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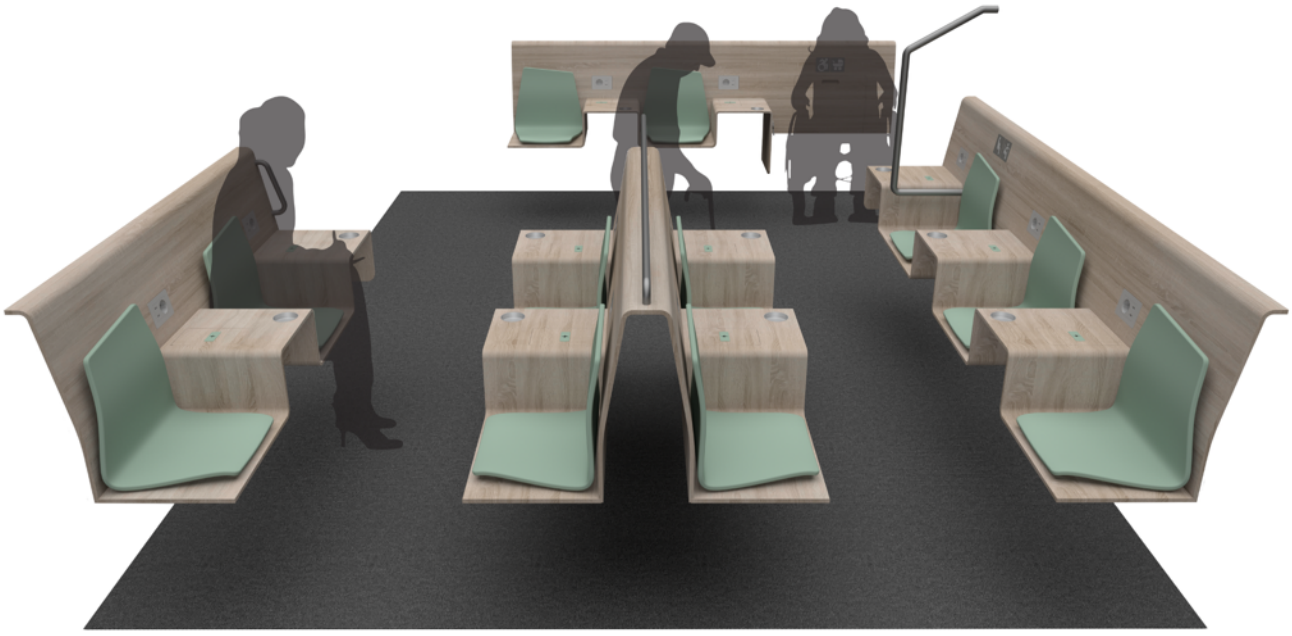

Interior Design of Sky Transportation Modules

Development of an Accessible Seating Environment for Passenger Transportation between Uppsala and Arlanda Airport

Master of Science Thesis in the Master Degree Program, Industrial Design Engineering

IDA EVERVALL

MIKAEL WIBERG

CHALMERS UNIVERSITY OF TECHNOLOGY
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Cover Photo: Rendering of the Seating Environment for Passenger Transportation between Uppsala and Arlanda Airport

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ABSTRACT

The General Transportation System (GTS) Foundation has a vision of creating an environmentally- and economically sustainable transportation system. The GTS Foundation is currently in the planning stage of a more developed “Rapid Transportation System” (RTS) that consists of cabins suspended under driving sleds that are elevated above ground. These cabins further have electro-dynamically propulsion and by means of employing many different cabin types, the GTS system can be adapted after many different passenger needs. The GTS project has so far focused mainly on the technical development with respect to current infrastructure. Therefore the end use, that is how future users would want to interact with the GTS system, has not yet been thoroughly investigated.

This master thesis was set up in order to showcase the benefits and the adaptability of the GTS-system in contrast to existing modes of transport. The project was carried out by means of designing two interior seating environments of GTS cabins, one for a primary and another for a secondary target group. The primary group consisted of travellers between Arlanda Airport and Uppsala, as this is the first intended GTS route. Moreover, the main goal of this thesis was to generate a pleasant and accessible travel experience for the primary target group. The secondary target group was chosen in contrast to the primary group, and consisted of weekly commuters with a current travel time of approximately three hours.

Seeing that the GTS system is nonexistent, the needs and requirements, as well as the experienced problems of passengers in currently available transportation systems, were firstly investigated. This investigation was carried out by means of conducting a survey, interviews on board of the flight buses between Gothenburg and Landvetter Airport as well as a dialogue. Moreover, to better anticipate some of the needs on the interiors of GTS cabins, the more explorative method “staging”, was used. In addition, the authors went abroad to the Netherlands and Germany in order to investigate existing transportation systems, some of which were suspended. The findings of the user studies resulted in many requirements on the interiors, as well as in several desired product expressions. These product expressions enabled the formulation of the visual design philosophy below:

“The design should aim to be modern, spacious, light and clean in its expression. The overall experience should evoke a sense of tranquility and safety for the users and at the same time provide an adequate degree of comfort as well as a certain level of novelty in relation to existing means of airport transportation.”

The project was largely focused on the investigation of user needs as well as on the design of the seating environments for the primary target group. Even though it was highly challenging to design a layout and interior adapted after the needs of different user groups, the main goal of creating a pleasant travel experience for passengers between Uppsala and Arlanda was achieved by means of including the researched product expressions as well as considering many user needs in the final design.

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NOMENCLATURE

Flygbussarna - The airport buses between Gothenburg and Landvetter Airport
GTS - General Transportation System
GRT - Group Rapid Transportation
Maglev - Magnetic Levitation
Platooning - Interlinking of two or more vehicles
PP - Polypropylene
PRT - Personal Rapid Transportation
RTS - Rapid Transportation System
Suspended - Elevated above ground

1. INTRODUCTION

This chapter will explain the project background, including for example a brief introduction to GTS and the goals of this thesis.

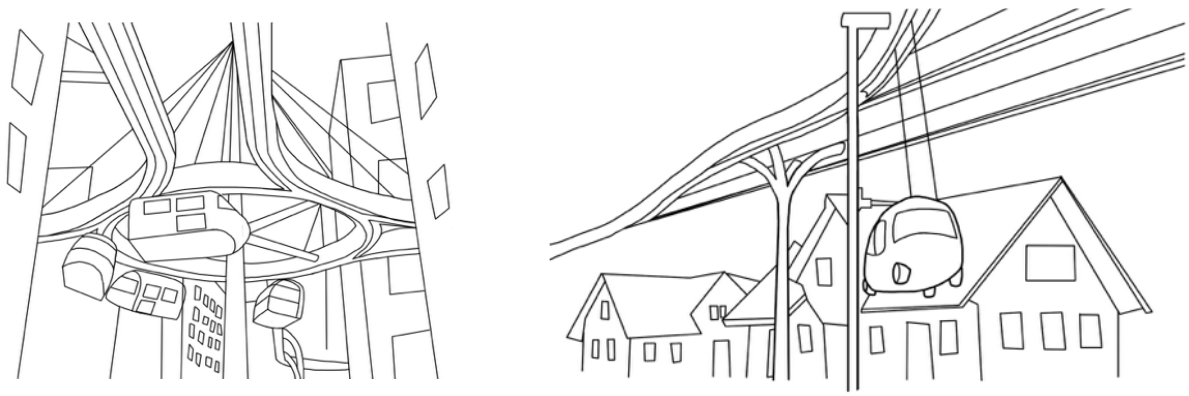
1.1 Background

Transportation systems of today are limited by existing infrastructure in form of roads or railroads and the friction that is created when tires or wheels of vehicles come in contact with these different surfaces. Although measures are being taken towards the transformation to electrical vehicles, the transport sector is still dominated by the use of inefficient combustion engines utilising fossil fuels. The automotive industry has come to develop lock-ins that limits today's transportation systems to solutions that are weak with regards to aspects such as sustainability, safety, functionality and accessibility. Today's high energy driven transportation systems not only have large negative impacts on the climate, but also result in health-related issues and more and more excessive use of land area. As the world's population grows, so does also the number of roads needed to provide sufficient mobility and accessibility for all people. It is therefore relevant to investigate new transportation systems that are not limited by the lock-ins of current systems, in order to design entirely new, sustainable means of transportation for the future.

The General Transport System (GTS) Foundation is in the planning stage of a "Rapid Transportation System" (RTS)[1]. This RTS consist of infrastructure in form of cabins that are suspended under driving sleds that are elevated from the ground (see figure below). These particular cabins further have electromagnetic propulsion. Moreover, some of the GTS cabins can be lowered to the ground and thereby be transformed into "conventional cars" in order for passengers to reach their final destinations on current road infrastructure. Currently the GTS Foundation has applied for financial contribution from EU for an initial research of the electromagnetic drive- and propulsion system, and from Vinnova for an initial network analysis in the Arlanda international airport surrounding region north of Stockholm city.

The GTS project has so far focused mainly on the technical development with respect to current infrastructure[1]. Therefore the end use, that is how future users would want to interact with the GTS system, has not yet been thoroughly investigated. Today, the GTS project is driven collaboratively by several organisations in the nordic countries, each focusing on specific parts of the project. The overall project is however coordinated by the GTS Foundation, that is located in Uppsala.

Yovinn is a design consultancy company that is part of Vinn Group, a network organisation consisting of seventeen subsidiaries with different focuses, within everything from aerodynamics to advertisement. In the GTS project Yovinn has taken on the challenge to work with the end users and is for example responsible for the interior and exterior design of the cabins, the terminals and the stations.



▲ *Figure 1: Illustration of GTS as a system.*

[1] Dahlström, Kjell, Co-founder of the GTS Foundation, Personal communication, 2016, February 15th.

1.2 Purpose

This project was a subproject of the overall projection of the GTS system that intended to showcase the benefits and the adaptability of the GTS-system in contrast to existing modes of transport. The project was carried out by means of designing two interior seating environments of GTS-cabins. The aim of these two interior design concepts was to illustrate the flexibility of the cabins' interior designs by visualising that the interior could be adapted to many different traveling times and associated user needs. This subproject was further carried out in collaboration with Yovinn.

1.3 Goal

By taking into account aspects such as infrastructure and dimensions given by the GTS Foundation, the goal was to develop two interior seating environments of GTS cabins based on the needs of a primary and secondary target group. The primary group consisted of travellers between Arlanda Airport and Uppsala. For convenience purposes when conducting user studies, travellers with equivalent needs in western Sweden were seen as substitutes for travellers between Arlanda and Uppsala. The secondary target group was chosen in contrast to the primary group, and consisted of weekly commuters with a current travel time of approximately three hours. Furthermore, the goal of the project was also to design the cabins from the "inside-out", instead of beginning with the exterior, in order to maximise functionality. The posed research questions are presented below.

• *How can the interior seating environment of a GTS cabin be designed in order to create a pleasant travel experience for future GTS passengers between Uppsala and Arlanda Airport?*

• *What are the current user related problems and limitations of today's transportation systems?*

• *What do users in the primary and secondary target group want to spend their travel time on?*

1.4 Delimitations and Limitations

Seeing that the first projected GTS route is intended to be projected between Uppsala and Arlanda, the project primarily focused on this route and its potential travellers. However, the project revolved both around the primary and secondary target groups to visualise how the GTS-system could be used in different ways. To enable the development of both the two seating environments, the design for the secondary target group was mainly based on the intuition of the authors, rather than on in-depth studies, this due to the set time frame. Therefore visualisations and materialisations of the secondary seating environment was not given equal attention as the primary environment.

Due to the fact that GTS is a non-existent system the user studies mainly investigated problems and needs in currently available transportations systems. However, some more explorative methods were used to investigate the needs for this non-existent system as well. The selection of participants for user studies of the primary and secondary target group were done mainly with regards to travel time. Furthermore, the project primarily focused on aesthetics, and on the user experience of the designed interiors. Therefore the exterior design was not considered more than to the extent of deciding on a suitable interior space. The dimensions that constituted this space were partly given by the GTS Foundation together with other technical limitations. In addition, the developed concepts were not concerned with interaction design, that is for example how users could begin or control travel routes.

Moreover, mainly visible surfaces were modelled and design elements used in the first concept (for the primary target group) were reused in the second concept. Seeing that the concepts were not intended to work as production data, sustainability considerations were mainly on a conceptual level and more related to the benefits of the system as a whole. However, the project did neither take into consideration the design of the system as a whole, nor did it consider required policy changes. Finally, the possible transformation

of GTS-cabins between sky and road transportation was disregarded in this project.

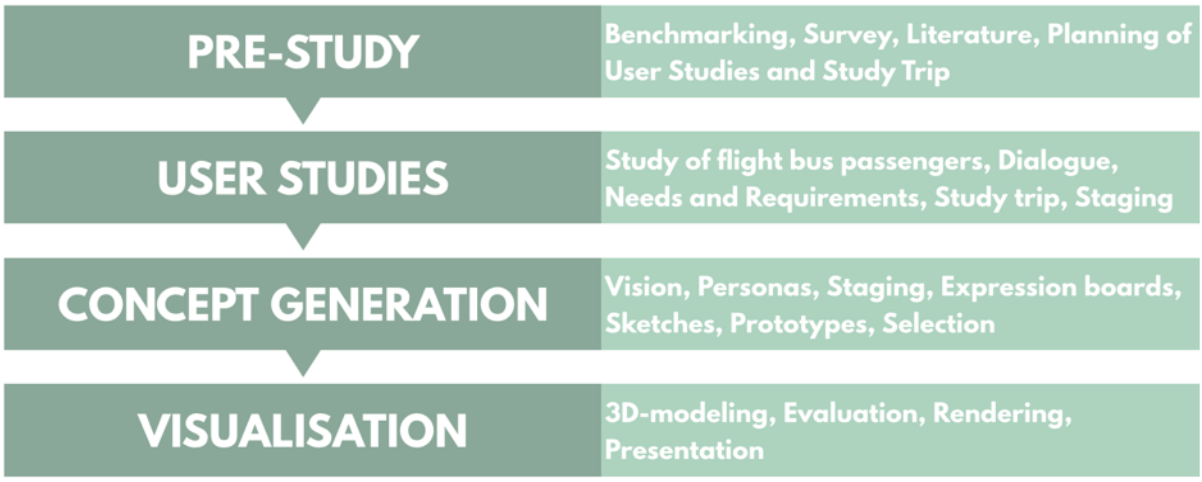
1.5 Deliverables

In the end of the project Yovinn and GTS Foundation were provided mainly with an interior design concept for the primary target group. This concept was nevertheless complemented by a non-detailed concept for the secondary target group that illustrated the adaptability of GTS. These concepts were supported by an analysis of the needs and desires of the primary and secondary target groups. Moreover, visual benchmarking and conclusions on interiors of competing RTS-systems and other current transportation systems also assisted the design work.

1.6 Time Plan

The figure below illustrates the employed project process, showing the work breakdown structure in brief. To control the progress and to ensure that goals were achieved in time, each of the stages were followed by gates. These gates represented part presentations that were presented to supervisors both at Chalmers and Yovinn.

To illustrate the relationship between activities and time and to get a clear overview over the scheduled time a Gantt chart is an effective tool. (Maylor, 2010). For this reason, a Gantt chart was generated for this project. For time specification, please refer to Appendix 1.



▲ *Figure 2: The employed project process.*

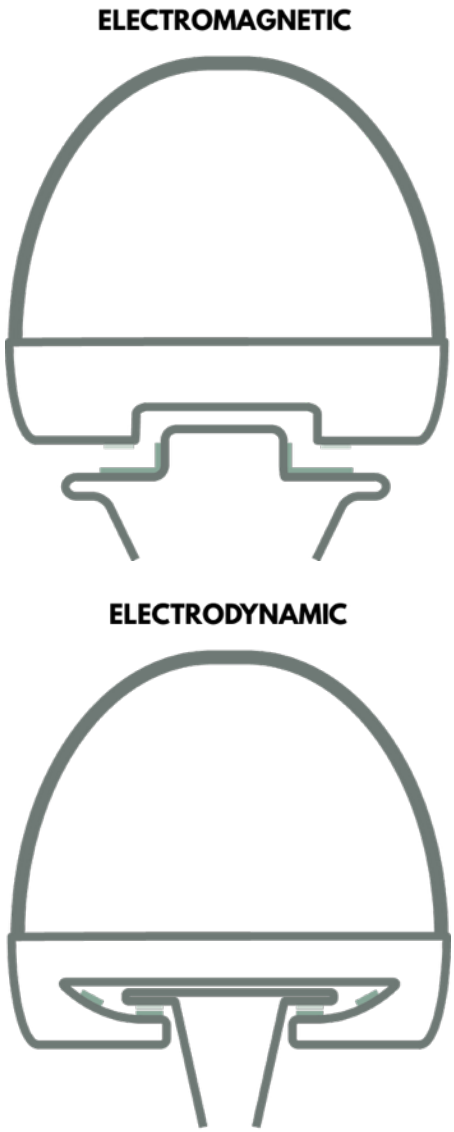
2. INTRODUCTION TO GTS

The aim of GTS as a system is to get past the problems caused by current transportation systems (GTS Foundation, 2010). Apart from evident issues of some modes of transports, such as cars' excessive use of fossil fuels, transport alternatives that can be seen as competitors to GTS, such as Maglev (Magnetic levitation) trains, exhibit problems as well. Maglev trains are for example grounded on concrete track solutions, rendering the alternation between two tracks impossible, whereas mechanical systems that utilises wheels result in vibrations, frictions and noise. The GTS Foundation has a vision of making a, new better transportation system, utilising electrodynamic propulsion (as seen in the comparative illustration in figure 3). Seeing that GTS is a novel system, the following description aims to elaborate on how the GTS is anticipated to be used as well as to provide background information on the first intended GTS route for projection between Uppsala and Arlanda Airport.

