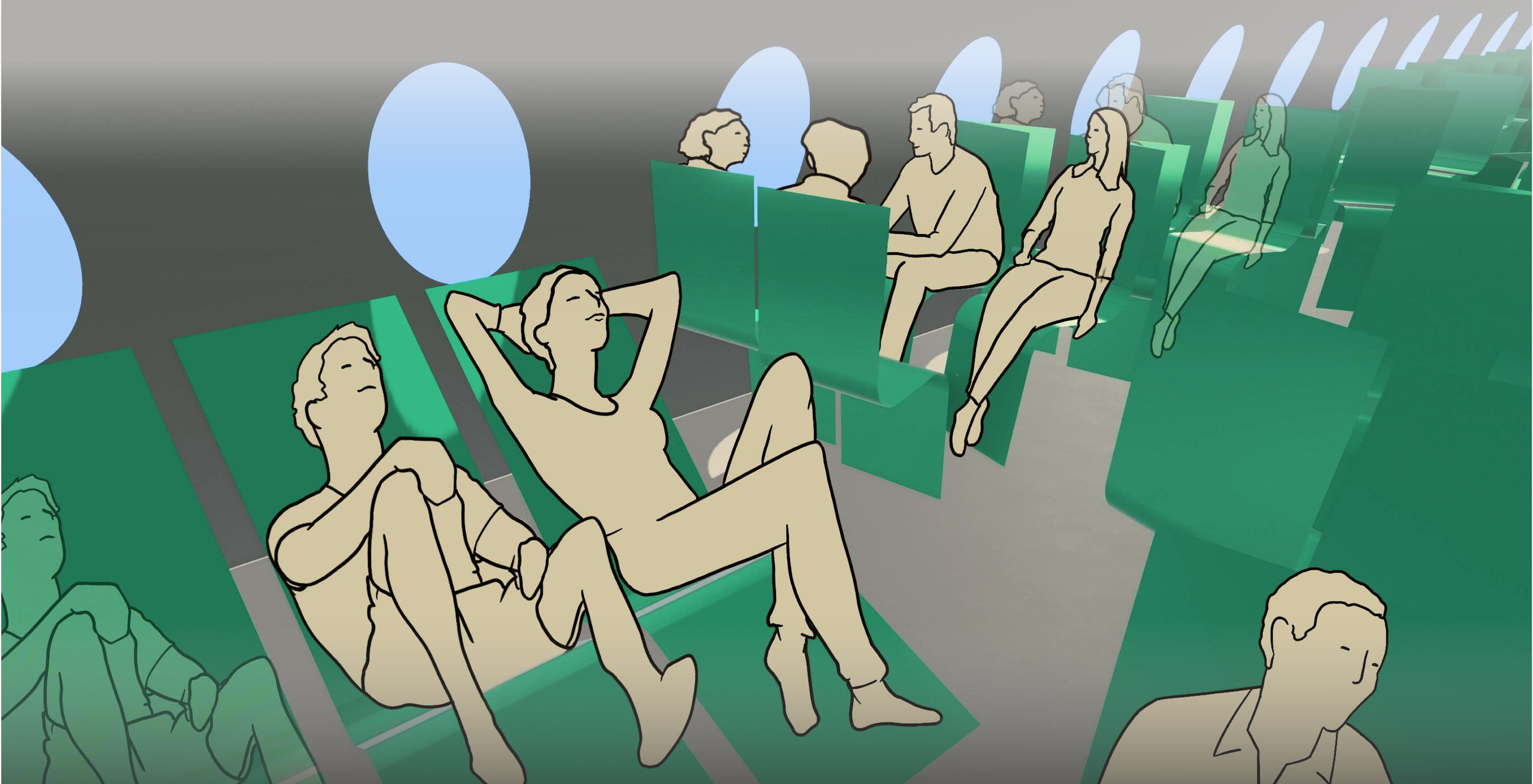

Passenger cabin concept layout for Elysian Aircraft E9X

Zero-emission regional airliner interior design in 2033

TU Delft ELYSIAN

Master Thesis | Christos Batsaras

Summary

Aircraft have been one of the most important means of travel for years. It is known that they produce a considerable amount of emissions.

Technological advancements have created enough room for innovation in mobility, including aviation.

Elysian Aircraft is a company with the vision to 'redefine zero-emission air travel,' focusing on medium flights in the category of regional airliners with their upcoming aircraft, the E9X. Additionally, the company aims to redefine the air travel experience as well. This project focuses on the interior design of this aircraft.

In general, comfort in air travel has been an important field that has attracted researchers until now. Over the years, the demand for air travel has increased, with airlines aiming to fit the maximum number of passengers while ensuring some level of comfort. However, whether this is sufficient overall is debatable.

Looking at society as a whole, it has been observed that people miss the sense of carefreeness as a consequence of today's way of living and distance from nature.

Nature-inspired design can provide psychological benefits, and this was envisioned for the project, starting with the passenger cabin layout. In this concept, passengers can sit in a way similar to their experiences in nature, creating a foundation for the later development of the aircraft interior.

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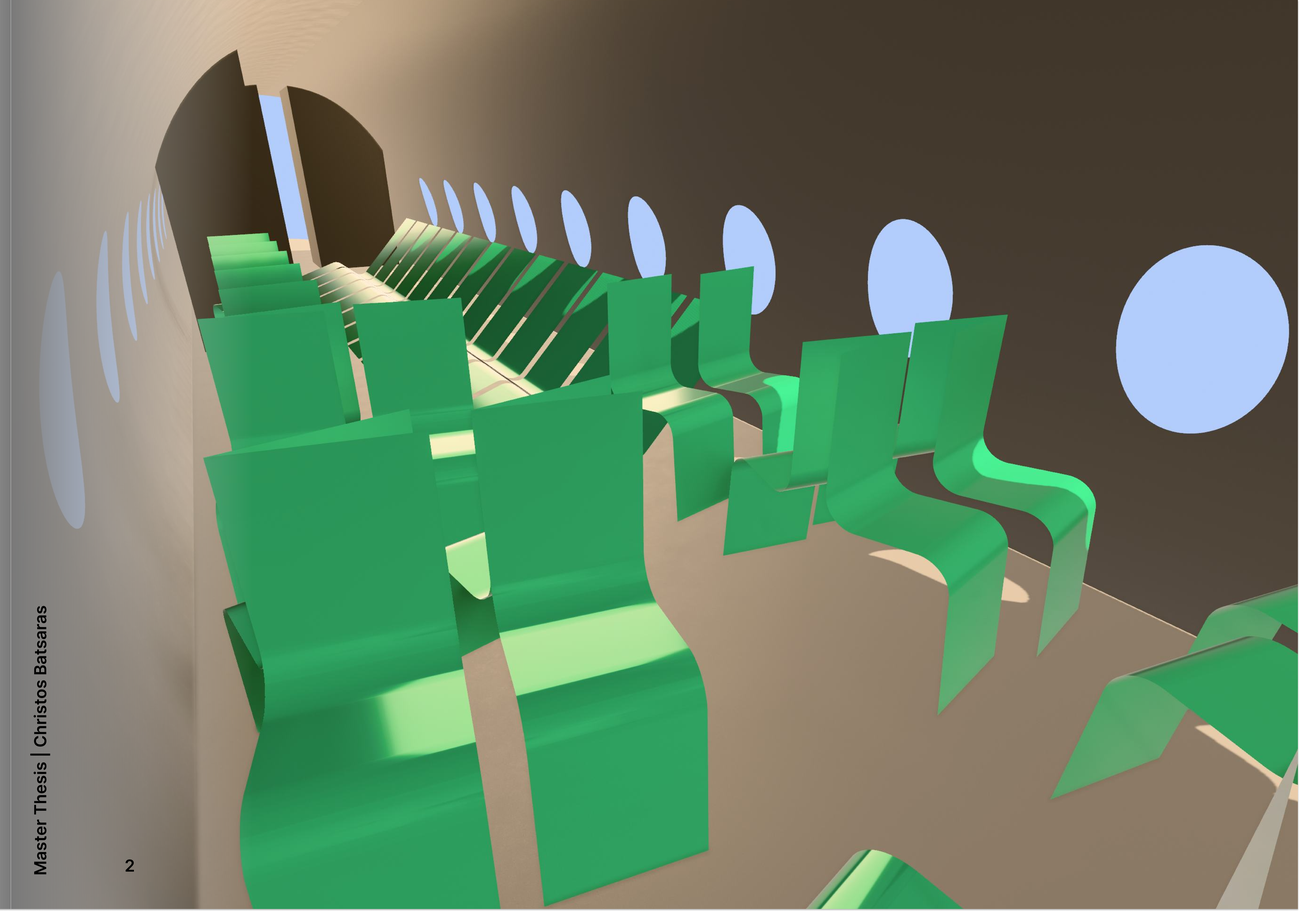

Acknowledgments

This graduation project would not have been done without the contribution of many people at the same time.

I would like to thank Mr. P. Vink from the bottom of my heart for giving me the opportunity to work on such a project and for his guidance through his knowledge and experience. Next, I would like to thank Ms. S. Anjani for her suggestions, feedback, and patience throughout the project. Also, I would like to thank Mr. D.A. Rosen Jacobson for his help and feedback from the client's perspective.

Thank you to my friends for their active support and daily presence, which have empowered me throughout this process.

Finally, I would like to say a huge thank you to God, my family, my parents and my brother, for supporting me every step of the way over the years with their best efforts. I could not have accomplished any of this without their support.

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Thesis general information

Disclaimer

This Master Thesis is written for completion of the MSc Integrated Product Design program at the faculty of Industrial Design Engineering (IDE) at Delft University of Technology (Delft, Netherlands).

Supervisory TU Delft team

Peter Vink (chair)
Shabila Anjani (mentor)

Graduate student

Christos Batsaras

Client

Elysian Aircraft Company B.V.
https://www.elysianaircraft.com

Daniel Rosen Jacobson (mentor)

Me as a designer

From my earliest memories, I have realized that curiosity is a defining characteristic of mine. Being curious makes you think about what is happening around you, how it happens, and especially why. I would say that this 'why' is the reason I chose to continue my studies at TU Delft. It's all about understanding the reasons behind results; this helps you develop a different way of thinking and fosters immediate associations, sometimes leading you to question yourself, 'What is going on in my head?

Although this has a large number of benefits, it has also some major downsides. When you follow your thoughts in this way, it is likely to fall into the 'assumption' trap, where it can be challenging to consider perspectives different from your own-this is the most important lesson from this Master in TU Delft-. If someone would ask me "What did you learn from this Master?" I think the most accurate answer would be "That I learnt how to learn". It is amazing how many times I thought that I know what to do and that I'm certainly correct, but in the end I understood that probably this was not the truth.

As I remember a lecture from mr Stefan Persaud, "the more you know, the more you understand that you do not know."

The personal aim for this project is to be more familiar to this situation, combine my 'curiosity' with methodologies and yet come up with a potential applicable concept for the client.

Project outline

Domain

Zero-emission regional airliner interior design in 2033.

Max 1000km of flight

Regional airliner aircraft

Sustainable aviation

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Thesis introduction

A considerable growth in aviation has been reported in the last decades which is being reflected from around 2 percent global carbon dioxide emissions and some 4 percent of all climate change impacts each year (Major Climate Benefits With Electric Aircraft, 2024). As this activity has some important effects on the climate change, the ability to electrify aviation could reduce environmental impacts. According to this, the first electric aircrafts are already in operation today and are mainly small planes used for pilot training and short flights in the immediate area (Major Climate Benefits With Electric Aircraft, 2024).

Elysian Aircraft Company B.V. set an important goal which is to “Redefine zero-emission air travel”. To do this, they are developing their first aircraft called ‘E9X’, aiming to be used in short-flights as it showcases the potential of battery-electric aviation as a scalable and economically viable option compared to traditional aviation, setting the stage for a zero-emission future of the industry (Elysian Aircraft, n.d.).

Currently, the interior of this aircraft is not developed yet, leaving the opportunity to create a completely different experience in future air travel. An important factor to create something innovative is that the solution space should be as broad as possible and this is how this thesis project is meant to be. Very few limitations-yet regulations-are taken into account through the whole design process, whereas in the beginning they were totally not considered.

Limitations

In the scope:

- Passenger cabin layout including only seats and lavatory
- Business-economy class split
- Regulation of 90 second evacuation (per CS-25 requirements)

Out of scope:

- Boarding and deboarding process
- Lavatory design
- Luggage system and storage
- Emergency systems
- Functions in the interior
- Pricing
- Materials and structure of seats
- Flight attendants and their equipment

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Stakeholders

TU Delft - Faculty of Industrial Design Engineering
The goal of this Master Thesis is to prove to the university that I have the expected level of knowledge and that I am able to manage a project myself. The end result will be available at the Repository of Delft University of Technology.

TU Delft - supervisory team
The role of supervisory team is to guide and help the student through the project. Their expertise and experience is more than important and of course more that welcomed and appreciated.

Design Context
The field of aviation is really specific with many factors influencing the user experience. At this project it was aimed to create a new approach to the experience of air travel which can lead to difficulties in acceptance from the end users-in this case passengers-as well as the project stakeholders.

World
As technology is-and becoming even more-a considerable constant to people’s everyday life, the value of products is increasing. In that context, means of sustainability are more than important to catch that demand.

Elysian Aircraft Company B.V
Elysian Aircraft is a new company which aims to contribute to sustainable aviation and enter the market in the next few years. Their goal is to have an attractive alternative that companies will be willing to choose among competitors.

Me
As a Master student it is a great opportunity to work on such a topic, supervisors and client for my Thesis project. Coming from Civil Engineering background, this topic is a challenge to combine my knowledge and give a more spherical perspective.

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Methods

Creating an innovative solution can be quite challenging, as individuals often think and imagine within the boundaries of their existing knowledge.

A method that approaches Product Design from a different perspective and creates opportunities for various new futures is Vision in Product design (ViP) by Paul Hekkert and Matthijs van Dijk. (Hekkert & Van Dijk, 2011).

According to an article from Caicedo (2022) who gives a summary about the ViP method, a very reasonable question to be answered is:
"Why to use ViP method?"

1. Design is about looking for possibilities, and possible futures, instead of solving present-day problems.
2. Products are a means of accomplishing appropriate actions, interactions, and relationships. In interaction with people, products obtain their meaning. This is why ViP is interaction-centered.
3. The appropriateness of an interaction is determined by the context for which it is designed. This context can be the world of today, tomorrow, or may lie years ahead. Future contexts demand new and different behaviors. This makes ViP context-driven (Caicedo, 2022)

At this point it is worth to mention that using this method creates the opportunity for an ***updatable*** outcome which is a very convenient approach for companies.

"ViP establishes the connection between a designer's unconscious and conscious thoughts."
(Hekkert & Van Dijk, 2011)

Main body

The beginning

The first thing to do was some general desktop research with the aim to gain some information and knowledge is this field. In general, the categorization of aircrafts is as following (Pilot Institute, 2023):

- **Category:** A general classification of aircraft which is based on their intended use and the environment that the operate such as airplane, glider, or helicopter (rotorcraft).
- **Class:** This is a more specific division within a category which is based on design and performance characteristics, such as single-engine or multi-engine.
- **Type:** As type of an aircraft we refer to a specific make and model, such as the Embraer E190 or Airbus A220. To fly an aircraft that weighs more than 12,500 pounds or a jet (regardless of weight), pilots require a “type rating.” (Pilot Institute, 2023)

At this project the focus is at ***Regional Airliner airplanes.***

Regional airliners are aircraft that designed to do short to medium-haul flights, either regional or domestic routes (Regional Airliners (20 - 70 Seats) - AEROAFFAIRES, n.d.). According to this, they usually carry a relatively small number of passengers (between 20 to 70) and are used to connect cities at a shorter distance than international flights.

These aircraft are specially designed to meet the needs of regional air transport, offering transport capacity tailored to local demand and capable of taking off and landing on shorter runways than those required for long-haul airliners. They have major importance in connecting remote or regions with a low population where larger aircraft could not be economically viable. Referring to both jets or turboprops, regional jets are used worldwide, specifically by airlines that aim to offer domestic flights at the best possible rates. Regional aircraft are operated by regional airlines or subsidiaries of larger airlines. They can include models such as Embraer’s E-Jet (Portal Embraer, n.d.), Bombardier’s CRJ (Bombardier, n.d.), ATR (ATR, 2024) and others. These aircraft help ensure air accessibility to communities that might not be served efficiently by larger aircraft (Regional Airliners (20 - 70 Seats) - AEROAFFAIRES, n.d.).

Key words:
aircraft, regional airliners, Embraer E-195, **Boeing 747**

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Regional airliner interior

Currently, airliners aiming to fit the maximum number of passengers and at the same time to ensure some level of comfort. This applies also to regional airliners as well as Economy class of larger airplanes. Seating on regional airliners tends to be narrow and tight. For instance, the ERJ 195 (see Figure 1) which is a regional jet serving short-haul destinations provide seats of 32” pitch and 18.25” width for both Economy and Business class (SeatGuru Seat Map Lufthansa, n.d.), whereas for Boeing 747 (see Figure 2) is 31” pitch and 17.1” width, 38” pitch and 19” width and 64/78” pitch and 20” width for Economy, Premium Economy and Business class respectively (SeatGuru Seat Map Lufthansa, n.d.-b).

Figure 1: Embraer E-195

Figure 2: Boeing 747-400

Historical analysis

Characterized as “Novel and exciting; loud and uncomfortable—an experience few people ever got to relish or regret” gives the expression of how aviation started. By that time, pilots and occasional passengers were sitting in open cockpits that were exposed to wind and weather. Even in Europe, where large transports carried passengers in comparative luxury, the ride was harsh, loud, and uncomfortable (The Evolution of the Commercial Flying Experience, 2022).

The interior of an Aeromarine Airways airliner. Note the wicker seats. Aeromarine Airways flew for four years, from 1920-1924.

1914-1927

Flying was still loud, cold and unsettling. As aircraft were not pressurized they had to flew at low altitudes, where weather conditions and wind could make flying bouncy. Due to this, air sickness was a common thing. Despite the fact that airlines provided many amenities to relief passengers from stress, the air travel remained a severe adventure into the 1940s (The Evolution of the Commercial Flying Experience, 2022).

Passengers on a Ford Tri-Motor. This photo was probably used to promote air travel.

1927-1941

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Historical analysis

In 1955, for the first time, more people in the United States traveled by air than by train. By 1957 airliners had replaced ocean liners as the preferred means of crossing the Atlantic (The Evolution of the Commercial Flying Experience, 2022b).

When World War II ended and travel restrictions ended passenger travel reached higher levels. New carriers emerged, and new technology began to revolutionize civil aviation.

Quantas Airways Limited

1941-1958

Children were often showcased in promotional postcards like this one by Pacific Southwest Airways in 1960. Families were welcome aboard for travel (Poirot, 2022b). Although, from summaries of 136 complaints filed against dozens of U.S. and foreign airlines we could consider that airliners are separating parents and children (Today, 2019).

Mike Roberts/Smithsonian Institute

1960

Historical analysis

In 1970, Delta offered a unique First Class experience introducing the 747 Penthouse the "world's first flying penthouse apartment" on its first “widebody" jet, the Boeing 747. Moreover, jets offered audio entertainment during the flight including music by the Beatles, Burt Bacharach and Beethoven (Delta Museum, n.d.).

The 747 Penthouse

1970s

Again Delta, introduced computer-generated boarding passes and automated advance seat selection, aim to create significant improvements is boarding process in gate areas. First major U.S. carrier to meet new federal standards reducing flyover noise in airport neighborhoods. Also, Boeing 737 joins fleet. A children program called “Fantastic Flyer” launches with Dusty the “Delta Air Lion” mascot, kid-friendly meals and a quarterly activity magazine (Delta Museum, n.d.).

Delta Museum

1980s

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Historical analysis

Delta changed the airline game when it launched its Medallion seating in 1983. Not First Class. Not general class. This was larger seating and separation meant for the ever-growing class of business travelers (Delta Museum, n.d.).
As airlines attempted to outdo one another, the seats began reclining like La-Z-Boy chairs. Business Class became so big that most airlines ditched their First Class for Business Class seating as the one with all the perks.

Delta Museum

1990s

Although movies were shown on airplanes as early as the 1920s, it wasn't too long ago that the only way to watch a film was through a shared system featuring screens located in the aisle of the plane (Poirot, 2022c).
In the 1990s, Airfones were still a feature of airplanes, as well (Verizon | AirFone® | Welcome to Verizon AirFone®, n.d.)

Hunter Desportes / Flickr

1999

Historical analysis

Entertainment began becoming more of a luxury on flights, with airlines installing seat-back systems to provide passengers with their own movie, television and game system (Poirot, 2022d).
More recently, airlines started ditching seat-back screens to embrace direct-to-device streaming instead (Rizzo, 2019).

Getty

2000s

British Airways (BA) brought us full circle in the early 2000s when they brought back seats that converted into beds (Flynn, 2024). It felt much more like being in a home lounge, and this 'lounge in the sky' concept was the main factor enhancing the overall customer experience. Although planes had originally flatbeds, and BA had similar seating in First Class in the mid-century, these seats became the first for Business Class. Again, this helped airlines eliminate First Class areas.
The way it feels to fly international on a standard fare ticket these days, it might as well be First Class! (Poirot, 2022d).

British Airways

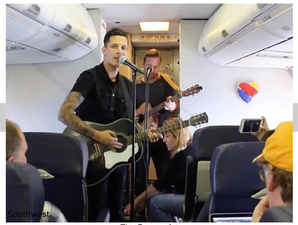
2000s

What passengers gained in entertainment and later Wi-Fi has been lost in terms of leg room. Airlines are squeezing seats tighter and tighter to fit more passengers in an effort to save on costs. In the early 2000s, rows in economy were 34 to 35 inches apart; now they're typically 28 to 31 inches apart. Anjani et al. (2021) showed that 28" pitch is reducing comfort tremendously. And the cramping is only poised to get worse in the coming years (Bloomberg, 2019).

Getty

2010

Some airlines have tried to find ways to make airline travel fun again. In 2017, for example, discount airline Southwest partnered with Warner Music Nashville for a Concerts in the Sky program. It didn't last long (The Economist, 2017).



The Economist

2017

Historical analysis

Originally, plane travel catered to those who could afford its luxuries, and today, First Class passengers still enjoy such comforts. For instance, Singapore Airlines offers private suites with seating and full bed space for long-haul flights. Meanwhile, many travelers are now packing carry-on bags more efficiently to avoid checked baggage fees. Although some airlines still charge for smaller roll-aboard suitcases based on fare class, JetBlue recently announced it will eliminate this fee (McCarthy, 2024). As luggage fees rise and instances of lost luggage increase, the size and number of carry-on bags are growing (Tams, 2023). In response, a new approach like 'hand baggage lite' express lanes might be introduced.

Singapore Airlines

2019-now

These lanes at security would be designated for travelers with a single, small carry-on bag containing no liquids, allowing those who have checked larger bags to move through security more quickly (BusinessTraveller, 2023).

Historical analysis-Results

If we could summarize the insights from the Historical analysis, we could say that:

- Already from the very beginning, there was a ‘bus-like’ layout set-up which gives us the impression that it was a flying bus it people’s mind.
- Started as luxury but demand due to global change of lifestyle, transformed flying into a means of traveling for most of people.
- Even though there are some efforts to improve quality and provide more comfort to the passengers (e.g. baby seats), all these were created mostly in the scope of sacrificing standards of provided comfort and adding additional features-increasing the number of passengers was the main aim-.
- Core-changes did not really happen; we can see that airplanes (in general) have really an established set-up, probably due to strict regulations and economical reasons.
- Changes are mainly ‘technological skin-like’ which not necessarily add new functions, but different ways of offering the same function (e.g. central movie screens/smart phone/ individual screen).

A general design direction could be considered that is:

“To make it feel like home.”

ViP method:
Deconstruction phase

Deconstruction phase

When faced with a design assignment-whether your own or brought to you by a client-it is inevitable that existing designs pop into your mind (they were probably already in the mind of the client as well) (Hekkert & Van Dijk, 2011). You could say that these designs were a solution to the problem as it was once stated. Before immediately starting the design process by (re)defining the domain, for a number of reasons it is going to be very helpful to first 'deconstruct' these familiar, existing solution .

Deconstruction is looking at an existing design, and asking yourself, "Why is this design the way it is?" (Hekkert & Van Dijk, 2011).

To answer these question we need to answer the following ones:

"What the product actually is?"
"What are its qualities?"

I thought that in order to answer these questions accurately, I have to travel myself as a passenger, as it will help me to actually feel the whole experience and see things with different lenses.

The airplane that I was traveling was Airbus A321, which is common in these routes. I did three air trips: From Amsterdam (AMS) to Istanbul (SAW), from Istanbul (SAW) to Athens (ATH), and from Athens (ATH) to Amsterdam (AMS) (see Figure 3).

