

# Designing for Different Passenger Experiences: Road, Railway and Aviation Seats

R. MARCELINO<sup>1</sup>, A. CASTRO<sup>2</sup> and C. FERREIRA<sup>2\*</sup>

<sup>1</sup> CEO Almadesign

<sup>2</sup> Design Manager and Designer

\* Tel.: +351 214 240 167; E-mail address: andre.castro@almadesign.pt

**Abstract** Transport products in Road, Railway and Aviation industries have many features in common, however seat design for buses, trains or aircrafts can differ widely across the range of materials, manufacturing processes or safety requirements, while trying to provide the best possible passenger travel experience. Almadesign has worked on seat designs for the three transport areas, developing a cross-knowledge of the requirements, technical processes and passenger needs. In this paper we will explore the differences and similarities between seat design in road, railway and aviation, using specific design and technical criteria such as Aesthetics, Ergonomics, Maintenance, Weight, Materials and Safety requirements. The broad experience across different industries – from transportation to products and interiors - has led Almadesign to develop design solutions based in cross-pollination strategies, migrating and integrating technologies and manufacturing processes. With a focus on the user-centered experience, we will compare three-seat design case studies based on projects developed by Almadesign over the last ten years for road, railway and aircraft. In the road vehicle industry, we will address the IBUS project: passenger seats developed to maximize the living space using lightweight, eco-efficient composites. In the railway industry, we will focus on the CPA 4000 train refurbishing process, in which the design team tackled the challenges of refurbishing an existing railway seat in order to improve passenger comfort, integrate new technologies and simplify maintenance processes. In the aviation industry, we will address the work developed for TAP Air Portugal fleet retrofit programs and H2020 Project PASSME, on Economy seats.

The discussion will focus on the comparative analysis of the seat designs in the three industries, its similarities and differences, and the role of the design teams in integrating different passenger's needs and expectations. The results will provide an overview in how design can play a key role in articulating different industries and fostering discussion between stakeholders. Seat design analysis and comparison in this three transport industries, will hopefully provide an overview of the role of design in exchanging knowledge, creating synergies and promoting cross-pollination between industries.

**Keywords:** Seat design, Passenger Experience, Road vehicles, Railway, Aviation, Cross-pollination

## 1. Introduction

Each transport industry may be different, with various technical needs and constraints, but all have one thing in common: they are centered in people in their role as passengers, regardless of their cultural background, age or experience in travelling. The passenger experience is a key factor in product development, specially the seat design. The concept of "experience" can be analyzed through the point of view of the

“Product Experience” theory - the research area that develops an understanding of users’ experiences that result from interacting with products and interior environment which we can define as follows: “An Experience occurs when services are used as the stage, and goods (used) as props, to engage individual consumers in a way that creates a memorable event” (SCHIFFERSTEIN, 2008) [1]. To create an “enhanced” experience is to engage the passenger at different levels - sensory, social, intellectual and behavioral. Careful attention must be given to the different “touch points” of the travel experience, and the seat is the product in which passengers spend most of their time while being transported.

Designers are able to develop seat design which differ in its functionality, comfort, and aesthetics and also on the different passenger perceptions and experiences. The technical specification of the product imposes certain constraints on shape but within these there is space to change functionality, geometry, surfacing, and materials, modify colors, and add textures...

The passenger experience is influenced by different product features, such as safety, look and feel, ergonomics, features and accessories, etcetera. At the same time, operational needs mean seats must be easy to maintain, durable, easy to clean, etcetera. User safety is also a central issue in transport seats, more importantly in aviation, where safety standards are very demanding. At the same time we know users vary in size, shape and strength. The product should therefore accommodate any person and allow population extremes (e.g. percentiles 5 and 95) to interact in a comfortable and safe mode with the seat. Materials also have an important role in products. The use of highly resistant materials, lightweight solutions or easy to build and to maintain material technologies are examples of requirements of different industries. In this paper we will take a closer look at three transport industries, its need and requirements, and at the different seat features in order to cope with the industry standards and provide the best passenger experience. We will use industry case studies, look at different design requirements and compare product features in order to get a global comparison of the seat design in three industries, its differences and similarities.