Detailed Description of GTS as a System

The GTS system is intended to be fully autonomous[2]. The system will consist of beams and pillars, that will be constructed on the ground to carry cabins that will be suspended approximately three meters above ground. This type of construction could result in reduced use of land area in comparison with existing transportation systems. The construction of the GTS infrastructure will not divide land into two separate areas and it will therefore be possible to make use of the space underneath the built infrastructure. Moreover, the construction of the infrastructure allow the use of land areas that are unfit for the construction of today's transportation infrastructure. The GTS infrastructure can for example be constructed on marshes or in the center field of already existing highways.

The GTS cabins will have capacity for velocities of up to 240 km/h (GTS Foundation, 2010), allowing passengers to travel between Arlanda and Uppsala in 10 minutes, compared to today's 20 minutes. In regional networks the cabins will have velocities of up to 120 km/h and in local tracks, 60 km/h. Platooning (interlinking of two or more vehicles) of GTS cabins will be enabled, which will lower the total energy consumption due to reduction of air resistance. Platooning will further occur during operation of the cabins. Moreover, the process of evacuation of passengers in GTS cabins is not entirely determined at the time of writing. However, there are several ideas on how evacuation could work. For example, the GTS cabins could be automatically relocated to nearby elevated platforms, or lowered to the ground, in the case that emergency situations would occur.



▲ *Figure 3: An illustration of two magnetic levitation principles.*

[2] Dahlström, Kjell, Co-founder of the GTS Foundation, Personal communication, 2016, February 15th.

▲ *Figure 4: An illustration of platooning.*

It will be possible to order cabins that will be available at any of the many stations in a future infrastructural GTS network[3]. The stations will be evenly distributed and the system will enable passengers to travel directly to the desired end stations. The advantage of this is that both waiting times and the need for changing between connecting vehicles will be reduced. Moreover, this type of system could even out the distribution and physical locations of passengers that are present in the transportation system at any given time. This mean that the pressure on today's hubs, such as the central stations of Gothenburg, could be significantly reduced. For more remote locations, the GTS Foundation suggests that cabins could be lowered onto the ground and be transformed into autonomous vehicles, and thus drive passengers all the way to their homes. GTS as a system can therefore be regarded as a means of door-to-door communication.

The cabins will be modularly designed and the GTS Foundation suggest that there will be many different kinds of cabin interiors, all of which are designed for different needs[3]. If for example a family wants go on a skiing holiday it will be possible for it to order a cabin that has sufficient space for luggage and skiing equipment as well as a toilet/shower, beds and entertainment. Furthermore, due to the system being autonomous it will be smart and efficient. For example, if a larger GTS infrastructure is established, potential ambulance cabins could be given priority to other cabins, that will automatically make room for rapid overtaking.

The GTS Foundation aims to create a system that is both available and efficient. Today's cars are parked 95% of the time (Thompson, 2016). If, instead of having to own cars in the future, individuals could meet their traveling needs solely by use of GTS. By establishing a GTS infrastructure instead of expanding road infrastructure, excessive use of land area could be immensely reduced.

A cabin has a length of four meters and a width of three meters[3]. For shorter journeys, 12 individuals are anticipated to make use of the available floor surface at the same time. The cabins will further have a maximum weight of approximately 2500 kg, this in order to enable supportability of its intended suspended construction. The cabin for the primary target group was requested by the GTS Foundation to be designed for all, meaning for example that it should be accessible for a wheelchair, a parent with a pram and an individual with visual disabilities.

The Stockholm-Uppsala link is one of the most important interregional, infrastructural link in Sweden with its distance of more than 50 km[3]. This link is used for approximately 18 million trips every year. Other important links in Sweden are for instance the link between Gothenburg and Borås and between Malmö/ Lund and Helsingborg. Each of these links accumulate approximately 10 million trips every year. Today there is a quadruple railway track from Upplands Väsby, that is further divided into two pairs of double railways prior to Märsta and Arlanda. The Swedish Chamber of Commerce and Uppsala Municipality together with its residents currently want the Swedish Transport Administration, that is Trafikverket, to build a quadruple railway track between Arlanda/Märsta and Uppsala. In conclusion, there is a pressing need for this particular route, why GTS Foundation has chosen this as the most appropriate first GTS projection.

[3] Dahlström, Kjell, Co-founder of the GTS Foundation, Personal communication, 2016, February 15th.

3. KNOWLEDGE BASE

This chapter will cover the theoretical framework that was utilised in this project, including design theory, research on public transportation as well as a brief macro-environmental analysis.

3.1 Design Theory

The next sections will address ergonomics in general and the philosophy *Design for All*, in particular. Moreover, the proceeding sections will for also cover gestalt psychology and the area *Design for Experience*.

3.1.1 Ergonomics

Ergonomics is a subject related to the understanding of the human body in interaction with products or systems, in relation to different populations. The aim of ergonomics as a discipline is to optimise human well-being. The subject is further divided into three different areas; physical-cognitive and organizational ergonomics.

Anthropometry

Anthropometry is a scientific discipline under the area of physical ergonomics that aims to collect measurements of the human body from different global populations. These measurements consider the sizes, shapes, strengths and work capacities of individuals of different populations. Anthropometric measurements are useful in design processes as a way of ensuring that the developed products are adapted to the different physical needs of different populations. There are two types of anthropometric measurements; structural and dynamic. The structural measurements, on one hand, are measured between two defined points of the human body. On the other hand, the dynamic measurements are dependent on the needed space of operation and range for different activities (HiS, 2011).

Percentiles

Human beings differ in many ways. Humans can for example be heavily built, thin, short or tall etc. Measurements of a certain population will most likely be normally distributed and most of the individuals belonging to a population will have expected measurements close to the mean value of that specific distribution. The 50th percentile in a normally distributed population therefore corresponds to the average value of a measurement for a population. In design it is however common to consider measurements between the 5th and 95th percentile of a certain population. This means that the extreme measurements, both minimums and maximums, are often disregarded (HiS, 2011). These measurements are however not disregarded in the design philosophy, *Design for All*.

Design for All

Design for all is achieved when the needs of all individuals in a population are taken into account in the product development. The below descriptions highlight some specific needs of individuals with disabilities and impairments, all of which were considered in this project.

Wheelchair Users

One group of individuals that often is excluded in some parts of society, because of poor accessibility, is people in wheelchairs. Stairs, edges, doors, obstacles and crowded areas constantly hamper the possibilities for wheelchair users to lead regular everyday lives. Individuals in wheelchairs need flatter and wider passageways than needed by most of the remaining individuals in different populations. Furthermore, the reach of wheelchair users is also limited due to their substantially lower centre of gravity in comparison with individuals that possess the ability to stand (Kroemer, 2005).

Visual Disabilities

There are many different visual disabilities, such as colour blindness, blurred vision and blindness. Individuals with colour blindness experience difficulties with distinguishment of colours, whereas individuals with blurred vision have an impaired ability to perceive the environment correctly. There are also individuals without any vision at all. For these individuals, other senses, such as hearing and haptics, are enhanced and further play important roles in the lives of these individuals. For blind individuals, braille,

ground patterns or audial stimuli can be crucial to be able to navigate. Obstacles, lack of audial information, low contrast between the color of information signs and their environments, and too small font sizes are examples of issues in society, all of which decrease the accessibility for people with visual disabilities (Kroemer, 2005).

Elderly People
Humans today prosper and live longer and longer. Seeing that human beings age differently, there are large variations in the needs of elderly. In fact, some elderly may not experience any age-related disabilities at all, while others may be affected by impairments at early ages. Examples of capabilities that usually deteriorates with age are; locomotion, bending, reaching, hearing, grasping, twisting and remembering. Seeing that elderly are weaker in general it can for example be difficult for these individuals to both sit down and get up from chairs. Some elderly prefer to stand up since they find sitting too hurtful. The balance and mobility deficiencies for instance complicate the of use staircases and render it impossible for some elderly individuals to exit buses. Furthermore, designing for elderly requires that products in general should be made easy and clear to use. Moreover, the requirements described in the section on visual disabilities are sometimes applicable to elderly as well, this because vision also deteriorates with age. In addition, flatter and wider passageways and ramps instead of staircases, both of which are examples of wheelchair needs, are also appropriate for elderly individuals (Kroemer, 2005).

3.1.2 Gestalt Psychology

The area of gestalt psychology is related to how individuals perceive the world and its artefacts (Johannesson et. al, 2005). For example people tend to simplify reality and see patterns in gestalts. There are several known gestalt laws, all of which can be useful in product design. The below descriptions of these laws are all based on descriptions by Johannesson et. al (2004, pp. 519-524). The law of past experiences is an addition to the below illustrated laws, which indicates that clear gestalts can be generated if consideration is taken to earlier experiences of a population. This is especially important in semiotics, when establishing signs (Johannesson et. al, 2004).

▲ *Figure 5: Illustration of gestalt laws.*

3.1.3 Design for Experience

The organizational landscape of different global markets are often characterised by competition. Therefore it is of utmost importance for organisations to securely position their brands as well as deciding on what their different brands should mediate to the customers. Furthermore, it is equally important to clearly mediate values or expressions so that specific brands can be easily recognisable (Hestad, 2013). Moreover, when designing for a brand it is essential to take all values of that specific brand into consideration in order to generate the desired expression and thereby design the appropriate experience. In addition, user centered design has become increasingly recognised and important for companies. User centered design is mainly connected to the perceived and actual usability of products or services. Organisations employing user centered processes see opportunities to gain advantage over competitors by focusing on usability, this in particular since products are getting increasingly more complex (Jordan, 1998).

There are many different theories on how to design pleasant designs. According to Jordan (1998), there are four different “pleasures” to

take into consideration in order to create a pleasant experience of a product; ideo- socio-, psycho- and physio-pleasures. Ideo-pleasures are based on users' taste, values and aspirations. Socio-pleasures are connected to social relationships where products can mediate for example status, images and interests of users. Psycho-pleasures are related to cognitive reaction and produces emotions when using a product, for instance good usability can result in a particularly pleasant experience. Physio-pleasures are the reactions that are based on the information retrieved from the senses (Jordan, 1998).

Norman (2005) further presents three levels of emotional design; visceral-, behavioural- and reflective-design. Visceral-design is based on the perceptions from our senses, and can result in desirability, caused e.g. by physical features of a product. Behavioural-design is based on the usability of products, that is the ease of use of products, their features and ease of interaction etc. Reflective-design can be formed opinions or judgements of products that are based on users' previous knowledge, learning and culture.

Human beings often use senses in order to evaluate products. Each sense together create the overall perception of a product, which can either result in a pleasant or unpleasant experience. For instance a sound of a closing door can be crucial in order for a car customer to perceive a car either as reliable or unreliable. Furthermore, there are large differences in the perceived experiences of products between different individuals. Nevertheless, the choice of color and materials of products can result in different expressions. As an example, by means of alternating these choices the weights of products can be perceived differently by users. Users can however evaluate these weights using tactile senses. Moreover, in some cases the perception of products, that is generated by the all impressions from the different senses, give rise to conflicts that can lead to unexpected reactions. This is referred to as incongruence, which can influence the product evaluation and thus also the overall experience. This reaction can result in negative emotions (e.g. irritation or disappointment) or positive emotions (e.g. interest or amusement) (Ludden et. al. 2006).

Experience of Colours

O'Connor (2011) indicates that recently conducted studies have shown that responses to colours depend on gender, age, culture and preferences. For long, interior architects and designers have known that colours can change mood, feelings and emotions (Kashmir, 2013). *Green*, that is perceived as soothing and connected to harmony, balance and healing, can be used to reduce stress (O'Connor, 2011). Green is furthermore suitable in public environments, because of its timelessness and cultural neutrality[4]. Moreover, *Red* is experienced to be psychologically stimulating and arousing as well as a warm and bright colour that evokes emotions, such as excitement and intensity (O'Connor, 2011). *Blue* is similarly to green seen as a soothing colour that evokes tranquility and safety. Studies have shown that blue can be connected to courage and strength and that it is seen as a timeless colour as well. Other studies have indicated that blue increases the productivity of people. However, blue can also generate sadness and indifference. In addition, while *Yellow,* is often considered to be a cheerful colour, it has been found that extensive use or yellow could result in feelings of frustration and anger. Some individuals are more likely to lose their tempers in yellow rooms and babies tend to cry more in rooms painted yellow" (Van Wagner, 2009), to only highlight two examples. Finally, *White* is a commonly used colour in western countries because it is perceived as pure, clean and innocent (Cherry, 2016). However, there are large cultural differences in the perception of white. Cherry illustrates this by exemplifying that white is indicative of mourning or sadness in some eastern countries.

3.1.4 Design for Manufacturability

As a designer it is important to carefully consider all details of products. By doing so products can for example be optimised with regards to weight, performance or cost. These kinds of optimisations often have the aim of

[4] Rydblom, Elin, Interior Architect, Personal communication, 2016, April 20th.

either generating increased value for customers or lowering production costs. In order to lower the costs designers need to consider the design of a product on a detailed level, based on its entire lifecycle. Therefore all elements and components of a product, such as materials, and shapes, need to be considered together with manufacturing methods and assembly processes (Cross, 2008).

DFM (Design for Manufacturing) is a method that is used throughout product development processes in order to minimise the number of parts of products, as well as to receive an overview of the production- and assembly processes and to estimate the manufacturing costs (Ulrich and Eppinger, 2008).

When developing the architecture of a product family, standardisation of parts is important in order to avoid complexity in manufacturing- or assembling processes. Standardisation of parts can further improve ease of interchangeability. Moreover, by making use of parts that have already been produced before, and by reducing the number of standardised parts, manufacturing costs can be significantly decreased. For instance, standardisation of bolts can make assembling more efficient (the need for different tools is thereby reduced). The same principles applies for keeping the number of parts low. Furthermore, it is also important to take the environmental aspects into consideration throughout the whole product development process. A suitable approach to this work is to identify the lifecycles of products, from the use of raw materials to the end life phase, if for instance the products are intended to be recycled. Finally, mixing of materials in products should be minimised and in some cases even avoided to facilitate for later recycling (Ulrich and Eppinger, 2008).

3.2 Enhancing the Experience of Public Transportation

In establishing an objective for future public transportation in western Sweden, Västra Götalandsregionen (2016) has investigated and analysed the views of 6338 survey respondents in a project called "Next Stop 2035". As a complement to this Västra Götalandsregionen also conducted 28 focus groups with a total of 340 participants, all of which were selected based on differences in both needs and geographical locations, this in order to increase the general understanding of current views on future public transportation among citizens in the region.

In general the result from the study indicated a demand for an increased level of comfort on board of public transportation, which was particularly valid for longer distances. To increase this perceived comfort level, the respondents and participants desired for example more comfortable seating, less overcrowding and more space, improved driving styles among drivers and smoother turning. This overcrowdedness is in line with the findings from Stradling et. al (2007), indicating that individuals were discouraged from using buses for example due to a perceived unavailability of space. Furthermore, the findings from Högström et. al (2016) indicates that good driving behaviour among drivers of public transportation is essential. Moreover, passengers with longer traveling times wanted to use the available time in an efficient manner, either for productive or relaxing purposes (Västra Götalandsregionen, 2016a). Moreover, an increased seating comfort, together with generously proportioned space and the availability of power outlets were seen as essentials in order for long- distance commuting to be perceived as pleasant. The below paraphrased quotation from one of the focus groups in the survey illustrates this need:

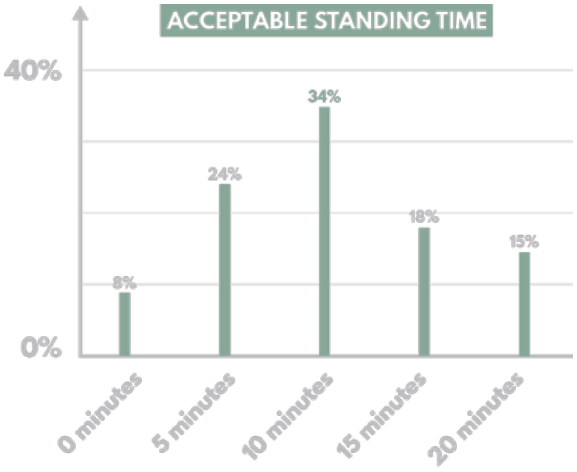
"Space is required to be able to work or do other things on board of public transportation. This is however only relevant on longer journeys, for instance in the case of rail travel".

For shorter distances the travel rapidity was seen as one of the most important aspects. The respondents did not believe that this "time efficiency" was equally important for shorter distances. The need for spending time on activities such as sleeping, working or reading was found to be significantly reduced in importance for traveling times that were less than 30 minutes. Working on board of public transportation was found to make the available on board time perceived as more

valuable. Furthermore, a study using a so called Satisfaction with Travel Scale (STS) showed that individuals that had talked to other passengers on board of public transportation displayed increased levels of well-being (Ettema et. al, 2012). In comparison, the spending of on board travel time on entertainment or relaxation was found to lead to lower STS, thus also lower levels of well-being. The reason for this was due to an experienced boredom. According to Ettema et. al, working in itself does not result in higher satisfaction with travel or a more positive experience of a specific means of transport. Nevertheless, enabling working in public transportation could lead to better overall satisfaction, this because individuals could then be relieved of some workload.

Furthermore 34% of the respondents in the survey believed that it was reasonable to stand up, for up to ten minutes on board of public transportation (Västra Götalandsregionen, 2016a). However, standing times of up to 15 minutes were also considered reasonable by 16 % of the respondents. Therefore comfort is not equally important in the case of shorter journeys. A compilation of this part of the survey, based on the survey results from Västra Götalandsregionen can be seen in the diagram below.