Figure 3: Personal airplane trip

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Product:Interior

First, the whole interior was defined as the product so we can have a more uzoomed approach. From the overall experience, I realized that traveling with an airplane can be split into phases, which could be:

1. **Boarding**
2. **Waiting to start**
3. **Traveling**
4. **Deboarding**

whereas according to literature (Wang & Zhao, 2020) are:

1. planning phase
2. takeoff phase
3. climb phase
4. cruise phase
5. descent phase
6. approach phase
7. taxi phase

These experiences have a large similarity with the ones mentioned in the study of Bouwens et al. (2017) 'The high and low comfort peaks in passengers' flight'. Considered as interactions of the interior they can be characterized us:

•Boarding: **anxious, rushy, awkward, disorganized, slow**
•Waiting to start: **endless, uncomfortable, boring, noisy**
•Traveling: **boring, awkward, noisy, limiting**
•Deboarding: **rushy, disorganized, awkward, slow,**

where they show some similarities with the 14 PreMo animations (Laurans & Desmet, 2017).

These findings could be linked to a study from Bouwens et al. (2017) where the lowest scores of perceived comfort occur during the stowage of hand luggage and the cruise phase. In contrast, the highest scores are observed immediately after take-off and upon arrival at the destination airport. These two lowest and two highest scores differ significantly from the phases immediately before and after them (see Figure 4).

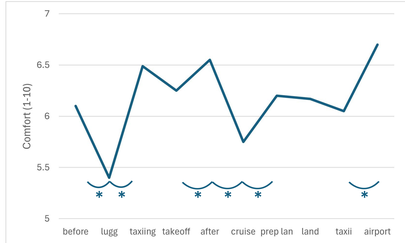

Figure 4:Average comfort scores at the different phases during a flight. *means significantly different from the adjacent phase (t-test for paired comparison, p<0.05).

Product:Interior

These are considered as the ‘qualities’ of the interior as a product. If we could consider the ‘air traveling’ as an even more unzoomed interaction, its qualities from personal experience would be:

- Freedom remover
- Fake formality applier
- Money-seeker

Comfort in aircraft interior

Scientific studies emphasize how important comfort is inside airplanes. The design of airplane interiors now pays more attention to making passengers comfortable (Vink et al., 2012). This study also found that comfort is closely connected to legroom, cleanliness, how helpful the crew is, and how much personal space passengers have. The study also found that unfriendly flight attendants and poor hygiene make passengers feel less comfortable. On the other hand, when passengers feel more comfortable, they are more likely to want to fly with the airline again (Vink et al., 2012).

According to research, comfort can be described as a pleasant state where a person feels physically, psychologically, and physiologically at ease with their surroundings, or simply a feeling of wellbeing (De Looze et al., 2003). The definition of comfort varies, but one common aspect is that it is a personal experience. Vink (2005) conducted a review of literature using the MEDLINE database and found 261 papers with comfort in the title from April 1993 to April 2003. A significant number of these papers (140 out of 261) focused on climate or thermal comfort.

Bronkhorst and Krause (2002) demonstrated that it is possible to create comfortable interiors by designing a train interior that 83% of passengers described as comfortable. Before starting the design process, they evaluated factors such as passenger characteristics (like body measurements) and activities performed during travel, which they integrated into the final design.

Two studies by Vink et al. (2012) highlight that the main factors influencing comfort in airplanes are legroom and seat comfort. According to their travel report study, hygiene and crew attentiveness are also crucial factors, while their interview study emphasizes the significance of personal space. Previous studies like Blok et al. (2007) and Richards and Jacobson (1977) also underscore legroom as a primary comfort factor.

However, Konieczny (2001) discovered that factors such as the pre-flight experience and crew attentiveness, along with softer elements like lighting (Mellert et al., 2008), also play vital roles in enhancing the comfort experience. These complex relationships require further exploration to better grasp the overall comfort dynamics in airplanes (Vink et al., 2012). Brindisi and Concilio (2008) introduced a method using neural networks to model passengers' perceptions of environmental comfort within aircraft cabins.

Key words:
aircraft, airplane, regional airliner, aircraft interior, comfort in aircraft interior

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Comfort in aircraft interior

According to Bouwens et al. (2018), the most important factor affecting comfort in aircraft is anthropometry, followed by engine and aerodynamic noise, and temperature variations. Smell, lighting, and vibrations are also considered significant factors, mentioned as fourth, fifth and sixth factors. Interestingly, the importance of these factors varies depending on passengers' activities (Bouwens et al., 2016). For example, temperature is crucial when passengers are sleeping, whereas lighting becomes more important during in-flight entertainment (IFE).

Hiemstra-van Mastrigt (2015) suggested that engaging in conversation with fellow passengers could help distract individuals from their perceived discomfort. Similarly, Kahn (2003) discovered that background noise, like that found on trains, can be viewed positively by passengers because it masks other sounds, such as conversations among passengers. Furthermore, Huang and Griffin (2012) noted that a strong stimulus can create a "masking effect" that affects comfort levels. In conclusion, understanding how these various factors interact is essential for a complete study of comfort in transportation.

Ending, the disadvantage of researching comfort and discomfort factors using questionnaires is that participants might not be aware of the single causes and how they are related to their perceived discomfort or comfort. Often humans are not aware of the environment (Vink, 2014).

Subproducts

Next, the interior was split into ‘subproducts’ which are:
fuselage, seat, smart phone/book, **window**, **meal**, where the interactions and qualities of these products were defined below:

•seating: static, forced, secure, uncomfortable, limiting
•observing: relieving, boredom remover
•sleeping: interrupted, disoriented, limited, fake
•smart phone use: obsessing, helpful, intuiting, discomfort reliever
•listening to music: boredom reliever, mind-traveling
•reading: unfocused, interrupted, disturbed
•looking (out of the window): peaceful, desired, enjoyable, limited, saver
•drinking/eating: unnecessary (in short flights), time spending-helper, boredom disorientator, break-giver

If we see them from a perspective concerning comfort we could relate them with a study of J. Bouwens et al. (2017b) that shows different in-flight activities require different environmental properties in order to facilitate passengers’ comfort during their flight. Moreover, it was shown that a hierarchy of any comfort-related environmental factors depends on the performed in-flight activity.

At this stage we have to think “What was the context the designer(s) of this product was (were) facing at the time of its design?”
We need to retrieve factors that once induced the designer to design the object we just analyzed, to think of consideration that designer have in mind at that time, what was his/her view on the world in general and the product domain in particular etc. (Hekkert & Van Dijk, 2011). According to this, the factors could be defined as following:

- Growth in travels with an airplane
- Bus layout seem to work as it is already tested
- More passengers in the same space means more money
- No competitive alternatives for air travels
- People like to feel as if they are at home
- People like using everyday means of technology such us their smart phones in the airplane
- In the early days of commercial flight, air travel was considered an adventure and sometimes romantic; it was mainly only accessible to the rich and famous, and was generally considered risky and even dangerous.
- Fear associated with flying was widespread among passengers and, of course, rational given the high accident rates in the era leading up to World War II. The fear deterred many from the experience. It was recognised that the travel experience produced significant physical discomfort, such as motion sickness, pain in the inner ears due to travelling in unpressurised cabins, and irritation due to noise and engine vibrations and, consequently, the first flight attendants were almost exclusively trained nurses (Bor, 2007b).
- Technological steps are big and quick and people use technology
- Materialism is something that people follow (Teenagers Do Grow More Materialistic:Study,2007), (Miles, 2022), (Global Attitudes on Materialism, Finances and Family, 2013)
- Due to globalization people need to travel more for work or enjoyment
- Revenue over comfort; followed the obvious economic model; more revenue will come with more passengers

Key words:
how much people follow materialism?

Past context

ViP method:
Design phase

To evaluate the observations and considerations (referred to as factors) that should be considered when designing a new product or solution using ViP, it is essential first to determine the domain in which these starting points are applicable. Therefore, any ViP design process must begin with defining the domain: a description of the area where you intend to make a contribution (Hekkert & Van Dijk, 2011).

Establishing the domain:

“Zero-emission regional airliner interior design in 2033.”

Factors include observations, thoughts, theories, laws, considerations, beliefs, or opinions. These factors can be found in various sources: within your own mind, the minds of friends, colleagues, or experts; in newspapers, on the internet, in books, movies, magazines, or other mediums where people share stories or scientific insights. Factors can be universally accepted truths or personal truths; they can range from plain facts to highly debatable opinions (Hekkert & Van Dijk, 2011).

For this project the factors are from: **Psychology**, **Sociology**, **Demographics**, **Biology**, **Economics**, **Politics.**

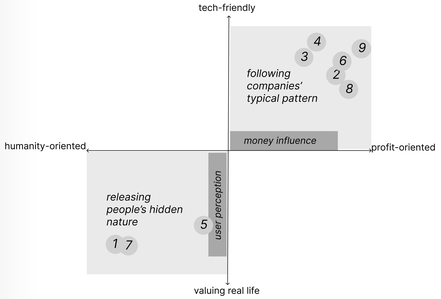
All factors as well as their cluster can be found below:
Link (or Appendix:ViP Thematic analysis)

Next step, is to structure the context.

From the gathered factors we can create groups that represent the connection between them in terms of meaning and values. These groups we called clusters and they are:

1. **Desired nostalgia**
2. **Revenue over respect**
3. **The decline of the belief in God**
4. **Backlash of technology to humanity**
5. **Nature still expresses humans**
6. **Dishonest designing**
7. **Uncertainty can be fear or excitement**
8. **World-airliners-passengers close relationship**
9. **Greenwashing is a thing**

A list of fine ingredients does not automatically make a good meal; eleven skilled players do not automatically form a good team, and a set of notes does not automatically create a beautiful composition. Similarly, a list of context factors, no matter how appropriate and appealing, does not (yet) constitute a context you can design from or for. To achieve this, the set of factors must be transformed into a unified whole, a coherent structure that explains how the separate elements are connected (Hekkert & Van Dijk, 2011). To create the statement definition the clusters were put into a 2-axis system:



My vision is:

“I want people to experience traveling with Elysian’s E9X as a resurrection of their human nature.”

By that time I already had a feeling of what I want to achieve with this project and the meaning through that this will be expressed. New design metaphors are capable of creating new understanding and therefore, new realities (Metaphors in Design Problem Solving: Implications for Creativity, 2007). Due to this, I used the Greek word “ξεγνοιασία” (~xegniasia) an analogy-metaphor, which has a similar meaning to jauntiness, carefree (see Figure 9 and 10). Observing society as a whole, it becomes clear that people are missing a sense of carefreeness due to modern lifestyles and a growing distance from nature. The translation of this word though, is not 100% complete due to language differences and personal experiences. To explain it more accurately we need more than words.

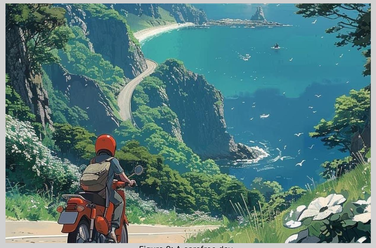


Figure 9: A carefree day

nostalgia + sound and smells of summer breeze

Figure 10: A carefree day

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The explaining of this feeling is probably impossible as the meaning is different for everyone; it results from the perception of personal experiences, culture and consciousness. I used Dall-E AI (https://labs.openai.com) image generator to try to be more accurate in visualizing the meaning and the results are the following:

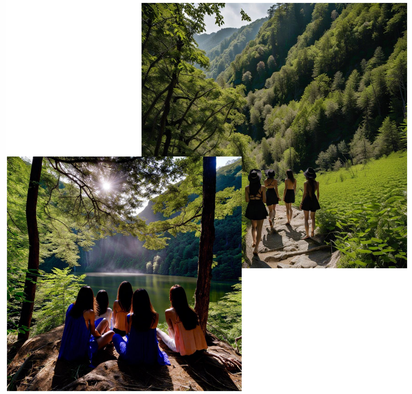

Figure 11: “A day in the nature that you feel jauntiness and you are with your friends.”

Design phase

“For me, it was the feeling I had when the summer holidays were starting and I knew that I will spend the whole summer at my village, meeting my friends that I could not meet in my everyday life, be mostly outside, riding our bicycles, play, exceed the boundaries (a bit), experience, feel.”

Design phase

good weather (summer breeze)

in contact with the nature

having company

all senses activated

ξεγνοιασία

explore

excitement

exceeding boarders

freedom

But there is something that is common for everyone, when you felt this feeling, all your senses were positively activated!

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Nature experiences and psychology

Recent research suggests that the benefits of nature experiences depend partly on how individuals mentally engage with nature (Macaulay et al., 2022). These experiences often lead to psychological restoration, a concept described in Attention Restoration Theory (ART; Kaplan & Kaplan, 1989), and foster a deeper connection with nature (Mayer et al., 2009), which are vital for psychological wellbeing (Capaldi et al., 2014; Hartig et al., 2014). Everyday encounters with nature, whether in urban settings or near one's home, provide valuable opportunities for spending time in natural surroundings (Bonnes et al., 2004; von Lindern et al., 2016).
Factors such as the built environment, work stress, and individual attitudes may restrict the benefits derived from nature experiences (Bonnes et al., 2004; Von Lindern et al., 2016). It is important to recognize the role of individual engagement in these constrained nature experiences, where greater levels of engagement could potentially enhance the benefits of everyday interactions with nature.
Macaulay et al. (2022) propose that cognitive engagement is crucial for both psychological restoration and developing a connection with nature. Psychological restoration refers to the renewal of mental resources (Hartig, 2004; Kaplan & Kaplan, 1989), while connection with nature is defined as a sense of oneness with the natural world that grows through nature experiences (Mayer & Frantz, 2004). There are different ways to engage with nature, with mindful engagement having distinct qualities compared to other forms of engagement (Macaulay et al., 2022). Therefore, mindful engagement in nature involves intentionally maintaining awareness of both internal and external experiences with curiosity and without reactivity or judgment. Macaulay et al. (2022) also identify key mechanisms that support the psychological benefits of mindful engagement in nature.

For this project the mechanism of "***Decentering***" was selected as means of direction as it is believed that is the most related to the situation at the airplanes (see Figure 5). According to this, Decentering is the ability to see thoughts as temporary mental events rather than as reflections of self-worth or truth (Baer, 2009). In mindfulness, decentering creates psychological distance from thoughts and emotions, making daily worries less intrusive. Regarding restoration in nature, Lymeus et al. (2018) suggest that mindful decentering helps individuals stay grounded in the present moment, enhancing the sense of being away and supporting the restorative effects of nature experiences. Hölzel et al. (2011) note that even small changes in how one identifies with their internal experiences can shift their perspective on the self, which is a key mechanism in achieving mindfulness and well-being outcomes.

Key words:
nature, nature + psychology

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Nature experiences and psychology

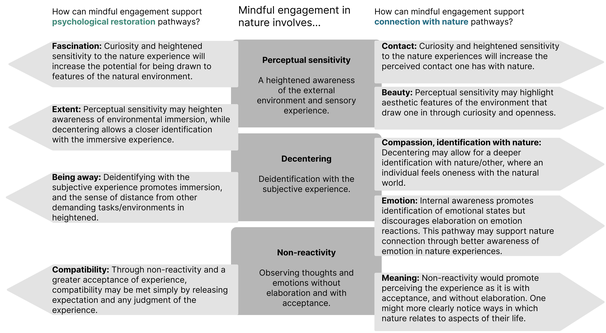

Figure 5: Conceptual model representing how mindful engagement functions within a nature experience. Perceptual sensitivity, decentering and non-reactivity arise through mindful engagement in nature and support psychological restoration and connection with nature. Overlapping text boxes represent links between mindful engagement mechanisms and pathways to outcomes. Two pathways (extent and emotion) connect with two mindful engagement mechanisms (Macaulay et al., 2022c).

Nature in interior design

Many designers draw inspiration from nature, but often miss some aspects of forms, function, or structure in their designs (El-Ghobashy & Mosaad, 2016). To optimize their designs, they should search deeper into every aspect of nature and apply these insights to their conceptual design process, which forms the foundation of the overall design process. Nature is an emotional element in our surroundings and plays a significant role in our daily lives, influencing everything around us (El-Ghobashy & Mosaad, 2016). Designers need to understand how spaces impact individuals to create environments that relieve everyday stress and promote personal well-being (Attia, 2012).

Mies van der Rohe's famous phrase "less is more" captures the idea of simplifying architectural design to its most basic and essential elements (Lawley & Tompkins, 2000). Ortony, a professor emeritus of education, psychology and computer science, identifies three key qualities of effective metaphors: vividness, compactness, and expressibility. Short metaphors can convey a great deal of abstract and intangible information in a concise and memorable way. According to Lakoff, "new metaphors create the entire conceptual system that human activities depend on" (Lawley & Tompkins, 2000).

Metaphors have an important role in formation of identity. By using creative metaphors we can enrich a certain cultural environment by adding new meanings (Ayıran, 2012).

Key words:
nature + interior, leisure air travel

Nature experiences and psychology

New design metaphors have the potential to foster new understanding and create new realities. These metaphors help integrate architecture with the environment to meet human needs and satisfaction, making building forms more familiar by drawing inspiration from nature. They are valuable tools for creativity, providing designers with opportunities to express their ideas and explore various design solutions (Metaphors in Design Problem Solving: Implications for Creativity, 2007).

The effects of the environment on people often evoke emotional responses. Humans naturally seek nature for relaxation, refreshment, and calmness, as these elements contribute to a sense of inner happiness (Vahedi, 2009; The Impact of the Surrounding Environment on People's Perception of Major Urban Environmental Attributes, 1990). Historically, nature was the primary source of inspiration for humans. However, with technological advancements, the ability to create new products increased, often leading to a reduced respect for and connection with nature. Many modern projects involve less integration of natural elements, emphasizing the need for designers to blend nature with their conceptual designs.

The best projects incorporate various aspects of inspiration from nature (Vahedi, 2009). It is essential to achieve complete integration between the exterior and interior of a building and its surrounding nature. This can be accomplished by using a clear natural concept from the environment to solve design problems and applying it to the building's form, shape, function, materials, colors, furniture, structure, interior elements, equipment, and environmental treatments (El-Ghobashy & Mosaad, 2016).

Human needs

Understanding human needs is foundational in both design research and practice (Desmet & Fokkinga, 2020). Hassenzahl et al. (2010) identified a positive link between the satisfaction of these needs and enjoyable experiences with technological products. They argue that designing for human needs is crucial for creating positive user experiences through technology. Abraham Maslow (1908–1970), a highly influential psychologist, emphasized that all individuals have an inherent drive for personal growth and the fulfillment of psychological needs, which are essential for long-term well-being (Koltko-Rivera, 2006; Sheldon et al., 2001).

Maslow's theory emerged from a fundamental inquiry into human motivation: "What motivates humans?" According to his framework, fulfilling psychological needs not only brings satisfaction but also contributes significantly to overall happiness (Hassenzahl, 2014). Therefore, positive experiences are rooted in the fulfillment of these psychological needs, and technology can play a vital role in enhancing user experiences by meeting these needs (Hassenzahl et al., 2010b; Hassenzahl, 2010; Tuch et al., 2013). This understanding spans various aspects of life, including leisure and work activities (Tuch et al., 2016).

Moreover, psychological needs (see Figure 6) serve as a framework for categorizing and understanding different positive user experiences, guiding design approaches effectively (Wiklund-Engblom et al., 2009).

‘What motivates humans?’ (Abraham Maslow)

Key words:
human needs

Nature experiences and psychology

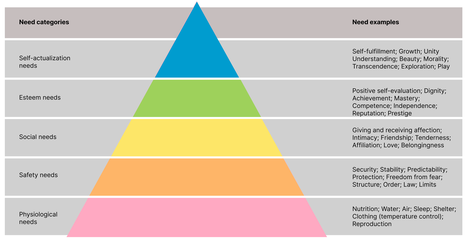

Figure 6: Pyramid representation of Maslow's Hierarchy of Needs.

The fulfillment of one need might actually detract from the fulfillment of another (Desmet & Fokkinga, 2020b). For instance, high-heeled shoes are regarded as elegant footwear in many cultures but also cause impracticality (affecting the need for competence) and physical discomfort (affecting the need for comfort). Need profiles are an excellent starting point for using fundamental needs as inspiration for new product ideas. We identify at least three design opportunities: (1) strengthen current needs; (2) introduce new needs; and (3) reduce harmed needs. At this project the general approach will be derived from the opportunity of “reduce need harm”. The first step is to identify which needs are being harmed, whether intentionally or not. Next, the product can be redesigned to address and resolve these harmed needs (Desmet & Fokkinga, 2020b). We could say that, the overview of comfort and discomfort levels when traveling with an aircraft have shown that the harmed needs are mostly related to physical ergonomics. Also, as mentioned before, there are possible needs that are harmed that people are not aware of (Vink, 2014). People's perceptions and interpretations of their surroundings become highly multimodal when they occupy and experience a space (Pallasmaa, 2005; Dischinger, 2006; Franck and Lepori, 2007; Heylighen et al., 2009; Heylighen, 2011; Wastiels et al., 2013; Kwon and Kim, 2021). While each sensation is partial and the senses are distinct, they are also indistinguishable; they are united through the body, forming its overall perception, as argued by Merleau-Ponty (2014).

The aim of this project is to create a direction where the perceived comfort can arise in a more multi functional way and consider traveling as a more complete, spherical experience.

Biophilic design

The built environment plays a crucial role in achieving sustainability, particularly by improving resource and energy efficiency while minimizing negative impacts on the environment and human health (Wilkinson et al., 2007). Disconnecting from nature can lead to difficulties in stress reduction and productivity. The global COVID-19 pandemic highlighted how vulnerable we are to various distractions and psychological stresses (Colding et al., 2020).

Psychologists and biologists interpreted the psychological need to connect with nature through the *biophilia* theory (Fromm, 1964; Kellert, 1993; Wilson, 1984). In the 21st century, pioneers of biophilic design applied this theory to architecture (Heerwagen and Hase, 2001; Joye, 2007; Kellert et al., 2008), integrating it with other environmental psychology theories, such as those on habitat settlement (Appleton, 1975; Hildebrand, 1999; Hidalgo and Hernández, 2001; Orians and Heerwagen, 1992) and psychological restoration (Kaplan, 1995; Ulrich, 1983). Numerous studies have highlighted the benefits of biophilic architecture in enhancing human-nature connectedness, health, well-being, productivity, biodiversity, and resilience (Africa et al., 2019; Gillis and Gatersleben, 2015; Wijesooriya and Brambilla, 2021). The potential of biophilic architecture to reduce energy consumption and combat climate change has also been explored (Beatley and Newman, 2013; El-Baghdadi and Desha, 2017; Kellert, 2016; Lee and Kim, 2021; Littke, 2016; Reeve et al., 2015). These findings have increased recognition of its benefits in the pursuit of sustainability. At the 26th UN Climate Change Conference (COP26, 2021) in Glasgow, Scotland, biophilic architecture was discussed as a key strategy for limiting global warming from 2°C to 1.5°C.

Researchers have proposed biophilic design frameworks with diverse categories and elements (Zhong et al., 2023).

Zhong et al. (2022) developed an optimized biophilic design framework by removing redundant, overlapping, and controversial elements from previous models and focusing on those crucial for modern architecture. This framework aims to support the creation of sustainable buildings. It defines "nature" in architecture through 18 elements categorized into three design approaches: "nature incorporation," which involves integrating various natural elements and processes; "nature inspiration," which involves mimicking natural shapes, patterns, and mechanisms to create visual or touchable nature experiences; and "nature interaction," which involves creating nature-like environments that offer survival advantages.

Key words:
biophilic design

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In recent architectural practice, there has been increasing interest in volumetric three-dimensional (3D) green spaces (Zhong et al., 2023). Unlike the more common two-dimensional (2D) green surfaces, 3D green spaces offer many unique features. They can be designed with rich spatial variations and greater accessibility, allowing for larger plants and a wider variety of species to thrive. We introduce the concept of the "green pocket" to characterize a broad range of 3D green spaces in buildings, establishing it as a distinct architectural typology (Zhong et al., 2023). "Green pockets" are 3D green spaces in buildings that can take on various spatial forms and layouts. This term is introduced for three primary reasons:

- Green pockets are three-dimensional spaces, highlighting their capacity to support dense vegetation.
- Green pockets offer flexibility in spatial design and can be situated in various locations throughout a building.
- Green pockets are accessible green spaces within urban environments, enabling people to coexist with other living species and be close to trees, shrubs, and plants in cities, rather than only experiencing greenery in suburban homes with gardens.

Advantages of biophilic design can be seen in **physical health**, **psychological health** and **well-being**, **social well-being and economic opportunities** (Zhong et al., 2023).

