Defining the experiential aspects of passengers’ comfort in the aircraft interior - an empirical study

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Abstract
The wellbeing and comfort of passengers have always been a concern for the aerospace industry; passenger comfort has therefore been subjected to a lot of research in the past few decades. While previous studies aimed at setting priorities for the aircraft interior elements that are significant to passenger’s comfort, this paper introduces passenger’s perception of those contextual elements in relation to comfort experience. Eight themes of passenger’s perceptions during the flight are identified as the result of a qualitative data analysis. They are named peace of mind, physical wellbeing, proxemics, pleasure, satisfaction, aesthetics, social, and association. The implication of some themes such as proxemics, i.e., recognition of one’s personal space by others, and association, i.e., the symbolic significance of the design to the passengers, for comfort are particularly original. Furthermore, psychological peace and tranquility is found to be as big an influence on passenger’s comfort as physical wellbeing. The eight themes are proposed to be used as a road map for generating design solutions in the aircraft interior with the aim of delivering pleasurable and positive experiences.

Keywords
Passenger, Comfort; Experience; Aircraft; Cabin Design

Introduction
The modern air travelling is becoming increasingly safer and reliable due to technological advances. The aerospace owes this to the numerous studies on aircraft engineering such as the sound and vibration (Quehl, 2001) as well as on health issues such as thermal (Haghighat et al., 1999) or air quality (Fox, 1999) comfort. As the result, passengers are becoming less concerned about their safety; however they are developing more expectations about their actual experience during the flight. Therefore it is crucial to achieve a clear understanding of what are the various aspects of passenger experience including their comfort and wellbeing. Such knowledge could potentially support design efforts and motivate new objectives in developing more appealing concepts. This paper is part of a comprehensive research program aiming to elucidate passengers’ sense of comfort and outline its dimensions and characteristics.

Comfort experience
The definitions of comfort are diverse and entail various aspects. Pineau (1982) defined this phenomenon with respect to human wellbeing and the material aspects of life, while Slater (1985) described comfort as a pleasant state characterized by physiological, psychological, and physical harmony between human being(s) and (their) environment. More specifically comfort in product use was described by Rozendaal and Schifferstein (2010) as cherishment of human senses, freshness, satiation and tranquillity to account for the subjective aspects of bodily experiences. The above definitions highlight the
subjective and personal nature of comfort in reaction to the environment (De Looze, Kuijt-Evers and Van Dieen, 2003).

A recent trend in the field of ergonomics coined the term “comfort experience” (Vink, Overbeeke and Desmet, 2005a), depicting comfort as a convenience experience that enhances product pleasure. For instance Helander (2003) describes seat comfort in terms of experiential aspects such as wellbeing, relaxation, aesthetics impression, and relief. He argued that the ergonomics aspects of the seat design have reached a level of sophistication that it is impossible for the users to discriminate the seats based on the biomechanics and ergonomics aspects of them. It was, then, suggested that the design should focus on delivering favourable experiences in order to appeal to the seat occupant and enhance their comfort.

The amount of research on experiential aspects of aircraft passenger comfort is scarce and comfort studies in this field are typically performed on two levels. First, on a micro level and with regard to the physical impacts of the environment (such as thermal, acoustic, vibration, turbulence and air quality) on the passenger's body and second, on a holistic level, investigating the cabin features and their significance to passengers' perceived level of comfort. While the former level of research provides information that is a valuable input into the engineering of safe aircrafts interiors and preventing adverse health issues, the latter prioritizes the contributing factors to passenger comfort as a whole and offers guidelines for the design and decision making.

One example of the latter type is a study performed by Richards, Jacobson, and Kulthau (1978) who investigated the correlation of physical/environmental (e.g., seat, noise, temperature, etc.), psychological (e.g., attitudes, expectations), physiological (e.g., age, sex), social, and situational (e.g., pre-flight experience) inputs to passenger's evaluation, memory, decision, choice and behaviour and consequently comfort. They concluded that higher levels of comfort increases passenger satisfaction. A more recent holistic study was conducted by Vink, Bazley, Kamp, and Blok (2012) who uncovered significant correlations between passenger comfort and a number of inputs such as physical (e.g., leg room, seat), social (e.g., crew attitude), psychological (e.g., expectations), situational (e.g., wide-body interior, class) and outputs such as evaluation (overall comfort/discomfort rating) and choice (fly again factor). However, a framework and information about the types of experiences that are induced by those contributing factors is missing from the abovementioned studies. More importantly, it is not clear what constitutes passenger comfort as a subjective construct despite the emphasis that was made by previous research on the concept (Helander, 2003; De Looze et al., 2003). In order to help designers systematically to design cabin interiors that enhance positive experiences such as comfort, pleasure and satisfaction, it is essential to understand how passengers perceive the cabin environment and what their comfort experience entails.