▼*Diagram 1: Acceptable standing time in public transportation, adapted after Västra Götalandsregionen (2016a).*



To further create a positive overall experience of commuting, Västra Götalandsregionen (2016a) indicates the importance of cleanliness and fresh-looking vehicles, together with reduced overcrowding and an increase in the available space, including chair widths. The latter aspects were found to significantly increase the perceived comfort. Furthermore, cleanliness was perceived to be the third most important service requirement of public transportation in the study by Högström et. al (2016). Moreover, many of the participants from the survey experienced public transportation vehicles to be dirty (Västra Götalandsregionen, 2016a). It was found that being on board of old or dirty vehicles resulted in reduced overall attractiveness of public transportation. Moreover, the participants in the focus groups emphasised that better air quality and temperature together with reduced vehicle noise levels could improve the overall experience. Many of the participants also expressed that the usability of boarding and payment had to be significantly improved. Simplicity was highly valued among passengers in public transportation.

Two of Västra Götalandsregionen's (2016a) focus groups were conducted with individuals with different disabilities and impairments, to ensure that these views were investigated as well. One of the main identified issues that arose during these focus groups was the lack of on- and off board accessibility. This lack of accessibility will however not be an issue for GTS as a system, this seeing that the interior environments can be more individually adjustable to specific needs. The participants in the focus groups however desired better signage, availability of tactile information, increased contrasts, better lightning and the use of larger font sizes for important information and real-time displays.

In relation to the perceived sense of security, Västra Götalandsregionen (2016a) also investigated both what generated comfort and discomfort. The findings indicated that individuals on board of public transportation that are under the influence of narcotics or alcohol give rise to high degrees of discomfort for most passengers. This level of discomfort was in particular perceived as high by young women. This is consistent with the findings of Stradling et. al (2007), indicating also that the discomfort was intensified during hours of darkness. Västra Götalandsregionen (2016a) further proposes countermeasures that were found to alleviate this discomfort and increase

the sense of security. These measures were for example better lightning, existence of surveillance cameras and a the experienced presence of drivers or security personnel.

Svensk Kollektivtrafik (2016a) have interviewed 50 660 individuals, all of which together represent the Swedish population, in order to investigate the general view on public transportation in Sweden. The findings indicate that the market share of public transportation increases when public transportation can be used for the majority of the interviewees' journeys. This does not only depend on departure times and availability, but also on the perceived travel simplicity and intrinsic knowledge about how to travel with a specific public transportation company. The availability of public transportation is deemed to be satisfactory by 46 % of the respondents (but only by 23 % of the infrequent travellers). Furthermore, for car drivers to switch to public means of transportation, simplicity and knowledge is particularly important. For example, only 51 % of the respondents believe that it is easy to acquire tickets and 16 % of the interviewed car drivers see advantages of public transportation over cars. Moreover, Svensk Kollektivtrafik illustrate that the perceived affordability of public transportation has slowly declined over the recent years. In 2015, only 36 % of the respondents considered public transportation to be affordable.

Svensk Kollektivtrafik (2016b) indicate that customer satisfaction is driven by both timeliness and the image of public transportation. This image mainly depends on the overall satisfaction level and the willingness to recommend public transportation to friends and colleagues. For infrequent travellers the image can also be improved through increased simplicity. In-depth interviews with travellers disclose that reliability and timeliness are vital factors for the perceived satisfaction. The perceived reliability is especially low for commuter trains. Svensk Kollektivtrafik show that passengers commonly distrust public transportation systems and therefore tend to depart earlier to compensate for anticipated delays. Furthermore, the overall perceived satisfaction of public transportation decreases significantly with increased delays (Svensk Kollektivtrafik, 2016a). This is particularly problematic, seeing that 73% of the respondents believe that the received information during delays is inadequate.

Through interviewing managers in public transportation organisations in Sweden, Svensk Kollektivtrafik (2016b) highlights that reliability, safety, comfort and cleanliness of public means of transportation must at least meet certain levels for customers not to be very dissatisfied with the overall travel experience. If these levels are sufficient the experience can be further enhanced by positively involving emotional aspects. These aspects are, among others, the attitude of the staff, efficient use of time, relaxation- or alone time and exciting social interactions. 60 % of the frequent travellers and only 41 % of infrequent travellers feel that the travel time can be used efficiently. Seeing that 55 % of the frequent travellers and 38 % of the infrequent travellers perceive their travel experiences to be efficient time-wise, the risk of generating frustration or a poor travelling experience is evident. The interviewed managers further argue that emotional aspects will become increasingly important in the near future and therefore Svensk Kollektivtrafik proposes a shift in mindset towards a more user-centered approach, claiming that the brand of public transportation can thereby be improved. However, Svensk Kollektivtrafik clearly visualises a reality far from this user centeredness. Moreover, only 23 % of the interviewees feel that public transportation organisations respond well to customer feedback.

3.3 Other Areas of Interest for the Development of GTS Interiors

The following sections aim to investigate some environmental factors that influence the development of GTS as a system, as well as to shed light on some psychological issues that are plausible in suspended transportation.

3.3.1 Macro Environmental Factors

More and more car organisations of today are putting emphasis on the development of autonomous vehicles. Volvo Cars, to only mention an example of such a company, is

currently undergoing a project called Drive-me, in which the goal is to have 100 driverless cars on the roads of Gothenburg by 2017. Nissan, as another example, has tripled its investments in the development of autonomous systems and its CEO, Max Fields, has formulated an entirely new vision for the company; to have fully autonomous vehicles accessible for millions of people in four years (Payne, 2016). However, one of the challenges with driverless vehicles of today, can be derived to legislation. For instance, the challenge lies in insurance and in allocation of responsibilities in case of accidents. To accelerate the development, Håkan Samuelsson, the CEO of Volvo Cars, has stated that Volvo will take all responsibilities for their autonomous cars (von Shultz, 2015).

If disregarding current legislative issues, it is more fruitful to understand how individuals relate to the recent development of autonomous vehicles and what their perceptions of autonomous vehicles are. In an article by Schoettle and Sivak (2014) public opinions of autonomous vehicles were investigated. The survey-based study was conducted in the UK, Australia and US and had 1533 respondents. The majority were in general positive about the technology behind autonomous driving. On questioning how likely it was that autonomous cars would contribute to improving society the respondents believed that is was likely that these cars would improve society by reducing the number of accidents as well as by improving emergency response to accidents. However the respondents anticipated no change in the levels of traffic congestion. Furthermore, most of the respondents exhibited concern and doubt towards driving or being on board of driverless vehicles. Moreover, the majority were found to be interested in having access to autonomous vehicles when these are made more publicly available.

Furthermore, many recent studies have also been conducted in the area of platooning, this to accelerate this development as well. Platooning means that several vehicles are autonomously driving in a row, by wirelessly letting the different vehicles communicate with each other. For instance, speed, distance between vehicles and deceleration can be adapted to the frontmost vehicle. Platooning could significantly decrease fuel consumption because of the reduced air resistance for all succeeding vehicles. The European truck platooning Challenge was an initiative from the Dutch EU-presidency in order to take a step closer to the implementation of platooning. Platooning today is prohibited by national laws that differ between countries (Karlsson, 2016) (Volvo Group, 2016a). In the beginning of 2016, Volvo Trucks participated in the challenge with three trucks that were driven from Gothenburg to Rotterdam in the Netherlands. The Volvo convey was a success for the research area of platooning, seeing that everything went as planned (Volvo Group, 2016a). Furthermore, the American army, that owns several hundreds of thousands of vehicles, showed interest in platooning in order to establish if it could possibly reduce the workload for its drivers (Amanuel, 2016). The allowment of platooning was also considered to be a necessary legislative change in the approved objective and vision for rail services in western Sweden the year of 2035 (Kollektivtrafiksekretariatet, 2013).

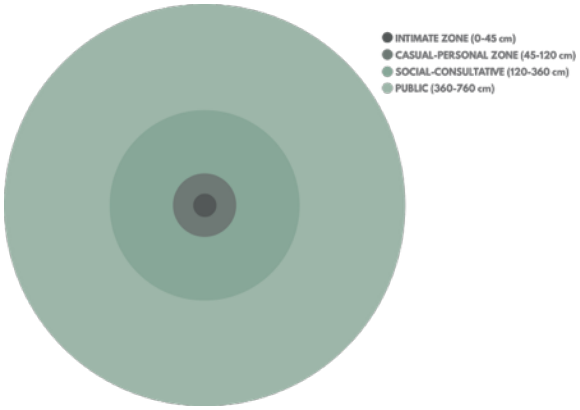
3.3.2 Psychological Aspects on Board of GTS Cabins

The three sections below will examine the scientific area of proxemics as well as acrophobia and motion sickness in public transportation.

Proxemics

Norms that constitute the interpersonal rules behind personal space (that are the physical distances that individuals tend to keep to each other to avoid discomfort) were described by Hall (1966) and further termed “proxemics”. Depending on the type of interaction and the relationships between individuals different physical distances are commonly established. According to Hall, these distances also vary greatly with culture. However, for western cultures Hall defines four zones that correspond to different types of interpersonal interaction. The “intimate zone”, with distances between 0-45 cm, is commonly only voluntarily established in intimate situations when close interpersonal relationships already are in place. Hall further illustrates a “casual-personal” zone (45 cm to 120 cm), in which friendly conversations often occur. Moreover,

interpersonal distances of between 120 cm and 360 cm are commonly employed in the case of non-existent interpersonal relationships. Hall refer to this zone as "social-consultative". Finally, a zone, that is denoted as "public", corresponds to interpersonal distances between 360 cm and 760 cm.



▲ *Figure 6: Four proxemic zones, adapted from Hall (1966).*

The interior layouts of today's public transportation systems often practically result in intimate interpersonal distances. Therefore, passengers in public transportation can sometimes be observed to prevent fellow passengers from invading on their personal space by means of blocking the seat directly adjacent to their own seats. Vallina and Pere (2016), which have designed an american bus interior to increase interpersonal interactions, indicate however that personal space is dependent on the activity and context, and that the need for personal space is slightly reduced on board of public transportation. Nevertheless, due to the potential of a perceived discomfort of an invasion of personal space the interior layouts of public transportation vehicles need to be carefully designed.

Motion Sickness on board of Public Transportation

Due to GTS being an untested system it is impossible to securely comprehend the impact that vehicle movements will have on passengers that board the cabins. However, due to potential side movements in curves, motion sickness can be important to anticipate and consider in the interior design of GTS cabins. Motion sickness occurs when there is incongruence between the movement perceived by visual stimuli and the movement detected by the vestibular sensory system (Benson, 2002). According to Turner (1999) the number of passengers experiencing motion sickness on board of public transportation can be significantly reduced by means of providing forward visibility for more passengers. Furthermore, Turner concludes that passengers that are seated close to windows or in the front parts of public transportation vehicles exhibit fewer signs of motion sickness.

Acrophobia

Seeing that GTS will be suspended above ground it is important to investigate the impact that this has on the passengers' experiences. According to Brandt et. al (2015) acrophobia, that is fear of heights, occurs when "*physiological height imbalance or height intolerance induces a conditioned phobic reaction characterised by a dissociation of the subjective and objective danger of falling*". Acrophobia can result in panic anxiety, which is not a preferred reaction of passenger that are on board of suspended cabins. However, Brandt et. al propose several strategies for coping with height intolerance. Subjects are helped by either sitting or lying down. Brandt et. al claim that the symptoms are intensified if standing. The symptoms can be further reduced by leaning or holding onto something stable in the environment. Moreover, Brand et. al indicate that subjects can also fixate nearby contrasting and stable elements or the horizon in order to further reduce the perceived symptoms of acrophobia.

4. METHODS

This chapter will describe the methodology that was adapted for the design of interior seating environments for GTS cabins.

4.1 Information Gathering and Analysis Methods

The sections below aim to describe the process of gathering and analysing information that was needed for the design phase. These descriptions cover for example benchmarking of existing PRT- and GRT systems, methodology of several conducted user studies and the compilation of needs into requirements.

4.1.1 Investigation of Existing PRT- and GRT-systems

To benchmark, explore and ultimately get inspired by already existing systems is important when new concepts are under development. Benchmarking can be used used to investigate existing solutions of main- or part functions of products or systems in order to get inspired and to understand what is currently available on the market (Paul, et.al 2007).

Already existing systems and concepts of PRT and GRT-systems were investigated by means of literature studies to get an understanding of what was available today, this to enable the design of something entirely new. The technical solutions of the analysed systems were also of interest since these could influence the passengers' travel experiences in different ways. For instance a system suspended above ground could evoke negative emotions among passengers that are afraid of heights, whereas, mechanical systems based on friction generates vibrations and noise, both of which could create discomfort.

Since the aim of the project was to develop interiors in suspended cabins, it was of interest to investigate the interiors of similar and dissimilar PRT- and GRT-systems but also interior solutions in today's public transportation systems, such as trains, trams and buses.

4.1.3 Survey

A survey is a written questionnaire that is intended to collect qualitative and quantitative information from end users, with the aim of understanding the users' perceptions of a product, their values as well as to identify potential use related problems of that particular product (Karlsson, 2007).

An online survey was conducted (see Appendix 2) in order to collect quantitative and qualitative data on the experiences and habits of commuting in Sweden today. The survey was for example intended to identify problematic means of transportation and issues in public transportation. Furthermore, it was also of interest to investigate what passengers spend their traveling times on in public transportation today and what they desired to do with their times in the future if they could choose freely. The posed questions in the survey were both open and closed questions, beginning with questions that required less detailed answers and concluding with questions that required more elaborate explanations from the respondents.

All of the answers from the survey were transcribed and printed out to facilitate for analysis. The result of the survey was finally compiled into different diagrams and illustrations and the qualitative data was categorised by the use of a KJ analysis, see also next section.

▲ *Figure 7: Image illustrating the process of analysing the survey.*

4.1.4 KJ Analysis

A KJ analysis is used in order to structurize a large amount of verbal data from any given qualitative study. Conducting a KJ analysis is an effective way to get a better overview and to

present the acquired data. The first step of a KJ analysis is to extract words and sentences from qualitative data. These extracts are secondly written on post-its and positioned adjacent to other post-its with similar themes. Finally these themes are divided into groups that are given suitable titles (Rexfelt, no date).

The data from the survey was categorised by means of using a KJ analysis. All important and interesting aspects from the survey were written down on post-its and later categorised into groups of specific themes.

4.1.5 Interviews on board of the Flight Buses to Landvetter Airport

To conduct interviews is one of the most common means of collecting data (Rexfelt, no date). A semi-structured interview guide (see Appendix 3) was made in order to collect qualitative data about the environmental and personal experiences of passengers on board of the flight buses (Flygbussarna) between Gothenburg and Landvetter Airport. The interviews, that were held on board of "Flygbussarna" to Landvetter, were introduced by letting the participants fill in Geneva emotion wheels, to indicate their experienced emotions prior to flights.

A Geneva emotion wheel is an instrument that is useful in emotion research (Sherer, 2005). Different emotions, both positive and negative, are presented, on a paper, around an inner circle that represents a field of "no emotions". An increased distance from the field of no emotions represents an increased intensity of that specific emotion. By the use of different words (each of which represent different emotions) around the inner circle participants can be asked to fill in the perceived intensities of their experienced emotions.

The emotion wheel had eight different emotions to choose between. The emotions of the wheel were selected by investigating plausible emotions prior to airports and on board of airplanes. The selected emotions were, for example, fear and excitement. Having concluded the initial part of each interview, questions were asked from the interview guide in a specific order corresponding to different steps of the users' journeys. The questions aimed to investigate for instance the worries that the participants experienced throughout their whole journeys. The questions and answers respectively were categorised into several categories that corresponded to identified steps of the users' journeys; "the day before" "on the bus" "on the way to the airport" and "prior to the flight". The participants were also asked to rate their perceived experiences of these steps, on a scale spanning between a "very negative experience" to a "very positive experience", in order to further establish issues throughout the entire journeys of the passengers. A total of ten individuals were interviewed on board of "Flygbussarna".

4.1.6 Observations on board of the Flight Buses to Landvetter Airport

To work in "field" by means of conducting observations enables a deeper understanding of real-life user behaviours in relation to products. Observing product interactions further enables designers to better understand the real use of products, which can differ substantially from verbal descriptions from users (Rexfelt, no date).

As a complement to the above described interviews, observations were conducted on board of "Flygbussarna" to Landvetter. Furthermore, the observations were recorded in notes and sometimes photographed. Moreover, these notes were summarised in the results and clarified by some of the taken photographs. The observations focused on identifying interesting user behaviours on board of the buses, from the moment of boarding until the moment of disembarkation upon approaching the airport. Interesting behaviour could be everything from luggage handling to experienced problems and use of time.

4.1.7 Customer Journey Mapping

When using products or services customers go through different steps. Customer journeys aim to describe these different steps of interactions in product-service systems. The goal of establishing customer journeys is to identify important touchpoints and to register

the experiences of customers, to finally enable the design of an overall good service experience. The method customer journey mapping can be conducted in many ways. However, one common way of understanding the overall experiences and touchpoints of users in a product-service system is to carry out observations and interviews where patterns of interaction, emotions and experienced issues are investigated, this to comprehend the service experience in its entirety (Wikberg-Nilsson et.al, 2015).

The performed customer journey focused on the service experiences prior to and on board of "Flygbussarna", that regularly operate by transporting passengers between Landvetter Airport and Gothenburg. The interviews, that have been previously described in section 4.1.5, were used as a basis for the generation of two customer journeys, one for business travellers and one for leisure travellers. The overall experiences, including emotions, were finally presented in two illustrating diagrams, both of which can be found in the results.

4.1.8 Field Studies and Observations

One method of understanding user behaviour is when designers use the product or service under development by means of conducting a user-trip and noting observations. A user-trip is conducted through actual testing of the product or service of interest, which according to Cross (2008) is a first step in the user research process to find critical tasks and problems.