Physical health
According to this, studies including the NASA Clean Air Study from the 1980s (Wolverton et al., 1989), have extensively investigated how plants help purify indoor air. Indoor plants can reduce levels of various contaminants, such as particulate matter (PM), volatile organic compounds (VOCs), and carbon dioxide (CO2) (Knowles et al., 2002). For example, indoor plant systems can lower CO2 levels by 10% to 20% and remove formaldehyde (a common VOC) completely within 45 minutes in a classroom (van Duijn et al., 2011). They can also reduce aerosol and formaldehyde concentrations by 41% to 50% and 23% to 37% respectively within 120 minutes, even without an air purification system (Velzeboer et al., 2019). Additionally, indoor greenery helps improve thermal comfort by lowering ambient air temperatures and increasing humidity (Hoelscher et al., 2016; Jimenez, 2018; Liu et al., 2022; Raji et al., 2015).

Biophilic design

Green spaces help reduce noise levels, creating a quieter indoor environment and providing acoustic isolation to improve privacy (D'Alessandro et al., 2015; Mediastika and Binarti, 2013; Van Renterghem et al., 2013; Yan et al., 2022). Additionally, greenery offers pleasant views that can alleviate fatigue and restore attention, thereby enhancing cognitive performance, concentration, and productivity (Gilchrist et al., 2015; Gillis and Gatersleben, 2015; Korpela et al., 2015; Lee et al., 2015; Li and Sullivan, 2016).

Psychological health
Green spaces in buildings enhance psychological health and well-being by increasing access to nature. They help with emotion regulation, reducing stress and negative emotions like anxiety and depression (Contini et al., 2022; Li et al., 2022; Nejati et al., 2016; van den Berg et al., 2010), while also promoting tranquility, aiding in healing, and speeding up recovery (Dijkstra et al., 2008; Jamshidi et al., 2020; Ulrich, 1984).

Additionally, green spaces contribute to hedonic happiness by offering enjoyment and pleasure, improving visual satisfaction, and fulfilling aesthetic preferences for nature, which in turn boosts positive emotions (Jungels et al., 2013; Lee et al., 2014; Loder, 2014; Xiao et al., 2022).

Finally, these spaces can foster eudaimonic happiness by providing a sense of purpose and fulfillment, enhancing self-identity (Kellert, 1993, 2009; Wilson, 1984), strengthening connections with nature, and creating a "sense of place" or place attachment (Andreucci et al., 2021; Boiral et al., 2019; Liu et al., 2018; Zhang, 2022).

Social well-being and economic opportunities
Designing green spaces offers solutions to various social and economic issues. For instance, public green spaces that are easily accessible foster social inclusion and cohesion by encouraging community engagement, enhancing feelings of belonging, and promoting altruism. They can also contribute to reducing violence and crime (Beatley and Newman, 2013; Gue´guen and Stefan, 2016; Oh et al., 2022; Sa¨umel and Sanft, 2022). Building-based forms of urban architecture, such as indoor farms and vertical farming, are suggested to address food production and food security (Appolloni et al., 2021; Benke and Tomkins, 2017; Benis et al., 2018; Specht et al., 2014; Walters and Midden, 2018). Green spaces in buildings also boost property values by improving occupant satisfaction and increasing willingness

Biolphilic design

to pay higher rental prices (Han et al., 2020; Manso et al., 2021; Perini and Rosasco, 2016). Additionally, they help reduce building operating costs through energy conservation and minimized water consumption (Claus and Rousseau, 2012; Medl et al., 2017; Tabatabaee et al., 2019).

Some examples that use "Green pockets" in the Netherlands are:

1) Erasmus University Medical Center (Erasmus MC) (Figure 8), a project that integrates various green spaces tailored to different needs within a healing environment. That significant project designed by EGM Architects in Rotterdam, initiated in 1999 and completed in 2018. From the beginning, Erasmus MC set three core principles for this complex redesign: (1) "safety," emphasizing human safety, including the prevention of health damage, over environmental factors; (2) "healing is leading," prioritizing the speedy and effective recovery of patients and the well-being of everyone in the facility; and (3) "sustainability," implementing environmental measures aimed at achieving positive financial outcomes within ten years (Zhong et al., 2023).

2) Hotel Jakarta (Figure 7), an energy-neutral building certified as BREEAM Excellent, distinguished by its large-scale indoor subtropical garden (Zhong et al., 2023). It is a commercial building project designed with environmental and social significance in mind. Created by the architectural firm SeARCH in close collaboration with WestCord Hotel in 2013, it was completed in 2018. The green pocket in Hotel Jakarta aimed to create a healthy and comfortable environment, enhancing psychological well-being. The concept behind the green pockets was to not only create a man-made natural environment but also to evoke positive emotions and increase happiness by strengthening the connection with nature. Additionally, opening the green pocket as a public green space for surrounding residents was intended to bring socio-psychological benefits and establish a connection to the place's history through plant species. Regarding building performance, the green pocket was designed to regulate temperature, allow natural ventilation, maintain proper humidity levels, minimize energy consumption, and operate in synergy with renewable energy production (Zhong et al., 2023).

Moreover, there are opportunities to enhance the design of green pockets that were not fully utilized in the two cases (Zhong et al., 2023). For instance, not all natural elements were explicitly integrated as design features. Instead of only incorporating

Biophilic design

"water" into the water supply system, it is suggested creating fluid water scenes near green pockets to enrich visual and auditory experiences. Designing green pockets in uncovered areas, such as patios, can allow people to physically experience different weather conditions rather than merely observe them.

Furthermore, considering "time and seasonal changes" in the planting configuration can introduce a variety of forms and colors, giving green pockets dynamic features and enhancing the realistic sensation of "nature." Another example that is worth to mention is the Airspace Cabin Vision 2035+, which according to Airbus "*..is all about reimagining the future travel experience. Passengers and the entire aviation industry are invited to envision a future of flying that prioritises sustainability while maintaining superior levels of comfort.*" (The C-Suite - the Business Class Concept Seat, 2023). We could say that, this future concept for aircraft interior design follows a similar approach as it integrates nature-inspired aesthetics and functions-fact that gives a feeling of looking towards a meaningful direction-.

Figure 7: Hotel Jakarta

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Experience perception

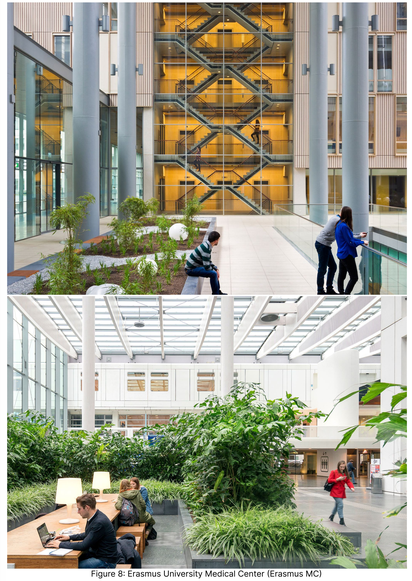


Figure 8: Erasmus University Medical Center (Erasmus MC)

The construct of human existence comprises four existentials—spatiality, corporeality, temporality, and relationality (Merleau-Ponty, 2014)—in a communicative relationship with the lifeworld constructed of lived space, lived body, lived time, and lived others (Van Manen, 1997); the four existentials play an essential role in embodiment. Embodiment refers to the tangible or visible form of perceived concept and meaning, integrating everyday life into the body and manifesting in the form of space (Attfield, 2000). An embodied space is enriched with personal memories, imaginations, and dreams accumulated through individual or collective experiences of the space, fundamentally involving the body and movement, whether actual or conceptual (Cresswell, 2004). Experience is understood from an embodied perspective (Ihde, 2012). Lived experience takes place in the intersubjective space of perception and the body, existing between the subject and the object (Simonsen, 2005; Merleau-Ponty, 2014).

Interviews

Interviews-Set up

In order to have a more user-centered approach to the design process user involvement is needed. To do this, interviews with 10 people were conducted where information was gathered for the current stage and also for future development of the concept. All participants where students from the faculty of Industrial Design Engineering of Delft University of Technology, aiming for equal number of males and females. Participants were given €10 voucher after the completion of this study. This research was approved by the Human Research Ethical Committee of Delft University of Technology on May 13th, 2024, application number 4343. Each participant completed an informed consent form before beginning the experiment. The topic of the interviews was “How a carefree day in the nature looks like?”. Major information for the next steps of this project was the sitting position that participants imagining having in their “carefree day in the nature”, which were called to mention. To ease the definition of the sitting position, there were 3 options where position could be classified: a stool, a chair and a beach chair, representing 3 different relaxation levels, from the least to the most respectively. The interview for each participant lasted around 30 minutes. The entire process was audio recorded and later transcribed. Participants were called to answer certain questions in the feeling of a friendly discussion, aiming to have some additional emotional and qualitative information as well. To help participants become more specific and expressive, they were called to sketch the nature experience they had in mind (see Figure 12). In the end, the transcripts of the interviews where coded and the following thematic analysis was made:
Link (or Appendix:Interview Thematic analysis)

Before starting interviewing, there was a pilot test to ensure that the interview set-up was precise. The output from it was to add some questions and change their raw in order to create an introduction-main theme-conclusion structure, assuming that this would ease the flow and enhance the friendliness of the test.

According to this, we can observe some overlap in participants’ responses which are:
-***satisfaction and relaxation*** is the feeling which describes that day
-a carefree day in the nature is perceived as a ***multi-sensed experience***, with vision as the most mentioned
-***activities*** within this day ***vary in intensity***
-***seat type*** of most participants are ***stool*** and ***beach chair*-typed**

The interview results show that 5 out of 10 participants mentioned the stool as the type of

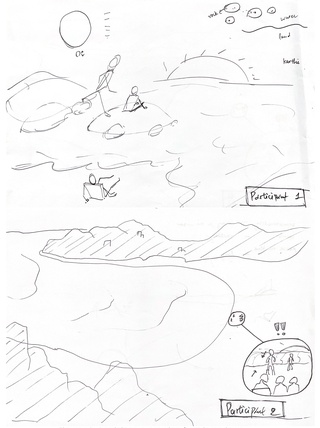


Figure 12: Participants’ drawing from interviews

seat matching better their experience, followed by beach chair (4 participants) and lastly, chair (1 participant) shown in (Figure 13). A word cloud was made based on the activities most mentioned in the interview, which are walking, talking, chilling and drinking or eating (Figure 14).

Interviews-Results

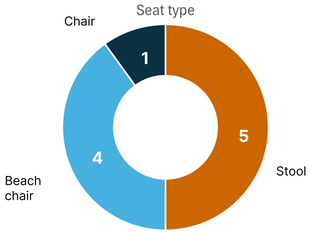


Figure 13: Seat type

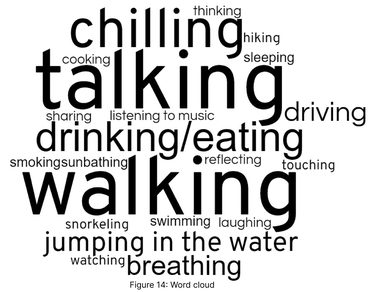


Figure 14: Word cloud

Interviews-Results

This study found that 5 out of 10 participants mentioned ‘beach’ as the experienced context, followed by 4 that mentioned ‘mountain’ and 1 ‘forest’ (Figure 15). Moreover, it is important to mention that at the question regarding purpose of traveling, 8.5 out of 10 stated ‘holidays’.
In line with our findings, Laroche et al. (2023) found that who found that visiting relatives and nature tourism are the primary holiday styles driving leisure travel within the Europe, each accounting for over one-fifth of total trips. Culture tourism, sea, sun and sand tourism, and city tourism each contribute between 10% and 17% to the total number of leisure-related trips, whereas active outdoors tourism, wellness tourism, and event tourism each contribute less than 10%. Air travel is more common for sea, sun, and sand tourism compared to other holiday styles. While most leisure-related trips are domestic, international travel between European countries is significant for all holiday styles, particularly for active outdoors tourism, city tourism, culture tourism, and sea, sun and sand tourism.
Another interesting finding of this study is that most participants (5 out of 10) mentioned something related to ‘view’ when they asked what is the thing they mostly remember from that day.

Here we can see another rising design opportunity where passengers could view a landscape or something that creates the relaxation and satisfaction feeling.

5 out of 10 mentioned something related to ‘view’

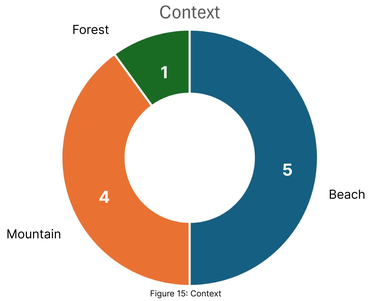


Figure 15: Context

Design phase

The next step is to define the human-product interaction. The core element of expertise in ViP design is understanding what type of relationship or interaction suits a specific context. Our aim is for people using the product (with its specific qualities) to achieve the goal outlined in the statement. The product is merely a means to accomplish what you, as a company or designer, want to deliver to people in the future (Hekkert & Van Dijk, 2011). According to the previous information from the past pages the interactions and their qualities are defined as followed:

I want people to have a positive multi-sense experience when traveling with the airplane
-***stimulative***

I want people to feel that they are connected with the surrounding environment of the interior
-***intimateness***

I want people to have the ability to explore the interior when traveling with the airplane
-***explorative***

I want people to feel excited when traveling with the airplane
-***exciting***

I want people to know that they will have similar experience at the next time as well
-***repetitive***

Defining product qualities

stimulative: ***like being at the beach at summer***
intimateness: ***like taking an apple from a tree***
explorative: ***like walking in a mountain***
repetitive: ***like your visit in Disneyland***
exciting: ***like your first times you drove a car/like your first kiss***

The next step is concept design. At this stage it is all about creating concept ideation (or directions) in which possible concepts would arise. To really differentiate the one concept idea from the other, a Pentagon Graph was created to show their focus area. Each interaction was rated with a 7-point Likert scale.

Concept Ideation 1: Summer school camp

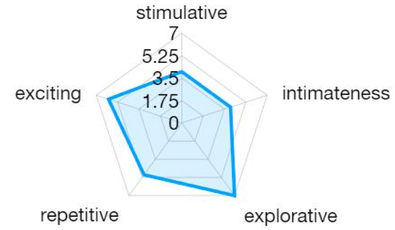


Figure 16: Interaction focus of Concept idea 1

Using analogies, **Summer school camp** (Figure 17) involves the defined interactions and qualities. A child at a summer school camp can expect a well-rounded experience that combines learning, creativity, physical activity, and social interaction.

The core idea is that passengers will 'roam' to their seat place and interact with that. As seen, this directions is more explorative-exciting oriented (Figure 16).

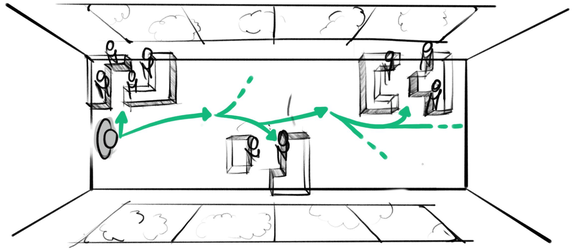


Figure 17: Forest camp

Concept Ideation 2: Free camping

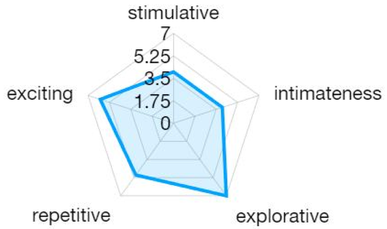
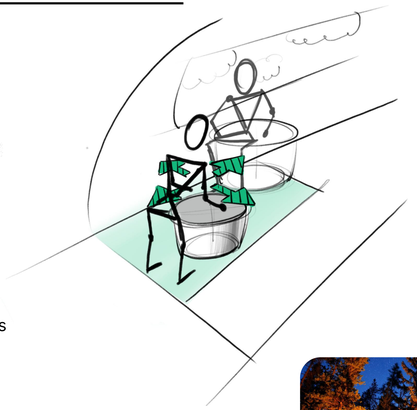


Figure 18: Interaction focus of Concept idea 2



Same as before, **Free camping** (Figure 19) involves the defined interactions and qualities. Free camping involves staying in areas without established campgrounds or amenities and offers a chance to disconnect from the hustle of everyday life and reconnect with nature.

The core idea is that passengers have an available space to customize it themselves. As seen, this direction is more exciting-intimateness oriented (Figure 18).

Figure 19: Camping

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Concept Ideation 3: Close with the nature

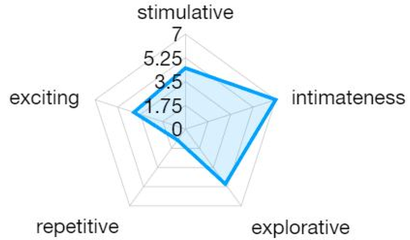


Figure 20: Interaction focus of Concept idea 4

Third, **Close to the nature** (Figure 21) involves the defined interactions and qualities. Engaging with nature offers numerous opportunities for recreation, relaxation, and personal growth.

The core idea is that passengers could sit and interact in an organic environment with mostly undefined seat areas. As seen, this direction is more intimateness-explorative oriented (Figure 20).

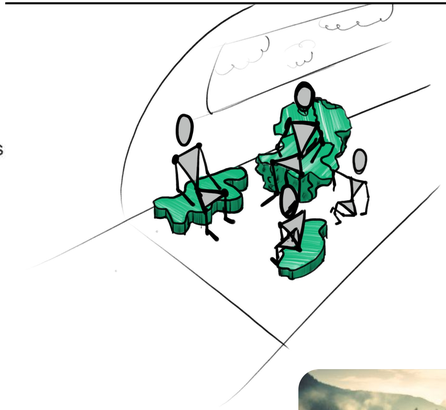


Figure 21: Sitting in the nature with friends

Design phase

After presenting these concept ideas it was concluded from the client that the desired one was ***Concept Ideation 3: Close to the nature***.

The next step is Design and Detailing. The primary activity in this phase is to transform the concept into its final form. All the design and engineering efforts typically required at this stage must be employed. The vision continues to guide every decision throughout this process (Hekkert & Van Dijk, 2011).

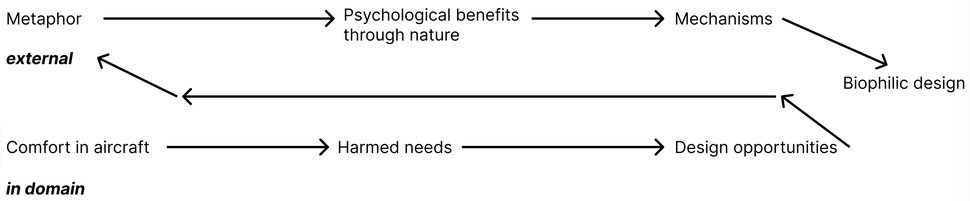
At this stage it is really important to define the research questions that need to be answered. These are:

1. **Is it possible to create a different layout of a 90-seat regional airliner than currently?**
2. **Can people feel comfortable in a different layout than currently?**
3. **Is it possible passengers to sit in the airplane similarly like in the nature?**
4. **Can nature-inspired interior aircraft design be beneficial for the passengers?**
5. **Is it possible to boost socializing through a flight?**

In the continuation of the project, an ergonomics user test was conducted to gain some insights about people's behavior within the defined context, perceived comfort and discomfort levels and preferences in terms of additional elements within the aircraft interior.

The sitting configuration test will define the experience perception of the passengers during traveling with E9X, as experience is understood from an embodied perspective (Ihde, 2012) (see Experience perception).

Research mind map



Ergonomics test

Ergonomics test-Research design

Background
Elysian Aircraft Company B.V. is developing a zero-emission regional airliner which aims to change way of travelling with an airplane. This project is focused on interior of this aircraft where an innovative direction aims to be followed.

Research purpose
This research is done to answer these following research question:
1. Define possible configurations of different types of seats within a defined area in the fuselage with 12 people.
2. What items/elements do the participants would like to have in their sitting area? And why?

To answer these questions, we will be asking you to select a seat and position yourself within a specific area with 11 other participants. Then you will be asked to mention and/or draw in a paper (with the top view of the area) any items/elements that you would like to have at your sitting place.

Equipment
- Test set-up
- Boundaries e.g. white boards
- Seats
- Pens and paper (for consent forms, personal data and drawings)
- Measuring tape
- 2 Phone/tablet with camera
- 12 Seats
- Voice recorder

Test setup

Defined area

Seat types

Procedure
1. A consent form is given prior to the experiment, which must be signed by each participant prior to the start of the experiment.
2. Participants are assigned use case scenario for a 90 minute flight. Some travel for leisure and others for business.
3. Each participant will be asked to choose one of the given seats.
4. All participants will enter in the defined area and asked to place their seats in the way they like.
5. All participants will be asked to seat for a few minutes.
6. All participants will be asked to get out of the

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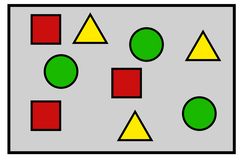
Ergonomics test-Research design

defined area, without moving the seats in order to map the configuration.
7. All participants will be asked to take their seats from the defined area and get out of it.
8. All participants will be asked to repeat the process again.
9. In the end, all participants will be asked to quick draw any items/elements they would like to have in their sitting area and explain why.
10. Vouchers will be given to all participants.

Expected data
1. Questionnaire
- Age
- Gender
- Nationality

2. Quick drawings on paper with layout



Expected Results & Analysis Methods
1. Define possible configurations of different types of seats within a defined area in the fuselage with 12 people.
- Summary of these layouts
- Coordinates could be processed

2. What items/elements do the participants would like to have in their sitting area? And why?
- Interview transcription
- Additional items/element list
- Reasoning list
- Sketches of the participants

Plan B

- If participants struggle to choose a seat, the seat will be assigned to them
- If participants struggle to fit it the specific area, they will be helped in order to recognize the space around them

(Plan B will be finalized after the pilot test)

Ergonomics test-Set up

The ergonomics user test took place on May 30th, 2024 at C-4-310 meeting room in the faculty of Industrial Design Engineering of Delft University of Technology and it was conducted by student Christos Batsaras. Main purpose of this user test was the creation of potential seat layout in a defined area and gathering individual insights from participants regarding perceived comfort, discomfort and need of additional elements or items. This research was approved by the Human Research Ethical Committee of Delft University of Technology on May 13th, 2024, application number 4343. Each participant completed an informed consent form before beginning the experiment. Participants were given €10 voucher after the completion of this study. The set up of the user test was as following:

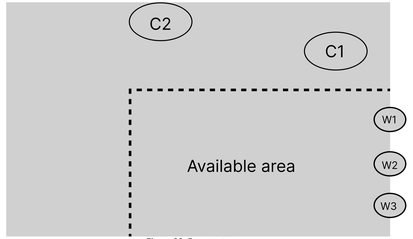


Figure 22: Room set-up

where C1, C2 are cameras, W1, W2 and W3 the intended windows (Figure 22).

The defined area was 2.64×2.87m and is marked with the hatch (see Figure 23), where the first dimension represents the width of the aircraft. It is worth to mention that the width of a Boeing 737 is 3.54m at the floor, and at an E195 and an ATR is 2.52m and 2.26m (or 2.57 at the widest point) respectively.
This area corresponds to the area that is covered from 12 passengers seating in a normal layout plus the available area from the delete of galley of an aircraft. Currently there are many airlines such as BRITISH AIRWAYS and FINNAIR that they offer pre-order food services (Our Guide to Which Airlines Allow You to Pre-order Food?, n.d.) and using this information the assumption of having absence of galley was created. Moreover, pictures of aircraft windows were put on the right wall (see Figure 24). Each participant used stickers on the floor to indicate his/her seat position in both rounds so its coordinates could be measured later (see Figure 25). Similarly, 12 people participated in this user test with most of them not knowing each other. This was intentional to better represent a realistic in-flight scenario.

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Ergonomics test-Set up

A pilot test beforehand helped to define some unknown (yet) uncertainties such as the window distance from ground and the questionnaire form. Also, it shown possible practical issues which could be expected at the final test, such as the difficulty in unfolding and locking the beach chairs in place.

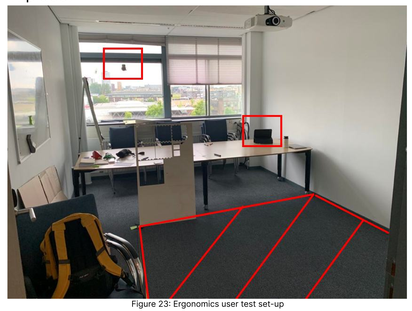

Figure 23: Ergonomics user test set-up

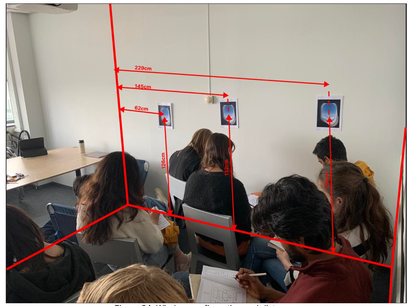

Figure 24: Window configuration and distances

Figure 25: Stickers from both round of user test and layout

Ergonomics test-Process

At first, all the 12 participants were informed about the process of the user test, its purpose and context. Second, each participant was called to select one of the available 10 chairs and 2 beach seats. Most participants were assigned to travel for leisure (10 out of 12) whereas the rest for work (see Figure 26). This separation was made to have a more realistic situation for the user test, as it concluded from desktop research around 80% of passengers are leisure travelers (Statista, n.d.). A book was given as a prop to work travelers representing a laptop/tablet, to see if there will be any influence in their experience, as the needs having such equipment could differ. Even though regional traveling in Europe accounts for 96.5% (Statista, 2024), it was assumed that the chairs represent the economy class which represents the 83.3% (10 out of 12).
Then participants called to position their seats and sit in the marked area. After the participants finished this step, they were asked to use some stickers to mark the legs of their seat on the floor. This would later help to measure the coordinates of each chair and create a layout map.
Then, participants were asked to take their seats and get out of the room to repeat the process. With this we would see how people were influenced from their first experience and if they would take different decisions when placing their seats again (Figure 28). In the end they were asked to complete a questionnaire (see Figure 27).

