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## PROCEEDINGS



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# PROCEEDINGS

# THE EXTENDED COMFORT. ANALYSING THE FLIGHT JOURNEY THROUGH A DESIGN-ORIENTED APPROACH.

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## ABSTRACT

*The study of passengers' comfort on an aircraft is a research field that has been able to accommodate both quantitative contributions, deriving from disciplines such as ergonomics, and qualitative contributions coming from product design. In recent years, design research has also focused on experiential and perceptive aspects, considering disciplines such as Interaction Design and User Experience. In the first instance, the paper aims to systemize the different design-oriented approaches that generated a complex map based also on the support of visual narration. In the map the flight experience is treated as if it was a service, analysing the entire customer journey to highlight the most critical issues. The methodological steps, based on the analysis of the activities, as well as those based on the optimization of the components, are then integrated into a holistic vision. The system has been created on the basis of case studies drawn from aircraft currently in service and from still embryonic concepts, capable of providing useful categories of analysis. The paper ends with the application of the map to an application study case: the CASTLE project (Cabin Systems design Toward passenger wellBeing).*

**Keywords:** User Experience, Customer Journey, Comfort, Interaction Design

## 1 INTRODUCTION

The concept of comfort intended as perceived, experienced, felt, or even simulated and induced on board an airplane has been a topic debated at scientific level for many years. Some scholars date back this kind of scientific interest to the increase in air traffic and to the consequent birth of low-cost airlines. In fact, they maximize the number of people transportable on board in order to lower the costs and, consequently, reduce space per person to a minimum [1]. The comfort issues in the current airlines context, however, cannot be limited to the only low-cost companies, but involves the entire sector in which, of course, economic classes appear to be disadvantaged. It also seems reductive, according to the scientific literature consulted in this regard, to consider comfort as an aspect that only involves the design of the seat; although most of the onboard experience actually takes place on the seat with few or limited possibilities to move inside the cabin. Many authors try, in the first instance, to give a definition of comfort and discomfort, debating about objective and subjective evaluation criteria but, above all, facing with a linguistic problem. Some articles, for example, introduce the concept of comfort by quoting some dictionary definitions, but comparing some of the main definitions many differences immediately appear. In the Italian encyclopaedia Treccani, for example, the word comfort seems to refer to the services offered or to a series of optional products. In the two cases found on UK dictionaries, i.e. Oxford and Cambridge, it is defined as “a state of physical ease and freedom from pain or constraint”, or

“the easing or alleviation of a person's feelings of grief or distress” [2] they assume an initial state described as negative. Comfort is described as “freedom from pain, well-being” in Dutch dictionaries like the Van Dale 2000 [3]. Those definitions clearly are not part of academic researches, but they show how difficult it is to agree on a unique concept of comfort in everyday life. This section concludes by pointing out that in Italian, for example, the word associated with the comfort of a seat is "comodo" whose meaning is described in a similar way to comfort: “it does not disturb or bother, which is in harmony with our desires and needs, it is therefore appropriate, easy, convenient”. But the etymology refers to the Latin "commodus"- in compliance with the measure - and in the same definition, concerning an armchair, it is written "wide, soft, where you feel at ease" [4]. Therefore, the mentioned factors clearly refer to characteristic features of a material, to ergonomics, to size but also to the parameter, which is often difficult to quantify for usability and user experience, called user satisfaction.