The above described method was used by travelling with different transport vehicles in the Netherlands and Germany. In order to be able to investigate already suspended systems in both Wuppertal and Düsseldorf in Germany the authors applied for and were granted two scholarships.

The user-trips were conducted to identify and comprehend potential feelings that could be evoked among users in suspended systems and to furthermore understand what was particularly important to consider when designing for a similar system. In accordance with the description in the section 4.1.6 above, observations were also conducted in several real user environments; onboard of the airport buses "Flygbussarna" between Gothenburg and Landvetter and onboard of trains, trams and metros in both Sweden, Germany and the Netherlands. The figure below illustrates the travel route of the field studies.

▲ *Figure 8: Illustration of the travel route.*

4.1.9 Function Tree

A function tree works as a simplified mission statement in which the the main function of a product, system or service is divided into sub functions. In a function tree, the relations between all functions are visualised in order to clarify the purpose of the product (Cross, 2008).

A function tree was established and illustrated to get a clearer view mainly of what GTS cabins needed to fulfil. Firstly a main function was determined from an overall vision of the desired product outcome. The function tree was secondly complemented with different sub functions that were based on results from previous conducted studies, such as the literature review, survey results, the observations and initial requirements from one of the founders of the GTS Foundation.

4.1.10 List of Requirements

A list of requirements is a written specification that indicate what a certain design or product should achieve. This list includes constraints that limit the range of approved solutions. Examples of requirements are cost or weight

limitations and legal requirements (Cross, 2008).

A list of requirements was used (see Appendix 7) both to ensure that the chosen design would meet necessary requirements and for evaluative purposes.

4.2 Ideation and Evaluation Methods

The following sections describe the process of designing and evaluating the seating environment for the two target groups. These descriptions cover for example the generation of personas and visual reference boards, as well as methods for concept generation, evaluation and visualisation.

4.2.1 Personas

A persona is a creation of a fictive person with needs and requirements on a product. This fictive person should be based on collected information about real users from previously conducted users studies. The aim of the method is to generate a written vivid story of the primary user, that is later useful in the design work, instead of using data and statistics (Nilsson et.al 2015). Personas are primarily used in order to put users in focus during the entire product development process. It is proven that the use of personas can lead to a decreased number of changes in late stages of product development processes (Miaskiewicz and Kozar, 2011).

Three different personas were generated from the information that were collected from the pre- and user-studies. The two first personas aimed to improve the intelligibility of the identified user groups in the primary target group, whereas the third persona was made to briefly summarise the secondary target group, weekly commuters.

4.2.2 Morphological Charts

Morphological charts lists solutions to different sub functions of a product in the same chart. The fulfilment of products' main functions can be achieved by combining solutions to different sub functions in various ways. The method allows an emergence of new concepts by these different combinations (Cross, 2008).

A morphological chart was first and foremost used to structurize the different visual material and inspirational concepts that arose as a result from the benchmarking, see section 4.2.3 below. Furthermore, during the concept generation morphological charts were also used, however in an unstructured way. Ideas for different sub functions were generated and combined in order to create concepts.

4.2.3 Visual Benchmarking

Before new products are developed it can be beneficial to explore what is available on the market today, this by assessing and evaluating the competition. By establishing business intelligence and comparing product specifications with successful products on a market it is possible to investigate important requirements and other aspects to consider or add to a product that undergoes development (Paul, et.al 2007).

By means of conducting online searches for visual material, such as new concepts in the area of public transportation and air travel, inspiration was found. All visual material was finally compiled into a developed version of a morphological chart that included sub functions on the vertical axis and expressions on the horizontal axis. Sub functions were for example "be modular" and "provide personal space". Examples of expressions were "comfortable" and "innovative".

4.2.4 Dialogue

In a dialogue individuals with different backgrounds, experiences, interests etc. are invited to discuss certain subjects. Winslow (in Senge Hamilton & Kania, 2015) argues that the different views and experiences are important for innovations to be generated. A discussion where not everyone agree all the time with each other could therefore be seen as preferable. Isaacs (1999) emphasises that dialogues are useful when discussing questions that are characterised by ambiguity and complexity. Seeing that the intended subject of discussion was how to create the "optimal" future collective means of transportation, it was deemed appropriate to

lead a dialogue. Isaacs further argues that it is important to generate trust in order to succeed with dialogues and that facilitators or leaders of dialogues should master the art of balancing advocacy and inquiry. A way of introducing a dialogue could therefore be to ask the participants to personally and briefly present themselves, describing also some of their emotions, such as how they are feeling at the time of the dialogue. Balancing advocacy and inquiry as a facilitator could be done by directing questions in different ways to all participants, ensuring that everyone are allowed to speak. Furthermore, according to Isaac, it is important during a dialogue that the participants bystands, opposes, moves and follows the statements of the other group members in a balanced manner.

8 individuals, between the ages 16 and 79 years participated in the dialogue session, as well as both the authors. All the participants employed different usage patterns of public transportation. Some were more in favor of public transportation while others preferred cars or other means of transportation over public transportation. Furthermore, the participants were selected partly based on their usage patterns of public transportation and partly based on earlier experiences and current roles, this in order to increase diversity of personal views. Therefore, a transport psychology researcher, a tram driver and cleaner from "Göteborgs Spårvägar" (a local organisation that is responsible for maintenance and operation of trams), a strategic planer and developer from Västtrafik (The public transportation organisation of Gothenburg), three individuals from three generations of a large family and finally two experts on autonomous driving, were all present during the dialogue. The dialogue was introduced with a shorter informal meeting where the participants were served coffee and homemade blueberry pie, this with the intention of reducing the awkwardness of meeting strangers, in hope to provide a welcoming atmosphere and to build trust. The same mindset was also applied to the dialogue itself, in which all the participants were instructed to sit on couches around a coffee table, providing a domestic environment as well as facilitating for eye contact. Initially the participants were also asked to state their names, describe their backgrounds and how they felt on that particular day. A scenario, aiming to illustrate a future without some of the systemic problems (such as delays and noise) of today's public transportation, was read out loud prior to posing any questions to the participants.

The session, that lasted an hour and a half, was recorded and later transcribed in its whole. Furthermore, a document supporting the dialogue was drawn up prior to the session. This document, that included the planning, the scenario and some of the posed questions (used in the same manner as a semi-structured interview guide) can be found in Appendix 4.

4.2.5 Product Expressions and Design Philosophy

Krippendorff (2005) proposes that the expression of artefacts can be classified into five groups of adjectives; traits of *social value*, *objective-*, *evaluative-*, *emotional* and *interface* traits. Krippendorff further claims that the expression of an artefacts is determined by the adjective associations that stakeholders or users of the particular artefacts make within these groups.

To ensure that the interior designs would match the desired expressions that were identified throughout the process of the pre-study and the user studies, important words were extracted and categorised into Krippendorff's proposed trait groups. These words (see 8.4 for results), that worked as drivers for the design of the interior environment, were later used for evaluative purposes by means of testing the generated products' expressions using a semantic differential scale, see also 4.2.12.

The product expressions were finally summarised for both the target groups in a more understandable design philosophy, with the aim of steering the design work in the desired direction.

4.2.6 Expression- and Inspiration Boards

Boards often consist of a collection of pictures that all together result in a common visual expression. Boards are usually established in the initial stages of design processes and

should be available throughout the entire process to steer the final design (Wikberg-Nilsson et.al, 2015).

An expression board was established on the basis of the identified and desired product expressions. This board was mainly used as inspiration when designing the seating environments for the primary target group. Furthermore, an inspiration board with images complementing the expression board was generated to steer the development of the interiors.

4.2.7 Sketching and Visualisation

Sketching is an efficient tool to use in order to mediate and quickly share, explore and visualise ideas with other individuals (Österlin, 2007). It is a tool to explore abstract design problems by concretising generated ideas. To further enhance communication and creativity, physical models in paper and clay can also be used. These materials are further easily processed in order to simplify visualisation, evaluation and exploration of design concepts. Visualised embodiments can in a simple manner be presented for immediate responses either from colleagues or customers (Wikberg-Nilsson et.al, 2015).

Sketching, by hand and by computer (in Adobe Illustrator and Photoshop), was used, together with brainstorming, throughout the project as these methods enabled a rapid way of communicating ideas. Sketching was used both early in the process to visualise non detailed sketches of ideas and later in the project for the development of more detailed 3D sketches with measurements in order to prepare for the process of computer aided modelling. Physical models were also made in clay to explore and evaluate shapes.

4.2.8 Staging and Layout Experimentation

New technologies and products are constantly being developed. To adapt to this ever growing market, it is important to understand users' future desires as well as the user desires of today. Staging is a method that can be conducted to receive an understanding of the needs on a future product-service system (Petterson, 2014). The main purpose of staging is to trigger users to start reflecting on the use of a certain product in the future. This can be problematic since users commonly describe realities that are too distant from the near future. To counteract this, staging is conducted by the use of props, to render users more active and creative, which makes staging substantially different from ordinary interviews. The participants of staging are asked to imagine and describe how something should look, be perceived and work in the future, with use of the props. According to Petterson, the design of interest should be minimally represented during staging, such as with illustrated outlines of a vehicle in the case of future interior vehicle design.

Primarily the purpose of using staging was to investigate how users would like to travel in GTS cabins, as this is an entirely new transportation system. The staging method focused on investigating where in the interior the participants wanted to be seated as well as on examining possible desires and thoughts. It was furthermore important to understand potential emotions of users of future GTS cabins. In particular it was deemed to be appropriate to investigate feelings related to the fact that the cabins will be suspended. Six rounds of staging were conducted and a total of seven participants attended both in groups and individually. Two of the subjects were weekly commuters and the remaining participants were experienced with both daily commuting and public transportation to airports.

Initially the participants of the study were interviewed about their travel habits of today, both on the subject of transportation to the airport and their experiences of long distance journeys. The second part of the study was conducted in a room where a square that measured 3 x 4 meters was outlined to represent the space of a GTS cabin. The participants were encouraged to think-out-loud throughout the proceeding part of the studies. In addition, all participants were recorded on video camera and notes were taken.

Prior to initiating the second part of the study a scenario describing GTS as a system was read out loud. The aim of this was to get

beyond the limitations of today by avoiding discussions about the problems in today's transportation systems. The participants were further asked to imagine how they preferably would like to travel during different situations; with friends, for work and with bulky items. Moreover, the second part of the study consisted of two parts, one corresponding to the travel context of the primary target group (a travel time of 15 min) and one to the context of the secondary target group (a travel time of around 3 hours). To increase creativity, and to simplify the process of understanding the available space, participants were asked to make use of props, such as chairs, luggages, tape, and a bag with bulky items. A document that guided the process of staging was also established, see Appendix 5.

4.2.9 Scenario-based Evaluation

A scenario-based evaluation is an evaluative method that is based on the philosophy *Design for All*. The goal of this philosophy is to make society accessible for all. The method can be used to evaluate different design concepts by questioning the usability of different concepts through continuously changing the context, that is changing user groups and thus also user needs. Scenarios, aiming to reflect different target groups with different needs, are firstly created. The ideated concepts are thereafter evaluated based on how well these fulfil the different needs and accessibility goals for the target groups defined in the scenarios. By evaluating concepts based on the different scenarios it is possible to ensure that a specific product is designed to meet the needs of these different target groups (Nilsson et. al 2015).

As a complement to the personas, scenario-based evaluations were used to take user groups with specific needs into consideration. The scenario-based evaluations were mainly used during the ideation of the layouts of the cabins, but also during the design and materialisation of the final interior. The context was changed between individuals in wheelchairs, elderly people, both taller and shorter individuals, users with visual disabilities and parents with prams and children. The context was continuously changed, as were the needs and requirements on the environment. Seeing that the needs of the different chosen user groups were often contradictory, the layout ideation was an iterative process consisting of many context changes. This was important to ensure an accessible layout solution that considered many needs simultaneously.

4.2.10 Concept Evaluation Matrix

A concept evaluation matrix with weighted criteria is a method used to evaluate and choose between different concepts. Different criteria, that are normally derived from the list of requirements, and functions are firstly weighted to determine a certain priority order, that is a relative importance of each criteria. Each of the ideated concepts are thereafter assessed based on whether the criteria or function is fulfilled or not, and given scores accordingly (Johannesson et. al, 2004).

The evaluation matrix was used to prioritise and finally choose between different generated layout sketches for the primary target group. Important functions and requirements were extracted partly from the function tree and partly from the list of requirements. These criteria were given weight between 1-5, where 1 was given to criteria of low importance, and 5 to criteria of high importance. Finally, several layout concepts were assessed and given scores between 0-3, where 0 corresponded to no fulfilment of a specific criteria, and 3 corresponded to complete fulfilment of a specific criteria. The weight of each criteria was thereafter multiplied with the given scores, resulting in criteria products. The total scores for each concept were calculated by adding all criteria products. The scores of the different concepts were finally compared individually.

4.2.11 Computer Aided Modelling

CAID, Computer Aided Industrial Design, and, CAD, Computer Aided Design, can be used to create three-dimensional object by means of using computer software. By using CAD and CAID the shapes, proportions, measurements and durability of earlier sketched concept can be explored and evaluated. Furthermore, modelling softwares often provide the functionality of rendering,

that is the generation of photorealistic images of CAD-models (Wikberg-Nilsson et.al, 2015).

Since the project aimed to deliver realistic visual material, CAD and CAID was used to generate models of the chosen interior concepts. For more advanced forms with double curved surfaces, Autodesk Alias AutoStudio was used, whereas easier forms were modelled in the solid-modelling software DSS CATIA V5. To enable more realistic concept images, all models were imported into VRED and finally ray-traced with applied materials.

4.2.12 Semantic Evaluation

In order to design successful products, it is important to understand the needs and requirements of end users. However, products of today should not only fulfil basic needs and requirements through the establishment of specific functionality. Aspects such as usability and product experience are equally important for success. Users have to understand, recognise and enjoy products. A semantic differential scale scale can be used to evaluate the differences between the characteristics of different artefacts based on users' individual perceptions of the artefacts of interest. By establishing adjectives corresponding to the desired expression on one side of a chosen numerical scale and contrasting these adjectives with their antonyms on the opposite side of the scale, test subjects can evaluate how well different artefacts match different expressions. Example of contrasting words are *simple* and *complex* (Karlsson & Wikström, 1999).

Semantic differential scales were established with evaluable words determined in accordance with Krippendorff's (2005) expression traits. Three rendered images of differently materialised concepts were shown, one by one, to a total of ten test subjects. The participants in the evaluation were asked to express their first impressions of each image prior to semantically evaluating the expressions of the materialised concepts. A numerical scale with numbers between -2 and 2 was used. However zero was was excluded from the scale to avoid neutral answers. The number -2 in the scale corresponded to the antonym adjectives, or the undesirable expressions, whereas the number 2 corresponded to the desired expressions. The order of occurrence of the images was randomised in hope to eliminate potential bias in the evaluations. Finally, the result of the semantic evaluation was analysed and the distributions of the test subjects' experienced perceptions were visualised in a diagram.

5. BENCHMARKING AND USER STUDIES

This chapter presents the findings from the benchmarking of current PRT- and GRT systems as well as from the survey and the user studies on board of the flight buses between Gothenburg and Landvetter Airport.

5.1 Existing PRT- and GRT-Systems

A selection of already existing and conceptual PRT- and GRT-systems are presented in this section. Most of the illustrated concepts below used rail infrastructure. In cases where roads were used navigation was either accomplished by preprogramming routes in internal computer systems, or by letting the vehicles follow magnets or similar objects installed in the ground. The main competitor to GTS was Skytran, which similarly to GTS was found to use electromagnetic propulsion.

Vectus offers two types of vehicles, both GRT- and PRT- vehicles, where the wheels are in contact with steel rail infrastructure. Both vehicles, are driven by (LIM) linear induction motors that utilise electromagnetic fields for propulsion. This means that the systems do not rely on friction and are therefore not weather sensitive (Force Engineering, 2016).

Hyperloop is a future transportation system that is still under development. In the Hyperloop concept passengers are intended to travel in cylindrical capsules. By using reduced-pressure tubes, capsules will be propelled on air cushions driven by linear induction motors and air compressors. Because of the low pressured air the capsules will have capacity for reaching high velocities (Hyperloop, 2016).

2getthere is a system that utilises automotive friction-based vehicles. 2getthere both have PRT and GRT vehicles. Both vehicles are computer controlled and can be driven to desired destinations along guideways. The systems follows virtual routes that are predefined in software. Magnets embedded in the road work as reference points for the system (2getthere, 2016).

ULTra are small electrical and autonomous PRT vehicles that are driven on guideways that resemble rails. The vehicles' tyres are made of rubber. The vehicles all have a carrying capacity of 4 passengers and a load limit of 450 kg and are therefore suitable for

▲ *Figure 9: Different PRT- and GRT-systems. The references for the images are available in the reference section.*

▲ *Figure 10: Interiors of different PRT- and GRT-systems. All references are found in the reference section.*

wheelchairs, prams and bicycles. The system is currently used at Heathrow Airport to transport passengers from the Business car park to the terminals (Ultra Global PRT, 2016).