## 2. Case Study I: Road Industry

The IBUS consortium presented a vision for the road transport sector materialized in an eco-efficient, lightweight, comfortable and integrated concept for interior bus coaches. The project aimed to demonstrate the acquisition of new technological skills by a consortium of companies, through the development of integrated, functional and technical solutions. It resulted in a full-scale mock-up (inner and outer cross-section) 2.4 meters long, to visualize, test and validate solutions for future applications in bus coaches, by using innovative solutions inspired by the aeronautical and automotive areas. Two different seats were developed – Raia and Shark, favoring capacity without compromising personal space and user comfort. The Raia is a sleek, lightweight design using natural and composite materials (core cork based thermoplastic composites). The Shark concept combined a unique design with a very comprehensive level of equipment, integrating table, footrest and LCD monitor, favoring the use of lightweight composites. All seats were trimmed in anti-allergenic, chrome free leather, developed for easy cleaning, excellent surface resistance and a high-end look and feel.



Fig. 1,2. I-BUS Seats.



**Fig. 3,4.** I-BUS Seats.

### 3. Case Study II: Railway Industry

After 16 years and over 26 million passengers transported, the CPA4000 train series needed a half-life maintenance, and so the opportunity arose to fully refurbish the train interior. Based on the collaboration experience in the INTRAIN project, Almadesign was invited to develop the project together with Portuguese suppliers. The refurbishing process aimed to achieve a new image of the product and associated service, improving passenger comfort, integrating new technologies and simplifying maintenance processes in five main areas: Exterior, Interior, Toilet, Bar and Signage. The seats were fully refurbished, with new foam geometry, new leather trimming, new colors and new materials. The differentiation between the two classes, Tourism and First Class was enhanced in the seat design, color, materials and trim.

The product development process took place over 22 months, from the definition of requirements and specifications, to research on user preferences and operators' needs, to concept generation, product development for prototyping, mock-up build, production and monitoring of industrialization. The new seats designed are now able to accommodate more activities and provide better comfort by including charging sockets, larger head support, revised foam geometry for better ergonomics, leather trim for cleanability and easy maintenance, premium look and feel).



**Fig. 5,6.** I-BUS Seats.

### 4. Case Study III: Aviation Industry

The challenge for Almadesign was to refurbish the medium-haul TAP fleet, with A320 and A319 aircraft, seeking to respond to increasing competition and develop a new TAP Portugal experience. Using the same design philosophy that guided the project, the intervention initially focused on business and economic class seats, developed in cooperation with RECARO in which new functionalities for greater connectivity were defined as well as new seat covers and materials.

The new cabin layout and the lighter and thinner seats chosen offer good ergonomics and personal comfort, maximizing seat numbers to make the fleet more efficient. It is worth noting the use of TAP colors to differentiate the economy class - fresh and modern lime green - from the business class - warm and comfortable red - reinforced the company's corporate identity. The laminated leather seat covers provide a high-end look and feel, easy maintenance and durability. The seat features a 4 positions adjustable headrest, tablet supports, and electrical charging points, providing the passenger with the possibility to work, sleep or have fun with more comfort.

This was the first retrofit project totally developed in Portugal with global suppliers, and included the full cabin retrofit carried out in Lisbon by TAP M&E.



Fig. 7.8. TAP A320 Seats.

## 5. Discussion: Passenger seat feature comparison

While travelling, passengers should be able to seat comfortably and perform different tasks according to different needs (i.e. relax, work, read, play, etc.). Several activities such as reading, sleeping, talking and working on laptop accommodate different body postures and influence passenger experience and seat comfort. Seats are designed for and used by people, and people come in many sizes and have varying physical attributes (DREYFUSS, 1955:26) [2]. A “passenger-centric” mindset adapted to the market trends and new technologies is very important when designing for transports in order to meet passengers’ needs and expectations. We will take a look at some of the criteria used at Almadesign to design and develop transport seats.

### 2.1 Look & Feel

Aesthetics play an important role in the way an object/environment is used, fostering positive attitudes and creating positive relations, which have implications in how effectively people interact. “Aesthetic designs are perceived as easier to use than less-aesthetic designs” (Lidwell, 2003:20) [3]. Both Road seat design, as well as Railway and Aviation design must provide the best aesthetic experience possible for the passenger, enhancing brand loyalty.

Quality perception also enhances brand loyalty and improves the passenger experience by providing a harmony and consistency in the design and assembly of parts, often considered and physical manifestation of precision and quality.

Living space is the space around the passenger during his travel. In industries such as road and aviation, the layout of passenger arrangements aim for maximum capacity (for maximum revenue) turning living space into a very expensive “real estate”. Each inch in an aircraft means revenue, which accounts for the compromise between living space and comfort for the passenger, or capacity and revenue for the airline.