Figure 26: Photo before the beginning of the user test and layout of the first round

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Ergonomics test-Set up

Figure 27: Participants during the user test

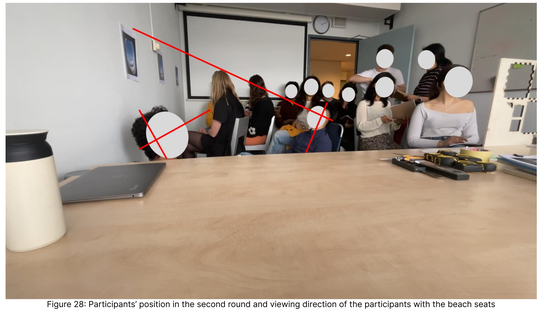

Figure 28: Participants' position in the second round and viewing direction of the participants with the beach seats

Ergonomics test-Results

This ergonomics test gave some qualitative insights that can give direction to design ideas. After analyzing and clustering the results we could draw some conclusions out of it. Half of the the participants (6 out of 12), decided to face a wall/ window and most of them positioned themselves close to one (10 out of 12) (Figure 29). Regarding the additional items they would like to have, most participants expressed the need of an individual table (11 out of 12) followed by head/neck rest (or cushion) (7 out of 12). The same number of participants (4 out of 12) mentioned the need of something that changes their leg rest angle and storage place under their seat (Figure 30). Full thematic analysis can be found ***here*** (or Appendix:Ergonomics user test Thematic analysis).

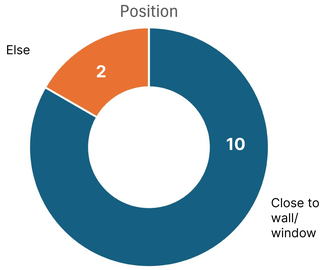

Figure 29: Position

It is worth it to mention that the participants that stated the need of something that changes their leg rest angle are 168, 168, 183 and 194 cm tall and according to Dutch adults, dined1982 (20-60 years old, male and female) they belong to P0.7, P8.8 and P29 respectively (DINED, n.d.).

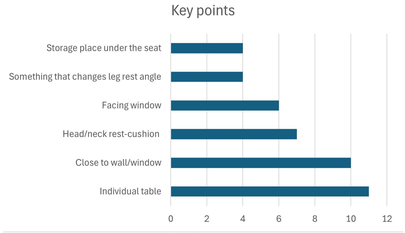

Figure 30: Key points

With the help of the coordinates of the stickers and AutoCad software layouts were formed (Figure 31). In general, at the first round it was observed that participants placed their seats to the direction of flight, following more the current situation where seats are stacked accordingly. At the first round the participants with the beach seats took the middle space of the area whereas the rest placed their seats around them. However, in the second round participants created multiple

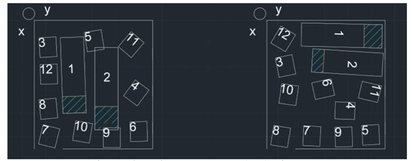

Figure 31: Layout from the first (left) and second round (right) defined by the 12 participants

variations of configurations and made sections. In the second round participants were influenced by the windows on the right wall and this can be seen from the different decisions that were taken from those close to the left 'wall', in which no physical wall or window indication were used for this user test. In the first round the distribution of people was more even than the second one, which probably comes from the variation in sections. From the results of the second round it can be observed that 4 sections (see Figure 32) were created as following:

Yellow and red section: in these sections participants seem to be more individual and desire more privacy. The main difference is that in the yellow section participants valued the view of the windows and/or they need less legroom than in red one, where 2 out of 3 participants are taller compared to the participants in the yellow one.

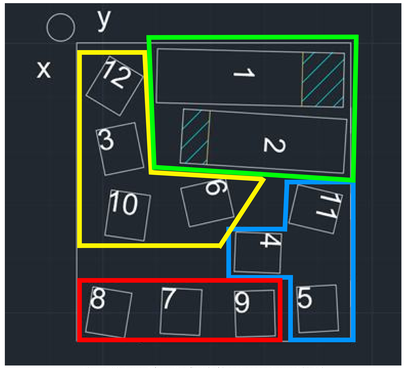

Figure 32: Layout from the first (left) and second round (right)

Blue section: in this section participants created a 'socializing' group even though they probably do not know each other. The group was shaped around the window(s).
Green section: in this section participants created a separate area were they have their own privacy but they could also communicate together if they would like to do so. It is a kind of hybrid situation.

Ergonomics test-Results

From the questionnaires that participants completed at the end of the user test we can see that in general there is a large variation between participants. For example, participant 2 rated the perceived comfort with an 8 out of 10, whereas participant 11 with 3 out of 10 (Figure 33). This is probably cause due to different sections that these participants were positioned, as the first belongs to green section and the second to the blue. The levels of perceived comfort and discomfort of the first round are marked with orange and green, and with blue and purple for the second round respectively.

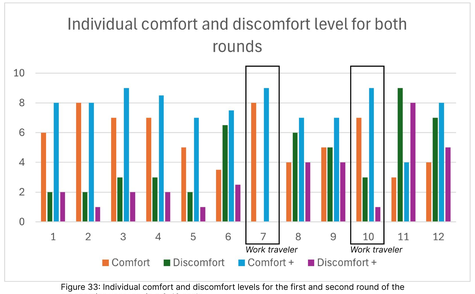

Figure 33: Individual comfort and discomfort levels for the first and second round of the ergonomics user test in a 0-10 scale

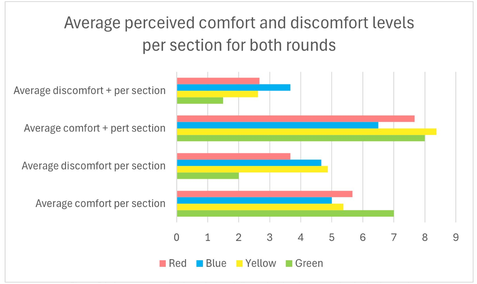

Figure 34: Average perceived comfort and discomfort levels per section for both rounds

To create a conclusion, instead of analyzing each participant individually, every section was analyzed in comparison with others. To do this, the average of the participants' scores was calculated for each section (Figure 34). This indicates that initially the green section was scored as most comfortable and the discomfort was the lowest. This could be due to the different types of seat they had, which were beach chairs. The section that rated highest comfort and lowest discomfort levels after the yellow section, which was red and possibly linked to the fact that they had the most legroom, as it is shown at the Figure 35.

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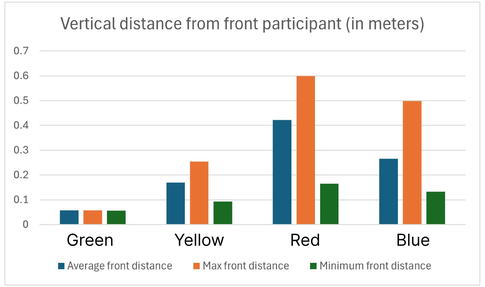


Figure 35: Vertical distance from front participant

Also, it can be seen that at the second round participants scored higher levels of comfort and lower of discomfort in general (Figure 34). This could be caused either due to the different placement in the area and/or the influence of the additional elements they imagined to have. Moreover, it was concluded that the participants from the red section had the highest maximum, average and minimum distance from a front participant compared to other sections (Figure 35). Another interesting finding is that the yellow section seems to experience the largest change in terms of perceived comfort and the least of discomfort, whereas in the green section the opposite was the case (Figure 36). We can understand the value of people being relocated in a more preferable place than the first round. For example participant 6 had the highest difference in rating discomfort between the 2 rounds, which was -4, and it definitely had major influence in the results of Figure 36.

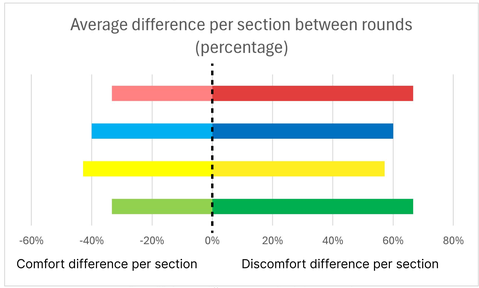


Figure 36: Average difference per section between rounds

Ergonomics test-Results

Having this information, the next step was define the minimum and maximum front and side distances for each section from obstacles (participant or wall). This was done by measuring the distances of each participant of every section and find the minimum and maximum. After this, three different variations of a 12-passenger layout were created with minimum, average and maximum front and side distances respectively (Figure 39).

It can be observed that the only possible direction is to continue with minimum distances as it is the only one that can have seats that fit within the area and no collision between seats is at hand. However, with a combination of minimum-average-maximum distances in the sections another solution might arise but it is out of the scope of this project.

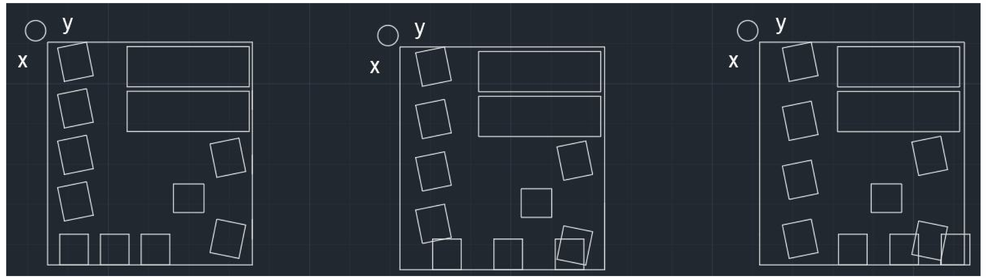


Figure 39 : Layouts with minimum (left), average (middle) and maximum (right) distances in every section

Passenger cabin layout

To continue with the next step, a complete layout of the passenger cabin is created (see Figure 23). After several variations it was concluded that the following layout was the most promising.

Economy class
-Baggage hold with the same volume as given from the client

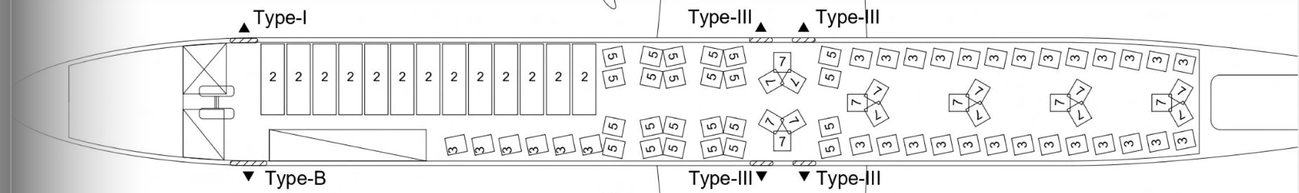


Figure 40 : Layout of the entire passenger cabin

This conclusion is based on the following reasons:
-Door arrangement similar to Fokker 100 (per CS-25 requirements):
• Passenger door at the front, port side (Type B)
• Service door at the front, starboard side (Type-I)
• 2x over-wing emergency exits on each side (Type-III)
-The area distribution is more even
-Available isle in the front, middle and back of the cabin
-The only lavatory can remain with the same dimensions (X marked area)
-Business class (beach seats) is separated from

Ergonomics test-Results

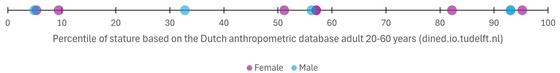


Figure 37: Percentile of stature based on the Dutch anthropometric database adult 20-60 years

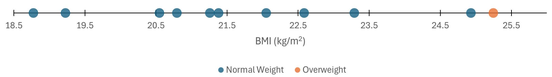


Figure 38: BMI of the participants

According the Figure 37, the distribution of percentiles of stature based on Dutch anthropometric database adult 20-60 years, has a range of around 5 to 95 percent, for both males and females. We see a more dense distribution from around 5 to 10 and 50 to 60 percent, where in both cases there are 2 females and 1 male. Also, there is a very sparse distribution from 10 to 30 and 60 to 85 percent approximately.

The Figure 38 shows the BMI distribution over the participants. Based on this, we can see that most of the participants are considered as normal weighted, except of one who is considered overweighted. We can see that the BMI range is from around 18.5 to around 25.5, where most of the participants have a BMI from around 20.5 to 23.5 approximately.

Passenger cabin layout in 3D

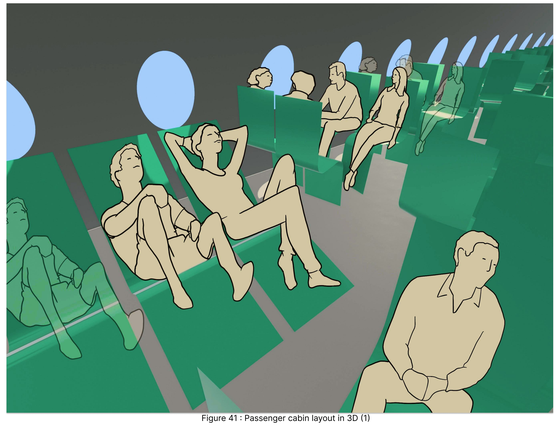
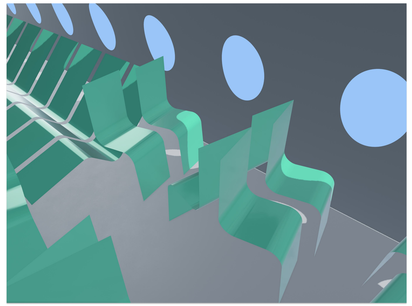


Figure 41 : Passenger cabin layout in 3D (1)



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Passenger cabin layout in 3D

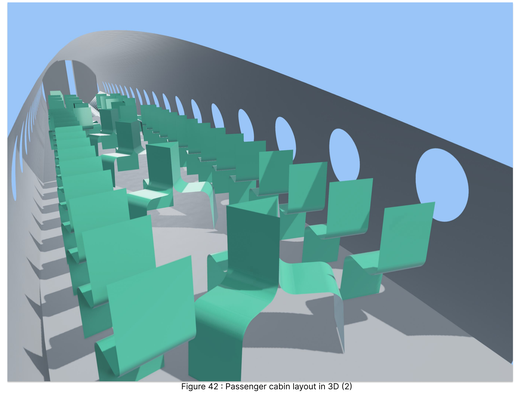
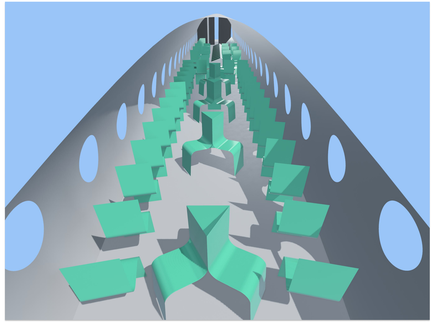


Figure 42 : Passenger cabin layout in 3D (2)



Summary

Feasibility

For proving the feasibility of this project we could say that the conditions under the ergonomics user test and interviews were conducted were realistic.

Specifically, we did an ergonomics user test with people in real time and used equipment in 1:1 scale. The user test was conducted in a defined area with dimensions measured according to the actual dimensions of the Elysian's E9X aircraft. Of course, a user test will always have some limitations.

The results of the user test shown that, using the minimum distances (front and side from obstacles) from each participant of each section created, can lead to the creation of a whole passenger cabin layout while covering the in-scope goals. The seat types that used for the creation of this layout are not seen as aircraft passenger seats, but areas that passengers sit with a certain posture. This shows that there is available room for a new type of passenger seats to be created, using new technologies, materials and structures (e.g. see Additional Ideation).

For the interviews, participants were asked to answer questions regarding some past experiences they had where the results were used for the conduction of the ergonomics user test (seat type) as well as for a later stage of interior development. Making a thematic analysis from the results, helped to cluster the findings of the participants where design opportunities can arise. For example, the fact that 5 out of 10 participants mentioned something related to view in their "carefree day in the nature", can bring a new function within the aircraft, where passengers can have a similar experience (e.g. see Additional Ideation). To create experiences which can provide psychological restoration can be done through the mechanism of 'Decentering' (see Figure 5).

Desirability

It is known that airliners aiming to fit the maximum number of passengers and at the same time to provide some level of comfort. However, we can not say that in general, traveling with an aircraft is an overall comfortable experience. Especially when studies that focus on comfort as an aspect which has many factors involved at the same time, is absent. As *"The aim of this project is to create a direction where the perceived comfort can arise in a more multi functional way and consider traveling as a more complete, spherical experience."* due to some 'harm of needs', using nature as inspiration it is proven that can have benefits in psychological restoration.

Also, the results of the user test shown that people rated perceived comfort from 6.5 to 8.5 out of 10 which could be considered better compared to other results during 'cruise' where participants rated perceived comfort with less that 6 (see Figure 4); even though at that research the rating scale was from 1-10. Moreover, the fact that the levels of perceived discomfort are from 3.5 to 1.5 out of 10 and are lower that the average rating (5 out of 10) we could say that is another importance factor that verifies the desirability of this project. However, rating of the final layout would be useful as a later step.

Viability

An important aim of this project is to create a concept that will be beneficial for the company as well. The main goal was to create a innovative solution that will work as a competitive advantage of Elysian-it was asked by the client to come up with something that provides a new, different experience to the passengers compared to the nowadays traveling-.

To show the viability of this project, the assumption that was made for the ergonomics user test (Economy and Business class split as well as the passengers' purpose of traveling) was made by taking into account realistic scenarios.

Although, having a complete different passenger cabin layout can bring opportunities in adapting the financial model into the company's vision. Various sections in the aircraft can cover various needs and therefore can have different pricing; something more that the typical Economy-Business class split.

Moreover, if we see traveling with Elysian E9X as a method of people's psychological restoration, we could say that there could be some benefits in a social level which might be reflected into other aspects of life.

Conclusion

This research aimed to create a future concept layout for aircraft interior using ViP method. The main driver of this approach was the use of metaphor “ξεγνοιασιά”, a Greek word with a similar meaning of “carefree”.

Based on the analysis of the interviews and the ergonomics and user test that were conducted, the final result was a 90-seat passenger cabin layout.

At the interviews 10 participants were asked questions about “how a carefree day in the nature looks like”, aiming to have insights about future functions and their sitting position in the nature; sitting like in the nature could help the perception of nature experience during flying. Their sitting position was defined by choosing between 3 types of chairs.

After conducting the interviews and analyzing the results, next was to do an ergonomics user test with 12 participants. The reason of this test was to create a seat-layout in a defined area which represents the area were the same number of people can sit in Elysian E9X with a typical layout (stacked seats). Participants used the seat types resulted from the interviews. Also, they asked to answer a questionnaire regarding comfort and discomfort as well as desired additional elements during the flight. Using thematic analysis method for both interviews and ergonomics user test helped to cluster the results and draw conclusions.

With the results of the ergonomics user test and some requirements from the client, a complete passenger cabin layout was created.

The answers to the research questions are:

1. ***Is it possible to create a different layout of a 90-seat regional airliner than currently?***

Yes, using the analyzed results coming from the ergonomics user test as well as client information a layout was created.

2. ***Can people feel comfortable in a different layout than currently?***

Yes, from the results of the questionnaires we can see that the average levels of perceived comfort and discomfort are more that 5 and less than 5 respectively.

3. ***Is it possible passengers to sit in the airplane similarly like in the nature?***

Yes, beach chairs and chairs are used in the new 90-seat layout mimicking the sitting position in nature experiences.

4. **Can nature-inspired interior aircraft design be beneficial for the passengers?**

Yes, it is proven from the research that was done

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that nature-inspired design can provide psychological benefits (psychological restoration).

Is it possible to boost socializing through a flight?

Yes, as seen in the ergonomics user test where strangers created a ‘socializing’ group around a window.

Future research

Starting with the layout, a useful step to do will be to test in a realistic environment with people and redefine it, as well as measuring perceived comfort and discomfort levels again.

Another very crucial sector that can play major role in the cabin design is the luggage. Currently, the projected need (in 2033) is missing and areas from checked-in and carry-on luggage can not be defined with accuracy.

Moreover, the definition of nature-inspired elements that help having nature experiences and benefits is also absent, as well as the functions within the interior. After this, creation of concept and evaluation with users is necessary.

Reflection

From the beginning of this project I was super excited. Working on such a topic with such people is an opportunity that maybe comes ones in your lifetime, especially when there is room for putting your personal perspective for something new, for something different that usual.

It is very interesting how design thinking and also perception of what design is, is changing in every project so far. Every time I feel ready for the next one; there is this feeling that you can completely handle this new situation that you will be into, but every time I'm ending up surprised on how many more things are out there, what are the different approaches and how many things until to the last detail is a result of research and testing.

If I could say that, from my previous experience design had to do with development to meet requirements, definition of functions, evaluation and testing methods, in this project, it has to do with scientific linking. Definitely, it is worth it to involve such practices, where starting reviewing scientific articles that are only connected with a first assumption, really bring new knowledge about the topic, validation, and yet improve creativity, even though it might sound a bit contradicting.

Of course, all this started with the method I chose to use, the ViP (Vision in Product design) method, which I'm planning to use in my future career as well. I found that, this method really expresses me as a designer because you can start with a product that looks very 'rigid' and 'strict' to change, and you might end up with creating a new 'something' that brings a new reality. Although, lack of experience created some collisions during the process and resulted in research gaps which are still present.

An interesting part was the use of metaphor that the method suggests and in my case, it was the track (direction) that this train (concept) was traveling the most of this period! Indeed, it is proven from literature that using metaphors helps to achieve this. Due to this, I used "ξεγνοιασιά" (~xegniasia), as I truly believe that it is something that is missing nowadays to people and it should be one our main drivers in life, in a sense of spiritual development and well-being and not inaction and laziness.

Ending, I'm very grateful for the whole experience in this thesis project and I would say that it was a useful preparation for facing upcoming challenges.

Extras

Additional:Ideation

Except of the final result, the literature research that was made during this project as well as others in the past helped to create some additional ideas that could possibly being implemented in the future. These ideas are only focusing on one function that could be defined in the later development of this concept.

In the next pages some ideas and their explanation are presented.

1. The lose of luggage as well as the difficulties in the process of checking and also taking the luggage back shows the need for a different system (Industry Makes Progress to Reduce Baggage Mishandling, New Survey Reveals, 2024). Smart suitcases started to be on the market, offering tracking services, charge your devices, lock it with your fingerprint etc. (Asurion, 2024). According to 'Air travel study' from Manon Renard, an intern in Elysian Aircraft, the percentage of checked luggage will be tremendously reduced by 2040, projecting just over of 30% of passengers will have a checked baggage (when it was 97.6% and 55% at 2009 and 2022 respectively) and this will remain stable (see Figure 43). According to the results of the global passenger survey by IATA in 2022, 81% of passengers said they are more likely to check a bag if a real-time tracking service is available ("IATA Global Passenger Survey," n.d.-b). Moreover, it was reported that that the average mass of carry-on luggage increased with the years (Figure 44). This may be related to the decreasing of the checked baggage, because people use less checked bags, they put more belongings in their handbags. Although, the end need for luggage after these statistics is absent either for nowadays or at the projected future as well as specific numbers on medium-haul flights (500-5000km) as Elysian's E9X will be made to fit in this category.

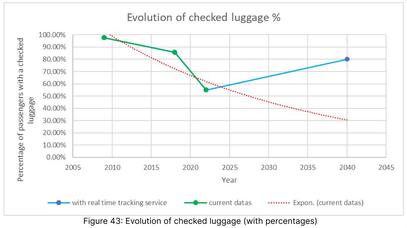

Figure 43: Evolution of checked luggage (with percentages)

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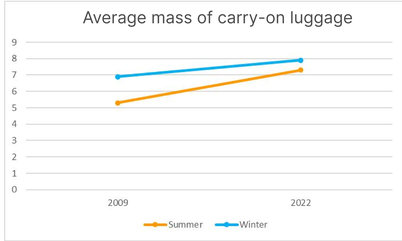

Figure 44: Evolution of average mass (kg) of carry-on luggage

2. Another idea inspired by the automotive industry is the development of seats made of innovative materials such us composites. For example, Hanwha Advanced Materials drew attention at JEC World 2018 in Paris, France, with an innovative new seat back for SUVs. Unlike traditional seat backs, the one that they presented is made entirely of composite materials, with no steel reinforcement. Some visitors were skeptical about its performance compared to steel-frame seat backs, but they were pleasantly surprised to find that it passed even the toughest safety tests. Additionally, they were impressed to learn that the prototype seat back is up to 30% lighter than conventional steel seat backs (Hanwha Advanced Materials: Composite Materials for More Than Just the Hypercar, n.d.). Also, we can see that in sports car industry some companies decide to have built-in seats (Figure 45). An integrated seat mast offers advantages such as reduced weight, enhanced stiffness, the potential for aerodynamically shaped designs, and a visually appealing aesthetic (Human Kinetics, n.d.).