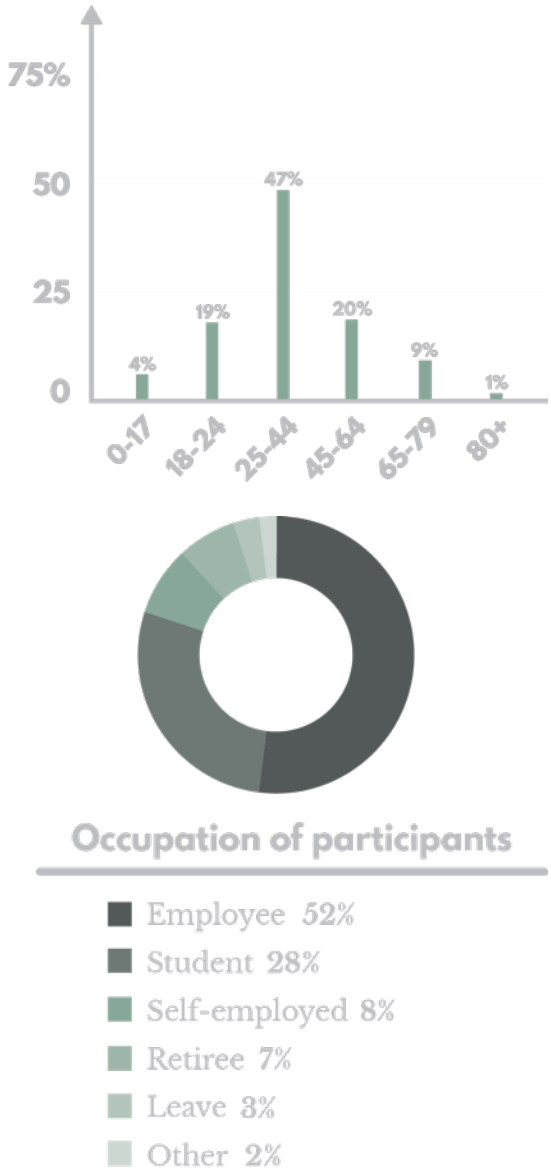
Skytrain is a mechanic transportation system utilising reverse trains for passenger transportation between the terminals at the airport in Düsseldorf. The reverse trains are suspended 10 meters above ground and run along a 2,5 kilometres long track (Düsseldorf Airport, 2016).

Skytran is a PRT system that is currently under development with the intention of making use of magnetic levitation (maglev), instead of wheels. Therefore the system's vehicles do not have physical contact with the guideway (Skytran, 2016).

The interiors of the existing PRT- and GRT-systems did not differ much from each other. However, it was found to be common with larger empty areas in the middle of these vehicles. In the case of the systems that were used in airports the reason for these spaces was found to be due to luggage space requirements and to accommodate passengers with special needs. In most systems, two benches or rows of seats facing each other were most commonly used to provide seating for passengers. Handrails were also made available, enabling users to maintain balance in standing positions. Details were sometimes highlighted with colours that were in contrast to the surrounding interior. However, one concept that differed substantially from most of the investigated systems was the main competitor technology-wise; Skytran. In Skytran, two users are seated in the direction of travel, granting the frontmost passenger a good view outwards. However, Skytran was not found to fulfil accessibility requirements of today, due to poor ergonomics for elderly and inaccessibility for wheelchairs. A drawn conclusion regarding the interiors of systems competing with GTS was that none of the competitors offered anything more than transporting passengers autonomously from point A to B.

5.2 Survey

A total of 179 respondents answered the online distributed survey. These respondents were primarily located in the Gothenburg metropolitan area, secondarily in the Stockholm metropolitan area, and tertiarily in the Malmö metropolitan area. The figure to the right illustrates the age distribution of the respondents, indicating a normal distribution with a mean value in the group of individuals between the ages of 25 and 44. The majority, 47 %, of the respondents, were part of that age group. Furthermore, 52 % of the respondents were employees, 28 % were students, 8 % were self-employed and 7 % were retirees. The remainder of the respondents were either on leave or job seekers. The commuting habits of the respondents were also identified through the background questions of the survey. Commuting was defined as a round trip between the home and a place of work or study, in accordance with the definition by NE (2016). 23 % of the respondents commuted more than five times per week, 49 % commuted three to five times per week and 12 % commuted one to two times per week. 4 % commuted a few times per month and the remaining 12 % never commuted. The group that did not commute were excluded from answering any questions related to the category "*Commuting and General Use of Public Transportation*". This group was instead allowed to answer questions related to the categories "*Use of public airport transportation*" and "*Requirements on GTS*". These three categories can all be found below (see 5.2.1-5.2.3).



▲ *Figure 11: The selection of participants.*

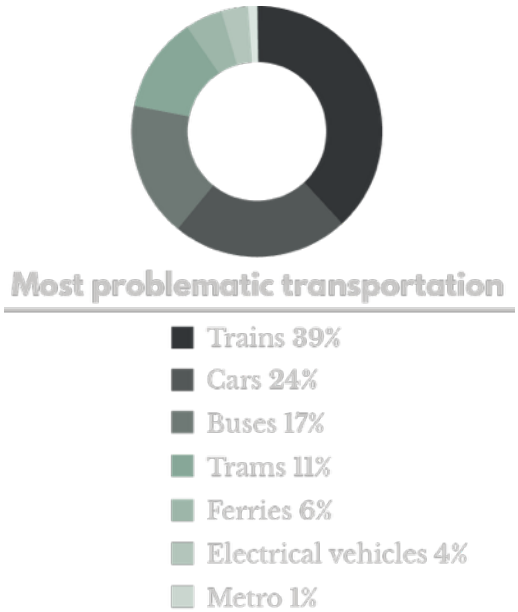
5.2.1 Commuting and General Use of Public Transportation

This section presents experiences and perceptions of today's public transportation in Sweden, including advantages and disadvantages of different means of transportation and commuting in general.

Identified Problems in Different Means of Transportation

The respondents of the survey were firstly asked to choose the means of transportation they believed to be the most problematic, and secondly describe the reasons for their made choices. The diagram below illustrates the results of these questions. A clear majority of the respondents, 39 %, indicated that trains were most problematic. The argued reasons for the distrust in trains were mainly system-related. The respondents believed trains to be the mode of transport that was most sensitive to disturbances and serious errors. Moreover, the respondents emphasised that disturbances often went hand in hand with delays and concluded that the available information or traffic updates during train delays were almost nonexistent. In conclusion this could quite easily result in vicious circles for train passengers. Finally, the respondents also complained about trains being inflexible departure-wise and that the interior environment and climate were both unpleasant.

▼ *Diagram 2: The most problematic means of transportation.*



Cars, that were chosen by 24 % of the respondents, were rated as the second most problematic means of transportation. The reasons for choosing cars were mainly due to operating- and environmental costs of using and owning cars. Some reasons were also linked to the inability to relax when driving cars and to congestion, particularly in cities.

17 % of the respondents believed buses to be the most problematic vehicles. Apart from system related reasons and an alleged weather sensitivity, the respondents also felt that buses were unstable, unreliable, had bad storage and were often overcrowded with passengers. The majority of the respondents that chose buses as most problematic complained about driving styles. Some respondents also argued that buses often had poor ventilation, rendering it easier for sensitive passengers to get motion sickness. Furthermore, 11 % of the respondents argued that trams were the most problematic means of transportation. According to the respondents trams had the same problems as buses, apart from problems with nausea. The respondents however complained that noise levels in trams were intolerably high.

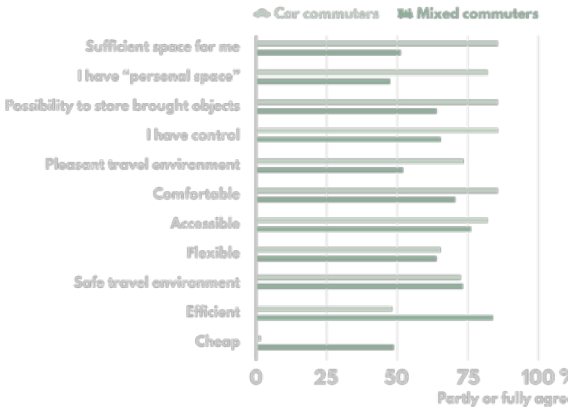
Finally, 6 % of the respondents chose ferries, 4 % chose electrical vehicles and only 1 % chose metros. The problems with metros were claimed to be crowding and claustrophobia. No system related or trust based problems were raised. This would suggests that metros are seen as reliable and efficient means of transportation.

Experiences of Car Commuters Versus Mixed Commuters

The respondents of the survey were presented to several statements in order to rate the perceived experience of their commuting. In order to better understand what was important to develop in a future interior design of collective transportation, the ratings of car commuters were compared to the ratings of mixed commuters. The car commuters did not use other means of transportation than cars, whereas the mixed

commuters used a variety of transportation means, including for example, trams, metros, buses, trains and cars. The diagram below illustrates the ratings from the car commuters (in light green colour) and the mixed commuters (in dark green colour) respectively, showing the percentage of respondents from each group that partly or fully agreed with the statements below. The remaining percentage of respondents not directly visualised by the bars either partly or fully disagreed with the statements below.

▼ *Diagram 3: Different experiences of commuting.*



The result indicated that the largest differences between car- and mixed commuters were related to the available space. Substantially fewer percentages of mixed commuters than car commuters perceived the available space and personal space to be sufficient. One respondent clearly illustrated the problem with space in the quotation below:

"If disregarding rush hours, public transportation works fine most of the time. However, people can be rude and annoying in public transportation, especially depending on the time of the day. Sometimes I think that people are bad at showing respect for others. Some people take up an awful lot of space, do not apologise if they bump into someone and do not move to make room for disembarking passengers."

As can be noticed in the diagram and in the quotation above, most of the respondents perceived the public commuting environment to be sufficiently safe. A big difference between the ratings of car- and mixed commuters was however observed for the statement "It is possible to store brought objects", indicating that storage areas in public transportation are somewhat limited. This is further elaborated below under the section "Objects that Users do not Bring". Moreover, fewer mixed commuters than car commuters felt that they were in control over the chosen public transportation vehicles. In addition, the mixed commuters perceived their commuting as less comfortable than the car commuters. In addition fewer mixed commuters than car commuters believed that their travel environments were pleasant. One of the respondents' experiences of buses aim to illustrate some of the problems related to several of the statements in this section:

"The interior environments of buses are often terrible, it is either too warm or too cold. I easily get affected by motion sickness because of poor outwards visibility. My motion sickness is aggravated when neither temperature, nor climate is properly regulated. Furthermore, there is no space for me to place my belongings. Seeing that I am 160 cm tall I have to tiptoe in an unsteadily moving bus in order to place my belongings on the luggage racks. Finally, bus seats are not that very comfortable in comparison with train seats."

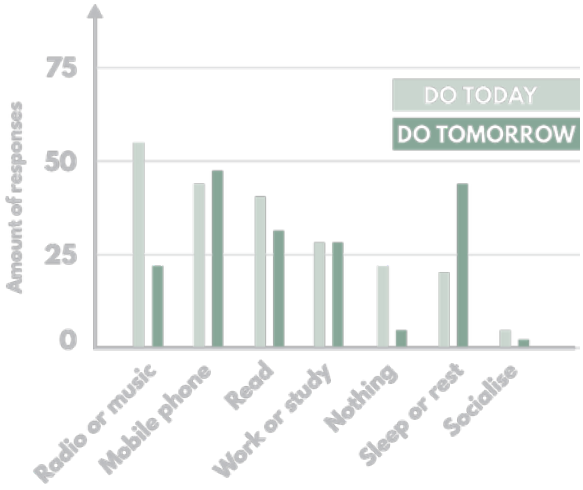
Finally, in line with the findings from Svensk Kollektivtrafik (2016a), the mixed commuters perceived their commuting to be very efficient (note however that the respondents were all from major metropolitan areas in Sweden) and, in contrast to the mixed commuters, the car commuters perceived their commuting to be expensive. It is therefore valid to conclude that the price may not be the determining factor for commuters to choose public means of transportation over cars.

Preferred Activities During Commuting

The respondents were asked to state what their travel times were spent on during commuting today, but also what they wanted to spend their times on in the future. The aim of this was to understand if the activities of today matched the desired activities or not. The result of these questions is shown in the diagram below, where the responses have been categorised into the seven most commonly mentioned activities. The residual activities have been omitted from the diagram

as these were only mentioned by very few individuals.

▼ *Diagram 4: Preferred activities during commuting.*



The diagram indicates that common activities during commuting today are "listening to radio or music", "using mobile phone", "reading", "working or studying", "doing nothing" and "sleeping or resting". "Socialising" was mentioned as an activity as well, but by few respondents. It is however still an important activity to consider in the future design of collective transportation. The diagram further shows that the respondents wanted to be able to sleep or rest more freely, presumably without the disruptions and worries of today. Several respondents mentioned that noise, uncomfortable seating, crowding and other people were reasons for not being able to sleep well today. One respondent emphasised the worry of getting robbed of valuables as a reason for not being able to sleep:

"Sometimes I keep a close eye on my belongings. You can never really relax completely, since you can easily lose both your wallet and your phone if you do not pay attention or sleep".

Furthermore, very few respondents expressed that they wanted to do nothing on board of future public transportation, indicating the need for time efficiency, that is doing something meaningful with the time. Additionally, much fewer respondents described the need for listening to music, whereas approximately the same amount of respondents wanted to carry on with the activities: "using mobile phone", "reading" and "working or studying".

Objects that Users do not Bring

The respondents were found to avoid bringing large and bulky items when traveling with public transportation. Examples of items classified as bulky were prams, bikes, heavy objects, training bags and food. Some of the most commonly mentioned reasons for not bringing these items were; to show respect to other passengers, because of difficulties with carrying or due to space limitations and restrictive rules on board of the chosen public transportation vehicle. The respondents were afraid of hurting other passengers with prams, and did not want to subject other passengers to bad smells emanating from e.g. training bags or food. Furthermore, some public transportation organisations have restricted the objects that are allowed on board of certain vehicles. An example of a commonly restricted items are bicycles. These restrictions were further found to differ between cities and the type of transportation. In some cities it was found that bikes were allowed on board of vehicles for a fee, but only in the case of space availability after all passengers have boarded. Bringing bicycles was also found to be problematic during rush hours, why some transport organisations have dedicated certain time slots when bicycles are allowed on board of public transportation. The quotations below illustrate some of the described views on bulky items in public transportation.

"I do not bring bikes, christmas trees, pieces of furniture or prams in public transportation since it is space demanding and can also injure other passengers"

"I prefer to bring as little luggage as possible since it is inconvenient for both me and other passengers if I carry too much luggage."

Experience of Traveling with Strangers

The respondents had a difference of opinion on the perceived experience of traveling with strangers or fellow passengers when commuting. On one hand, some responses indicated that traveling with others was completely natural. The quotation below aims to illustrate this particular opinion:

"I think that it is very interesting to observe other people and their behaviours. I believe that most commuters in public transportation accept and exhibit greater tolerance for other people and their differences than those commuting alone in cars or with people they are already familiar with."

On the other hand, some respondents highlighted problems related to perceived comfort- or space shortcomings, and particularly to having insufficient personal space. This discomfort was further intensified during flu seasons. Furthermore, the respondents highlighted that fellow passengers could sometimes behave inappropriately, be loud or be under the influence of drugs or alcohol. This was seen as very unpleasant and was described to result in a deteriorated sense of security. One respondent described the experience of traveling with others with the following words:

"It totally depends on the specific case. A quiet first class cabin filled only to 75 % is a pleasant experience. An overfilled tram that is crowded with screaming children and vigorously perfumed ladies is a less pleasant experience. I prefer a more premium and tranquil experience, good comfort and sufficient space"

Pros and Cons of Commuting

In the below illustrated pros- and cons list different views of commuting, that were identified in the survey, are presented. It was important to understand what users perceive as positive during commuting, in order to maintain these aspects in the proceeding design phase. Similarly it is essential to understand what users interpret as problematic in public transportation and commuting in general, to allow for possible improvements.

▲ *Figure 12: Pros and cons of commuting.*

Pros

On one hand, it was found that some participants viewed commuting as 'relaxing', and as a break in their everyday life where they did not need to do anything, apart from enjoying the view and perhaps listening to music. On the other hand some participants viewed commuting as time saving or time efficient. These participants used their commuting time to finish or prepare different necessary activities, for instance to answer urgent emails or plan their days, prior to work or school. The following quotations aim to illustrate these two point of views.

"It is comfortable to commute. When I commuted longer distances I could to get things done."

"I want to be able to just observe the surroundings. I like when I get some alone time."

Furthermore, public commuting was seen as an *environmental friendly, relatively fast* means of transportation. Some participants claimed that everyday commuting is calm and quiet. This was however was found to be strongly dependent on the type of transportation and time of the day.

Cons

The identified cons were mainly related to *reliability*. Even if trams, buses and trains have predetermined departure times, from time to time it was seen as difficult to know and trust that the chosen means of transportation would arrive punctually at a specific stop. Delays, followed by the potential risk of missing connecting transportation was seen as very stressful, especially in the case of longer waiting times for connections. One quotation clearly summarises the above described lack of trust:

"Commuting is like a lottery, in which the prize is to be in time and the loss is to get stuck on the train."

'Environmental' aspects, such as poor air quality and badly regulated temperature were also frequently mentioned cons by the participants. Furthermore, bad ventilation was often found to result in bad smells. Due to these ventilation deficiencies the participants perceived the infection risks to be significantly higher, in particular during flu seasons. Many participants described commuting with public transportation as 'inflexible', typically due to system shortcomings. These shortages were, inter alia, an insufficient amount of departures and connections, slow transportation and a perceived inflexibility due to the need to change to connecting vehicles in order to reach the desired destinations. Moreover, even though 'other passengers' were expected on board public transportation, fellow passengers were sometimes regarded as disturbances, for different reasons. Examples of these sources of irritations that occurred in the interaction with other passengers were loud telephone calls or conversations, infection risks due to sickness, too much perfume and headphones leaking sound or music.

Traveling with public transportation was further described as 'uncomfortable'. This was found to be due to ergonomic conditions, badly designed interiors and poor driving styles. A commonly reoccurring problem was often that the available 'space' on board public transportation was perceived as insufficient at most times of the day. However, rush hours were particularly pointed out as problematic, in which standing was the norm. Furthermore, luggage space was also deemed to be inadequate. Moreover, 'lack of information' was commonly experienced in the case of congestion, traffic jams or vehicle related problems, due to the public transportation organisations' incapability to inform the passengers about the status of the specific problem. Additionally, participants often perceived noise levels, both from different public transportation vehicles and from other passengers, to be too loud. Reluctantly having to listen to engine noise or loud conversations of other passengers was problematic and impeded the possibility for passengers that wanted to relax. One final identified con of today's public transportation was weather sensitivity, leading to increased delays or even cancelled departures.

