger groups, each with their own set of needs and requirements [11]. The Nomadic business woman persona covers the needs of a business woman, often making work-related trips. The Solo-socializer describes a person willingly undertaking longer trips to learn new cultures and meet new people. The last group is identified as the Luxploring family; families with young children where parents feel the need to get their children acquainted with other cultures as soon as appropriate and possible.

In-house research has shown that there is a slow but eminent change in the way people travel and the reasoning behind it. There is a vast amount of people turning the so-called flight shaming into a positive “train bragging” [12]. Especially the younger people, belonging to a group popularly known as “Millennials” are aware of climate change and its impact on the world. Especially in Europe, summer travel by train is more popular than ever. According to a study done by Eurail Group, trains are used in 78% of the cases by families and 44% of the cases by groups of friends. This implies that train travel appeals to people with various backgrounds and age groups [13]. Different sources imply that people are becoming aware of a phenomenon called overtourism. Overtourism, also known as overcrowding, is perceived congestion of a single location at the same time [14]. This results in travelers seeking for a more authentic experience and travel to less known regions

Several other sources also state that personalization is a very important factor for the travelers, illustrating the desire for a one-of-a-kind experience [15]. The way traveling is currently organized, together with what it has to offer in means of comfort and experience, seems to be less than satisfactory for the travelers of the future. In addition, people are more willing to compensate for the additional CO2 emissions caused by their journey. Also, the forecast is that travelers will be more inclined to be detached from their mobile devices, to reconnect with the outside world [16]

During early 2020 research concerning air traffic development, it appeared that until 2038 there will be more single aisle aircraft [17], a steady growth of passengers [18] and regional traffic will become more important, most of it occupied by business passengers [19]. However, this is based on data gathered before the COVID-19 virus was globally spread and its influence on air traffic was known. Early November 2020, Song and Choi have published A Study on the Behavioral Change of Passengers on Sustainable Air Transport after COVID-19 [6], where they point out five factors which directly influence willingness of the passengers to fly. According to the study, a vaccine for COVID-19, requirements for self-isolation, circumstances at the destination, the social atmosphere with regards to overseas travel, and level of disinfection measures employed in the aviation service sector are critical for the recovery of air travel. These findings have been confirmed by results of a series of in-house workshops on the perception of the current situation and the forecast for the future, performed with people having various backgrounds. From those workshops, it became clear that the current way of working remotely is experienced as quite effective and most of the meetings held in-person before are more or less seamlessly replaced by video conferences. This is also partly confirmed by an article in Nature, which states that the obstacles of technology readiness are overcome in the meantime. Most of the events were also executed in the early period of pandemics, making them solve the

problems for the ones to come [8].

These recent developments indicate that something needs to change drastically in order to revive air travel. The playground is colossal and the stakes are high.

Making sense out of alleged nonsense: the Define phase

According to the Institute of Design at Stanford, “Framing the right problem is the only way to create the right solution” [20]. In other words, to make some sense out of the vast amount of data collected and to provide a sensible solution to the passengers especially in these unprecedented times, narrowing down is highly necessary. With the intention of creating order in the chaos of gathered data, a twofold approach was taken. To begin with, factual data accumulated during the research, is categorized as-certain factor and is classified according to the seven umbrella classes: Airlines & Flight routes current state, Past cabin developments, Future forecast, Infrastructure, Passengers, Other transport, Risk factors. Following the process of pairwise comparison, the factors are weighted on their influence on future flight missions (Figure 1).