## **2 THE ON BOARD COMFORT IN LITERATURE**

The first attempts to define comfort and discomfort date back to the late 1950s when Hertzberg describes it as a neutral feeling, or a state without discomfort [5]. More recently, Zhang et al. clearly separate comfort and discomfort, excluding that one is the negation of the other and highlighting how they are dependent on uncommon factors [6]. Discomfort would enclose and derive from by physical constraints generating emotions like pain, soreness, numbness and stiffness. Comfort, on the other hand, would be associated with relaxation and well-being, and can be influenced by, for example, the aesthetic impression [7]. In both cases comfort is considered a personal perception, but from the design point of view, although formal languages are one of the bases of aesthetics, it is necessary to dispel the doubt that such languages alone can generate comfort and can be disconnected from other aspects. In many studies Vink et al. [2] state that comfort is not only an important factor, but that it strongly impacts on the loyalty of the user, while the discomfort has a negative impact on the human well-being and human performance, placing itself as major cause of dissatisfaction. Starting in the early 2000s, comfort began to be linked to other factors such as the context of use and scholars attempt to correlate the impact that certain components of the aircraft may have on comfort. Vink and Hallbeck [8], as well as De Looze et al. [9], agree on the definition that describes comfort as an interaction between a human and a product within a context. At the moment, one of the most holistic definitions, both from the point of view of the factors mentioned and due to its scalability, is the one written by Li et al. which defines comfort as a “complex and dynamic construct, associated with physical, psychosocial, physiological, cultural and social element, as well as environment and situational elements. From the time dimension, comfort can be studied in different durations, the first sight comfort, short-term comfort, and long-term comfort” [10]. This definition insists on the main factor that comfort varies depending on the time elapsed and is different between a flight of a few hours and a long-haul one [11]. Therefore, if a first literature review dated 2005 showed how 140 out of 261 papers on the subject of comfort belonged to the climate or thermal comfort category and only 28 dealt with physical comfort including seating, posture, physical loading, and foot pressure measurements; currently, humanistic and psychological aspects are more considered, showing how these influence the way in which the passenger understands, acts upon and experiences their surrounding environment. Even because they are supposed to change their modus operandi, adopting new strategies during activities, in order to elaborate future actions. In general, aspects related to the seat are more in-depth analysed in the literature, including project verticalizations on the correct cushions to be used or on the playful interactive experiments to stimulate passengers to move [12]. Instead, all the studies that research the ways and tools to distract passengers should be considered under the cover of strategies to

mitigate discomfort, in this article we only mention the use of VR [13] or rather the frequent administration of food and drinks [14] that, however, appears more suitable for long-term flights. It is worthwhile to cite the research by Menegon et al. [15] that shows how various aspects can contribute to the perception of comfort. For example, the level that the authors define as without-comfort is strongly connected to: “experiencing wellbeing while seated; a good seat; feeling relaxed in the seat; the back was comfortable on the backrest; the aircraft was silent”. Instead, the category defined as maximum-comfort is dominated by the psychological aspect like feeling pleasure while seated and more comfortable than expected. Many authors, in fact, agree on the conclusion that pleasure and exceeding expectations act as triggers for positive emotions for the segment of passengers who experience the highest level of comfort in the aircraft seat. As many authors concentrate their research looking for a correlation between an element, or factor, and comfort, others, in smaller numbers, attempt to create a reference model connecting as many factors as possible; their research acts from components to the whole system. Those models should be used by the entire group of designers who are usually involved in the design of a complex system such as an airplane. In the literature review, which included the analysis of over 50 articles tracked down through Scopus, the factors that could generate comfort are in turn enclosed in macro-categories; it is important to note that in all models, however accurate, it is difficult to correlate both the different factors and the categories to which they belong. This issue comes from the very high degree of scalability that the cabin project must have, but above all because, although the user on board is forced into a few centimetres of space, over the total duration of the flight, so for a few hours, can constantly change needs. In particular, especially for the purposes of this article, some characteristic elements of the User Experience are very interesting and little explored, first of all the motivation that drives users to take a plane. Motivation does not mean only work, tourism or even a visit to relatives or friends but includes the exploration of the dimension that drives a person to choose that specific means of transport, what will take place not only on board but also before and after, in order to reach the size of the service and all the touchpoints. If this research field may seem too wide, it should be noticed that, for example, the judgment that the user will give to the journey will not be limited to the seat-object itself, but will be extended to the entire company, including all possible factors, from the purchase of the ticket to the management of possible complaints. To date, publications on the subject are limited to some reports or to some user profiling attempts which may, at the present time, store certain preferences on entertainment systems (IFE) on board or check-in operations, or boarding.