The present study investigates the experiential aspects of passengers’ comfort in the aircraft interior environment during the flight. The aim is to understand how the cabin interior elements are perceived by passengers and to explain the comfort experience from the perspective of the people involved in it. It must be noted that although we acknowledge the significance of other phases of the air travel (e.g., airport, delays, luggage check-in, etc.) for comfort, this research is limited to the in-flight experience and perception of the cabin interior. The goal is to obtain information that is potentially useful to the aircraft interior designers.

**Method**

Qualitative data was collected to study subjective experiences through passengers’ written accounts of their flight experiences. A number of mailing lists were created in collaboration with Bombardier Aerospace in addition to personal contacts with students of Polytechnique Montréal (Canada). The participants were contacted by email upon their return from summer vacation and requested to voluntarily participate in a study on passenger comfort. The email directed the respondents to the online consent form and the
questionnaire which posed questions about age, gender, disability, number of previous flights (none, less than five, more than five) and included an open-end question about the comfort experience of their recent flight. They were encouraged to describe their in-flight experience as if they were telling it to a friend and provide as much detail as possible including the context, people involved in their experience, as well as personal aspects such as their feelings.

In total 158 responses were received in 10 days. Three responses were discarded due to incomplete information, leaving 155 responses for analysis. The sample included 98 male and 57 female participants, aged between 20 and 61 years (mean 38, median 35 years). They all had more than five flight experiences and none had any disability.

Data analysis

Content analysis was performed with the aim of generating a number of themes that could subjectively describe passenger’s descriptions (i.e., their perception) of the environment when reporting a comfort experience. This included reducing the volume of the data in several steps until a number of emerging themes were elicited. The data reduction process began by identifying different types of comments, resulting in a set of 857 comments. They were then re-read several times and summarized (by the principle researcher) into 244 descriptors. Next, the descriptors were organized into 79 groups in a hierarchical fashion based on their commonalities. This gave some 19 groups, of which those with similarities were merged into a theme. Eight themes were formed in total. Then all 857 comments were re-visited and carefully assigned into the themes emerging from the above process.

In order to test the reliability of the elicited themes, a second researcher was invited to assign the defined themes to a randomly selected 10% sample of the raw data. The degree of agreement between the two researchers was established using Cohen’s Kappa inter-rater reliability test. Cohen’s Kappa coefficient was K= 0.88 (p<0.005), which implies a strong agreement between the researchers (Vierra and Garrett, 2005).

Results

The eight passenger comfort themes, their 19 subsequent groups, and the number of comments received in each are presented in Table 1 together with illustrative examples of respondents’ reports. Each theme is discussed in some detail in this section. It must be noted that the names of the themes are chosen operationally and the given definitions are context-driven. The theme ‘peace of mind’ was mentioned most frequently in relation to passengers’ comfort experience whereas the theme ‘association’ received the least comments.

‘Peace of mind’ implied a perception of security, tranquillity and relief. The security group described a feeling of being safe when the cabin design was perceived as predictable. Most comments on security and predictability were related to the temperature (34%, n=40) and in particular to its fluctuations. Respondents repeatedly expressed their wish for automated stabilization of the temperature by the pilot or having the option to adjust it manually. Security also entailed a feeling of satiation (e.g., not hungry nor thirsty, not hot nor cold, etc.) when the in-flight service attended to passengers’ respective needs. Tranquillity referred to feeling calm and 51% (n=35) of comments in this group were concerned with interior noise (e.g., engine noise). Passengers demanded for quieter cabins or services that provide them with amenities to cancel the noise. Relief referred to a state of being relaxed and rested such as being able to sleep. Most comments in this group were related to the seat (38%, n=22), demanding a relaxing experience through a more flexible recline mechanism enabling the occupant to adopt a variety of postures.
being nothing was bothering me, I reclined the seat and went to sleep.

Privacy was offered by the environment. Careful consideration of the space between two consecutive seats but also its shape and its related to the seat. Privacy was demonstrated most by comments on the seat efficiency compartments on the seat or otherwise. For instance small sandwhiches in a nice lunch box, even though it was a short flight and their perceived autonomy and control as individuals. Privacy group was demonstrated most by comments on the seat. Similarly legroom design was not limited to the pitch distance between two consecutive seats but also its shape and affordance for different activities. Energy group referred to the perception of being refreshed and energetic. Most comments in this group were related to the air quality (80%, n=8) and its freshness.