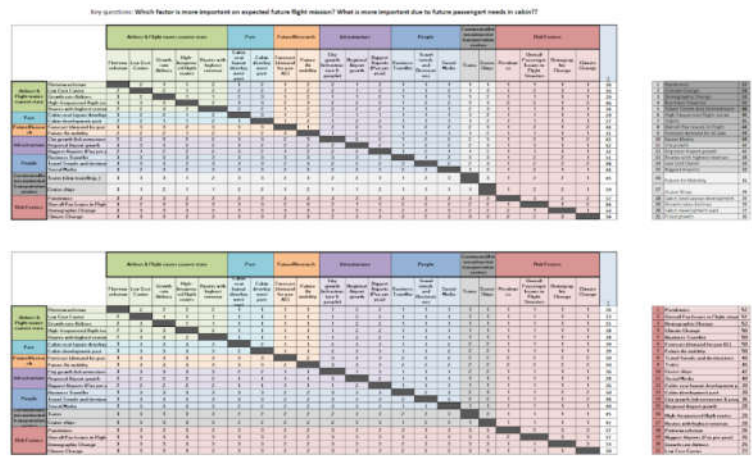


Figure 1. Pairwise comparison of the factors for future flight missions
 High-resolution picture available upon request at the main author

Based on the results from literature research explained in the previous chapter, each of those factors are given a weight in range one to three, where three implies the largest impact on the expected future cabin mission, and one the smallest impact. As figure 1 shows, these factors were measured twice: once without the influence of pandemic, and once with. The influence of the pandemic is derived from the more subjective side of data, being reactions from the workshop participants and articles from the daily news. As there are two main elements deciding on the cabins’ overall appearance, namely distance flown and passenger capacity, the impact of the aforementioned factors is measured for each of those elements separately. This results in two matrices, as shown in figure 2. For both matrices, three different possible outcomes

were chosen: a world without Covid-19, developing as forecasted in late 2019, a world after Covid-19, where passengers are still very cautious when it comes to air travel and an extreme scenario, where the current circumstances still hold and have disastrous consequences for civil aviation. Third scenario implies developments in the civil aviation which are not feasible in the short term. Therefore, the scenario was dropped, as it exceeds the scope of the project. Narrowing down the implications of the remaining four possibilities (2 scenario for each matrix), two sets of overall requirements are distilled. These are called cabin mission definitions, similar to an aircraft mission definition. In aviation, the latter coarsely describes the purpose of a particular aircraft. In this case, a Cabin Mission Definition does the same for a particular aircraft cabin. Table 1 shows the descriptions of the two mission possibilities. However, this only covers one side of the challenge. To form a complete resolution on this subject, input from the passengers, containing their needs, fears and views on the matter have to be incorporated as well. This is done by executing a series of workshops and interviews with representatives of different layers and groups of the population, with variation in age, gender and professional occupation. Resulting are seven fictive personas, each depicting a certain demographic group. In figure 3 a short description of each persona is given.