### **3 RELATED WORKS**

Some groups of authors carry out a similar study, as an approach, to what will be presented later, building a map in which the various factors or components are put into a system. Extremely important, especially for the amount of work presented, are the articles by Ahmadpour [16] who generates a model in which the comfort experience during the flight essentially involves physical, physiological and psychological elements. The authors also show that, according to the research data, “future design efforts should focus on enhancing the perception of physical wellbeing, peace of mind, proxemics and pleasure, by providing stimulation while maintaining passenger’s satisfaction with the quality and adequacy of the environment”. Another research is presented by Hiemstra van Mastrigt et al. highlighting the relationships between human, seat and context variables in order to predict passenger comfort and discomfort. They found correlations between anthropometric variables and interface pressure variables, and how this relationship is affected by body posture [17]. The interesting aspect of this work is the effort in giving different weight to the correlation, even if this effort is still difficult to carry on, due to the amount of data to be considered. Another model appears

on the work of Patel & Mirabelle D’Cruz who aims to create a personal comfort profile to personalize the flight experience, which is one of the theoretical pillars of UX. The model is based on the assumption that the experience of comfort itself is psychological, and any intervention can positively change how a person perceives a sub-optimal situation and/or provides options to improve the situation can help to increase comfort [18]. The most design-oriented model is shown in the work of Tao et al. who create a very complex system organized through importance factors, systems and subsystems that compose the cabin of an aircraft [19]. This work is extremely important in the roadmap that leads to the design of the entire cabin and has the merit of connecting, even graphically, all the elements from the subsystems up to the complete system. The factor of importance runs, perhaps, the risk of being a criterion perceived only by the designer and is based on the current perception; if we consider that the design cycle of an airplane from the brief on the first flight can even exceed 10 years, it is clear that the aspects linked to innovation and the habits and future needs of users are difficult to integrate. For example, more than 10 years after the introduction on the market, and the enormous spread, of the first smartphone, the on board wi-fi connection, which according to online commercial reports is considered essential by the users since 2012, is not so common on many aircrafts that travel on short distances, the so-called regionals. Although it is a different UX, it is worth remembering that wi-fi coverage, or connection to telephone operators (a non-comparable element on an aircraft journey) is now guaranteed on any train, to allow passengers seamless experience. In particular, one publication analyses an important phenomenon such as proxemics, showing not only how it can impact on comfort, but highlighting the relational factors on board [20]. Among of all the papers analysed, it is the only one that considers the journey not necessarily as a solitary experience but that can be experienced in pairs or in groups. These considerations are, in our view, essential for a correct analysis of an aircraft cabin not only in terms of Human Centred Design but also of User Experience.

#### 4 VISIONS ABOUT COMFORT AND UX

In order to better understand the current visions, not only in the academic field but also from the industrial point of view, the research group focused on the scenario, which is a peculiar phase of design research. The scenario is, in fact, an exploratory method that allows the designer to gather as much material as possible, even if it is often divergent and not relevant to the specific theme of the project. The goal is to create a system on the basis of a series of case studies drawn from both aircraft in service, and from still embryonic concepts, capable of providing useful categories of analysis.