Additional:Ideation

Figure 45: Examples of built-in (integrated) seats *(Top: SP Automotive, Bottom: McLaren)*

Additional:Ideation

3. Two-way group seat
From the ergonomics user test it was observed that some people created a group even though they did not know each other (Blue section). Although, we can not say that this will certainly happen in every possible scenario. The idea of Two-way group seat highlights the opportunity of having a space that can host group passengers or for individuals offering the option to socialize if they would like to. Moreover, a tendency to group traveling seems to rise (see Figure 46).

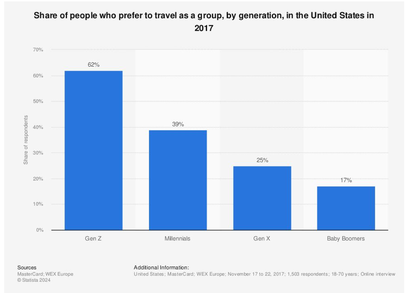

Figure 46: Share of people who prefer to travel as a group, by generation, in the United States in 2017

4. We all share the same sun

The results from the interviews shown that 5 out of 10 participants mentioned something related to ‘view’ when they asked what is the thing they mostly remember from that day. Also, there was a small variation in terms of the context they described (Figure 15). This idea aims to create an visual-acoustic-scent shared experience for all the passengers, aiming to provide relaxation.

References

References

Major climate benefits with electric aircraft. (2024, January 24). ScienceDaily. https://www.sciencedaily.com/releases/2024/01/240123122145.htm#:~:text=While%20aviation%20is%20an%20important,flights%20in%20the%20immediate%20area.

Elysian Aircraft. (n.d.). Elysian Aircraft. https://elysianaircraft.com/

Caicedo, D. G. (2022, March 30). TL;DR: Vision in Product Design — The VIP approach - David Güiza Caicedo - Medium. Medium. https://medium.com/@bluehair.co/tl-dr-vision-in-product-design-the-vip-approach-62c3cb1f8f99

Hekkert, P., & Van Dijk, M. (2011). Vision in Design: A Guidebook for innovators. http://ci.nii.ac.jp/ncid/BB08114241

Pilot Institute. (2023, August 20). The difference between category, class, and type of aircraft. https://pilotinstitute.com/category-class-and-type-of-aircraft/

SeatGuru Seat Map Lufthansa. (n.d.). SeatGuru. https://www.seatguru.com/airlines/Lufthansa/Lufthansa_Embraer_195.php

SeatGuru Seat Map Lufthansa. (n.d.-b). SeatGuru. https://www.seatguru.com/airlines/Lufthansa/Lufthansa_Boeing_747_400_V4.php

Regional Airliners (20 - 70 seats) - AEROAFFAIRES. (n.d.). AEROAFFAIRES. https://aeroaffaires.com/private-jet-hire/regional-airliners/

Bombardier. (n.d.). https://bombardier.com/en

Portal Embraer. (n.d.). https://embraer.com/

ATR. (2024, March 12). Home - ATR. https://www.atr-aircraft.com/

Ros, M., & Ros, M. (2023, May 30). Airbus unveils futuristic Airspace Cabin Vision 2035+ - AeroTime. AeroTime. https://www.aerotime.aero/articles/airbus-unveils-futuristic-airspace-cabin-vision-2035

Bor, R. (2007b). Psychological factors in airline passenger and crew behaviour: A clinical overview. Travel Medicine and Infectious Disease, 5(4), 207–216. https://doi.org/10.1016/j.tmaid.2007.03.003

Maslow AH. Motivation and personality. Oxford, England: Harpers; 1954.

Peng, J., Luo, Z., Tan, Y., Jiang, H., Yin, R., & Yan, J. (2024). Balancing Stakeholder Benefits: A Many-Objective Optimal Dispatch framework for home energy systems inspired by Maslow's hierarchy of needs. Advances in Applied Energy, 13, 100160. https://doi.org/10.1016/j.adapen.2023.100160

Regional Jet | Information on regional jets. (n.d.). https://www.alternativeairlines.com/regional-jets

Palma, K. (2022, March 24). Check out these potential airplane cabins of the future. Boston.com. https://www.boston.com/travel/flights/2022/03/24/check-out-these-potential-airplane-cabins-of-the-future/

Wang, G., & Zhao, W. (2020). The requirement organization of the avionics system. In Elsevier eBooks (pp. 103–167). https://doi.org/10.1016/b978-0-12-816651-2.00003-4

Bouwens, J. M., Tsay, W. J., & Vink, P. (2017). The high and low comfort peaks in passengers' flight. Work, 58(4), 579–584. https://doi.org/10.3233/wor-172637

Bouwens, J., Mastrigt, S. H., & Vink, P. (n.d.). Ranking of human senses in relation to different in-flight activities contributing to the comfort experience of airplane passengers. Scholarly Commons. https://commons.erau.edu/ijaaa/vol5/iss2/9/

References

Teenagers do grow more materialistic: study. (2007). Reuters. https://www.reuters.com/article/idUSN16208792/

Miles, J. R. (2022, January 7). Why materialism is impacting your happiness and success. https://www.linkedin.com/pulse/why-materialism-impacting-your-happiness-andsuccess-john-r-miles/

1990's. (n.d.). https://www.deltamuseum.org/delta-history/timeline/decades/1990

Desportes, H. (n.d.). Tourist Class (1999). Flickr. https://www.flickr.com/photos/hdport/4365924676/in/photolist-7DNvio-6ySC6i-7Gu7c5-68Gvom-8Lc4y5-6YtBxF-7EJvvs-68TcPY-6xvbka-8Lc4z1-68GvpA-7yt1W8-dD8gMQ-8Lc4AE-8Lc4×1-68Ch5i-ejZCdN-6YHByZ-ejTT6D-67dYpy-6zSaEM-7s6KMz-7CB3Db-68TcQq-8L8ZmD-6yWGQN-7zsv3d-euxYSA-6YMD51-ejTT5p-ejTT6c-7uedaW-8zZLAj-7xz6Ge-68Chbi-7C2Wir-e5DTwd-7ywBpo-e11Bmj-68GvgS-6DgKUz-6DgKXr-e5yfWa-6J6BZh-7rqkia-7rugLS-8Lc4GE-7vnk4o-e5yfVr-6xzkm3

Verizon | AirFone® | Welcome to Verizon AirFone®. (n.d.). https://web.archive.org/web/20060317075132/http://www22.verizon.com/airfone/af_index.html

Rizzo, C. (2019, March 20). Why JetBlue is keeping seatback screens while other airlines are getting rid of them (Video). Travel + Leisure. https://www.travelandleisure.com/travel-news/new-jetblue-entertainment-systems

Flynn, D. (2024, April 9). How British Airways created the business class bed. Executive Traveller. https://www.executivetraveller.com/news/british-airways-lie-flat-business-class-bed#:~:text=British%20Airways%20unleashed%20its%20fully,carrying%2096%20business%20class%20passengers.

Bloomberg, A. W. a. S. G. /. (2019, July 26). Legroom on planes has been shrinking for years. It's about to get much, much worse. TIME. https://time.com/5636154/airplane-legroom-shrinking-asia/

The Economist. (2017, November 3). Southwest Airlines tries to bring music concerts to the skies. The Economist. https://www.economist.com/gulliver/2017/11/03/southwest-airlines-tries-to-bring-music-concerts-to-the-skies

Anjani, S., Kühne, M., Naddeo, A., Frohriep, S., Mansfield, N., Song, Y., & Vink, P. (2021). PCQ: Preferred Comfort Questionnaires for product design. Work, 68(s1), S19–S28. https://doi.org/10.3233/wor-208002

BusinessTraveller. (2023, November). A new approach to hand baggage. businesstraveller.com. https://www.businesstraveller.com/opinion/a-new-approach-to-hand-baggage/

Global attitudes on materialism, finances and family. (2013). Ipsos. https://www.ipsos.com/en-us/news-polls/global-attitudes-materialism-finances-and-family

Statista. (n.d.). Statista - the statistics portal. https://www.statista.com/markets/420/topic/493/leisure-travel/#statistic1

Statista. (2024, April 22). European air travel - economy class ratio by sector 2014-2016. https://www.statista.com/statistics/748500/european-air-travel-economy-class-ratio-sector/

DINED. (n.d.). https://dined.io.tudelft.nl/en

Desmet, P., & Fokkinga, S. (2020c). Beyond Maslow's Pyramid: Introducing a typology of thirteen fundamental needs for Human-Centered Design. Multimodal Technologies and Interaction, 4(3), 38. https://doi.org/10.3390/mti4030038

Bouwens, J. M., Tsay, W. J., & Vink, P. (2017b). The high and low comfort peaks in passengers' flight. Work, 58(4), 579–584. https://doi.org/10.3233/wor-172637

Laurans, G., & Desmet, P. M. (2017). Developing 14 animated characters for non-verbal self-report of categorical emotions. Journal of Design Research, 15(3/4), 214. https://doi.org/10.1504/jdr.2017.089903

Our guide to Which airlines allow you to pre-order food? (n.d.). Issuu. https://issuu.com/motivatepublishing/docs/btme_10_2022_digital/s/16983449

References

Ortony, A. (1979). Metaphor and thought. https://ci.nii.ac.jp/ncid/BA21576528

Asurion. (2024, March 5). What's a smart bag? | Asurion. Asurion. https://www.asurion.com/connect/tech-tips/smart-bags/#:~:text=A%20smart%20bag%20can%20help,weigh%20it%20automatically%2C%20and%20more.

Industry makes progress to reduce baggage mishandling, new survey reveals. (2024, May 9). https://www.iata.org/en/pressroom/2024-releases/2024-05-09-01/

IATA Global Passenger Survey. (n.d.-b). In https://www.iata.org. https://www.iata.org/contentassets/baf7cb5eed64472aaac8906608085aff/global-passenger-survey-2022-media-briefing.pdf

Hanwha Advanced Materials: Composite Materials for More than Just the Hypercar. (n.d.). https://www.hanwha.com/newsroom/news/feature-stories/hanwha-advanced-materials-composite-materials-for-more-than-just-the-hypercar.do

Human Kinetics. (n.d.). Adjusting an integrated seat mast. https://us.humankinetics.com/blogs/excerpt/adjusting-an-integrated-seat-mast

Baer, R. A. (2009). Self-focused attention and mechanisms of change in mindfulnessbased treatment. Cognitive Behaviour Therapy, 38(sup1), 15–20. https://doi.org/ 10.1080/16506070902980703

Lymeus, F., Lindberg, P., & Hartig, T. (2018). Building mindfulness bottom-up: Meditation in natural settings supports open monitoring and attention restoration. Consciousness and Cognition, 59, 40–56. https://doi.org/10.1016/j. concog.2018.01.008

Holzel, ¨ B. K., Lazar, S. W., Gard, T., Schuman-Olivier, Z., Vago, D. R., & Ott, U. (2011). How does mindfulness meditation work? Proposing mechanisms of action from a conceptual and neural perspective. Perspectives on Psychological Science, 6(6), 537–559. https://doi.org/10.1177/1745691611419671

Wilkinson, P., Smith, K.R., Beevers, S., Tonne, C., Oreszczyn, T., 2007. Energy, energy efficiency, and the built environment. Lancet 370, 1175e1187. https://doi.org/10.1016/S0140 6736(07)61255-0.

Colding, J., Giusti, M., Haga, A., Wallhagen, M., Barthel, S., 2020. Enabling relationships with nature in cities. Sustainability 12, 1e16. https://doi.org/10.3390/su12114394.

Fromm, E., 1964. Love of death and love of life. In: The Heart of Man: Its Genius for Good and Evil.

Kellert, S.R., 1993. The biological basis for human values of nature. In: Kellert, S.R., Wilson, E.O. (Eds.), The Biophilia Hypothesis. Island Press, pp. 42e69.

Wilson, E.O., 1984. Biophilia. Harvard University Press. https: //doi.org/10.1016/B978-0-444-63768-0.00636-3.

Heerwagen, J.H., Hase, B., 2001. Building biophilia: connecting people to nature in building design. Environ. Des. Constr. 3, 30-36.

Joye, Y., 2007. Architectural lessons from environmental psychol ogy: the case of biophilic architecture. Rev. Gen. Psychol. 11, 305e328. https://doi.org/10.1037/1089-2680.11.4.305.

Kellert, S.R., Heerwagen, J.H., Mador, M.L., 2008. Biophilic Design: the Theory, Science, and Practice of Bringing Buildings to Life. John Wiley & Sons, Hoboken.

Appleton, J., 1975. The Experience of Landscape. John Wiley & Sons. https://doi.org/10.2307/633509.

Hildebrand, G., 1999. Origins of Architectural Pleasure. University of California Press. https://doi.org/10.5860/choice.37-2581.

Hidalgo, M.C., Herna´ndez, B., 2001. Place attachment: conceptual and empirical questions. J. Environ. Psychol. 273e281. https: //doi.org/10.1006/jevp.2001.0221.

Orians, G.H., Heerwagen, J.H., 1992. Evolved responses to land scapes. In: The Adapted Mind: Evolutionary Psychology and the Generation of Culture, pp. 555e580.

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References

Kaplan, S., 1995. The restorative benefits of nature: toward an integrative framework. J. Environ. Psychol. 15, 169e182. https: //doi.org/10.1016/0272-4944(95)90001-2.

Ulrich, R.S., 1983. Aesthetic and affective response to natural environment. Hum. Behav. Environ. 6, 85e125. https: //doi.org/10.1007/978-1-4613-3539-9.

Africa, J., Heerwagen, J., Loftness, V., Ryan Balagtas, C., 2019. Biophilic design and climate change: performance parameters for health. Front. Built Environ. 5. https://doi.org/ 10.3389/fbuil.2019.00028.

Gillis, K., Gatersleben, B., 2015. A review of psychological litera ture on the health and wellbeing benefits of biophilic design. Buildings 5, 948-963. https://doi.org/10.3390/buildings5030948

Wijesooriya, N., Brambilla, A., 2021. Bridging biophilic design and environmentally sustainable design: a critical review. J. Clean. Prod. 283, 124591. https://doi.org/10.1016/j.jclepro.2020. 124591.

Beatley, T., Newman, P., 2013. Biophilic cities are sustainable, resilient cities. Sustainability //doi.org/10.3390/su5083328.

El-Baghdadi, O., Desha, C., 2017. Conceptualising a biophilic ser vices model for urban areas. Urban For. Urban Green. 27, 399e408. https://doi.org/10.1016/j.ufug.2016.10.016.

Kellert, S., 2016. Biophilic urbanism: the potential to transform. Smart Sustain. Built Environ. 5, 4-8. https://doi.org/10.1108/SASBE-10-2015-0035.

Lee, S., Kim, Y., 2021. A framework of biophilic urbanism for improving climate change adaptability in urban environments. Urban For. Urban Green. 61, 127104. https://doi.org/10.1016/j.ufug.2021.127104.

Littke, H., 2016. Becoming biophilic: challenges and opportunities for biophilic urbanism in urban planning policy. Smart Sustain. Built Environ. 5, 15e24. https://doi.org/10.1108/SASBE-10 2015-0036.

COP26, 2021. The 26th United Nations Climate Change Conference. Available online at: https://ukcop26.org/the-conference/ cop26-outcomes/.

Zhong, W., Schroeder, T., & Bekkering, J. (2023). Designing with nature: Advancing three-dimensional green spaces in architecture through frameworks for biophilic design and sustainability. Frontiers of Architectural Research, 12(4), 732–753. https://doi.org/10.1016/j.foar.2023.03.001

Wolverton, B.C., Johnson, A., Bounds, K., 1989. Interior Landscape Plants for Indoor Air Pollution Abatement.

Knowles, L., Maclean, P., Rosato, M., Stanley, C., Volpe, S., Yousif, D., Wismer, S., 2002. Living Wall: a Feasibility Study for the Student Life Center.

van Duijn, B., van Bergen, S., Klein Hesselink, J., Kuijt-Evers, L., Jansen, J., Spitters, H., Kester, M., 2011. Plant in de klas. Available online at: http://resolver.tudelft.nl/uuid:ab629263 88da-4f6b-9111-889ad0130bd2.

Velzeboer, I., Blom, M.J., Duyzer, J.H., 2019. Effects of Plant Systems on Air Quality.

Hoelscher, M.T., Nehls, T., Ja¨nicke, B., Wessolek, G., 2016. Quantifying cooling effects of facade greening: shading, tran spiration and insulation. Energy Build. 114, 283e290. https: //doi.org/10.1016/j.enbuild.2015.06.047.

Jimenez, M.S., 2018. Green walls: a sustainable approach to climate change, a case study of London. Archit. Sci. Rev. 61, 48e57. https://doi.org/10.1080/00038628. 2017.1405789.

Liu, F., Yan, L., Meng, X., Zhang, C., 2022. A review on indoor green plants employed to improve indoor environment. J. Build. Eng. 53, 104542. https://doi.org/10.1016/j.jobe.2022.104542.

Raji, B., Tenpierik, M.J., Van Den Dobbelsteen, A., 2015. The impact of greening systems on building energy performance: a literature review. Renew. Sustain. Energy Rev. 45, 610e623. https://doi.org/10.1016/j.rser.2015.02.011.

References

D'Alessandro, F., Asdrubali, F., Mencarelli, N., 2015. Experimental evaluation and modelling of the sound absorption properties of plants for indoor acoustic applications. Build. Environ. 94, 913e923. https://doi.org/10.1016/j.buildenv.2015.06.004.

Mediastika, C.E., Binarti, F., 2013. Reducing indoor noise levels using people's perception on greenery. Environ. Clim. Technol. 11, 19e27. https://doi.org/10.2478/rtuect-2013-0003.

Van Renterghem, T., Hornikx, M., Forssen, J., Botteldooren, D., 2013. The potential of building envelope greening to achieve quietness. Build. Environ. 61, 34-44. https://doi.org/10.1016/j.buildenv.2012.12.001.

Yan, F., Shen, J., Zhang, W., Ye, L., Lin, X., 2022. A review of the application of green walls in the acoustic field. Build. Acoust. 29, 295-313. https://doi.org/10.1177/1351010X221096789.

Gilchrist, K., Brown, C., Montarzino, A., 2015. Workplace settings and wellbeing: greenspace use and views contribute to employee wellbeing at peri-urban business sites. Landsc. Urban Plan. 138, 32-40. https://doi.org/10.1016/j.landurbplan.2015.02.004.

Korpela, K., De Bloom, J., Kinnunen, U., 2015. From restorative environments to restoration in work. Intell. Build. Int. 7, 215-223. https://doi.org/10.1080/17508975.2014.959461.

Lee, K.E., Williams, K.J.H., Sargent, L.D., Williams, N.S.G., Johnson, K.A., 2015. 40-second green roof views sustain atten tion: the role of micro-breaks in attention restoration. J. Environ. Psychol. 42 182-189. https://doi.org/10.1016/j.jenvp.2015.04.003.

Li, D., Sullivan, W.C., 2016. Impact of views to school landscapes on recovery from stress and mental fatigue. Landsc. Urban Plan. 148, 149-158. 2015.12.015. https://doi.org/10.1016/j.landurbplan.

Contini, P., Di Nuovo, S., Sinatra, M., Osmanaj, E., Monacis, L., 2022. Investigating the buffering effects of greenery on the adverse emotional, mental and behavioral health during the pandemic period. Int. J. Environ. Res. Public Health 19. https: //doi.org/10.3390/ijerph19148749.

Li, Z., Wang, Y., Liu, Hui, Liu, Hong, 2022. Physiological and psy chological effects of exposure to different types and numbers of biophilic vegetable walls in small spaces. Build. Environ. 225, 109645. https://doi.org/10.1016/j.buildenv.2022.109645.

Nejati, A., Shepley, M., Rodiek, S., Lee, C., Varni, J., 2016. Restorative design features for hospital staff break areas: a multi-method study. Heal. Environ. Res. Des. J. 9, 16e35. https: //doi.org/10.1177/1937586715592632.

van den Berg, A.E., Maas, J., Verheij, R.A., Groenewegen, P.P., 2010. Green space as a buffer between stressful life events and health. Soc. Sci. Med. 70, 1203-1210. https://doi.org/10.1016/j.socscimed.2010.01.002.

Dijkstra, K., Pieterse, M.E., Pruyn, A., 2008. Stress-reducing effects of indoor plants in the built healthcare environment: the mediating role of perceived attractiveness. Prev. Med. 47, 279-283. https://doi.org/10.1016/j.ypmed.2008.01.013.

Jamshidi, S., Parker, J.S., Hashemi, S., 2020. The effects of environmental factors on the patient outcomes in hospital environments: a review of literature. Front. Archit. Res. 9, 249e263. https://doi.org/10.1016/j.foar.2019.10.001.

Ulrich, R.S., 1984. View through a window may influence recovery from surgery. Science 224 (80), 420e421. https://doi.org/10.1126/science.6143402.

Jungels, J., Rakow, D.A., Allred, S.B., Skelly, S.M., 2013. Attitudes and aesthetic reactions toward green roofs in the Northeastern United States. Landsc. Urban Plan. 117, 13-21. https://doi.org/10.1016/j.landurbplan.2013.04.013.

Lee, K.E., Williams, K.J.H., Sargent, L.D., Farrell, C., Williams, N.S., 2014. Living roof preference is influenced by plant characteristics and diversity. Landsc. Urban Plan. 122, 152-159. https://doi.org/10.1016/j.landurbplan.2013.09.011.

References

Loder, A., 2014. There's a meadow outside my workplace": a phenomenological exploration of aesthetics and green roofs in Chicago and Toronto. Landsc. Urban Plan. 126, 94-106. https://doi.org/10.1016/j.landurbplan.2014.01.008.

Xiao, L., Wu, R., Huang, J., Yang, X., Xu, A., 2022. Study on the relationship between restoration benefit and visual satisfaction of LONG-PLAN's indoor vertical greenery. Buildings 12. https://doi.org/10.3390/buildings12081267.

Kellert, S.R., 1993. The biological basis for human values of nature. In: Kellert, S.R., Wilson, E.O. (Eds.), The Biophilia Hypothesis. Island Press, pp. 42-69.

Wilson, E.O., 1984. Biophilia. Harvard University Press. https: //doi.org/10.1016/B978-0-444-63768-0.00636-3. Wolverton, B.C., Johnson, A., Bounds, K., 1989. Interior Landscape Plants for Indoor Air Pollution Abatement.

Kellert, S.R., 2009. A Biocultural Basis for an Environmental Ethic. Coming Transform. In: Values to Sustain Hum. Nat. Commu nities, pp. 21-38. https://doi.org/10.1093/acprof:oso/9780195309454.003.0021.

Andreucci, M.B., Loder, A., Brown, M., Brajkovic, J., 2021. Exploring challenges and opportunities of biophilic urban design: evidence from research and experimentation. Sustain ability 13, 1-24. https://doi.org/10.3390/su13084323.

Boiral, O., Heras-Saizarbitoria, I., Brotherton, M.C., 2019. Nature connectedness and environmental management in natural re sources companies: an exploratory study. J. Clean. Prod. 206, 227-237. https://doi.org/10.1016/j.jclepro.2018.09.174.

Liu, Q., Fu, W., van den Bosch, C.C.K., Xiao, Y., Zhu, Z., You, D., Zhu, N., Huang, Q., Lan, S., 2018. Do local landscape elements enhance individuals' place attachment to new environments? A cross-regional comparative study in China. Sustainability 10, 1-17. https://doi.org/10.3390/su10093100.

Zhang, R., 2022. Integrating ergonomics data and emotional scale to analyze people's emotional attachment to different land scape features in the Wudaokou Urban Park. Front. Archit. Res. https://doi.org/10.1016/j.foar.2022.06.007.

Beatley, T., Newman, P., 2013. Biophilic cities are sustainable, resilient cities. Sustainability 5, 3328-3345. https://doi.org/10.3390/su5083328.

Gue ´guen, N., Stefan, J., 2016. "Green altruism": short immersion in natural green environments and helping behavior. Environ. Behav. 48, 324-342 https://doi.org/10.1177/0013916514536576.

Oh, R.R.Y., Zhang, Y., Nghiem, L.T.P., Chang, C. chen, Tan, C.L.Y., Quazi, S.A., Shanahan, D.F., Lin, B.B., Gaston, K.J., Fuller, R.A., Carrasco, R.L., 2022. Connection to nature and time spent in gardens predicts social cohesion. Urban For. Urban Green. 74, 127655. https://doi.org/10.1016/j.ufug.2022.127655.