Proxemics theme referred to the reaction of the passengers to the shared space (with other passengers as well as crew) during the flight. The term proxemics was first coined by Hall (1963) to refer to the relationship between the perceived social and physical distance. It describes how we interpret distance to and posture of other people in a context (Ballendat, Marquardt and Greenberg, 2010). In flight context, we borrowed the term to describe passengers’ experience of privacy and their perceived autonomy and control as individuals. Privacy group was demonstrated most by comments on the seat (74%, n=39). This included how the seat created a personal space within which the passenger was not left vulnerable to others’ (neighbours, crew) intrusions, either physical or otherwise. For instance a proper separation of the seats from each other could increase one’s privacy. Most comments related to control were also related to the seat (32%, n=21) but here the emphasis was on how it enabled passengers to perform activities freely and when desired, or to customize their personal space to their taste. For instance small and efficient compartments on the seat addressed this group.

Pleasure was defined as the enjoyment and pleasantness offered by the environment. Three groups associated with perception of pleasure in the cabin were stimulation, anticipation, and ambience. Stimulation depicted the joy of interacting with innovative designs. Most comments of the group were related to the In-Flight Entertainment (IFE) (86%, n=32) that offered insightful information, entertained participants, and/or helped them to pass time joyfully. Anticipation was related to enjoyment when participants’

<table>
<thead>
<tr>
<th>Theme</th>
<th>Group</th>
<th>Examples</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peace of mind</td>
<td>Security</td>
<td>the temperature was just right, not hot, not cold!</td>
<td>117</td>
</tr>
<tr>
<td>Physical well-being</td>
<td>Bodily support</td>
<td>the ears of the headrest supported my neck when I was sleep.</td>
<td>202</td>
</tr>
<tr>
<td></td>
<td>Energy</td>
<td>they offered really good fruits with the meal, that was refreshing</td>
<td>10</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>Accessibility</td>
<td>I could store my glasses in the little compartment on the side.</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Adequacy</td>
<td>The window was large enough to enable a good view.</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Quality</td>
<td>The sound was clear and flight attendant’s voice was not all muffled.</td>
<td>37</td>
</tr>
<tr>
<td>Pleasure</td>
<td>Ambiance</td>
<td>after the meal, they eventually damed the light which was quite enjoyable.</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Stimulation</td>
<td>I could follow the flight route and some information on the screen.</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>Anticipation</td>
<td>they served small sandwiches in a nice lunch box even though it was a short flight</td>
<td>18</td>
</tr>
<tr>
<td>Social</td>
<td>Tolerance</td>
<td>my neighbor was talking to me and I didn’t want to have a conversation</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Connectedness</td>
<td>my wife and I removed the arm-rest and got more room to cuddle.</td>
<td>16</td>
</tr>
<tr>
<td>Aesthetics</td>
<td>Neatness</td>
<td>the seat covers were clean and looked new.</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>Style</td>
<td>it was chic that the cabin color was matching with crew outfits</td>
<td>10</td>
</tr>
<tr>
<td>Association</td>
<td>Recognition &amp; evocation</td>
<td>the seat reminded me of a comfortable salon chair.</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Imagination &amp; symbolism</td>
<td>I wish there was a stretching area.</td>
<td>13</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>857</td>
</tr>
</tbody>
</table>

Table 1. Eight themes of passenger’s perception in relation to comfort during the flight.
expectations were met or positive surprises when participants’ expectations were exceeded. Of these, 50% (n=9) of comments were about service, e.g., being offered free wine on a domestic flight. Ambience was the perceived (semantic) characteristic of the cabin environment such as humane (vs. industrial) or cozy. Most comments in this group were related to the light (53%, n=8).

‘Satisfaction’ theme was coined to a sense of fulfilment and contentment that resulted from achieving desired goals with the help of the environmental elements. The theme is comprised of three groups namely quality, adequacy, and accessibility. Quality comments referred to the perceived goodness of the cabin in terms of being wholesome, solid and trustworthy. The seat was mentioned most frequently in this group (46%, n=17). The ease of use and efficiency of cabin elements were associated with the perception of adequacy, of which 61% (n=17) of comments were concerned with the window and the effectiveness its design in displaying the outside world. Accessibility referred to the reachability of artefacts/elements such as IFE, which was the subject of most comments in this group (72%, n=18).