## ***2.2 Ergonomics***

The physical capabilities of users in relation to the physical qualities of a product are paramount to improve comfort. By undertaking an ergonomic evaluation, the sizes and positions of points of user contact with products can be identified and optimized. This approach enables the physical comfort and ease of use of our products to be improved for all users. The product should therefore accommodate any person within a range of body dimensions and allow population extremes (percentiles 5 and 95) to interact in a comfortable and safe mode. In aviation “Since the 70’s leg room has been reported as the biggest problem for passengers. The thickness of the backrest is very relevant, provides more leg room than a seat at the same pitch with a different thickness of the backrest.” (Mastricht, 2015:138) [4]. To design a thin, lightweight seat is to provide the passenger with more leg room. “Several studies indicate that increasing leg room, knee space, and personal space have a positive effect on the comfort experience. So, leg room and personal space have a have priority in the design and also expectations and preflight experiences.” (Vink, Brauer, 201:25) [5].

Seat design must also accommodate different activities, such as eating, sleeping or interacting with digital media. A good headrest with enough neck support will increase comfort by providing a good posture for sleeping: “The presence of a headrest is beneficial for both privacy and variations in posture. It also prevents the head from slipping off to the side.” (Vink, 2016) [6].

In longer trips where there is no stopping, such as aircraft long haul flights, seat comfort is very important. In trains passenger can get up and go for a walk or even to a bar carriage. Not on a normal flight, In buses, operators usually stop every three hours in restaurants which have all kinds of services for the passengers,

## ***2.3 Features / Accessories***

The seat features play an important role and contribute to an improved passenger experience. Eating/drinking or using a laptop are activities performed by passengers that require a tray table. In the railway industry the tray tables tend to large and very resistant, proving and support to work and eat comfortably. In aviation tables are smaller and more fragile, but also provide and important support to air meals.

In aviation the literature pocket provides space for passengers to keep personal items, promote operators services, provide revenue opportunities. But first and foremost, literature pockets keep safety instructions in front of each passenger.

Nowadays in the digital age passengers expect permanent connectivity so power supplies have become a standard feature in most industries.

## ***2.4 Maintenance***

Designers should also give consideration to the durability and the levels of maintenance required to maintain the products. Seats in transportation systems have to be durable, since each seat will carry hundreds of passengers a day. They have to last for years, be easy to clean, and be able to resist to accidents with food and/or liquids and vandalism.