Sa¨umel, I., Sanft, S.J., 2022. Crisis Mediated New Discoveries, Claims and Encounters: Changing Use and Perception of Resi dential Greenery in Multistory Housing in Berlin, vol. 74. Urban For. Urban Green, Germany. https://doi.org/10.1016/j.ufug.2022.127622.

Appolloni, E., Orsini, F., Specht, K., Thomaier, S., Sanye ´ Mengual, E., Pennisi, G., Gianquinto, G., 2021. The global rise of urban rooftop agriculture: a review of worldwide cases. J. Clean. Prod. 296. https://doi.org/10.1016/j.jclepro.2021.126556.

Benke, K., Tomkins, B., 2017. Future food-production systems: vertical farming and controlled-environment agriculture. Sus tain. Sci. Pract. Policy 13, 13-26. https://doi.org/10.1080/15487733.2017.1394054.

Benis, K., Turan, I., Reinhart, C., Ferra˜o, P., 2018. Putting rooftops to use e a cost-benefit analysis of food production vs. energy generation under Mediterranean climates. Cities 78, 166-179. https://doi.org/10.1016/j.cities.2018.02.011.

Specht, K., Siebert, R., Hartmann, I., Freisinger, U.B., Sawicka, M., Werner, A., Thomaier, S., Henckel, D., Walk, H., Dierich, A., 2014. Urban agriculture of the future: an overview of sustain ability aspects of food production in and on buildings. Agric. Human Values 31, 33-51. https://doi.org/10.1007/s10460-013-9448-4.

References

Walters, S.A., Midden, K.S., 2018. Sustainability of urban agriculture: vegetable production on green roofs. Agriculture 8, 1–16. https://doi.org/10.3390/agriculture8110168.

Han, H., Jongsik, Y., Hyun, S.S., 2020. Nature based solutions and customer retention strategy: eliciting customer well-being ex periences and self-rated mental health. Int. J. Hosp. Manag. 86. https://doi.org/10.1016/j.ijhm.2019.102446.

Manso, M., Teoto ´nio, I., Silva, C.M., Cruz, C.O., 2021. Green roof and green wall benefits and costs: a review of the quantitative evidence. Renew. Sustain. Energy Rev. 135. https://doi.org/10.1016/j.rser.2020.110111.

Perini, K., Rosasco, P., 2016. Is greening the building envelope economically sustainable? An analysis to evaluate the advantages of economy of scope of vertical greening systems and green roofs. Urban For. Urban Green. 20, 328-337. https://doi.org/10.1016/j.ufug.2016.08.002.

Claus, K., Rousseau, S., 2012. Public versus private incentives to invest in green roofs: a cost benefit analysis for Flanders. Urban For. Urban Green. 11, 417-425. https://doi.org/10.1016/j.ufug.2012.07.003.

Medl, A., Stangl, R., Florineth, F., 2017. Vertical greening systems e a review on recent technologies and research advancement. Build. Environ. 125, 227-239. https://doi.org/10.1016/j.buildenv.2017.08.054.

Tabatabaee, S., Mahdiyar, A., Durdyev, S., Mohandes, S.R., Ismail, S., 2019. An assessment model of benefits, opportunities, costs, and risks of green roof installation: a multi criteria decision making approach. J. Clean. Prod. 238, 117956. https://doi.org/10.1016/j.jclepro.2019.117956.

The C-Suite - the Business Class concept seat. (2023, May 23). Airbus Aircraft. https://aircraft.airbus.com/en/airspace-cabin-vision-2035

Haddad, J. M., Rietdyk, S., Claxton, L. J., & Huber, J. (2013). Task-dependent postural control throughout the lifespan. Exercise and Sport Sciences Reviews, 41(2), 123–132.

Chang, C. H., Wade, M. G., Stoffregen, T. A., Hsu, C. Y., & Pan, C. Y. (2010). Visual tasks and postural sway in children with and without autism spectrum disorders. Research in Developmental Disabilities, 31(6), 1536–1542.

Chen, F. C., Tsai, C. L., Stoffregen, T. A., & Wade, M. G. (2011). Postural responses to a suprapostural visual task among children with and without developmental coordination disorder. Research in Developmental Disabilities, 32(5), 1948–1956.

Izquierdo-Herrera, R., García-Massó, X., González, L. M., Wade, M. G., & Stoffregen, T. A. (2018). Visual tasks and stance width influence the spatial magnitude and temporal dynamics of standing body sway in 6- to 12-year-old children. Human Movement Science, 59, 56–65.

Stoffregen, T. A., Hove, P., Bardy, B. G., Riley, M., & Bonnet, C. T. (2007). Postural stabilization of perceptual but not cognitive performance. Journal of Motor Behavior, 39(2), 126–138.

Stoffregen, T. A., Pagulayan, R. J., Bardy, B. G., & Hettinger, L. J. (2000). Modulating postural control to facilitate visual performance. Human Movement Science, 19(2), 203–220.

Pallasmaa, J. (2005). The Eyes of the Skin: Architecture and the Senses. London, UK: Wiley-Academy.

Dischinger, M. (2006). "The non-careful sight," in Blindness and the Multi-Sensorial City. eds. P. Devlieger, F. Renders, H. Froyen, and K. Wildiers (Antwerp, Belgium: Garant), 143–176.

Franck, K. A., and Lepori, B. (2007). Architecture from the Inside Out. London, UK: Wiley.

Heylighen, A., Devlieger, P., and Strickfaden, M. (2009). "Design expertise as disability and vice versa." in Proceedings from the Communicating (by) Design Conference; January 26-27, 2009; (Brussels, Belgium: Hogeschool voor Wetenschap en Kunst St.-Lucas), 227–235.

References

Heylighen, A. (2011). "Studying the unthinkable designer: designing in the absence of sight," in Design Computing & Cognition '10. ed. J. S. Gero (Dordrecht, the Netherlands: Springer), 23–34.

Wastiels, L. W., Schifferstein, H. J., Wouters, I., and Heylighen, A. (2013). Touching materials visually: about the dominance of vision in building material assessment. Int. J. Des. 7, 31–41.

Kwon, J., and Kim, J. Y. (2021). Meaning of gaze behaviors in individuals' perception and interpretation of commercial interior environments: an experimental phenomenology approach involving eye-tracking. Front. Psychol. 12:581918. doi: 10.3389/fpsyg.2021.581918

Merleau-Ponty, M. (2014). Phenomenology of Perception. (D. A. Landes, Trans.). Abingdon and New York, NY: Routledge.

Van Manen, M. (1997). Researching Lived Experience: Human Science for an Action Sensitive Pedagogy. 2nd Edn. London, UK: The Althouse Press.

Attfield, J. (2000). Wild Things: The Material Culture of Everyday Life. Oxford: Berg.

Cresswell, T. (2004). Place: A Short Introduction. Malden, MA: Blackwell.

Ihde, D. (2012). Experiemental Phenomenology: Multistabilities. 2nd Edn. Albany, NY: State University of New York Press.

Simonsen, K. (2005). Bodies, sensations, space and time: the contribution from Henri Lefebvre. Geogr. Ann. Ser. B 87, 1–14. doi: 10.1111/j.0435-3684.2005.00174.x

Historical analysis

The evolution of the commercial flying experience. (2022, January 3). National Air and Space Museum. https://airandspace.si.edu/explore/stories/evolution-commercial-flying-experience

Poirot, L. (2022, October 18). Airplane cabins through the years. Far & Wide. https://www.farandwide.com/s/airplane-cabins-history-timeline-011caad44b6e4eb9

Gebicki, M. (2019, April 11). How class divisions evolved in planes: The evolution of cabins through the decades. The Sydney Morning Herald. https://www.smh.com.au/traveller/reviews-and-advice/how-class-divisions-evolved-in-planes-the-evolution-of-cabins-through-the-decades-20190410-h1dcr5.html

Today, W. J. M. U. (2019, November 20). Airlines tell parents to pay up or risk sitting rows away from their kids. That's wrong. USA TODAY. https://eu.usatoday.com/story/opinion/voices/2019/11/20/airlines-seat-reservations-families-children-separate-column/4196405002/

Delta Air Lines service classes history timeline. (n.d.). https://www.deltamuseum.org/delta-history/delta-brand/service-classes

Figures of Historical analysis

Delta museum. (n.d.). https://www.deltamuseum.org/delta-history/timeline/decades/1970

Smithsonian Institution. (n.d.). https://www.si.edu

McCarthy, K. (2024, June 20). JetBlue will soon offer free carry-on bags for Blue Basic fares. ABC News. https://abcnews.go.com/GMA/Travel/jetblue-offer-free-carry-bags-blue-basic-fares/story?id=111274735

The evolution of the commercial flying experience. (2022c, January 3). National Air and Space Museum. https://airandspace.si.edu/explore/stories/evolution-commercial-flying-experience

References

Figures

Airplane covers and Icons: https://www.elysianaircraft.com

XENiA cover: https://similarworlds.com/nature-outdoors/peace-nature/4969663-I-love-the-city-But-nothing-beats-Natures-beauty

3D model images: personal creation

1. https://www.seatguru.com/airlines/Lufthansa/Lufthansa_Embraer_195.php
2. https://www.seatguru.com/airlines/Lufthansa/Lufthansa_Boeing_747_400_V4.php
3. Personal airplane trip
4. Bouwens, J. M., Tsay, W. J., & Vink, P. (2017). The high and low comfort peaks in passengers' flight. Work, 58(4), 579–584. https://doi.org/10.3233/wor-172637
5. Macaulay, R., Lee, K., Johnson, K., & Williams, K. (2022b). Mindful engagement, psychological restoration, and connection with nature in constrained nature experiences. Landscape and Urban Planning, 217, 104263. https://doi.org/10.1016/j.landurbplan.2021.104263
6. Desmet, P., & Fokkinga, S. (2020c). Beyond Maslow's Pyramid: Introducing a typology of thirteen fundamental needs for Human-Centered Design. Multimodal Technologies and Interaction, 4(3), 38. https://doi.org/10.3390/mti4030038
7. https://archello.com/story/53256/attachments/photos-videos/
8. https://www.egm.nl/en/architects/projects/erasmus-mc-hospital/347
9. https://similarworlds.com/nature-outdoors/peace-nature/4969663-I-love-the-city-But-nothing-beats-Natures-beauty
10. https://www.linkedin.com/posts/manit-m-989799256_true-life-before-the-internet-was-simpler-activity-7132902725058494464-o-Sk/
11. https://www.dall-efree.com/user/image-generator
12. Drawings from interviews
13. Seat type
14. https://www.wordclouds.com
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16. Interaction focus of Concept idea 1
17. https://campsummit.ca/retreats-rentals/
18. Interaction focus of Concept idea 2
19. https://www.mthigh.com/site/connect/blog/authors/john_mccolly/camping-at-mountain-high
20. Interaction focus of Concept idea 3
21. https://de.123rf.com/lizenzfreie-bilder/Freizeit.html?oriSearch=freizeit
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46. Share of people who prefer to travel as a group, by generation, in the United States in 2017, Statista. (2021, March 16). Percentage of people that prefer to travel as a group, by generation in the U.S. 2017. https://www.statista.com/statistics/938978/people-who-prefer-to-travel-as-a-group-by-generation-us/

Disclaimer

For rephrasing texts it was used the assistance of ChatGPT (https://chatgpt.com).

Appendices

Appendix:Interviews *(set-up)*

Interviews

Background

Elysian Aircraft Company B.V. is developing a zero-emission regional airliner which aims to change way of travelling with an airplane. This project is focused on interior of this aircraft where an innovative direction aims to be followed.

Research purpose

This research is done to answer these following research question:

1. Define possible sitting configuration.
2. Define interactions and/or functions.

Information from participants.
Personal Data
Age :.....years
Gender:.....Male/Female/Others

What are your ethnic origins or ancestry?
(Please select all geographic areas from which your ancestors first originated.)
- **Western Europe (e.g., Hungary, Poland, Russia)**
- **Eastern Europe (e.g., Hungary, Poland, Russia)**
- **North Africa (e.g., Egypt, Morocco, Sudan)**
- **Sub-Saharan Africa (e.g., Kenya, Nigeria, South Africa)**
- **West Asia / Middle East (e.g., Iran, Israel, Saudi Arabia)**
- **South and Southeast Asia (e.g., India, Indonesia, Singapore)**
- **East and Central Asia (e.g., China, Japan, Uzbekistan)**
- **Pacific / Oceania (e.g., Australia, Fiji, Papua New Guinea)**
- **North America (Canada, United States)**
- **Central America and Caribbean (e.g., Jamaica, Mexico, Panama)**
- **South America (e.g., Brazil, Chile, Colombia)**
- **Self-describe:**

Questions, instructions and brief.
Scope: This study/interview is to gather information about ergonomics, culture and technology part of the project, and will take you approximately 30 minutes to complete. The data will be used for defining functions, ergonomic needs, which will be shared within the Thesis report.

- What is the feeling that describes that day? Is there anything that you would like to change or to add?
- Which sense(s) were most activated that day? Why?
- How was your way to that place? What you liked most about it and why?
- Would imagine any of the things you said or drew be in an airplane?
- Have you ever flown with an airplane? If yes, have you ever done a short-haul flight (~1.5 hrs)
- If yes, what was the reason of the travel? (Work or leisure)

Closing: Are you still having these kind of days? (If yes, how often? If not, why do you think you are not?)
End: Feedback question and draw something additional (optional)

Equipment
- Pens and papers (for consent forms, personal data, notes, sketches)
- Voice recorder

Expected data
Questionnaire
- Age
- Gender
- Nationality

Notes and voice recording
- Seat types
- Interactions

Analysis Methods

The output will help to form concept certain concept aspects:
- Interactions
- Functions
- Seat types

Interview diagram (mind map)

Questions
- Opening: What would you do to enjoy the weekend that is coming? (or similar)
- *(Then explaining how a carefree day in the nature looks like to me)*
- How a carefree day in the nature looks like to you?

- Where do you imagine this day? *(context)*

(as in to explain the context and experience in detail)
- Draw something *(how it will look like)*

(if participant can not answer, ask him/her to choose between beach, forest, mountain)
- What were you doing at that day? Name 3 activities. *(activities)*

(if participant can not answer, asking him/her directly to name 3 activities)
- What is the thing that you mostly remember?

(if participant can not answer, ask him/her to choose one of the previous)
- How were you sitting at that day?

(if participant can not answer, ask him/her to choose one of the following:

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Appendix:Interviews *(consent forms)*

Study Information (informed consent for participants)
Interview
[30/04/2024]

Dear participant,
You are being invited to participate in a research study titled Interview. This study is being done by Christos Batsaras from the Delft University of Technology for a master thesis. The thesis project partner is Elysian Aircraft Company B.V., a company developing a zero-emission regional airliner which aims to change way of travelling with an airplane. This project is focused on interior of this aircraft where an innovative direction aims to be followed.

Research purpose

This research is done to answer these following research question:
1. Define possible sitting configuration.
2. Define interaction and/or functions.

Method
Interview brainstorm session. The interview session will be voice/screen recorded and transcribed.

Participant Selection
From personal stream. Participants will fit in the following age groups: 20-31, 31-40, 41-50, 50+

Equipment
- Consent form
- Result summary
- Voice or screen recorder
- Questionnaire

Benefits and Risks of Participating

There are no heightened risks during these studies. Your participation will contribute to the future interior design of Elysian Aircraft Company B.V. aircraft. As a TU Delft employee, you will be offered a voucher of €10. For TU Delft employees a number of EDI has to be able to pay this benefit, we would be collecting your data, which will only be processed for financial administrations. This data will not be processed for the researched. The data collected are as follows:

• TU Delft students	Name (as in your ID), email address, home address (street, number, postcode, city, and country), phone number, student number and (NL) bank account number. Additionally, some other data for foreign bank accounts see (*)
• Non-TU Delft students	Name (in your ID), email address, home address (street, number, postcode, city, and country), phone number, BSN, date-of-birth, and (NL) bank account number. Additionally, some other data for foreign bank accounts see (*)

Withdrawal from the study

Your participation in this study is entirely voluntary and you can withdraw at any time. You are free to omit any questions. If requested, the collected data regarding your participation will be destroyed.

Anonymize, Storage & Access of the Data

As with any activity the risk of a breach is always possible. To the best of our ability your answers in this study will remain confidential. We will minimize any risks by keeping anonymity in the whole process, **no** collecting any data that can identify participants, and no names or locations will be used. Only anonymous quotes from the group level will be published. Some pictures will be taken during the user test, in which the face of the participant will be covered/blurred before being shared. Anonymized pictures will be saved within TU Delft cloud system to maximize confidentiality in the current context. Interview recordings will be transcribed, and the original recording will be destroyed at the end of the project. Only anonymized quotes will be published in the thesis report. The final design will be shared with Elysian Aircraft Company. Possible regional aircrafts and will be shared in the thesis report which will be shared at the TU Delft repository.

The data will NOT be shared and re-used by default. But the participants can voluntarily donate the data to the repository of TU Delft for being anonymously used in future research.

For any questions regarding this research the following researchers can be contacted:
Corresponding researcher (Student) contact details: Chris Batsaras (c.batsaras@student.tudelft.nl)
Responsible Researcher contact details: Dr. Shabda Anjani (s.anjani-1@tudelft.nl)

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Faculty of Industrial Design Engineering
Landbergstraat 15, 2628 CE Delft, the Netherlands
tf www.io.tudelft.nl

PLEASE TICK THE APPROPRIATE BOXES	**Yes**	**No**
A- GENERAL AGREEMENT – RESEARCH GOALS, PARTICIPANT TASKS AND VOLUNTARY PARTICIPATION		
1. I have read and understood the study information dated [30/04/2024], or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.	☐	☐
2. I consent voluntarily to be a participant in this study. (As a legal guardian, I consent to allow my child to be a participant in this study). I understand that I (or my child) can refuse to answer questions and I (or my child) can withdraw from the study at any time, without having to give a reason.	☐	☐
3. I understand that taking part in the study involves:	☐	☐

PLEASE TICK THE APPROPRIATE BOXES	**Yes**	**No**
• Recording my basic information (age, gender and nationality).		
• Voice recording during the process of user test.		
• Filling a questionnaire		
4. I understand that I will be compensated for my participation by voucher of 10 euros, upon completion of the study.	☐	☐
5. I understand that the study will take 30 minutes.		
B- POTENTIAL RISKS OF PARTICIPATING (INCLUDING DATA PROTECTION)		
I understand that taking part in the study involves no heightened risks.		
9. I understand that the following steps will be taken to minimise the threat of a data breach, and protect my identity in the event of such a breach. Voice recordings will be stored within TU Delft cloud system.	☐	☐
I understand that taking part in the study also involves collecting specific personally identifiable information (PII) (age, gender, weight, height, nationality/ethnicity, photos, videos, and 3D map) and associated personally identifiable research data (PIRD) with the potential risk of my identity being revealed.		
I understand that some of this PIRD is considered as sensitive data within GDPR legislation		
I understand the following steps will be taken to minimise the threat of a data breach and protect my identity in the event of such a breach. The collected data will be saved in the cloud system, anonymizing all data collected, anonymizing discussion quotes, statistically processing measured data, etc.) and the shared data will be done in a secure server.		
I understand that personal information collected about me that can identify me, such as my name will not be shared beyond the study team.		
C- RESEARCH PUBLICATION, DISSEMINATION AND APPLICATION		
12. I understand that after the research study the de-identified information I provide will be used for (*one point is below*):	☐	☐
• Taking design decisions • Contribute to concept development • Will be used in the report and presentation		
13 I agree that my responses, views or other input can be quoted anonymously in research outputs	☐	☐
D- (CONSTENT) DATA STORAGE, ACCESS AND REUSE		
16. I give permission for the de-identified, transcription and interview results that I provide to be archived in TU Delft repository so it can be used for future research and learning.	☐	☐

SIGNATURES		
(For participants >12 years old)		
Name of participant [printed]	Signature	Date
I, as parent/guardian, have witnessed the accurate reading of the consent form with the potential participant and the individual has had the opportunity to ask questions. I confirm that the individual has given consent freely.		
Name of legal guardian [printed]	Signature	Date
I, as researcher, have accurately shown the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.		
Christos Batsaras Researcher name [printed]	Signature	30/04/2024 Date
Shabda Anjani Researcher name [printed]	Signature	30/04/2024 Date
Study contact details for further information: Chris Batsaras, +31649358945, c.batsaras@student.tudelft.nl		

Appendix:Ergonomics user test *(set-up)*

Ergonomics Test

Background
Elysian Aircraft Company B.V. is developing a zero-emission regional airliner which aims to change way of travelling with an airplane. This project is focused on interior of this aircraft where an innovative direction aims to be followed.

Research purpose
This research is done to answer these following research question:
1. Define possible configurations of different types of seats within a defined area in the fuselage with 12 people.
2. What items/elements do the participants would like to have in their sitting area? And why?

To answer these questions, we will be asking you to select a seat and position yourself within a specific area with 11 other participants. Then you will be asked to mention and/or draw in a paper (with the top view of the area) any items/elements that you would like to have at your sitting place.

Equipment
- Test set-up
  - Boundaries e.g. white boards
  - Seats
- Pens and paper (for consent forms, personal data and drawings)
- Measuring tape
- 2 Phone/tablet with camera
- 12 Seats
- Voice recorder

Test setup

Defined area Seat types

Procedure
1. A consent form is given prior to the experiment, which must be signed by each participant prior to the start of the experiment.
2. Participants are assigned use case scenario for a 90 minute flight. Some travel for leisure and others for business.
3. Each participant will be asked to choose one of the given seats.
4. All participants will enter in the defined area and asked to place their seats in the way they like.
5. All participants will be asked to seat for a few minutes.
6. All participants will be asked to get out of the defined area, without moving the seats in order to map the configuration.
7. All participants will be asked to take their seats from the defined area and get out of it.
8. All participants will be asked to repeat the process again.
9. In the end, all participants will be asked to quick draw any items/elements they would like to have in their sitting area and explain why.
10. Vouchers will be given to all participants.

Expected data
1. Questionnaire
   - Age
   - Gender
   - Nationality
2. Quick drawings on paper with layout

Expected Results & Analysis Methods
1. Define possible configurations of different types of seats within a defined area in the fuselage with 12 people.

Summary of these layouts

Coordinates could be processed.

2. What items/elements do the participants would like to have in their sitting area? And why?
   - Interview transcription.
   - Additional items/element list.
   - Reasoning list.
   - Sketches of the participants

Plan B
- If participants struggle to choose a seat, the seat will be assigned to them.
- If participants struggle to fit it the specific area, they will be helped in order to recognize the space around them.

(Plan B will be finalized after the pilot test)

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Appendix:Ergonomics user test *(consent forms)*

Study Information (informed consent for participants)
Ergonomics Test
[30/04/2024]

Dear participant,
You are being invited to participate in a research study titled Ergonomics Test. This study is being done by Christos Batsaras from the Delft University of Technology for a master thesis. The thesis project partner is Elysian Aircraft Company B.V., a company developing a zero-emission regional airliner which aims to change way of travelling with an airplane. This project is focused on interior of this aircraft where an innovative direction aims to be followed.

Research purpose
This research is done to answer these following research question:
1. Define possible configurations of different types of seats within a defined area in the fuselage with 12 people.
2. What items/elements do the participants would like to have in their sitting area? And why?

To answer these questions, we will be asking you to select a seat and position yourself within a specific area with 11 other participants. Then you will be asked to mention and/or draw in a paper (with the top view of the area) any items/elements that you would like to have at your sitting place.

Benefits and Risks of Participating
There are no heightened risks during these studies. Your participation will contribute to the future interior design of regional airplanes. If you complete the study and is not a TU Delft employee, you will be offered a voucher of €10. For TU Delft employees a voucher of €5/hour. To be able to pay this benefit, we would be collecting your data, which will only be processed for financial administrations. This data will not be processed for the researched. The data collected are as follows: Name (as in your ID), email address, home address (street, number, postcode, city, and country), phone number, student number (for TU Delft students only), BSN, date-of-birth, and (NL) bank account number.

Withdrawal from the study
Your participation in this study is entirely voluntary and you can withdraw at any time. You are free to omit any questions. If requested, the collected data regarding your participation will be destroyed.

Anonymize, Storage & Access of the Data
As with any activity the risk of a breach is always possible. To the best of our ability your answers in this study will remain confidential. We will minimize any risks by keeping anonymity in the whole process, **not** collecting, or sharing other personal information than age, gender, and nationality. Only statistical processed data in group level will be published. Some pictures will be taken during the user test, in which the face of the participant will be covered/blurred before being shared. Anonymized pictures will be saved within TU Delft cloud system to maximize confidentiality in the current context. Interview recordings will be transcribed, and the original recording will be destroyed at the end of the project. Only anonymized quotes will be published in the report. The data will be used for taking designing new fleets of sustainable regional aircrafts and will be shared in the thesis report which will be shared at the TU Delft repository.