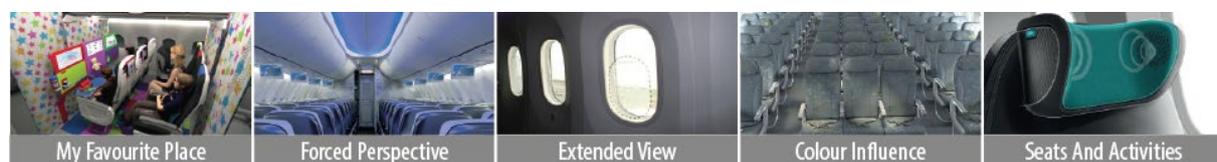


Figure 1: Example of one case study for each macro-category

The research group conducted a desk-type scenario research, analysing the solutions proposed by the already operating airlines and those still in the concept phase in the last 8 years, a period comparable to the project cycle adopted in the CASTLE application case (Cabin Systems design Toward passenger wellBeing). The search has obviously used as main keywords comfort, user experience, well-being but also associating the term future and innovation, in order to include not only the perspective view of the airplane producers but also the hidden desiderata of passengers. This scenario, although it also uses also not openly scientific sources, some magazines of the aeronautical sector taken into consideration can, in

fact, be used as a communication tool, gives an overview of some current trends. From the 55 case studies analysed, 5 macro-categories were then extracted to better highlight which were the most present project interventions. The 5 categories are: my favourite place, forced perspective, colour influence, extended view, seats and activities. The research team decided the categories names avoiding the name of a component in order to maintain a higher level and to include heterogeneous projects with a holistic view. The only exception is the seat, the most recurrent element, this is due to two main factors: the seat element is one of the most taught teaching themes in design schools with a consequent proliferation of concepts published on the web; it is an element of discussion that does not only concern experts and consequently impasses and involves a wider audience. The category my favourite place implies ergonomic, cognitive, emotional, cultural and social factors, and it is composed of two main elements: the need to choose a place based on the relationships the user wants to get or avoid with other passengers, including the elements of privacy and social relations; the need to choose a place based on the offered services (greater space, infotainment, services for business man, for families, for children, FIFO priority boarding). This macro-category includes aspects related to both the product and the service that can best manage this type of needs. The forced perspective category refers to the tunnel effect that is peculiar of regional aircrafts since the proportion between length, width and, above all, height of the cabin perceptively communicates a feeling of occlusion. The case studies analysed in this category show some formal strategies that tend to mitigate the effect, such as the use of vaults, which harmoniously connect surfaces, or softer lights that attenuate the jutting effect of some surfaces, like the stowage bins. The research team, in this case, analysed the phenomenon by performing 3D simulation and creating focus groups during the design phase. The preliminary results, still being processed, show that this effect is perceived during the boarding phase rather than walking on the plane. These two phases are limited in time but of great impact since they are concentrated precisely in the first touchpoints of the experience. The boarding phase is, in fact, often slowed because of the loading of the suitcases in the stowage bins, the accommodation of the passengers in the correct place. In this phase the narrow space around the person, which usually corresponds in width to the distance between the two stowage bins or between the two seats (with respect to the height of the passengers) is even more restricted for: the opening of the bins, the queue that reduces the distance between people, the urgency of finding one's place as soon as possible to comfortably sit. According to the simulations, forced perspective is not perceived when the passenger is seated, without distinction between the occupied place (window, middle or aisle), in that case the analysed projects propose solutions inherent to the extended view. The extended view category obviously has the ambition to suggest structural changes to the windows usually designed on regional aircraft to widen them and, thus, allowing passengers to enjoy a panoramic view, a greater light, a wider perception of the entire cabin. If it is not possible to intervene on a structural level, some case studies show some applicable strategies to perceptually communicate the same factors as, for example, widening the internal shape of the windows compared to the external one. In this way passengers are supposed to receive more light and perceive a bigger space. Colour Influence is the capability to use tints like a communication vehicle, the chosen colour, or the range of colour, depends on some correlations: colour-brand; colour-context; colour-cultures (including trends); colour-material (including hi-tech and cleanliness). Airlines usually choose the colour of their setting up according to the colour of their brand (e.g. colours of logo). This allows the airlines to perceptually emphasize a group identity level and a formal coherence. Seats and Activities category resumes all the formal concepts and the solutions that allow the passenger to personally interact with, for example, interior climate, lights, sound. Many examples concern the elements of the seat that can support relaxing activities like headrests that guarantee a degree of privacy, not only spatially, but also by eliminating unwanted noise.