‘Aesthetics’ theme refers to the pleasure experienced through sensory perceptions. These experiences went beyond the mere visual inputs and included those that were pleasant to other senses as well (e.g., hearing, taste, smell and touch). The two main groups referring to the passengers’ perceived aesthetics in the cabin are neatness and style. Neatness included cleanliness, no tears and wears or absence of unpleasant odours. 41% (n=13) of comments in this group were concerned with the hygiene. The style referred to the perception of glamor, elegance, modernity, and luxury of the environment. Most comments in this group were related to cabin interior design (60%, n=6) in terms of its colours and patterns.

‘Social’ theme referred to the social interactions among people in the cabin (i.e., passengers, flight crew) characterized by social tolerance and social connectedness. Social tolerance included participants’ tolerance for certain aspects of social contexts such as behaviours of other passengers. The 45% (n=14) comments on neighbours in this group showed that the design should facilitate this type of human relationship in particular. Social connectedness referred to the empathy experienced in participants’ contacts. Interestingly, the main comments in this group were related to the crew (37%, n=7) and seat (37%, n=6). The comments on the seat displayed an opportunity for the manufacturer to address this group. For instance a passenger mentioned that a folding armrest provided him with the opportunity to share the sitting space with his partner and enjoy traveling more.

‘Association’ theme included the personal significance of the environment for the participants and the association of a meaning to its design. The theme comprised two groups, the first of which is called recognition and evocation and the second is imagination and symbolism. The former refers to how the environment might evoke a place or a familiar personal experience. For instance one participant described a comfortable seat as a “nice salon chair”. The comments on seat (24%, n=5) and IFE (24%, n=5) were dominant in this group. The latter group referred to perceiving the flight experience as the reminiscent of an ultimate comfortable experience such as travelling in first class for someone who had never experienced it before. Here again the seat comments were dominant (31%, n=4).

**DISCUSSION**

The results of this study suggest a definition of passenger comfort that takes the experiential and contextual aspects of the flight into consideration. An experience is highly personal and subjective by nature and thus any effort towards understanding it calls for in-depth analysis and contemplation. For that reason, qualitative data was collected in the present study in order to explore the in-flight comfort experience. The experiential aspects of passengers’ comfort experience were described in terms of their perception of the cabin environment. The perceived ‘peace of mind’, ‘physical
wellbeing' and ‘proxemics’ were mentioned most frequently in relation to flight comfort. Those were followed by the perception of ‘satisfaction’ and ‘pleasure’, ‘aesthetics’, ‘social’ and ‘associations’. Figure 1 visualizes the results of this paper in a model that pins the passenger as the centre piece of the flight experience and positions the comfort themes in their surrounding space.

Figure 1. A model outlining the experiential aspects of passengers’ comfort in relation to their surrounding space.

The theme ‘peace of mind’ depicts passenger’s psychological wellbeing while his/her physical state is represented by the theme ‘physical wellbeing’. Thus these are placed in the centre of the model with the passenger. ‘Proxemics’ refers to how control and privacy are perceived within one’s personal space or in Hall’s (1966) terms, the space that passenger perceives as his. Subsequently ‘proxemics’ is located immediately around the passenger. The space around one’s personal space is the ‘social’ space that is shared with others for the duration of the flight. The other four themes cannot be positioned anywhere in particular as they could be induced due to passenger’s interaction with any environmental element (at any distance). Thus they are shown by arrows that are stretched through the entire space. The model is proposed to be used a framework for designing for passenger comfort.

The results of this study demonstrated passengers' high concern for ‘peace of mind’, which implies that psychological comfort is equally (if not more) important as physical comfort. The perception of ‘proxemics’ should be taken as a potential area for more study and examination as literature on comfort (or passenger comfort for that matter) has not previously mentioned any link to this concept. The seat was attributed most frequently in relation to this theme with respect to both personal space and privacy. This means that providing passengers with more free space and reasonable distance from others would potentially enhance their comfort. However, the airlines’ constraints with regard to the number of seats in the cabin limit the seat size. The results of this study suggest other solutions when proxemics aspects cannot be tackled through increasing the immediate space (i.e., seat width). For instance by designing a light or a sign for passengers to inform the flight attendants that he is sleeping and wish to not be disturbed for food service. This simple solution, while not requiring drastic changes in the seat design, could improve the experience of privacy. Another solution includes better separation between neighbouring passengers, for instance under the arms, at head/shoulder level and in the leg space.
The theme ‘pleasure’ portrays comfort as an experience with positive and joyful aspects. Coelho and Dahlman (2002) have previously illustrated a relationship between comfort and pleasure for automobiles. In the same vein, ‘aesthetics’ was confirmed to be influential on aircraft passengers’ perception of comfort. A visually (or otherwise) pleasing design goes a long way in setting a positive impression and elevating one’s mood. The implications of these two themes for passengers’ experience are evidence that designing for comfort in the aircrafts should go beyond the mere prevention of physical discomfort. The same applies to the theme ‘association’. Although not unknown in product design (Hassenzahl, 2003), this theme has not received particular attention as an aspect of passenger comfort. Here is an opportunity for airlines and aircraft manufacturers to connect to passengers on a semantic level. In addition, the knowledge about this theme could be used by airlines in defining their identity and what they want to project as their image. A lot of respondents in this study associated their comfort with a feeling of being at home. The interior or service design could make such impression in numerous ways, varying from hanging curtains on the windows to serving food in packages with less industrial look. Finally, the theme ‘social’ is a testament that comfort should be viewed within a context and that passengers experience comfort while interacting with other human persona and not in isolation of their seats. A comprehensive design for passenger comfort should account for these inter-personal relationships.