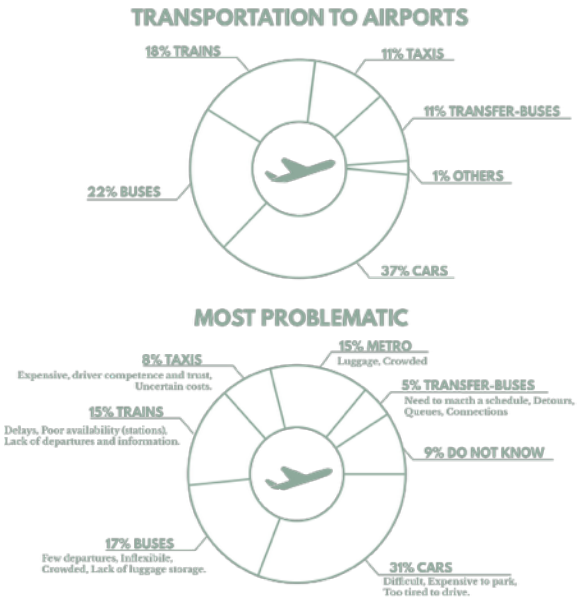
5.2.2 Use of Public Airport Transportation

This section covers background information on Arlanda Airport, identified problems in today's means of airport transportation and the preferred activities on board of airport transportation vehicles.

Common Means of Airport Transportation

Seeing that the airport of interest for the project was Arlanda, it was important to firstly understand some underlying passenger statistics for this particular airport. In 2014, approximately 22 million flight passengers traveled to Arlanda airport (Swedavia, 2015). Of these travellers, 63 % were Swedish citizens. Furthermore, 65 % of these airport visitors traveled for leisure purposes, whereas 35 % of the journeys were business related. In addition, 31 % of the flight passengers went to Arlanda by cars, 29 % by trains, 19 % by taxi, 18 % by bus and 3 % by other transport alternatives.

Through conducting the survey, the most commonly used means of transportation to airports were determined as well as the main problems with each of the identified airport transportation modes. The result of this investigation is presented in the two charts



▲ *Figure 13: Issues in different means of airport transportation.*

below. The majority of the responders used cars, buses or trains as transportation to airports. 37% of the respondents were found to drive own cars or be driven to airports by friends or relatives. The reason for this was the perceived comfortability and sense of security, this due to the supposed control over time. Some respondents that argued for cars emphasised the advantages in terms of an adaptable velocity, a high availability and sufficient luggage space. Furthermore, 11% of the respondents were found to use taxi transportation to airports. This alternative was deemed to be a good door-to-door transportation with the advantage to cars of neither having to focus on the driving, nor on finding parking. However, taxi transportation was perceived as expensive for alone travellers but as more affordable if not traveling alone, this due to the reduction in price per person. 18% of the respondents commonly took the train to airports, whereas 22% were found to prefer buses. The respondents that made use of bus transportation claimed that the airport buses were comfortable, and that these had an adequate number of daily departures and stops that were conveniently close to the airports. 11% of the respondents normally used transfer buses to airports. This was however a more common transportation alternative abroad than in Sweden.

Even though the majority of the respondents commonly drove cars to airports it was perceived as the most problematic mode of transportation. The reasons for this was issues with parking, such as availability, price and walking distances from parking areas to to the airports. Furthermore, some of the respondents also claimed that car driving was not preferable too early in the morning. Seeing that airplanes commonly depart early this was often seen as the case. Moreover, 17% of the respondents believed that buses were the most problematic means of public transportation. This was primarily due to unavailability of departures or lack of other early public transportation to the station of departure of the airport buses. In addition, the amount of flight bus departures were regarded to be inadequate and the available bus departures were not perceived to match the flight departures well enough. It was further found that travelling with too much luggage on board of airport buses was seen as inconvenient because of the experienced difficulties of handling large or bulky luggage on board of these vehicles.

15% of the respondents argued that trains as a means of transportation to airports is the most problematic. The reason for this was the perceived unreliability of trains together with the concern about arriving too late. Moreover, 15% of the respondents argued that subways are most problematic, emphasising the issues of overcrowding and thus also the unavailability of space for luggage. Furthermore, the identified issues with taxi transportation were found to mainly be related to high costs as well as to distrust in the competence of taxi drivers. 8% of the respondents believed that the taxi transportation is the most problematic airport transportation. The remaining 5 % of the respondents who believed that transfer-buses were most problematic by 5% complained about detours, delays and congestion.

In conclusion, in order to design a better transport alternative than the available modes of transport today, availability, reliability, trust, adequate departure times, avoidance of delays and in particular comfortability and flexibility of luggage handling, are all important aspects to consider.

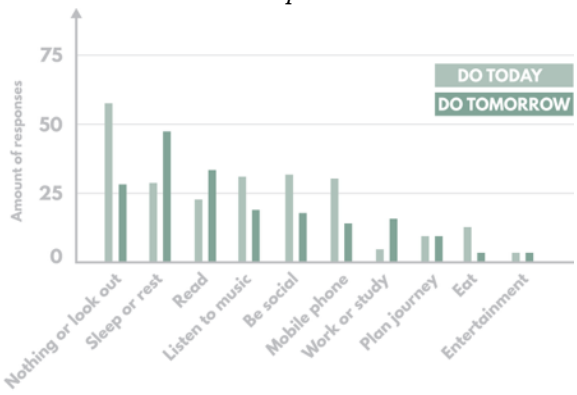
Activities on the way to Airports

It was of interest for the project to investigate what passengers normally spent their time on when travelling to airports, as well as to understand what activities the passengers would like to engage in when travelling to the airport in the near future.

The result of the described investigation can be seen in diagram 5 below. The findings suggest that most passengers do nothing throughout their entire journeys to airports. It is further possible to deduce that the respondents desired to be able to sleep or rest more easily than what is possible today. One of the identified reasons for not being able to sleep on board of collective transportation to airports today was derived to concerns about being robbed of belongings or valuables. The desirability of the activities “sleeping” and “reading” and “working” were all found to high, whereas the desirability for most other

activities was lower. Similar questions were also posted in the context of regular commuting (see previous chapter). If comparing the results from these two investigations it is possible to conclude that the desired activities are quite similar. However, one activity that was added as a desired activity among passengers to airports, that not was mentioned by regular commuters was, evidently "planning of the journey". This indicates the importance of being able to check travel documents and prepare for flight departures on board of the chosen airport transportation vehicle.

▼ *Diagram 5: Preferred activities during transportation to airports.*



Seeing that the respondent usually did not spend the available travel time on anything in particular, at the same time as the expectations on airport transportation vehicles are low, adding something new in the interior environment could generate a more positive experience than that of today. This is also in line with the findings in the theory about design for experience. This potential addition does not need to be comprehensive in character. Due to the prevailing low expectations on the interiors of today, even smaller improvements could result in exceeded expectations among the passengers.

5.2.3 Requirements on GTS Interiors

On one hand, most of the participants in the survey were positive to GTS as a system and pointed out benefits of it, such as increased accessibility and flexibility and different environmental advantages to conventional cars and public transportation. One the other hand, there were many views that questioned uncertainties and that even disputed the existence of GTS as a system. These negative views were for example visual intrusion and space consumption in urban environments, cost of establishing new infrastructure and distrust in the possibility of designing a sufficiently smart system that is able to provide the alleged flexibility advantages over conventional alternatives. Furthermore, some of the participants expressed more direct concerns, related to aspects such as evacuation of wheelchairs or prams and acrophobia. These views are important to include in the detailed development of GTS as a system. Nevertheless, the following sections aim to shed light on some of the demands on the interior design of GTS cabins.

Important Aspects in GTS Interiors

Two word clouds, that are based on two different questions in the survey, can be found in figure 14 below. The size of the words in these clouds are in direct relation to the word occurrence in the responses, meaning that bigger words correspond to more common answers. The first word cloud illustrates what the respondents considered to be important features in the interior of GTS cabins. Prior to answering this particular question, the respondents were shown a concept movie illustrating GTS as an entirely new transportation system. The respondents could thereafter freely highlight features they considered to be important. The second word cloud illustrates the responses from the survey question: "What could be added in the interior so that GTS would be the natural choice over already existing transport alternatives?".

Several amenities, such as WiFi, USB- and power outlets were repeatedly mentioned in the answers of these two survey questions. For longer distances, toilets were considered to be vital. Furthermore the respondents also emphasised the importance of comfortability and space, particularly for longer distances, and described these aspects in terms of ergonomics, well-designed seating environments, adjustability, personal space, legroom and supports for different parts of the body. The respondents wanted to feel that the available private space was generous, rather than having to be on board of a crowded vehicle as well as being too close to

fellow passengers. Furthermore, some respondents highlighted the significance of windows with adequate outward views. As traveling distances increase the respondents desired increased individual adjustability together with the ability to move and stretch more freely. Some respondents wanted to be able to sleep more easily when traveling longer distances, while others wanted space or surfaces for unloading of computers and other work related equipment. A few described that the seating environments for longer distances would benefit from being regarded as work environments. Several respondents that did not mention work areas wished for better unloading surfaces in general. Additionally, for longer journeys many respondents wanted to be able to eat or drink something.

A significant proportion of the responses were found to be environmentally related. Ensuring both good air quality and suitable temperature were examples of what was particularly highlighted. Furthermore, some respondents displayed worries about emergency or evacuation protocols, questioning for example how evacuation would work in cabins suspended three meters above ground. Because of the cabins' operating heights, some respondents were also worried about being confined into a small space, above ground, with strangers. A quotation from one of the respondents illustrates this in detail:

"What if some disgusting dog boards the vehicle if I hate dogs or am allergic to fur? Or what if a fool boards? A drunkard? Or an addict? I would not want to be trapped in these small cabins with complete strangers. If someone pulls the emergency brake, how do I get off? With a rope ladder? How about prams and wheelchairs, how are they evacuated?"

The word clouds below are quite similar in their word occurrences. The identified differences were however related to the system itself. For example, many respondents argued that travel time, comfortability, price, quality of service, space, ease of use, personal service and availability were all important factors to weigh in when choosing to use GTS or not. This is in line with the conclusions from the survey conducted by Svensk Kollektivtrafik (2016a). Moreover, only a few responses were related to non existing functionality in today's means of transportation, such as the use of multimedia or entertainment of various kinds. What was however remarkably emphasised as a reason for choosing GTS, especially for longer routes, was availability of coffee, food and beverages.

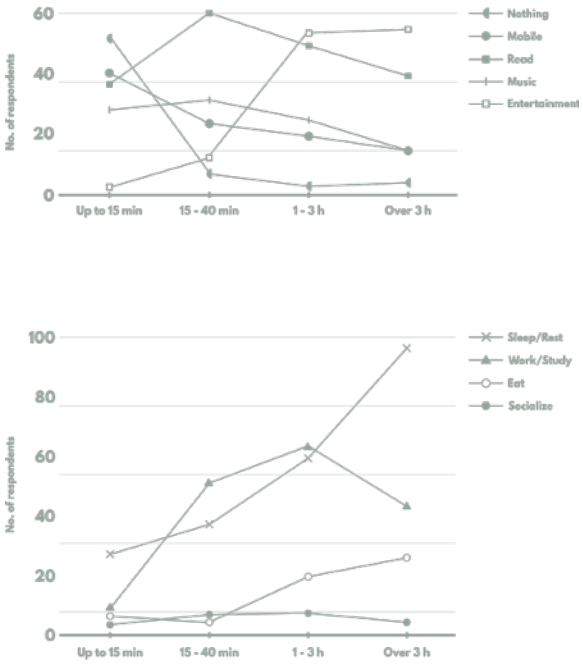
In addition, some specific requirements were identified through establishing these word clouds. Some examples of these requirements were availability of fire extinguishers, emergency exits, surveillance cameras, emergency/panic alarms, cup holders and luggage space.

▲ *Figure 14: Two word clouds that illustrate requirements on GTS interiors.*

Activities in relation to Traveling Times

The respondents were also asked what they would like to do in the GTS cabins if they had different available traveling times, in other words, different excess times. Diagram 6 illustrates the result of these questions. In this diagram, the x axis represents the different available traveling times, and the y axis corresponds to the number of respondents that mentioned an activity category. The different activity categories, represented by lines with different markings in the diagrams below, were identified by means of finding the most commonly communicated answers. Each respondent could choose several activities, meaning that the activity categories are not mutually exclusive.

▼ *Diagram 6: Time and activities in GTS cabins.*



The findings indicated that efficient use of time was important, that is, the longer the journey the more important it is to do something meaningful with the time. Several survey respondents continuously returned to this time efficiency. On questioning what was regarded to be negative with commuting, a respondent answered:

"I believe that it is difficult to use the travel time efficiently when commuting. Some regional trains enables you to work, study or sleep, but generally this is not possible when commuting with all train operators."

The responses indicated further that for shorter traveling distances of up to 15 minutes, doing nothing or observing the surrounding environment is acceptable. However, as traveling time increases, so does also the need for spending time on different activities. The need for sleeping or resting was found to increase almost exponentially with time, and the need for entertainment (e.g. multimedia and games) was seen to increase rapidly with time as well. On journeys longer than three hours "eating" was identified as an important activity. Furthermore, it can be seen in the diagram that "reading" had a maximum point in the time interval of 15-40 minutes. The need for reading was identified to be slightly reduced for longer distances. The same trend can be observed for the activity "listening to music". Moreover, the need for using mobile phones was identified to decrease over time as well.

▼ *Figure 15: The categories from the KJ-analysis .*

5.2.4 Concluding KJ Analysis

The survey generated a large amount of data, both on the respondents' commuting habits and on their positive and negative experiences of travelling in different contexts. The KJ-analysis (which can be found in its whole entirety in Appendix 6) was used to structurize all qualitative data from the survey into seven main categories, which were; 'safety', 'experience', 'information', 'seating', 'environmental', 'system' and 'layout'. These categories or headings broadly concludes what was seen as important in order to create a pleasant commuting or traveling experience. The headings further categorises the requirements, needs and desires that were directly communicated by the respondents in the survey. Each of these headings (that can be found in the figure above) consist of a number of subheadings explaining the particular heading as a whole. For instance, the heading 'environmental' consists of: light, noise, ventilation and cleanliness. Some of the most important findings from the survey were related to the desirability of a perceived tranquility, more space, and a higher system availability of public transportation.

Some of the aspects related to the design of the system as a whole that were identified through the survey were disregarded in this project that mainly focused on interior design. However, all the identified aspects from the survey are presented below in the illustration since all these aspects are of significance for the GTS Foundation and future projects related to the development of GTS as a system or other part systems of GTS.

5.3 Interviews and Observations on board of "Flygbussarna"

Interviews were conducted on board of "Flygbussarna" to collect qualitative data about users' experiences of traveling to airports in public transportation. The result of this investigation is presented below.

5.3.1 Emotions Prior to Flights

The results from the initial part of the studies of passengers on board of the flight buses to and from Landvetter is visualised in the illustration below. The participants in the study did barely display any negative emotions, apart from stress. However, the result indicates that business travellers displayed less elicited emotions than leisure travellers. For example, the interviewed business travellers were less excited and stressed than the interviewed leisure travellers. When questioning this, the business travellers mainly answered that travel was rooted in their every-day life. Looking at the business travellers' yearly mean of flight round trips, which was calculated to 15 times per year, it is possible to conclude that the

▲ *Figure 16: The emotions experienced by the interviewees on board of "Flygbussarna".*

interviewed business travellers were indeed frequent travellers. One business interviewee even stated that he entered an "autopilot mode" during traveling because he was used to it. Leisure travellers on the other hand were in general more excited about the journeys ahead of them. Furthermore, business travellers were more calm, unafraid and less stressed than leisure travellers. This was also concluded to be attributed to travel experience.

5.3.2 Customer Journey Mapping

The interviews and the perceived user experience were analysed and finally summarised in two customer journey illustrations, one for business travellers (see fig 17) and one for leisure travellers (see fig. 18). The lower rows in each illustration display the perceived user experiences, spanning from

very negative, to very positive experiences, throughout pre-identified parts of the users' journeys. The plotted values correspond to the mean values of the interviewed business- and leisure travellers respectively. The filled circles represent values for participants that were traveling to the airport, whereas unfilled circles represent values for participants that had traveled from a destination and were at the point of the interviews traveling from Landvetter Airport to Gothenburg.

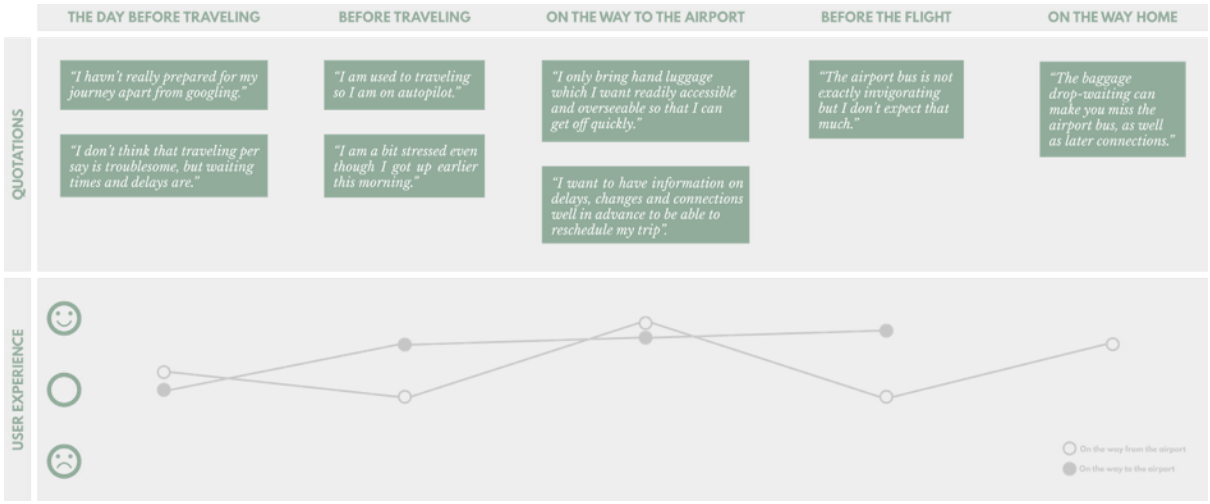
If analysing the diagram for business travellers it is possible to notice that prior to the journey, particularly the day before the fight, business travellers were more neutral. However, as business travellers approached the airport, emotions were more positive. Seeing that business travellers were used to traveling, preparations on the day before the flight were often not very extensive. The experiences of business travellers that were returning from destinations abroad were however more unstable and varied with time.