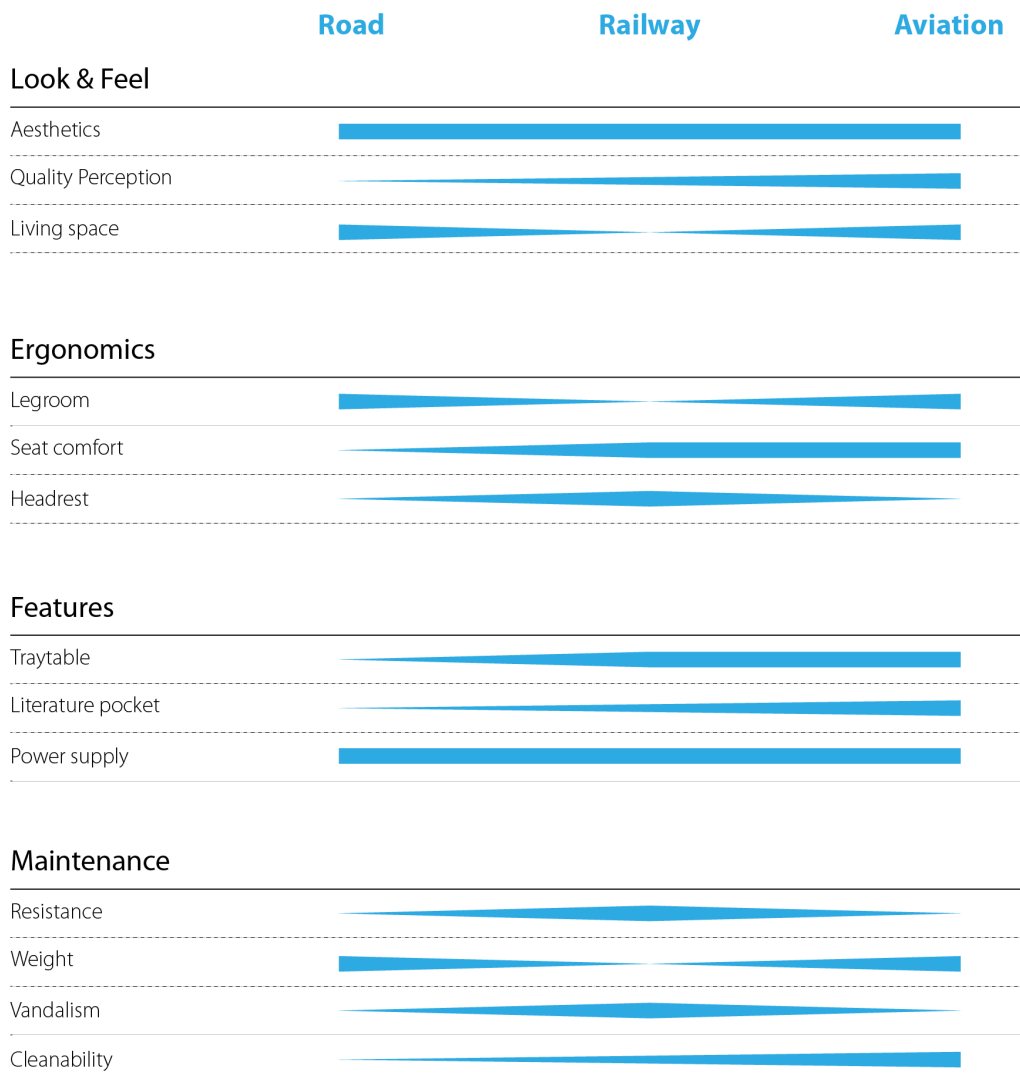
Resistance and cleanability is strongly connected to passenger comfort in public transports, as it is one of the most important aspects in the theory of comfort. Seats in the transport areas, specifically in Railway and Aviation need to comply with strict normatives considering fire and smoke. In the automotive industry and aviation industry crashworthiness is also crucial, with seats being provided with active and passive safety features. Weight saving is crucial in all industries but it is especially important in the aviation industry. The weight savings p/Pax achieved in a high-density layout are the difference between an airline that makes a profit or goes bankrupt. The use of lighter materials, without compromising the load stability, should be possible by the use of the right geometry as well as light metal alloys, polymers and composites that can also improve the living space by reducing volume.

Vandalism is a bigger problem in transports where passengers are not supervised, as in trains or even buses. It is much less important in aviation, where passengers could get arrested for “misbehaving”. Railway seats are hence extremely resistant and heavier, as norms and standards demand very high standards.

## 6. Conclusions

It is important to analyze design practices and standards in different industries in order to get the best out of each practice in a cross-pollination approach. We can conclude that transport products in Road, Railway and Aviation industries have many features in common, however seat design can differ widely across the range of materials, manufacturing processes or safety requirements, while trying to provide the best possible passenger experience. Looking in detail on Table 1, we can spot the main differences:

**Table 1.** Road, Railway and Aviation comparison.



Regarding 'Look & Feel', in all three industries, the aesthetic topic is quite important. Quality perception is more relevant in the Aviation industry while the living space in the railway it's not critical. In both Road and Aviation industry the intensive layouts and tight pitches makes these feature a challenge.

Looking in detail into 'Ergonomics' different feature influence these industries. In the Aviation industry the legroom and seat comfort are very important while in the Railway industry the headrest is a critical feature to improve passenger comfort.

Relatively to the features that can improve passenger experience, in the Road industry the tray table and literature pocket are not critical, as power for permanent connectivity are the main point.

Regarding Maintenance in the railway industry the seat must offer more resistance to usage and vandalism. In the aviation industry the presence of a flight attendant can be persuasive to not damage the seat.

The weight is definitely a topic to be addressed in the road and aviation industries, as is connected to performance and efficiency for operators. This paper explores how different seat approaches developed for one industry can benefit successfully other industries, contributing to improvements in passenger experience.

**Acknowledgments** The research work reported here was made possible by Almadesign and all partners involved in IBUS Project, in the CPA 4000 Project and TAP Project.

## 7. References

1. Schifferstein, H., 2008. Product Experience. Amsterdam: Elsevier.
2. Dreyfuss, H., 1955. Designing for people. New York.
3. Lidwell, W., Holden, K., Butler, J. 2003. Universal Principles of Design.
4. Mastrigt, Suzanne, 2015. Comfortable Passengers Seats- Recommendations for design and research. 138.
5. Vink, P., Brauer, K., 2011. Aircraft Interior Comfort and Design, 25.
6. Vink, P., 2016. Vehicle Seat Comfort and Design.