An issue highlighted by the results of this study is the parallel influences of a single element on passenger’s experience. For instance, the much acclaimed impact of the seat on passenger comfort (Vink et al., 2012) is intuitively justified, given that passengers spend most of the flight duration seated. However, this study demonstrated the pivotal role of the seat in eliciting various perceptions. The seat was linked to six comfort themes. Those are ‘peace of mind ’, ‘physical wellbeing, ‘proxemics’, ‘satisfaction’, ‘social’, and ‘association’. An apparent conclusion drawn from this result is that depending on how a seat is developed (e.g., more adjustability of headrest, effective and built-in storage, separation from neighbours, or a nice-to-touch material), various aspects of passenger’s comfort experience could be tackled. Such knowledge could inform the design efforts in various ways. First, by directing them towards a more human-oriented practice, second, by providing higher degrees of predictability for the design impacts, and third, through inputs for more innovative design solutions that clearly capture a particular comfort theme or group. Future studies should explore the possibility of employing the presented themes as a means to set design objectives.

In an important statement, Vink, De Looze and Kuijt-Evers (2005b) noted that being comfortable is not a product’s quality; rather a product becomes comfortable or uncomfortable when being used in the context. This emphasizes the importance of considering the contextual element (physical, temporal and social) in designing for comfort. As discussed in the introduction of this paper, previous studies on passenger comfort (Vink et al., 2012; Richards et al., 1978) provided valuable information about the environmental elements (such as seat, legroom, temperature) that effectively correlate with comfort. This study made a step forward by characterizing the context of passengers’ interaction with those environmental elements in terms of its experiential aspects. This resulted in identifying the type of perceptions that those should convey in order to enhance the comfort experience. The elicited comfort themes in this study provide designers with a unique opportunity to reflect on the particular impacts of the cabin interior elements on passengers’ experience. It is therefore suggested that those eight themes be used as a road map for the design of cabin interiors. Indeed the results of former studies could set priorities for the cabin elements that are subjected to development and change. Future research should intend to validate the introduced comfort themes and weigh their significance quantitatively.
CONCLUSION
The present study introduced eight comfort themes in relation to passenger’s experience in the aircraft cabin. These themes describe how passengers perceive the environmental cues and consequently experience a level of comfort. Comfort was shown to be related to not only physical wellbeing, but also psychological, proxemics, satisfaction, pleasure, aesthetics, social as well as association to familiar experiences. In addition, it was concluded that psychological aspects of comfort are as important as the physical aspects. The implication of the results for future design practice was put forward by highlighting the parallel impacts of the environmental elements (e.g., seat) on various comfort themes.

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REFERENCES


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Professor Gitte Lindgaard, PhD, was until recently director of Carleton University's Human Oriented Technology Lab (HOTLab) at Carleton University, Ottawa, Canada where she held one of only nine of the prestigious Natural Sciences & Engineering Research Council (NSERC) Senior Industry Research Chairs in User-Centred Product Design, a branch of Human-Computer Interaction. She is currently Professor in neuroaffective design at Swinburne University of Technology in Melbourne. In an earlier life, she was Principal Scientist and Head of the Human Factors team at the Telstra Research Laboratories in Clayton, Victoria, while also being the Chair of the Computer-Human Interaction Special Interest Group (CHISIG) of the Ergonomics Society of Australia for many years. She has published over 240 peer-reviewed papers. She has been Deputy Editor of the international journal Interacting with Computers and Associate editor on several HCI journals.

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