For business travellers, time and time efficiency were both important aspects. One interviewee stated that he did not consider traveling troublesome per say, concluding that the issue was rather delays and waiting times. Several business interviewees displayed a certain level of stress related to the journey and all the required steps to be able to reach a desired destination. Moreover, stress was also found to be related to the reason for the travel in the first place, e.g. preparations for upcoming meetings and presentations abroad.

Furthermore, none of the business interviewees had very high expectations of the journey between Gothenburg and Landvetter Airport. The interviewees saw the airport bus as a means of transportation to and from the airport, rather than something more. One conclusion from this is that even small measures in the interior design to come can be valuable because of the already prevailing low expectations on the airport buses. This conclusion is reinforced by the results from the survey. On questioning the activities to the airport the most common activity today was to do nothing.

The interviewed business travellers all agreed on the importance of having luggage easily overseeable and accessible in order to increase sense of security and to make the egress at the airport bus station more efficient. This was particularly important since the business interviewees often did not have much excess time from the moment of arrival at the airport to the time of flight departure. What was further noteworthy was that some of the interviewees perceived themselves to be more stressed prior to flights, because of the many steps required throughout the whole journey from their homes to their final destinations. This "travel seamlessness" was concluded to be an important aspect to consider later in the design phase.

The business interviewees further wanted information on changes to their first- or connecting flights as immediate as possible to accommodate for any necessary re-planning



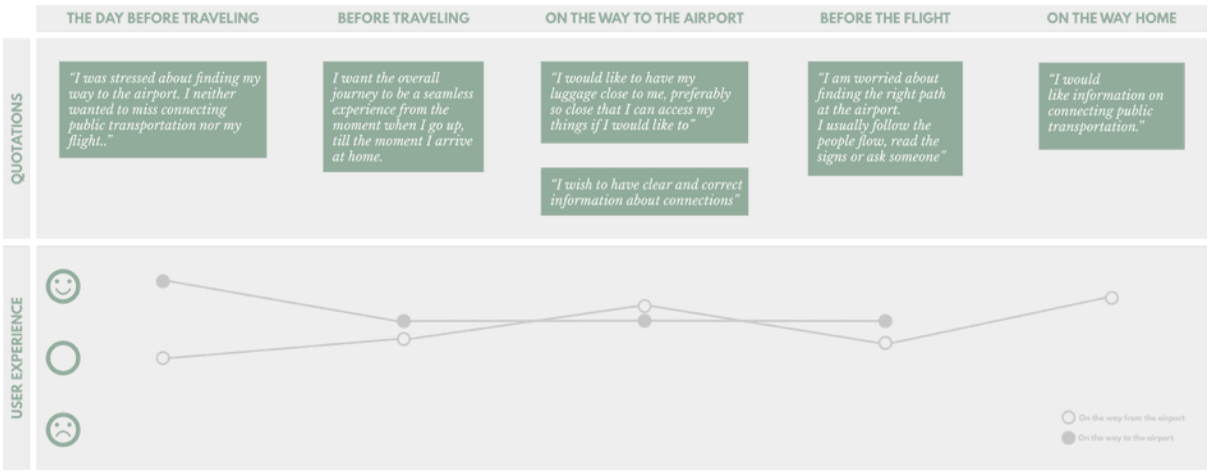
▲ *Figure 17: The customer journey of business travellers.*

of e.g. routes or meetings. Most of the interviewed business travellers used the airlines' mobile applications to access this information today. Furthermore, the majority of the interviewees described the steps required at airports (including for example check-in and security controls) as routine activities. It was therefore valid to conclude that the sense of direction for business travellers was high, at least at domestic airports. Additionally, the interviewees that were traveling from Landvetter to Gothenburg highlighted the stress related to missing the airport bus or connecting means of transportation in Gothenburg, due to flight delays or waiting times at the airport.

If instead examining the perceived user experience of the interviewed leisure travellers (see figure 18) a difference from business travellers was that leisure travellers often showed much more excitement prior to flights. This can be seen as evident, seeing that the purpose of the flight itself is often recreation, and more often self-chosen as well. As the interviewed leisure travellers approached the airport less positive experiences were apparent, resulting in the negative trend that can be seen in the diagram below. This negative trend is important to counteract by means of regarding the needs of this particular user group in the design phase. This negative trend was derived to the identified increase in stress level as leisure travellers start to worry about the required steps at the airport. By earlier assisting these users with their problems a better overall experience can be achieved.

Seeing that leisure travellers in general are less accustomed to traveling, the identified problems of this target group differed from those of business travellers. The interviewed leisure travellers were more stressed about all the steps required to go by flight. One interviewee wanted the whole travel experience to become more seamless, meaning a reduction of the stress related to e.g. the transportation to the airport, the orientation at the airport and the extensive airport security controls. Leisure travellers had worse sense of direction at airports than business travellers and got stressed about missing connecting public transportation to the airport and finding their way at airports. On board of the airport buses leisure travellers believed that it was crucial to have close access to their belongings and travel documents and therefor they preferred to have their luggages nearby. Several of the leisure travellers on board of the flight buses that were not completely filled with passengers, were observed to position their luggage on the adjacent seats.

The interviewed leisure travellers further wanted clear and accurate information about their flights and any potential changes, but also on connecting public transportation in Gothenburg.



▲ *Figure 18: The customer journey of leisure travellers.*

5.3.3 Observations

Apart from conducting interviews with passengers onboard the flight buses, observations were also carried out. To be prepared for easy exit upon arrival at the airport, the observed passengers tended to keep their outerwear on throughout the whole journey. However, the outdoor temperature during the week when the observations were done was quite low. Had the observations instead been carried out during summer, passengers would speculatively want to take off their outerwear. Some of the interviewees particularly highlighted the importance of a smooth egress, which was also their supposed reason for not taking off their jackets. It was however concluded that during the last ten minutes of the journey to Landvetter it was too stuffy to wear outerwear.

One of the biggest issues onboard the flight buses was the boarding of the vehicles. Although "Flygbussarna" provided many payment alternatives prior to boarding, a queue was almost always rapidly formed at all stations for passengers that had not yet bought a ticket or because of the poorly designed ticket reader. This queue was even extended because of the struggle related to carrying heavy luggage, and in an non ergonomic way, lifting luggage onto one of the luggage racks (that are visible in figure 19), while being under the stress of other stampeding passengers. Apart from already having to lift luggage above shoulder level (the upper rack shelf was positioned approximately 155 cm) to securely store it during the journey, passengers also had to lift their luggage over a bent pipe positioned above the upper shelf level. The function of this pipe was to stop the luggage from falling down to the floor level in case of heavy braking or turning. This particular security function further increased the difficulty of lifting luggage onto the racks. Moreover, during deceleration or heavy braking, luggage was observed to be insecurely fastened on the slightly sloping luggage rack and in some cases luggage would even fall down and instead become positioned horizontally on the luggage rack. No luggage was however observed to fall to the floor level, which was presumably because of the earlier mentioned security pipe. Furthermore, when the passenger amount was low, most passengers carried their luggages to adjacent seats where a better overview and thus also an increased sense of security could be achieved. To further enhance the sense of security some leisure passengers also had their hands on their cabin luggages as safety measures. As was mentioned earlier it was observed that easy access to cabin luggage was preferable in order for passengers to ensure that all necessary travel documents were in place. Some passengers also had books and similar belongings that they preferred to have close by.

▲ *Figure 19: An image illustrating the interior of "Flygbussarna". The luggage rack is visible to the left.*

Passengers were observed to carry out the same activities that were identified in the survey. Some were conversing with accompanying friends or partners, while others read newspapers and books or listened to music. However, most of the passengers did nothing apart from observing the surrounding environment and occasionally checking their belongings. This was not remarkable seeing that the flight buses to Landvetter Airport can almost be viewed as city buses, with capacity for longer distances. The flight buses do not have any extra features, apart from luggage racks, and have less space than city buses.

Glare control for individual passengers was achieved with curtains that were somewhat inconvenient to use. Upon reaching higher velocities on the highway the noise level was too high and on lower-speed city roads, vibrations and vehicle shakings were particularly apparent. What however made the experience of the flight buses better than city buses were the outstanding digital information screens in the center aisles, which displayed all upcoming stops and related estimated times of arrival in real-time. These arrival times were accurate as well. This particular information was appreciated among the passengers, together with the drivers' individual bi-lingual information messages both during departure and close to arrival at the final destination. The reminder not to forget any belongings aboard was also seen as important.

6. FIELD STUDIES

The following two sections illustrate some gained insight from the field studies that were conducted in the Netherlands and Germany during the spring of 2016.

6.1 Public Transportation Abroad

Following the attacks of Brussel's airport and metro (Vice News and Reuters, 2016), the hijacking of an Egyptian plane (Branford et. al, 2016) and the recent threat in one of the waiting rooms at Landvetter Airport (Abrahamsson et. al, 2016), all of which occurred within a very short period of time, we had both become somewhat anxious about our upcoming trip. How could we not? In addition, about one week before departure we were fully involved in creating the final itinerary. This work included bookings of flights, hotel nights in three different cities and high-speed train-tickets from two operators in two countries. Moreover, we had to prepare for the Intertraffic exhibition by deciding on the events we wanted to attend and we also did research on the cities we were travelling to and their respective surroundings in relation to public transportation. As this was almost a mini-version of a euro-trip, we were of course worried that some parts would not go according to what we had planned, but at the same time there was a certain excitement in the (ad)venture itself.

Having finished all preparations, including budgeting, ordering of tickets and planning, over a period of two weeks, the day of departure had finally arrived. In accordance with earlier findings we tried to anticipate the issues that would most likely occur throughout our journey. In order to better understand extreme users of public transport and air travel we both brought one cabin luggage and one larger luggage. All four luggages were further filled completely. The journey began with us experiencing traveling with the flight bus to Landvetter. As we concluded earlier we believed that it was unpleasant not being able to have oversight of our luggage. Therefore we chose to get seated close to the luggage rack that was positioned in the aisle.

As none of us had visited any of the intended destinations, there were many uncertainties. Even though we had planned for the journey in terms of printing tickets, and downloading offline maps, we faced unexpected challenges nevertheless. That is the nature of traveling, you don't really know what you will face.

Our first use of public transportation abroad was the ride with the airport train from Schiphol Airport to a station close to our hotel in Amsterdam. On this particular train there was no prioritised space for any of our luggages. For that reason we had to place our luggages adjacent to our seats and manually hold them in order to get sufficient oversight and to prevent overturning. This was particularly problematic seeing that we were forced to place the luggages in the already narrow aisle. By means of this luggage placement we also felt that we blocked the aisle because other passengers could not easily get past us.

One of the main goals of our adventure was to largely make use of public transportation in the various destinations we traveled to, and so we did. We used metros and trams in Amsterdam, intercity trains between the Netherlands and Germany and across Germany, trams in Düsseldorf, interregional trains around the entire region of North Rhine-Westphalia in Germany, as well as metros, trams, buses and S-bahns in Berlin. Having experienced the interiors of all these transportation means we concluded that the the interiors often were not holistically designed, meaning that materials and shapes were often used without consideration to the overall product expression. This was something that we wanted to change for the better in our design to come.

When we waited for the intercity train between Amsterdam and Düsseldorf we were somewhat worried. As the station was filling up we started to reflect on whether there would be sufficient space for us on board of the train, even though we had our tickets readily available. We later experienced the same problem prior to boarding the train between Düsseldorf and Berlin. As this latter journey was scheduled to take five hours, we did not want to sit on the floor, on top of our four bulky luggages. We were also worried

about storing our luggages. When we finally boarded the last intercity train we rapidly found available seats. However we had to position all our luggages on overhead shelves that extended alongside the walls of the train. This immensely complicated the oversight of two of our luggages, seeing that we had to place these further away from our seats than we were comfortable with. This lead us to constantly having to look after these luggages throughout the entire journey. This particularly generated discomfort when the train stopped at different railway stations. At each of these stops we looked back and forth to ensure the security of our luggages and our valuables.

6.2 Skytrain and Schwebebahn

Early in the morning after one rewarding day on Bicycles in Düsseldorf we went to the closest train station to catch a train that transported us to Düsseldorf's Airport. At this airport the earlier researched "Skytrain" could be found. This system, that was mechanically suspended, transported passengers between the different terminals at the airport. The autonomously operated Skytrain consisted of several suspended interlinked trains. The first identified issue that we perceived was overcrowdedness, which was further intensified because of poor luggage storage, slippery plastic seating and lack of handrails. Seeing that the system also was mechanical it felt somewhat shaky and uncomfortable to be on board of these crowded reverse trains. However, even though the skytrains were suspended up to 10 meters above ground we were not at all afraid of being on board of these vehicles. This was partly related to the perceived reliability of these trains, and partly to the window placements. All windows were positioned on a height of at least one meter from the floor surface. This was believed to reduce the risk of triggering acrophobia. The Skytrain interior can further be seen in figure 19 below.

Later on that very same day we arrived at Wuppertal in Germany, where suspended trains were used as the main means of public transportation. The infrastructure for this system, that was called “Schwebebahn”, was much older than the infrastructure of Skytrain. Therefore the interiors of this system’s trains were old-fashioned and not very impressive. The trains further swung out upon approaching curves and swayed at all the stops. However, we noticed that passengers on board of the “Schwebebahn” were used to this suspended means of transportation. Increasing the general acceptance of suspended systems can therefore be seen as a matter of establishing habits. What we believed to be particularly interesting on board of the Schwebebahn was that most passengers stood directed towards the windows by holding on to the handrails that extended alongside both walls of the train. The passengers did so to enjoy the quite stunning view outwards.

▲ *Figure 20: The interior of Skytrain.*

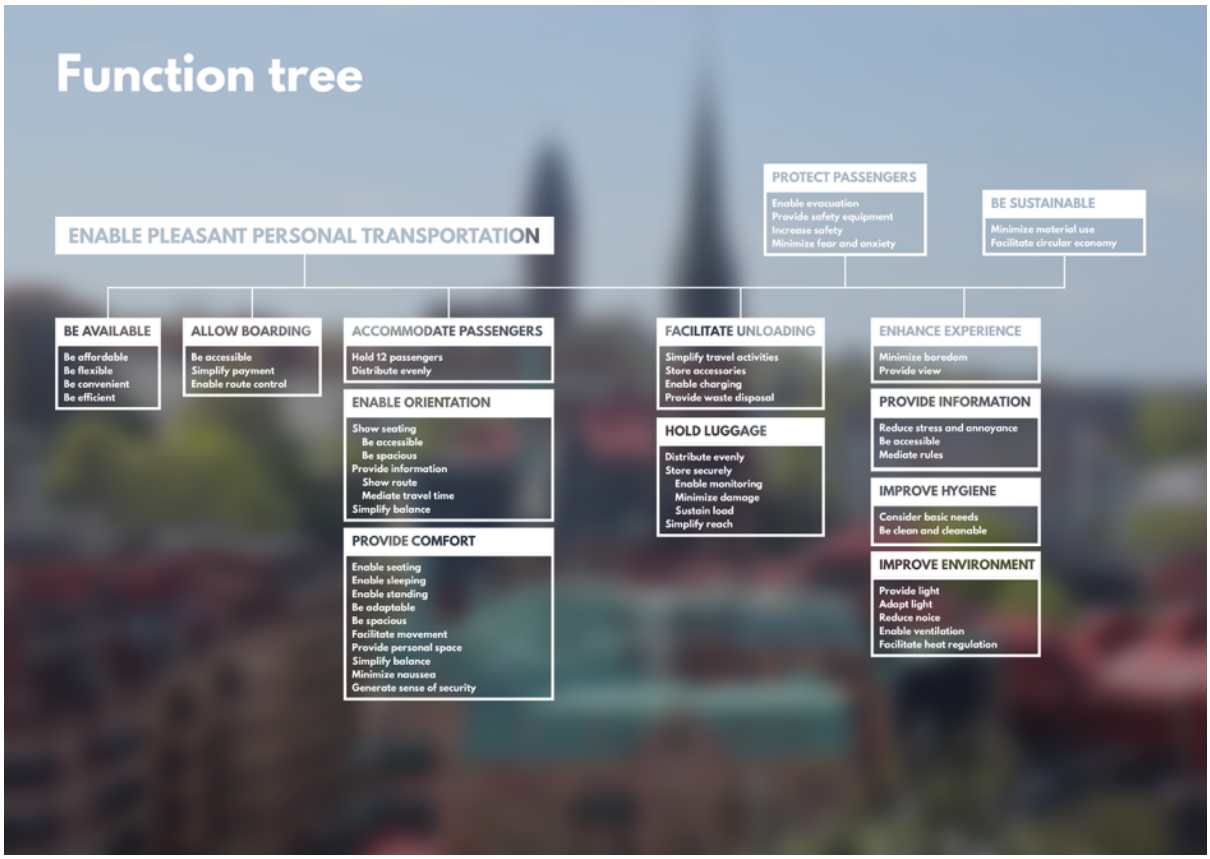
▼ *Figure 21: The interior and exterior of Schwebebahn.*

7. NEEDS AND REQUIREMENTS

The following sections aim to clarify the needs and requirements on GTS interiors.