Many concepts focus on modular solutions that can change in width and depth to better adapt to passengers. In particular, students or makers propose unconventional interactions, experimenting with innovative technologies that allow passengers a more fun and playful interaction, using simple devices that can be attached to the belt, or by mounting helmets integrated with the headrest or even projecting holograms with virtual assistants. All the case studies point out that even if the proposed solution is very punctual and vertical, the core of the 5 macro categories stands in the interaction between passengers and other people or elements inside the cabin. In this way matching literature, visions, UX and IxD principles the research team created, at first, a complex map in order to connect and visualise all the elements that can influence the extended comfort. Then a structure of the customer journey has been built focusing on activities, touchpoints and the above relations.

## 5 CUSTOMER JOURNEY AND EXTENDED COMFORT

The customer journey is a graphical and methodological tool widely used during the meta-design phase both in the User Experience methodology and in Interaction Design. In this case it is used to systemize the user research data obtained through the study of the literature and the observation carried out both in the field and through 3D models to define the extended comfort. By extended comfort we mean, therefore, a scalable and adaptable model not only linked to the presence of some components, intended as optional, or to their excellent quality, but it is enlarged to the Persona's features and motivations in order to understand the whole experience related to flight. For the CASTLE project this model is applied to a regional aircraft that has characteristics such as a small-sized cabin, a single aisle and a limited duration of flight. In the figure, the various phases and possible perceptual impacts are then highlighted.

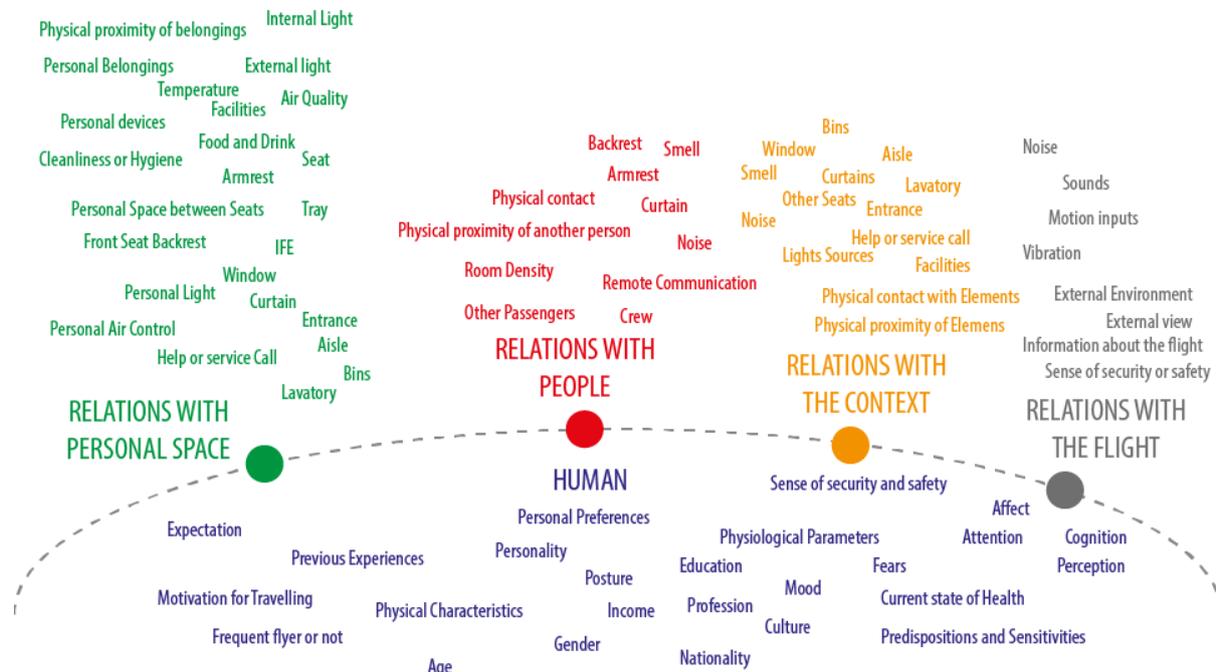


Figure 2: All the factors and components that are included in the extended comfort