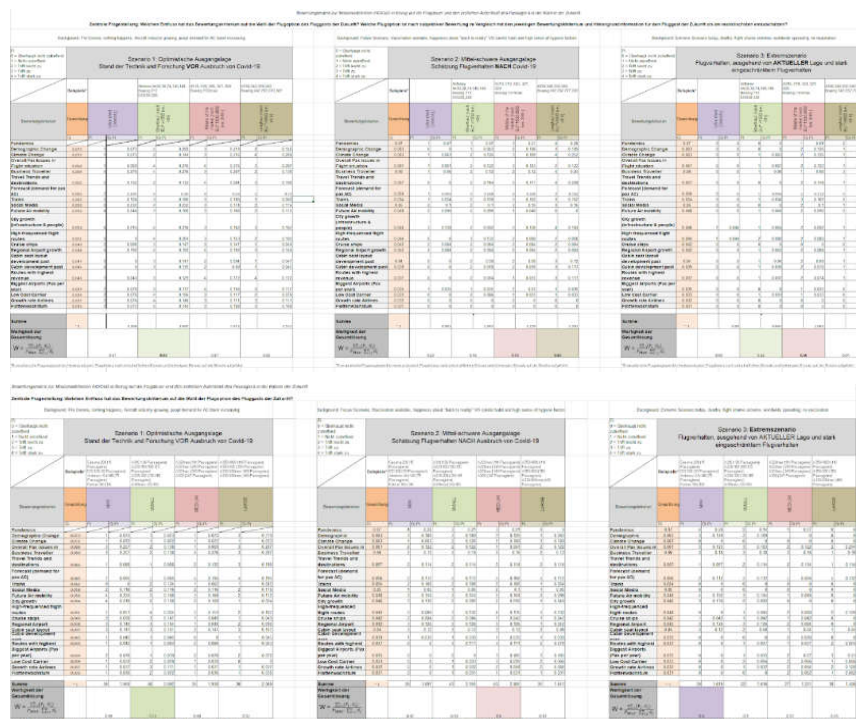


Figure 2. Scenario Matrices, uppermost being the distance matrix and the lower the passenger capacity *High-resolution picture available upon request at the main author*

Table 1. Overview of the two cabin missions and their properties

<p>Mission 1: Optimistic point of view Background: Pre-Corona, nothing happens, Aircraft industry growing, people demand for AC travel increasing Short-haul < 1500km, 3h</p>	<p>Mission 2: Semi-Optimistic point of view Background: Future Scenario, Vaccination available, happiness about "back to reality" versus careful habit and high sense of hygiene factors Long-haul >3500km, 6h</p>
<ul style="list-style-type: none"> - The demand for short-haul flights is increasing worldwide (as of February 2020) - The business flight sector is an essential factor here, - Flying is becoming increasingly safer and is a strong competitor for fast travel compared to rail or car - Trends also point to local thinking, so that nearby travel destinations are becoming increasingly attractive - The increased presence of low-cost airlines and low ticket prices mean that there is an increased need for maximum occupied, sometimes "high density" economy class and single aisle cabins with maximum seating 	<ul style="list-style-type: none"> - "If you fly then only long distances" - For short-haul travel, train travel will replace aircraft - Long stay in the aircraft in the wake of the overcome pandemic is bearable - Business travel tends to be less frequent, home office is also possible, plane only for intercontinental travel - No great confinement in long-haul aircraft - Travel within Europe as a trend, too long travel time for trains - Discover the neighboring European countries - Longer air travel more sustainable, short distances can also be done by train - Flying as a luxury again, more time on long-haul flights and the more time-consuming boarding due to corona checks

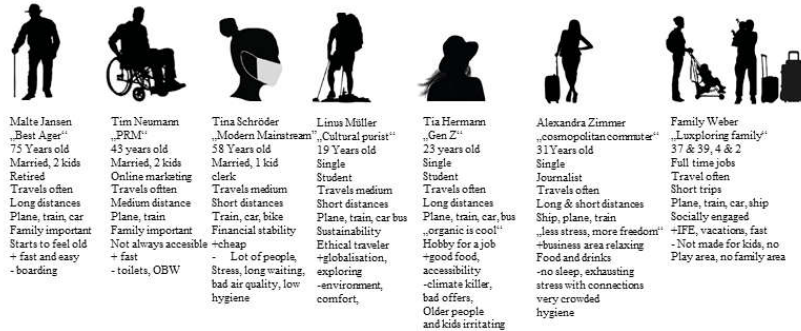


Figure 3. Short description of 7 personas

Each persona has provided a set of requirements on the expected comfort level during a flight. Although the participants of the workshops have also offered a lot of data on the booking process, waiting times on the airports, boarding protocols and alike, these were omitted in the creation of the depicted personas, as they do not fit the scope of the project. This data is stored for future purposes.