The data will NOT be shared and re-used by default. But the participants can voluntarily donate the data to the repository of TU Delft for being anonymously used in future research.

For any questions regarding this research the following researchers can be contacted:
Corresponding researcher (Student) contact details: Chris Batsaras (c.batsaras@student.tudelft.nl)
Responsible Researcher contact details: Dr. Shabila Anjani (s.anjani-1@tudelft.nl)

TU Delft
Faculty of Industrial Design Engineering
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Consent Form

PLEASE TICK THE APPROPRIATE BOXES	Yes	No
A: GENERAL AGREEMENT – RESEARCH GOALS, PARTICPANT TASKS AND VOLUNTARY PARTICIPATION		
1. I have read and understood the study information dated [30/04/2024], or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.	☐	☐
2. I consent voluntarily to be a participant in this study. I understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.	☐	☐
3. I understand that taking part in the study involves: • Selecting a seat and position myself within a specific area with 11 other participants. • Mentioning and/or drawing in a paper (with the top view of the area) any items/elements that preferred at my sitting place. • Recording my basic information (age, gender and nationality). • Taking photos and voice recording during the process of user test.	☐	☐
4. I understand that I will be compensated for my participation by voucher of 10 euros, upon completion of the study.	☐	☐
5. I understand that the study will take 30 minutes.	☐	☐
B: POTENTIAL RISKS OF PARTICIPATING (INCLUDING DATA PROTECTION)		
6. I understand that taking part in the study involves no heightened risks.	☐	☐
7. I understand that the following steps will be taken to minimise the threat of a data breach, and protect my identity in the event of such a breach. Faces of the participants will be blurred/covered before being shared in any means. Photos will be stored within TU Delft cloud system.	☐	☐
8. I understand that taking part in the study also involves collecting specific personally identifiable information (PII) (age, gender, weight, height, nationality/ethnicity, photos, videos, and 3D map) and associated personally identifiable research data (PIRD) with the potential risk of my identity being revealed.	☐	☐
9. I understand that some of this PIRD is considered as sensitive data within GDPR legislation.	☐	☐
10. I understand that the following steps will be taken to minimise the threat of a data breach and protect my identity in the event of such a breach. The published data will be not traceable to each individual (e.g. anonymizing all data collected, blurring faces out of photos, anonymizing discussion quotes, statistically processing measured data, etc.) and the shared data will be done in a secure server.	☐	☐
11. I understand that personal information collected about me that can identify me, such as my name will not be shared beyond the study team.	☐	☐
C: RESEARCH PUBLICATION, DISSEMINATION AND APPLICATION		
12. I understand that after the research study the de-identified information I provide will be used for: • Taking design decisions • Contribute to concept development • Will be used in the report and presentation • Gathering insights for particular age groups in this domain	☐	☐

PLEASE TICK THE APPROPRIATE BOXES	Yes	No
13. I agree that my responses, views or other input can be quoted anonymously in research outputs	☐	☐
D: (LONGTERM) DATA STORAGE, ACCESS AND REUSE		
14. I give permission for the de-identified photos, transcription and layout results that I provide to be archived in TU Delft repository so it can be used for future research and learning.	☐	☐

SIGNATURES	
I have read the consent form and had the opportunity to ask questions. I confirm that I consent freely.	
Name of participant [printed] / Signature / Date	
I, as researcher, have accurately shown the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.	
Christos Batsaras (Researcher name [printed]) / Signature / 30/04/2024 (Date)	
Shabila Anjani (Researcher name [printed]) / Signature / 30/04/2024 (Date)	
Study contact details for further information: Chris Batsaras, +31649146945, c.batsaras@student.tudelft.nl	

Appendix:Ergonomics user test *(questionnaire)*

Please rate the level of comfort

No comfort — extreme comfort

0 1 2 3 4 5 6 7 8 9 10

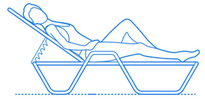
Please rate the level discomfort

no discomfort — extreme discomfort

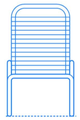
0 1 2 3 4 5 6 7 8 9 10

Please draw things that you would like to have with you (e.g. table)

(top view)

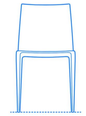


(Side view)



(Front view)

(Side view)



(Front view)

Why would you like to have these things with you?

(Reasoning list; please name at least 3 reasons)

1.
2.
3.
.
.
.

Please rate the level of comfort imagining having these things

No comfort — extreme comfort

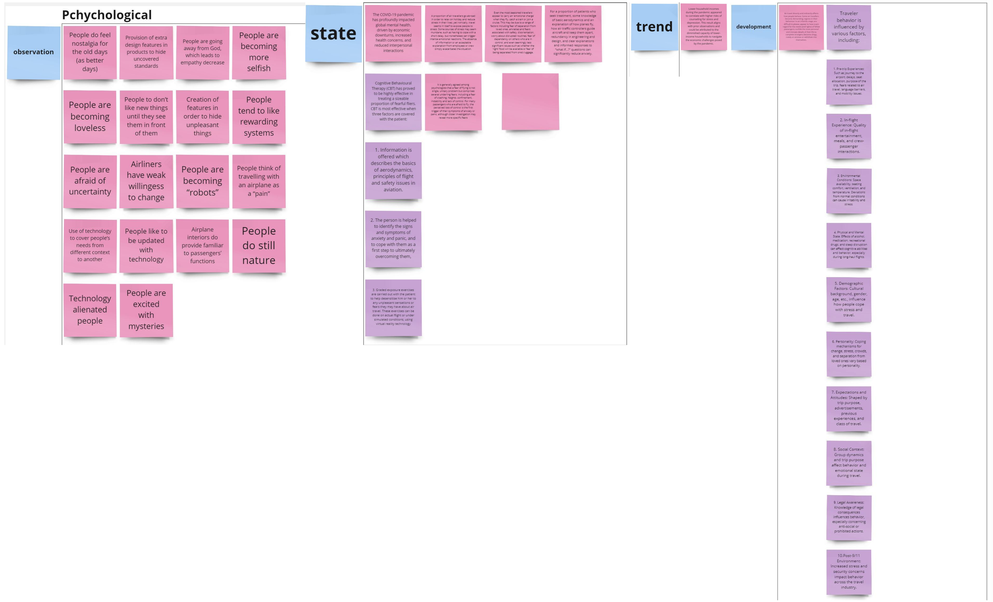
0 1 2 3 4 5 6 7 8 9 10

Please rate the level discomfort imagining having these things

no discomfort — extreme discomfort

0 1 2 3 4 5 6 7 8 9 10

Appendix:ViP Thematic analysis



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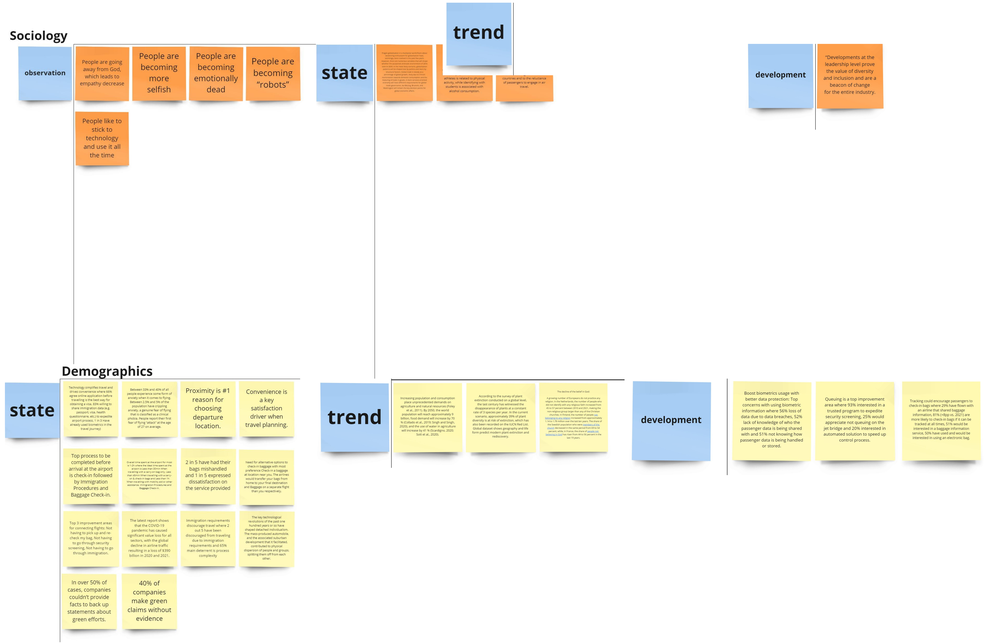
Appendix:ViP Thematic analysis



Appendix:ViP Thematic analysis

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Appendix:ViP Thematic analysis

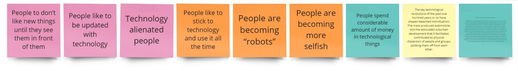
Appendix:ViP Thematic analysis (*clusters*)

Desired nostalgia

Revenue over respect

The decline of the belief in God

Backlash of technology to humanity



Nature still expresses humans

Dishonest designing

Uncertainty can be fear or excitement

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Appendix:ViP Thematic analysis (*clusters*)

World-airliners-passengers close relationship

Greenwashing is a thing

Appendix:ViP Thematic analysis (*references*)

Psychological

- People do feel nostalgia for the old days (as better days)
- Provision of extra design features in products to hide uncovered standards
- People are going away from God, which leads to empathy decrease
- People are becoming more selfish
- People are becoming loveless
- People to don't like new things until they see them in front of them
- Creation of features in order to hide unpleasant things
- People tend to like rewarding systems
- People are afraid of uncertainty
- Airliners have weak willingess to change
- People are becoming "robots"
- People think of travelling with an airplane as a "pain"
- Use of technology to cover people's needs from different context to another
- People like to be updated with technology
- Airplane interiors do provide familiar to passengers' functions
- People do still nature
- Airplane interiors do provide familiar to passengers' functions
- People do still nature
- Technology alienated people
- People are excited with mysteries
- The COVID-19 pandemic has profoundly impacted global mental health, driven by economic downturns, increased health concerns, and reduced interpersonal interactions
- (Cheong, C., Park, J., Shim, K., Kim, S., Kim, M. S., Fond, G., Boyer, L., Kim, T., Kim, T., & Yon, D. K. (2024). National trends in counseling for stress and depression and COVID-19 pandemic-related factors among adults, 2009-2022: a nationwide study in South Korea. Psychiatry Research, 115919. https://doi.org/10.1016/j.psychres.2024.115919)
- Lower household incomes during the pandemic appeared to correlate with higher risks of counseling for stress and depression. This result aligns with prior observations and could be attributed to the diminished capacity of lower-income households to navigate the economic challenges posed by the pandemic.
- (Cheong, C., Park, J., Shim, K., Kim, S., Kim, M. S., Fond, G., Boyer, L., Kim, T., Kim, T., & Yon, D. K. (2024). National trends in counseling for stress and depression and COVID-19 pandemic-related factors among adults, 2009-2022: a nationwide study in South Korea. Psychiatry Research, 115919. https://doi.org/10.1016/j.psychres.2024.115919)
- IATA released its recommended practice on Digitalization of Admissibility. This will enable travelers to digitally prove admissibility to an international destination, avoiding a stop at the checkin desk or boarding gate for document checks. Programs are already in use in various airports enabling travelers to move through such airport processes as boarding without producing paper documentation because their boarding pass is linked to a biometric identifier (https://www.iata.org/contentassets/c81222d96c9a4e0bb4ff6ced0126f0bb/annual-review-2023.pdf)
- A proportion of air travellers go abroad in order to relax on holiday and reduce stress in their lives, yet ironically, travel seems in itself to expose people to stress. Some sources of stress may seem mundane, such as having to cope with a short delay, but nonetheless can trigger intense emotional reactions. The absence of information or an acceptable explanation from employees or crew simply exacerbates the situation.
- (Bor, R. (2007). Psychological factors in airline passenger and crew behaviour: A clinical overview. Travel Medicine and Infectious Disease, 5(4), 207–216. https://doi.org/10.1016/j.tmaid.2007.03.003)
- Even the most seasoned travellers appear to carry an 'emotional charge' when they fly, catch a train or join a cruise. This may be due to a range of factors including fear of separation from loved ones, anxieties and fears associated with safety, disorientation, worry about disrupted routines, fear of dependency on others who are in control, and even seemingly less significant issues such as whether the 'right' food will be available or fear of being separated from one's luggage. (same as before)
- Air travel directly and indirectly affects how people behave. Some air travellers become demanding; regress in their behaviour to an infantile stage; are difficult to please; appear to have scant regard for the needs (and rights) of fellow passengers; confide the most personal and intimate details of their life to complete strangers; become clingy, rowdy or anxious or withdraw into themselves.
- (Bor, R. (2007). Psychological factors in airline passenger and crew behaviour: A clinical overview. Travel Medicine and Infectious Disease, 5(4), 207–216. https://doi.org/10.1016/j.tmaid.2007.03.003)
- Cognitive Behavioural Therapy (CBT) has proved to be highly effective in treating a sizeable proportion of fearful fliers. CBT is most effective when three factors are covered with the patient: 1. Information is offered which describes the basics of aerodynamics, principles of flight and safety issues in aviation. ARTICLE IN PRESS 210 R. Bor 2. The person is helped to identify the signs and symptoms of anxiety and panic, and to cope with them as a first step to ultimately overcoming them, and 3. Graded exposure exercises are carried out with the patient to help desensitise him or her to any unpleasant sensations or fears they may have about air travel. These exercises can be done on actual flight or under simulated conditions, using virtual reality technology.
- (Bor, R. (2007). Psychological factors in airline passenger and crew behaviour: A clinical overview. Travel Medicine and Infectious Disease, 5(4), 207–216. https://doi.org/10.1016/j.tmaid.2007.03.003)
- Traveler behavior is influenced by various factors, including:

1. Pre-trip Experiences: Such as journey to the airport, delays, seat allocation, purpose of the trip, fears related to air travel, language barriers, and mobility issues.
2. In-flight Experience: Quality of in-flight entertainment, meals, and crew-passenger interactions.
3. Environmental Conditions: Space availability, seating comfort, ventilation, and temperature. Deviations from normal conditions can cause irritability and stress.
4. Physical and Mental State: Effects of alcohol, medication, recreational drugs, and sleep disruption can affect cognitive abilities and behavior, especially during long-haul flights.
5. Demographic Factors: Cultural background, gender, age, etc., influence how people cope with stress and travel.
6. Personality: Coping mechanisms for change, stress, crowds, and separation from loved ones vary based on personality.
7. Expectations and Attitudes: Shaped by trip purpose, advertisements, previous experiences, and class of travel.
8. Social Context: Group dynamics and trip purpose affect behavior and emotional state during travel.
9. Legal Awareness: Knowledge of legal consequences influences behavior, especially concerning anti-social or prohibited actions.
10. Post-9/11 Environment: Increased stress and security concerns impact behavior across the travel industry.

- It is generally agreed among psychologists that a fear of flying is not single, unitary problem but comprises several underling fears, including a fear of crashing, heights, confinement, instability and lack of control.18 For many passengers who are afraid to fly, the perceived loss of control is the first trigger of their symptoms of anxiety or panic, although closer investigation may reveal more specific fears.
- (Bor, R. (2007). Psychological factors in airline passenger and crew behaviour: A clinical overview. Travel Medicine and Infectious Disease, 5(4), 207–216. https://doi.org/10.1016/j.tmaid.2007.03.003)

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Appendix:ViP Thematic analysis (*references*)

Sociology

- People are going away from God, which leads to empathy decrease
- People are becoming more selfish
- People are having quick life, full of anxiety and money-centered
- People are becoming "robots"
- People like to stick to technology and use it all the time
- Fragile globalisation in a multipolar world Fears about weakening enthusiasm for globalisation have, seemingly, been realised in the past few years. However, there are numerous variables that will shape whether the purported antitrade environment of 2016 lasts to 2035. In the most likely scenario, globalisation patterns will be shaped less by politics and more by structural factors. Global trade is steady as a percentage of global growth, likely due to China's reorientation towards domestic consumption and the maturing of trade in goods. A more services-oriented economy will have different requirements for global trade governance, but Beijing, Brussels, and Washington will remain the key decision points for global economic affairs. (https://www.europarl.europa.eu/RegData/etudes/STUD/2017/603263/EPRS_STU(2017)603263_EN.pdf)
- "Developments at the leadership level prove the value of diversity and inclusion and are a beacon of change for the entire industry. (https://www.iata.org/contentassets/c81222d96c9a4e0bb4ff6ced0126f0bb/annual-review-2023.pdf)
- Studies have shown that the degree of identification with certain groups is related to certain health-related behavior. For example, identification with athletes is related to physical activity (Berry et al., 2014), while identifying with students is associated with alcohol consumption (Rimal and Real, 2003).
- (Berry, T.R., Strachan, S.M., Verkooijen, K.T., 2014. The relationship between exercise schema and identity. Int. J. Sport Exerc. Psychol. 12 (1), 49–63. https://doi.org/10.1080/1612197X.2013.775742.)
- (Rimal, R.N., Real, K., 2003. Understanding the influence of perceived norms on behaviors. Commun. Theor. 13 (2), 184–203. https://doi.org/10.1093/ct/13.2.184.)
- Airplane transportation is one of the main sectors affected by the coronavirus outbreak due to the both the limitations imposed on international flights in different countries and to the reluctance of passengers to engage in air travel (Taylor, 2020)
- (Taylor, S., 2020. Air Transport 2035: Four Possible Post-COVID-19 Scenarios for Aviation [WWW Document]. APEX | Airline Passenger Experience. https://apex.aero/2020 /05/04/air-transport-2035-webinar-results. accessed 5.31.2020.)
- People becoming technological "robots"
- People do still like nature
- Biomimicry offers an empathetic, interconnected understanding of how life works and ultimately where we fit in. It is a practice that learns from and mimics the strategies used by species alive today.(state) (https://biomimicry.org/what-is-biomimicry/#:~:text=Biomimicry%20offers%20an%20empathetic%2C%20interconnected,used%20by%20species%20alive%20today.)
- Humans can adapt to climate change by reducing their vulnerability to its impacts.(principle) (https://www.climate.gov/teaching/literacy/gp-f-strategies-human-adaptation-climate-change#:~:text=Actions%20such%20as%20moving%20to,research%2C%20technology%2C%20and%20infrastructure.)
- People love to be in nature, and according to scientists, this is something that has been passed down for generations. Regardless of cultural differences, humans gravitate toward natural images, whether that's in photographs or the views outside our windows.(state) (https://www.lowa.co.uk/blogs/news/10-reasons-why-we-love-nature#:~:text=Satisfies%20Our%20Instincts,the%20views%20outside%20our%20windows.)
- . [9] E. Nic Lughadha, S.P. Bachman, T.C. Leao, " et al.,
- Addressing the global environmental problems facing our planet requires a significant shift in human behaviour. Personal experiences with nature are suggested to be a key driver of pro-environmental behaviour. https://pdf.sciencedirectassets.com/271811/1-s2.0-S0006320723X00123/1-s2.0-S0006320723005189/main.pdf?X-Amz-Security-Token=IQoJb3JpZ2luX2VjEOH%2F%2F%2F%2F%2F%2F%2F%2F%2FwEaCXVzLWVhc3QtMSJHMEUCIQCDu72iyXH8OtZKmh54ZyLNkhznBsjS9x%2BQZoYK0GpokgIgWArx1cXJLybl4IKhabtCDAtN%2BOFZm8PEumgG2yp2DQoqsgUIKhAFGgwwNTkwMDM1NDY4NjUiDKjQOiTi6sz%2B0XTL7yqPBRHWmXQJdbO7recwiYxUPVIcQXpLTV2soRekVX7t6UyTw5vVtJC1fZweazeVd8HhqcA%2F7cvygBW0sLKY1xCQ%2BaZMVfgL0hEFZJDfJbhJnUz5FE40Y0r5NtfKAMjNUekjnQ6bdHPvFXPfDLJwgiqj5ga9m%2Bdq605mVvmriiHRURXU0G%2B1PcO0sIa9nU74DSxaRvJQ649qbczl1VstuU6NG1dByHeuhuuSZxOH5vDQIzMWno8nvDcApz8NJ84oTHNavunao%2FT8sHIDCne6zpk%2FAkBE%2Bt%2BtN2QMqFu1heefr32KD7qXooPm7wgSqU2Q6fOCZRKRK%2FfTMqFySmwk1%2BrpiqhL%2Fk7MYJ8iayQ%2FcugHPVamDO5xYnGfCV0EnT0Wsaw17lkclw4bTTV6BX9AfPjz7wNbdVIEqZSeYFkE317PmS99lQIEjeUEYfIPSEkPMTa94uGSBNh5SGjUQ1KkHOQtkaUHrWrksV%2BiPCkdSSR2GLMpnEc%2BkuvKuXnch5XOY0VGYwNJcUvpzctJstNt80P8si%2BILkfgLSiCj44Mgk913f7YBjNpY6qpV%2FNR4IHKUmuPHjOEZco%2BoH2K65h4EppYagNEqUCXGGMhkHJ1vNmKx7en3bPau0z1QyHS4HoxqROe60ukxuDfH0%2BqqCXdUlc%2FTSV57Ysrx7rPdcgVSZTlv5KXpwKpTsbVY%2F9Sqk%2Bpb%2Ffy3e3Z4d9I9U7phPA68QCC9XNEzqVEozP5ChhvmecC2Psqq6zV8HH%2B52KMLLnhsQZbrAGXz8J2NddHwcuQtqc6gEjE5xcnEuCo8JELYdnUCc9Ci6NedLuRyNjDxDoEJjmuYJ3Rs6LGrH5gMu6JQYHgoOo0tS3%2BrgZaHclbowSv4w14aOsQY6sQEDnaQDp6AgQSe3DhIKTAvT957f4KrzP7lUZgJm6SOfD4%2F0neyQYeCvmodwTvQVWkHp03YLgEFgmzN7lQXccjU4b%2BEwfALB%2BskhyFs2pwwqX9clQwaZ1Ufn1j7ebmzinZgKJsuRZLewtGs617qoUN%2FVsBBF65xDDOdNRxSScNw7eQullCHBbOWdDKTPRb5QgoBNl%2B%2FX23Prey1fGt1gBTRIDLh6%2Tg4NQ3PzSlszWBo%3D&X-Amz-Algorithm=AWS4-HMAC-SHA256&X-Amz-Date=20240420T102458Z&X-Amz-SignedHeaders=host&X-Amz-Expires=300&X-Amz-Credential=ASIAQ3PHCVTY3CKID26B%2F20240420%2Fus-east-1%2Fs3%2Faws4_request&X-Amz-Signature=233ab4d3610d4ee4def001584a93321055ad1821089aa1ba0d72799fa9f13e75&hash=44d45e5f2906cac725bd68fcbb97f82ab965c7d424e495462a25b99ddb05315e&host=68042c943591013ac2b2430a89b270f6af2c76d8dfd086a07176afe7c76c2c61&pii=S0006320723005189&tid=spdf-cf8254c1-8ee7-4654-a91b-cc72590c1f4f&sid=ef4858782e87f74dce5b56a9012e4422e64dgxrqb&type=client&tsoh=d3d3LnNjaWVuY2VkaXJlY3QuY29t&ua=010957505656550755&rr=87746d7aec755c47&cc=nl