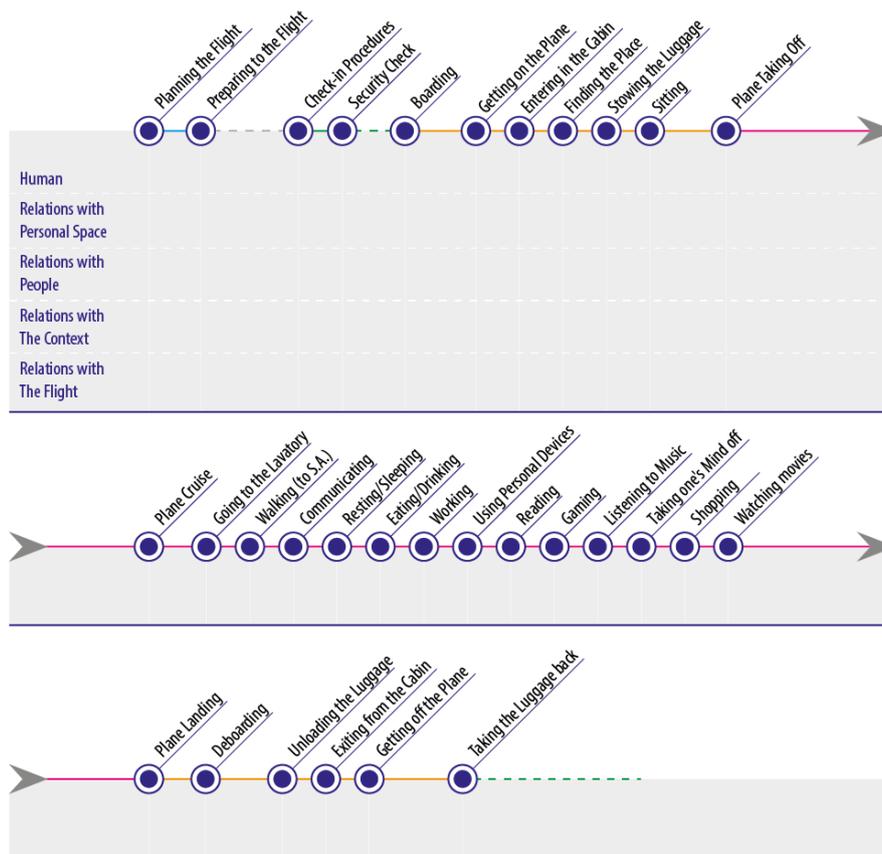


Figure 3: Structure of the customer journey based on activities, touchpoints and the above relations

## 6 CONCLUSIONS

The construction of the customer journey based on the extended comfort concept is a tool able to highlight the critical phases, that may occur at certain specific times, and some desiderata. By virtue of this model it is possible, referring to the categories identified above, to draw up a series of guidelines based on a specific user research. Based on the data found, the literature and the visions it seems no longer possible to design a product capable of responding to the needs of all, on the contrary, considering the variations that occur at each touchpoint it is appropriate to design a system that allows to structure and use multiple environments and differentiated services. The future work, already in progress on the CASTLE project, has also allowed us to draw up a series of guidelines that take into account the complexity of the achieved customer journey.

## REFERENCES

- [1] Porta, J., Saco-Ledo, G., & Cabañas, M. D. The ergonomics of airplane seats: The problem with economy class. *International Journal of Industrial Ergonomics*, 69, 90-95 (2019).
- [2] Comfort: Definition of comfort in English by Lexico Dictionaries. (n.d.). Retrieved July 15, 2019, from <https://www.lexico.com/en/definition/comfort>
- [3] Vink, P., Bazley, C., Kamp, I., & Blok, M. Possibilities to improve the aircraft interior comfort experience. *Applied ergonomics*, 43(2), 354-359 (2012).
- [4] Còmodo<sup>1</sup> in Vocabolario. (n.d.). Retrieved July 15, 2019, from <http://www.treccani.it/vocabolario/comodo1/>.