Turning raw data into visual results: the Ideation phase

The main results of the first two phases can be summarized in three conclusions. The most striking conclusion is that the need to travel once again can be expected, especially in the Western Europe. This holds more for long-distance flights. Short distance flights are inclined to be replaced by train travel, if they are deemed necessary at all – business travel, which counts for the largest part of the short-haul flights, can to a

large extent be replaced by video conferences. However, another result is that, even in the case that the virus is officially contained or even eradicated, there is a strong desire for passengers to be able to keep their distance to their fellow travelers. At this point in time, this seems to be a long-term effect and it is hard to predict if this is prone to change in the future. This distancing can be translated in for example organized boarding and deboarding, cutting down the queuing time in close vicinity to each other. In addition, the possibility of separating a sick passenger from the rest of the cabin attendants is seen as a highly valued expansion of cabin comfort [21]. Following a similar pattern, third category can be classified as “clean and contactless”. During the workshops and interviews, an extreme need for cleanliness and sterility of shared spaces (e.g. toilets) was clearly voiced. Cleanliness needs to be obvious from the design of the space, such as no narrow edges where dirt can accumulate, and no difficult to reach corners. Also, the level of cleanliness has to be communicated to the passengers, if desired. Self-cleaning materials are preferred as well as the usage of UV lamps for disinfection as most reliable and human- and environment friendly method. Contactless control of functions in the cabin is desired, when not possible, then by means of touchscreen instead of physical buttons.

Combining the requirements gathered from the personas and the requirements resulting from the two scenarios, a top-level cabin requirement list (TLCRL) has been created. It contains over 180 different requirements necessary for a cabin to provide the majority of the passengers with the intended comfort and safety level as well as new travel experiences (Due to its sheer extensiveness, full list is available upon request at the main author). This list is targeted at concept design level, meaning that implications of a singular requirement on different cabin systems responsible for their potential fulfillment are not considered yet. When translating the aforementioned results into implications they could have for the cabin and seat arrangements, a couple of low hanging fruits emerge. For example, avoiding the long obstructions of the aisles can be achieved by removing the hatracks and widening the aisles, fitting the personas 1,2 and 7. Increased seat pitches along with the avoidance of so-called “excuse me seats” (seats where a passenger has to ask for passage to get to the aisle) also provides an enlarged sense of comfort and private space, according to the demands from personas 1, 3, 5 and 6. In figure 4, three ideas are presented which respond to the posed implications.

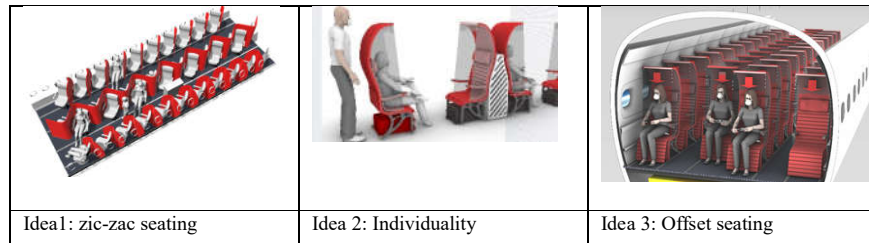


Figure 4: three cabin design ideas based on the acquired data

This is just a small grasp from a wide spectrum of the possible solutions to the posed challenge. The design team has created a vast portfolio of varying ideas providing solutions to one or more of the identified requirements, the ones standing out the most will be presented at the conference.

The road ahead: Next steps and further directions

At the time of presenting this paper on the conference, the idea portfolio will be completed and the phase of the design process will be well underway. This portfolio contains mostly partial solutions to one or more challenges, addressing the problems more in detail. To create a complete cabin which complies to most of the requirements, another step in the design process needs to be taken. The partial solutions are classified in the portfolio by means of a so-called morphological chart [22]. By carefully selecting the most promising partial solutions and combining these, a general solution in form of a complete cabin concept will be formed. Per scenario at least one full concept will be created. The final design touch is done by Rhino3D, where the concepts are translated into rendered and parametrized 3D models. As such, the concept will be handed over to the experts in the field of structural integrity, aircraft materials and airport management, for testing and simulation purposes. The concepts are then expected to return to the design team, together with feedback on feasibility from the aforementioned experts. After implementing the feedback, concepts will be tested with potential users in the form of Virtual Reality models.

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