Appendix:ViP Thematic analysis (*references*)

direct experiences of nature are positively associated with a wide range of positive actions towards the natural environment, including recycling, energy conservation, green purchasing, and participating in conservation volunteering. (Personal experiences with nature are suggested to be a key driver of pro-environmental behaviour. https://pdf.sciencedirectassets.com/271811/1-s2.0-S0006320723X00123/1-s2.0-S0006320723005189/main.pdf?X-Amz-Security-Token=IQoJb3JpZ2luX2VjEGH%2F%2F%2F%2F%2F%2F%2F%2FwEaCXVzLWVhc3QtMSJHMEUCIQCDu72iyXH8OtZKmh54ZyLNkhznBsJS9x%2BQZrYK0GpzkgIgWArx1cXJLyIl4IKhabtCDAtN%2BOF2re8PEumgG2yp2DOoqsgUIKhAFGgwwNTkwMDM1NDY4NjUiDKjQOiTi6szX%2BOXTL7yqPBRHIWmXQJdbO7recwiYxUPVlcQXpLTV2soReKVX7t6UyTw5vVtJC1fZweazeVdBHhqcA%2F7cvygBW0sLKY1xCQ%2BaZMVfgL0hEFZJDfJbhJmJz5FE40Y0rtKAMjNUekjnQ6bdHPvFXPfDLJwgioj5ga9m%2Bdq605mVvmriiHRURXU0G%2B1PcO0sla9nU74DSxaRvJQ649qbcz1VstuLO6NG1dByHeuhuuSZxOH5vDQIzMWno8nvDcApz8NJB4oTHNavunao%2FT8sHIDCne6zpk%2FAkBE%2Bt%2BtN2QMqFu1heefr32KD7qXooPm7wgSqU2Q6fOCZRkRK%2FTMqFySmwk1%2BrpiqhL%2Fk7MYJBiayQ%2FcugHPVamDO5xYnGfCV0EnTOWsaw17IkcIw4bTTV6BX9AFPjz7wNbdVIEqZSeYFkE317PmS99IQiEjeUEYfPSEkPMTa94uGSBNh5SGjUQ1KkHOQtkaUHrWksV%2BiPCkdSSR2GLMpnEc%2BkuvKuXncn5XOYOVGYwNJcUvpzctJstNt80P8si%2BILkfgLSICjj44Mgk913f7YBjNpY6gpV%2FNR4HKUmuPHjOEZco%2BoH2K65h4EppYagNEqUCXGGMhKHJ1hNmKx7en3tPau0zTQyHS4HoxqROe60ukxuDfH0%2BggCXdUlc%2FTSV57Ysrx7rPdcgVSZTlv5KXpwKpTsbVY%2F9Sqk%2Bpb%2Fly3e3Z4d9I9U7phPA68QCC9XNEzqVEoz P5ChhvmecC2Psqq6zV8HI%2B52KMLLnhsQZbrAGXz8J2NddHwcuqDtqc6gEjE5xcnEuCo8JELYdnUCc9Ci6NedLuRyNjDxDoEJjmuYJ3Rs6LGrH5gMu6JQYHgoOo0tS3%2BrgZaHclbowSv4w14aOsQY6sQEDnaQDp8AgQSe3DhlKTAvT9S7l4Krp7IUZgJm6SOfD4%2F0neyQYeCvmodwTvQVWkHp03YLgEFgmzN7IQXccjJJ4b%2BEwfALB%2BskhyFs2pwwqX9clQwaZ1Ufn1j7ebmzinZgKJsuRZLewtGs6l7qoUN%2FVsBBF65xDDOdNRxSScNw7eQullCHBbOWdDKTPRb5QgobN%2B%2FX23Preyl1f0t1gBTRIDLh6%2Tg4NQ3PzSlszWBo%3D&X-Amz-Algorithm=AWS4-HMAC-SHA256&X-Amz-Date=20240420T102458Z&X-Amz-SignedHeaders=host&X-Amz-Expires=300&X-Amz-Credential=ASIAQ3PHCVTY3CKID26B%2F20240420%2Fus-east-1%2Fs3%2Faws4_request&X-Amz-Signature=233ab4d3610d4ee4def001584a93321055ad182108aa1ba0d72799fa9f13e75&hash=44d45e5f2906cac725bd68fcbb97f82ab965c7d424e495462a25b99ddb05315e&host=68042c943591013ac2b2430a89b270f6af2c76d8dfd086a0717 6afe7c76c2c61&pii=S0006320723005189&tid=spdf-cf8254c1-8ee7-4654-a91b-cc72590c1f4f&sid=ef4858782eb7f74dce5b56a9012e6422e64dgxrqb&type=client&tsoh=d3d3LnNjaWVuY2VkaXJlY3QuY29t&ua=0109575056565507 55&rr=87746d7aec755c47&cc=nl)

- , Tackling these problems will require more than just technological and governance approaches. It will necessitate widespread and significant changes in individual and household behaviour (Steg and Vlek, 2009; Kurisu, 2015; Whitmarsh et al., 2021). (Steg, L., Vlek, C., 2009. Encouraging pro-environmental behaviour: an integrative review and research agenda. J. Environ. Psychol. 29, 309–317.)
- Direct experiences of nature are thought to be one of the key predictors of pro-environmental behaviour (Soga and Gaston, 2016; Alcock et al., 2020; Martin et al., 2020; Molinario et al., 2020; Richardson et al., 2020; Soga and Gaston, 2022; Soga and Gaston, 2023a)(NA CHECK EDW GIA TA OLOKLHRA AYTAI (https://pdf.sciencedirectassets.com/313777/1-s2.0-S2452199X23002517/main.pdf?X-Amz-Security-Token=IQoJb3JpZ2luX2VjEOL%2F%2F%2F%2F%2F%2F%2F%2FwEaCXVzLWVhc3QtMSJGMEQCIEvlqGoxTxYo8VLhUvtvdf9gAWgvEs4bMo61kWznNiXmAiA3o24Lkct%2FYGNW8nQDWiaiWRYa6XBS4FDPY6fqQYFvTSqzBQgrEAUaDDA1OTAwMzU0Njg2NSIMI1nC6R1KaejV9pcMKpAFCdHBRgKSUbkVrTQyhnIkbVHsqkG4sNGoMeaaMad%2Beo7eS%2FjCRzA%2BqGw9fikn4LJNhDubzURdavdjZkXhq60BLxin0cI08YFigb0Q3theZQzi6Sxqp7AgRiCzJzVPnDVsR%2B3GeMhPCoQLh208I0PKeg5myc4NtU%2B8FmzdAimn7a51vohVrunCrHCeRYgGupbVw6tNRiaiodDl4z5ElxBzg3P7FYQGaz7srkLqla9RzRZd32n4Vl6IY2Bbhw9w7IsiIt3%2F%2BHwMM214vcRjEKBbc7frOwdsdFPqCA2ej%2BHqUByfshKwOud2FAoW6I7JUEhhnXFcyoYgirHMqi6BOPfSiy8e99aA1MHp9stmy6A5A3kIv

Demographics

- Increasing population and consumption place unprecedented demands on agriculture and natural resources (Foley et al., 2011). By 2050, the world population will reach approximately 9 billion, food demand will increase by 70 % (Collado et al., 2019; Singh and Singh, 2020), and the use of water in agriculture will increase by 41 % (Scardigno, 2020; Sott et al., 2020).
- Technology simplifies travel and drives convenience where 66% agree online application before travelling is the best way for obtaining a visa, 83% willing to share immigration data (e.g. passport, visa, health questionnaire, etc.) to expedite airport process, 1 in 3 Have already used biometrics in the travel journey)
- Boost biometrics usage with better data protection: Top concerns with using biometric information where 56% loss of data due to data breaches, 52% lack of knowledge of who the passenger data is being shared with and 51% not knowing how passenger data is being handled or stored. (https://www.iata.org/contentassets/baf7cb5eed64472aaac8906608085aff/global-passenger-survey-2022-media-briefing.pdf)
- Between 33% and 40% of all people experience some form of anxiety when it comes to flying. (https://www.stratosjets.com/blog/fear-of-flying-statistics-trends-facts/)Between 2.5% and 5% of the population have crippling anxiety, a genuine fear of flying that is classified as a clinical phobia.People report their first fear of flying "attack" at the age of 27 on average.
- Proximity is #1 reason for choosing departure location (https://www.iata.org/contentassets/baf7cb5eed64472aaac8906608085aff/global-passenger-survey-2022-media-briefing.pdf)
- Convenience is a key satisfaction driver when travel planning (same as before)
- Top process to be completed before arrival at the airport is check-in followed by Immigration Procedures and Baggage Check-in. (https://www.iata.org/contentassets/baf7cb5eed64472aaac8906608085aff/global-passenger-survey-2022-media-briefing.pdf)
- Overall time spent at the airport for most is 1-2h where the Ideal time spent at the airport is Less than 30min When travelling with a carry-on bag only, Less than 45min When travelling with a carry-on & check-in bags and Less than 1h When travelling with mobility aid or other assistance.
- Queuing is a top improvement area where 93% interested in a trusted program to expedite security screening, 25% would appreciate not queuing on the jet bridge and 20% interested in automated solution to speed up control process. (https://www.iata.org/contentassets/baf7cb5eed64472aaac8906608085aff/global-passenger-survey-2022-media-briefing.pdf)
- 2 in 5 have had their bags mishandled and 1 in 5 expressed dissatisfaction on the service provided
- (https://www.iata.org/contentassets/baf7cb5eed64472aaac8906608085aff/global-passenger-survey-2022-media-briefing.pdf)
- Tracking could encourage passengers to check-in bags where 29% have flown with an airline that shared baggage information, 81% (+8pp vs. 2021) are more likely to check-in bags if it can be tracked at all times, 51% would be interested in a baggage information service, 50% have used and would be interested in using an electronic bag. (https://www.iata.org/contentassets/baf7cb5eed64472aaac8906608085aff/global-passenger-survey-2022-media-briefing.pdf)
- Need for alternative options to check-in baggage with most preference Check-in a baggage at location near you, The airlines would transfer your bags from home to your final destination and Baggage on a separate flight than you respectively. (https://www.iata.org/contentassets/baf7cb5eed64472aaac8906608085aff/global-passenger-survey-2022-media-briefing.pdf)
- Top 3 improvement areas for connecting flights: Not having to pick up and re-check my bag, Not having to go through security screening, Not having to go through immigration. (https://www.iata.org/contentassets/baf7cb5eed64472aaac8906608085aff/global-passenger-survey-2022-media-briefing.pdf)
- According to the survey of plant extinction conducted on a global level, the last century has witnessed the disappearance of plants at a constant rate of 3 species per year. In the current scenario, approximately 39% of plant diversity is at risk of extinction, which has also been recorded on the IUCN Red List
- (A.M. Humphreys, R. Govaerts, S.Z. Ficinski, et al., Global dataset shows geography and life form predict modern plant extinction and rediscovery, Nat. Ecol. Evol. 3 (2019) 1043–1047, https://doi.org/10.1038/s41559-019-0906-2)
- The latest report shows that the COVID-19 pandemic has caused significant value loss for all sectors, with the global decline in airline traffic resulting in a loss of $390 billion in 2020 and 2021. (McKinsey value chain modeling for IATA) (https://www.iata.org/contentassets/baf7cb5eed64472aaac8906608085aff/global-passenger-survey-2022-media-briefing.pdf)

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Appendix:ViP Thematic analysis (*references*)

Economics

- Airliners provide their services aiming to maximize revenue by quantity (more passsengers)
- Airliners have weak willingness to change
- People spend considerable amount of money in technological things
- People do mind to spend that amount for the flight ticket most of the times
- Technology alienated people
- Industrial and technological revolution
- By 2035, technological advances will have a major impact on the social and economic foundations of society, potentially more far-reaching than the initial phase of computerisation from the 1980s onwards. Technologies involving automation and machine learning have the potential to disrupt job markets, making millions of jobs obsolete. As technologies like selfdriving cars begins to proliferate, governments at all levels will be faced with questions of adaptation, governance, and human development. Countries will be forced to consider how much of their core information infrastructure they will permit to be run by companies domiciled in other countries. Parties may be faced with a trade-off between protecting consumers' privacy and encouraging the growth of artificial intelligence firms that rely on large amount of data for training and improving algorithms. The question of when platform companies achieve monopolistic power will be a key issue brought before the court system in many countries. (https://www.europarl.europa.eu/RegData/etudes/STUD/2017/603263/EPRS_STU(2017)603263_EN.pdf)
- New arenas of state competition
- When projecting long-term trends in international affairs, it is important to consider the possibility that the major conflicts of 2035 will be centred on issues that barely register in the international arena today, or are secondary matters at best. Over the next two decades, these will likely include: the space market; new weapons systems like unmanned vehicles; policing rogue states; cyberwarfare and internet governance; and the Arctic Ocean. (same as before)
- Harness the power of artificial intelligence
- Automation and artificial intelligence will accentuate several economic and public policy trends over the next 20 years. While there is a tendency to emphasise employment displacement, there is also a positive impact, as new jobs are established in R&D, programming and technology-related services. Major policy challenges and potential solutions include: building a social consensus around the future of automation; encouraging the rapid adoption of relevant new technologies, particularly by small- and medium-sized companies, which are at a disadvantage in any field that requires access to large amounts of data; re-assessing the development models for poorer countries; and considering income assistance programmes for those whose jobs have been eliminated by technological change.
- Industry cost pressures remain high
- Following Russia's invasion of Ukraine in February 2022, the crude oil price exceeded $120 per barrel for the first time in a decade. Air travel demand continued to recover over the same period, which increased demand for jet fuel while refinery capacity remained limited. (: IATA S&E Economics, using data from S&P Global, Macrobond)
- Due to increased capacity and lower demand, cargo load factors dropped back to their pre-COVID range (: IATA S&E Economics, using data from IATA CargoIS)
- Airlines experienced a significant increase in their costs in 2022. A primary contributing factor is the war in Ukraine, which has led to a sharp rise in global commodity prices. ()IATA S&E Economics, using data from S&P Global, Refinitiv Eikon, IEA
- (https://www.europarl.europa.eu/RegData/etudes/STUD/2017/603263/EPRS_STU(2017)603263_EN.pdf)
- Amsterdam Schiphol Airport: The airport intends to increase its charges 37% over three years beginning in 2022. Considering the poor performance of the airport in 2022, the 12% increase scheduled for that year deserves careful scrutiny. (https://www.iata.org/contentassets/c81222d96c9a4e0bb4ff6ced0126f0bb/annual-review-2023.pdf)

Politics

- People are moving away from God
- People are having quick life, full of anxiety and money-centered.
- People become "robotized"
- Companies do things sustainability related
- Green washing is a strategy from companies and governments to increase revenue
- Changing power in the international system In many ways, the power balance in the international system in 2017 looks broadly similar to the world in 2000. Yet in some fundamental ways, the world has changed considerably. The wars in Iraq and Afghanistan have left its participants wary of foreign intervention. China has expanded its global presence. Russia has demonstrated a willingness to intervene in neighbouring countries and attack democracies with information 'wars'. And the impact of the 2007-08 financial crisis has hit many nations' capabilities to fund military increases.
- There are some broad trends that are likely to continue through 2035: the United States will remain the largest military power; China and regional leaders will see their power grow; Russia will focus on areas of asymmetric advantage to counteract its declining population; and the creation of a unified European military structure with significant expeditionary power will be one of the biggest wild cards in the international system. (https://www.europarl.europa.eu/RegData/etudes/STUD/2017/603263/EPRS_STU(2017)603263_EN.pdf)

Appendix:ViP Thematic analysis (*references*)

- Strengthen cybersecurity Cyber attacks will present major challenges for EU countries over the next 20 years, in large part due to their unpredictable nature. For example, most cybersecurity experts failed to foresee the apparent Russian attempts to influence the outcomes of the US election by manipulating online information and hacking key participants' email accounts. Nonetheless, certain specific challenges appear very likely over the next 20 years, such as attempts by Global Trends to 2035 11 foreign intelligence services or related groups to influence European elections; data localisation regulations, as EU citizens' pressure may mount to stop non-EU intelligence agencies or criminal groups from accessing their online data; and the development of a cyberwarfare doctrine. (https://www.europarl.europa.eu/RegData/etudes/STUD/2017/603263/EPRS_STU(2017)603263_EN.pdf)
- "Lack of transparency remains an issue with increases in charges often decided without the required user consultation process." (https://www.iata.org/contentassets/c81222d96c9a4e0bb4ff6ced0126f0bb/annual-review-2023.pdf)
- The new standards have been developed to protect passengers' data and ensure that travel remains accessible to all. (https://www.iata.org/contentassets/c81222d96c9a4e0bb4ff6ced0126f0bb/annual-review-2023.pdf)
- Immigration requirements discourage travel where 2 out 5 have been discouraged from traveling due to immigration requirements and 65% main deterrent is process complexity (https://www.iata.org/contentassets/baf7cb5eed64472aaac8906608085aff/global-passenger-survey-2022-media-briefing.pdf)

Appendix:Interview Thematic analysis

Participant	Sketch	Context	Activities(s)	Thing thats mostly remember	Tool	Feeling about traveling to that place	Feeling that describes that day	Sense(s) most activated (max 3)	Have you ever flown? If yes, have ever had a short flight? (around 1.5 hours)	Do you travel with an airplane for holidays of work most of the times?	Extra insights
1		beach	walking talking smoking	jokes with friends			relaxation	smell taste	Yes	Holidays	whole day experience, starts with sunset, very relaxed changing of places need to see outside the airplane 12 things that a person needs to be happy
2		beach	jumping (in the water) chilling laughing	The view			satisfaction	vision touch	Yes	50-50 Holidays-Work	I always need company
3		beach	hiking snorkeling laying	the landscape		not really focusing on the travel	experience	vision touch	Yes	Holidays	focusing on the purpose of the trip
4		forest	walking talking driving	the heat			excitement	smell vision	Yes	Holidays	the sun also plays a big role; Because if you look around, you see a higher stuff. I like places that are still very much untouched
5		mountain	walking talking reflecting	realization that we are away from nature			satisfaction it has the feeling of friday	vision hearing smell	Yes	Holidays	There is the air, the sun, the nature, the clean, the

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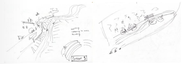
Appendix:Interview Thematic analysis

6		mountain	drinking breathing sharing	people that are nature hanging out together		satisfaction	touch vision hearing	Yes	Holidays
7		beach	sleeping eating touching	food as a reward		complicated satisfaction	smell touch vision	Yes	Holidays
8		mountain	cooking talking watching	the sunset because it was very calm		need for more comfort but nice due to a different experience relaxation	hearing vision	Yes	Holidays
9		mountain	walking listening to music thinking	the natural view		experience started during to way to get there relaxation	vision	Yes	Work
10		beach	sunbathing swimming drinking	The blue of the ocean because it relaxes you		Calm,it's a happy travel relaxation	touch vision smell	Yes	Holidays

Appendix:Ergonomics user test Thematic analysis

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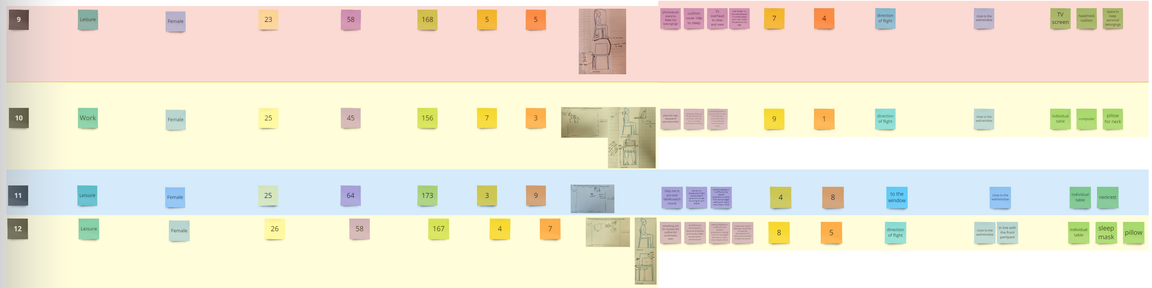
Appendix:Ergonomics user test Thematic analysis



Appendix:Graduation brief

DESIGN FOR Our future

TU Delft

Personal Project Brief – IDE Master Graduation Project

Name student Christos Batsaras **Student number** 5,834,392

PROJECT TITLE, INTRODUCTION, PROBLEM DEFINITION and ASSIGNMENT
Complete all fields, keep information clear, specific and concise

Project title

Design an interior of an electric aircraft that will launch in 2033 and is suitable for 1000 kilometer range of flight.

Please state the title of your graduation project (above). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

Introduction

Describe the context of your project here; What is the domain in which your project takes place? Who are the main stakeholders and what interests are at stake? Describe the opportunities (and limitations) in this domain to better serve the stakeholder interests. (max 250 words)

Mobility is undergoing a profound shift worldwide. Air travel has put Europe at our fingertips and has become one of our favourite ways to travel around Europe. From a sustainability perspective, there is a huge demand for more sustainable mobility. Elysian is developing a zero-emission airplane. Elysian Aircraft has achieved a significant advancement in battery-electric aviation with the unveiling of the E9X. This aircraft, designed for regional routes, showcases the potential of battery-electric aviation as a scalable and economically viable option compared to traditional aviation, setting the stage for a zero-emission future of the industry.
However, the interior of this airplane is not developed yet. Starting with a "blank canvas", the opportunities to come up with a different interior design than the existing ones are endless, when the only limitation is to fit 90 passengers. Elysian's vision is to have as big as possible share of the market in its segment which means that passengers should be attracted in selecting what they offer among others, but their comfort has major importance as well. Moreover, being lightweight is another priority because it helps reducing the battery capacity needed while flying. In this project a new interior will be designed. The fact that there is not a designed interior yet creates the opportunity for innovation and change what travelling with an aircraft means for the passengers.
The focus of the project is on the aircraft interior layout of the passenger's cabin and not at airfield and booking. It is important to have a quick boarding and deboarding and at the same time a 'wow' effect, while boarding and while seated. Partly, this can be done based on what is researched before, but on the other hand there is also a need for completely new ideas. The ideas should also be presented in an attractive and convincing visual way.

space available for images / figures on next page

introduction (continued): space for images

image / figure 1

image / figure 2

DESIGN FOR Our future

TU Delft

Personal Project Brief – IDE Master Graduation Project

Problem Definition

What problem do you want to solve in the context described in the introduction, and within the available time frame of 100 working days? (= Master Graduation Project of 30 EC). What opportunities do you see to create added value for the described stakeholders? Substantiate your choice.
(max 200 words)

In order to attract passengers to a more sustainable way of flying (zero-emission), the aircraft interior should look and feel attractive and comfortable. On the other hand, it is important to make it economically feasible for fitting 90 passengers and it should be lightweight. This is a challenging assignment, but the goal is to set a step in the right direction. Therefore, the end result should be an 'unconned' concept (layout) of the overall interior from the passengers' perspective, but the way of achieving it should give a good impression of what it is about. Parts of the concept will be tested by passengers. Dimensions of the fuselage are given from the client in order to have reference of the available space. These dimensions could slightly change if justified.

Assignment

This is the most important part of the project brief because it will give a clear direction of what you are heading for. Formulate an assignment to yourself regarding what you expect to deliver as result at the end of your project. (1 sentence) As you graduate as an industrial design engineer, your assignment will start with a verb (Design/Investigate/Validate/Create), and you may use the green text format:

Create a concept to enhance the experience for the passengers travelling with an airplane.

Then explain your project approach to carrying out your graduation project and what research and design methods you plan to use to generate your design solution (max 150 words)

The general method that will be used is VIP (Vision in Product Design). Through comprehensive research encompassing aircraft interiors and upcoming developments, I aim to examine the passenger experience and identify potential opportunities for interior and layout enhancements (deconstruction phase). Then, I will introduce the new context as well as new interactions of the users at the aircraft interior (construction phase) and create my Vision. This will be followed by conceptualization phase. The outcome of this will be X number of concepts which I will visualize (sketches and/or 3D representation) and after evaluation, I will conclude into one and develop it further.

Master Thesis | Christos Batsaras

Appendix:Graduation brief

Project planning and key moments

To make visible how you plan to spend your time, you must make a planning for the full project. You are advised to use a Gantt chart format to show the different phases of your project, deliverables you have in mind, meetings and in-between deadlines. Keep in mind that all activities should fit within the given run time of 100 working days. Your planning should include a ***kick-off meeting****,* ***mid-term evaluation meeting****,* ***green light meeting*** *and* ***graduation ceremony****. Please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any (for instance because of holidays or parallel course activities).*

Make sure to attach the full plan to this project brief.
The four key moment dates must be filled in below

Kick off meeting	2 Apr 2024
Mid-term evaluation	7 May 2024
Green light meeting	24 Jun 2024
Graduation ceremony	1 Aug 2024

In exceptional cases (part of) the Graduation Project may need to be scheduled part-time. Indicate here if such applies to your project

Part of project scheduled part-time	
For how many project weeks	20
Number of project days per week	5,0

Comments:

Motivation and personal ambitions

Explain why you wish to start this project, what competencies you want to prove or develop (e.g. competencies acquired in your MSc programme, electives, extra-curricular activities or other).

Optionally, describe whether you have some personal learning ambitions which you explicitly want to address in this project, on top of the learning objectives of the Graduation Project itself. You might think of e.g. acquiring in depth knowledge on a specific subject, broadening your competencies or experimenting with a specific tool or methodology. Personal learning ambitions are limited to a maximum number of five.
(200 words max)

My background in Civil Engineering except of deep knowledge in statics also gave me knowledge in interior layouts of buildings, where I learnt how to create different compositions that would cover people's needs. This project is a very interesting challenge to gain in depth knowledge into this sector. In addition to this, during my part time internship along my studies (84 glasses for visually impaired people), I worked in the field of aesthetics in combination with product experience and embodiment as these sectors are immediatelety influencing each other and I would really like to challenge myself to do something like this in a completely different product. Also, I would like to learn how to develop high quality digital prototypes (3D representation in Unreal Engine 5) where my experience and skills are not the desired.
As learning ambitions, I would like to learn more in the Conceptualization phase of a product, where using VIP method would be very useful. Moreover, to learn how to analyze form and elements from a different product in order to understand the reasoning behind them (why they were chosen to be in this way) and also to learn how to incorporate those elements into my concepts (how to adapt them to give the same value to the user).

teamgantt
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