- [5] Hertzberg, H. T. E. Seat comfort. In H. T. E. Hertzberg (Ed.), *Annotated bibliography of applied physical anthropology in human engineering* (WADC technical report 56-30) pp. 297-300 Springfield, VA: Aero Medical Laboratory (1958).
- [6] Zhang, L., Helander, M., & Drury, C. G. Identifying factors of comfort and discomfort in seating. *Human Factors*, 38, 377-389 (1996).
- [7] Helander, M. G., & Zhang, L. Field studies of comfort and discomfort in sitting. *Ergonomics*, 40, 895-915 (1997).
- [8] Vink, P., & Hallbeck, S. Editorial: Comfort and discomfort studies demonstrate the need for a new model. *Applied Ergonomics*, 43, 271-276 (2012).
- [9] De Looze, M.P., Kuijt-Evers, L.F.M., Van Dieën, J.H. Sitting comfort and discomfort and the relationships with objective measures. *Ergonomics* 46, 985-997 (2003).
- [10] Li, W., Chu, J., Gou, B., & Wang, H. An Investigation of Key Factors Influencing Aircraft Comfort Experience. In *International Conference on Applied Human Factors and Ergonomics* (pp. 222-232). Springer, Cham (2018).
- [11] Bouwens, J., Tsay, W. J. J., & Vink, P. The high and low comfort peaks in passengers' flight. *Work*, 58(4), 579-584 (2017).
- [12] Bouwens, J. M., Fasulo, L., Hiemstra-van Mastrigt, S., Schultheis, U. W., Naddeo, A., & Vink, P. Effect of in-seat exercising on comfort perception of airplane passengers. *Applied ergonomics*, 73, 7-12 (2018).
- [13] Lewis, L. Investigating the ways in which virtual environments could influence aircraft passengers' comfort and experiences. Doctoral dissertation, University of Nottingham (2015).
- [14] Hiemstra-van Mastrigt, S., Meyenborg, I., & Hoogenhout, M. The influence of activities and duration on comfort and discomfort development in time of aircraft passengers. *Work*, 54(4), 955-961 (2016).
- [15] da Silva Menegon, L., Vincenzi, S. L., de Andrade, D. F., Barbeta, P. A., Merino, E. A. D., & Vink, P. Design and validation of an aircraft seat comfort scale using item response theory. *Applied ergonomics*, 62, 216-226r (2017).
- [16] Ahmadpour, N., Lindgaard, G., Robert, J.-M., & Pownall, B. The thematic structure of passenger comfort experience and its relationship to the context features in the aircraft cabin. *Ergonomics*, 57, 801-815 (2014).
- [17] Hiemstra-van Mastrigt, S., Groenesteijn, L., Vink, P., & Kuijt-Evers, L. F. (2017). Predicting passenger seat comfort and discomfort on the basis of human, context and seat characteristics: a literature review. *Ergonomics*, 60(7), 889-911 (2017).
- [18] Patel, H., & D'Cruz, M. Passenger-centric factors influencing the experience of aircraft comfort. *Transport Reviews*, 38(2), 252-269 (2018).
- [19] Tao, X., Ren, S., & Han, T. Mapping System Between Passenger Experience and the Factors of Aircraft Cabin Design. In *International Conference on Digital Human Modeling and Applications in Health, Safety, Ergonomics and Risk Management* (pp. 109-125). Springer, Cham (2018).
- [20] Lewis, L., Patel, H., D'Cruz, M., & Cobb, S. What makes a space invader? Passenger perceptions of personal space invasion in aircraft travel. *Ergonomics*, 60 (11), 1461-1470 (2017).