7.1 Function Tree

The function tree below visualise a tree structure that contains different sub functions under the main identified function: "Enable *pleasant* personal transportation". This main function was used to steer the project, seeing that it was important to design an entirely new experience for collective transportation. The sub functions were generated based on all earlier results, and was later used for the purpose of ideating different concepts to meet different needs. The first two sub functions, "Be available" and "Allow boarding" were not in focus in this project. However, to succeed with fulfilling the main function, the interiors of the cabins needed to accommodate passengers, through enabling orientation and providing a sufficient degree of comfort. Furthermore, the interiors needed to facilitate for unloading of belongings, enable charging of phones and computers, as well as easily and securely store luggage while enabling users to oversee their belongings. Moreover, the interior environments had to both be sufficiently safe and provide a sense of security among passengers. Finally, the sub function "Enhance experience" was also added to the tree for example in order to ensure that environmental factors were considered in the development to come.



▲ *Figure 22: An illustration of the established function tree.*

7.2 List of Requirements

The earlier investigative methods resulted in a requirements list. In this list of requirements, guidelines of recommended measurements were added to enable the final design of layouts and seating environments. Seat width and space demands for wheelchairs are both examples of measurements that were added. All requirements are summarised and explained in the categories below. For a detailed list of requirements that include recommended measurements and references see Appendix 7.

Seating Requirements

Primary Travel Route between Arlanda and Uppsala (travel time of approximately 15 minutes).

Shorter journeys did not have the same strict requirements on seating environments in comparison with longer journeys. For instance seating adjustability was not required since it was concluded in the user studies that flexibility of the seating position was unnecessary for shorter journeys. From the user studies, personal space was also deemed to be important. Through comparing the results of staging (see 8.6) with theory about proxemics it was concluded that an interpersonal distance of 300 mm between two strangers (measured between the two closest shoulders) was adequate to minimise potential intrusions of personal space. This distance was further not found to adversely affect interpersonal communication.

More general requirements on the seat itself were also considered. For instance, to achieve a higher degree of comfort, angling of the back support relative to the seat surface was seen as essential. Furthermore, the general seating requirements and measurements in the requirements list were established through comparing functional requirements for buses (Svensk Kollektivtrafik, 2016c) with measurements from an anthropometric database that are based on research by Hanson et. al (2009). The requirements that were taken into account were for example width and depth of seat surfaces, positioning of armrests and requirements on legroom. Most of the used measurements were recommended minimum values. By increasing these values a more specious environment could be generated for the primary target group.

Secondary Travel Route between Gothenburg and Stockholm (travel time of approximately 3 hours).

For longer journeys the requirements on comfort were essential. By both increasing the values of all seating dimensions a higher degree of comfort was found to be generated. However, being seated for longer periods of time, without the ability to move freely was found to be uncomfortable and even unpleasant. In the preceding studies users expressed the need to change seating position and to be able to stand up during longer journeys. The reason for this was mainly to facilitate for the circulatory system. In addition, some users expressed the need for sleeping as well.

Longer distances travellers further wanted to spend the travel time in an efficient manner. This was found to place higher demands on the interior itself, for instance on the need for space and unloading surfaces. Furthermore, basic needs, such as eating and going to the toilet, were identified to be increasingly important to consider as well.

Accessibility Requirements

It is essential to take different needs into consideration in order to design an accessible cabin interior. Needs were found to differ significantly between individuals in different phases of their lives and between individuals with different disabilities. This was also in line with the earlier defined theoretical framework on ergonomics (see also 3.1.1). Sometimes the needs and requirements on different groups of individuals were contradictory. Therefore all ideated concepts were continuously evaluated against each other so that a better level of accessibility could finally be achieved.

For wheelchair users space and flat surfaces were significant. The measurements that were used as a framework for the consideration of wheelchair users were all taken from the

European Parliament Council directive 2001/85/EG. This directive includes, inter alia, a measurement of a standard wheelchair and the required turning diameter of this standard wheelchair, as well as a minimum door width to generate accessibility. The same requirements on space were found to be applicable for passengers with prams as well. Good accessibility for both these user groups was found to be achieved by only making use of flat, non-slip surfaces, by eliminating any obstacles that impeded navigation on board of the GTS cabin and by providing an accessible entrance. Furthermore, to increase security, fastening of wheelchairs and prams was essential.

Individuals with visual disabilities needed clear contrast markings, on the floor to mark the entrance, on handrails and on obstacles. Furthermore, signs (for instance indications of priority seating) were required to contrast the surrounding environment. Moreover, structures in the floor and braille was identified to be helpful for blind individuals. Finally, to increase balance, for all individuals in general, and for individuals with reduced mobility (such as pregnant women and elderly people) in particular, handrails or similar aids were deemed to be appropriate.

Safety Requirements

In the previously conducted studies and in theory it was concluded that the sense of security among passengers could be increased if certain safety equipment was both available and clearly visible. For instance surveillance cameras were found to increase sense of security when travelling with strangers. Equipment and functionality that were identified to be required on board of GTS cabins from a safety point of view were: emergency phones, fire extinguishers, emergency brakes, first aid kits, emergency exits and easy evacuation as well as surveillance cameras.

Luggage Requirements

This section will present requirements on both cabin luggages and larger luggages.

Cabin Luggages

Most users were observed to store valuables in their cabin luggages. Therefore proximity and oversight of these luggages were both concluded to be important aspects to consider in the design for the primary target group. To simplify handling during embarking and disembarking and to increase sense of security as well as to match current user behavior, it was deemed appropriate that all cabin luggages should be easily accessible for all passengers throughout the entire journey. Even though cabin luggages are small in general, lifting these luggages was nevertheless identified as problematic in the user studies. Therefore it was seen as preferable to avoid higher lifts. In addition, measurements of cabin luggages that are allowed on board of commercial airlines were used to ensure that space requirements were met.

Larger Luggages

Proximity and oversight were found to not be as important for larger luggages as it were for cabin luggages. Nevertheless, oversight of larger luggages was still concluded to be important among passengers to airports. Seeing that larger luggages are heavier and bulkier than cabin luggages, the generation of an easy access to potential luggage storages was found to be important. Moreover, high lifts were seen as undesirable.

Requirements on Information

It was found to be essential to consider the availability and clarity of information in order to increase accessibility. For individuals with visual disabilities clear contrast between information (or symbols) and the surrounding environments were required, whereas verbal information was a necessary substitute for blind passengers. Furthermore, the placement of information needed to be considered to simplify reading for all passengers. In addition, internationally recognised symbols were essential to increase comprehension for all potential passengers.

Door Requirements

In accordance with 2001/85/EG, to increase accessibility for wheelchair users, exit doors had to have a width of 1200 mm, and a height of 1800 mm.

Material Requirements

The defined expressions below (see 8.4) had to be taken into consideration in order to generate the desired expression. This was particularly important when selecting the materials for the interior. Apart from this requirement, it was deemed to be appropriate that none of the chosen materials could cause allergic reactions. Furthermore, it was essential that all materials were durable in their nature, this to minimise wear and fatigue generated by the many anticipated use cycles of passengers on board of the GTS cabins. Finally, from a sustainability point of view, excessive use of materials was not seen as preferable.

Environmental Requirements

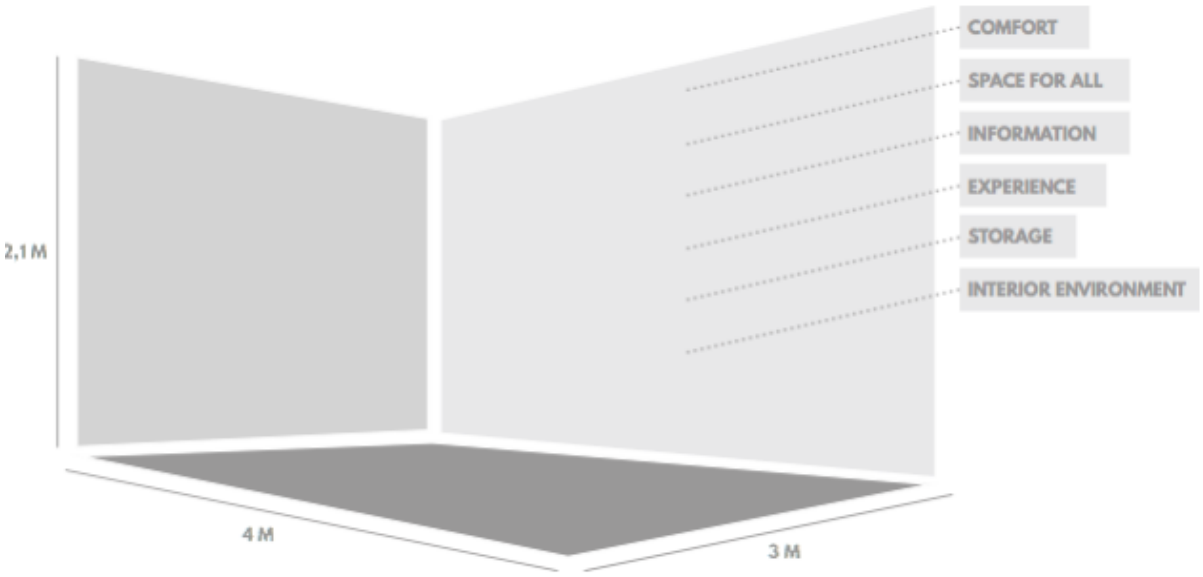
It was concluded to be important that passengers should be presented to clean and fresh environments in the cabins, this to enhance the overall travel experience. As the findings in the previously conducted studies indicated, ventilation, temperature and sufficient lighting were all important aspects that enhanced the travel pleasantness. Furthermore, it was concluded that the interiors should provide outward views for all passengers. Additionally, the risk of nausea and glare had to be minimised.

Extra Features

The extra features are not generally required in today's transportation systems, but can rather be viewed as requirements in order to create an even more pleasant travel experience. Seeing that the main function (that was defined in 7.1) was to generate a more pleasant experience, these extra features were significant. These features were all expressed by users in the previously conducted studies (for instance in the survey and the dialogue) and were often explained in terms of features that would enhance the overall travel experience or somehow add value. Examples of mentioned features were access to wi-fi and power outlets, cup holders and microwaves. The desired features differed however between shorter and longer journeys.

7.3 Focus Areas

To visualise the areas of importance for the ideation phase to come, a simplified illustration (see figure 23 below) was made, including also the measurements of the available space. These focus areas are visualised without regard to the order of priority. However the area *"Space for All"* was valued highly for the primary target group.



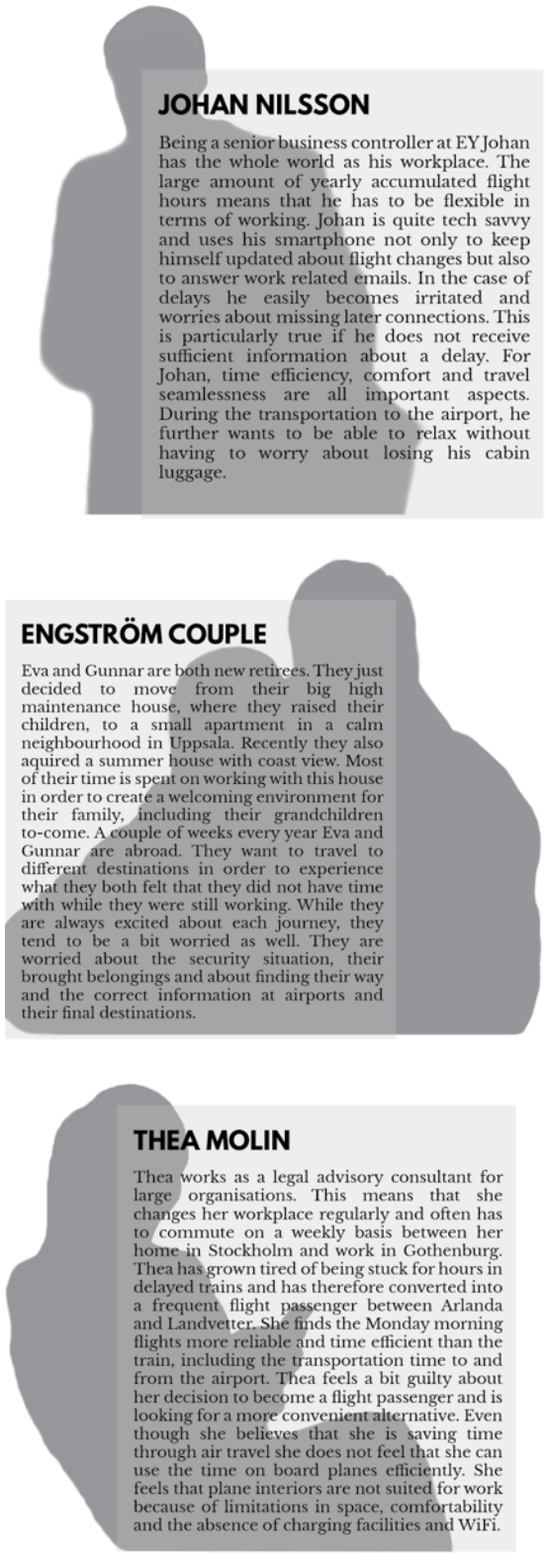
▲ *Figure 23: The focus areas for the design phase.*

8. IDEATION

The following sections will elaborate on the process of designing seating environments for the primary and the secondary target groups.

8.1 Personas

On the basis of earlier studies, and with an emphasis on the conducted user studies as a framework, three personas were compiled and used as references in the proceeding design work. Two personas were generated for the primary target group of airport travellers, one for frequent business travellers (see Appendix 8) and one for less frequent leisure travellers (see Appendix 9). Finally, one simplified persona was also created for the secondary target group, weekly commuters (visualised in its entirety below). Each persona was given a vivid and suitable description that was followed by the goals, frustrations and motivations of each fictive individual. Quick abstracts of the three generated personas can be found below.



▲ *Figure 24: The three developed personas.*

8.2 Visual Benchmarking

In the visual benchmarking phase many interesting, both futuristic and existing, concepts were found. These were then categorised in a morphological chart with functions on one axis and perceived expressions on the other. Example of functions were “be spacious”, “be modular”, “provide surfaces”, “provide light and view” etc. Moreover, examples of expressions were “innovative”,“contemporary”, “inexpensive”, “luxurious” etc. The figure below aims to further illustrate the procedure of the visual benchmarking.

▲ *Figure 25: An image illustrating the process of the visual benchmarking.*

Some of the interesting visual findings are further illustrated in figure 26. The yellow-golden seats in the upper left corner were perceived as luxurious and were further believed to provide passengers with comfort as well as personal space. The interior environment shown in the image in the upper right corner was perceived to express cleanliness and flexibility, as the seats in this environment were retractable. This flexibility was further found to have the potential of improving the overall accessibility as these seats could free up floor surface if needed. Moreover, the contrast markings in the floor were also identified to be an interesting aspect of this particular concept. The lower left image shows an interior with slightly organic forms. This environment was perceived as calm, comforting and clean. The interior was further found to accommodate bicycles. The lower middle image visualises a train interior that utilises a combination of organic curves and simple straight lines together with sharp material transitions. This particular concept was perceived as contemporary and spacious. The interior in the final image was perceived as spacious and innovative. The reason for this perception was the use of light in combination with the provision of outward views. In addition, the lower seating height together with the overall exterior design was found to increase the expression of comfort and relaxation.

Many more interior solutions were investigated and used as references throughout the design work. One of these solutions was the Windowless Jet Concept, made by Technicon design. In this concept, the surrounding environment of the fuselage is recorded by wing mounted cameras. This enables the flight passengers to experience the surrounding environment by means of projecting real-time footages on the walls of the aircraft (De Zeen Magazine, 2014). This particular concept was emphasised in this section for future projects involving the exterior design of GTS cabins.

▲ *Figure 26: A sample of concepts that were analysed throughout the process of visual benchmarking. The references to the images above are available in the reference section.*

8.3 Dialogue

In this section the result from the dialogue is presented. Five different topics were discussed in the dialogue; *Safety and Security, Time, Environmental, Flexibility* and *Autonomous driving*.

▲ *Figure 27: The discussion areas in the dialogue.*

When discussing *safety and security* most of the participants argued that the presence of personnel was important in order to feel safe with strangers in any given public transport vehicle. The participants believed that the presence of for instance drivers could greatly improve sense of security, even though the actual safety would not increase in the case that dangerous situations would occur. Drivers of today are not allowed to intervene for example when passengers are fighting or when passengers otherwise behave inappropriately. Some of the participants also believed that strangers were more likely to refrain from behaving inappropriately with the presence of drivers. Furthermore, surveillance cameras were believed to prevent crimes on board of public transportation.

One younger participant expressed that fellow passengers sometimes took advantage of the overcrowdedness, that often prevails in public transportation, by sitting uncomfortably close to her. In some cases these passengers even subjected her to inappropriate touching. Even though the mere occurrence of such behavior was surprising for most of the participants it was perceived to be strongly upsetting by all participants. This further reinforced the importance of personal space on board of collective transportation. It should not be possible for passengers on board of GTS cabins to take advantage over or generate discomfort for other passengers. The quotes below summarise the first area of discussion in the dialogue.

"I think it is difficult to feel safe without human presence."

"Sometimes I feel like people, deliberately sit down a little too close to me. It would be great if this was impossible."

The questions in the dialogue were further aimed to investigate how the participants wanted to spend their available travel *time*. The result indicated that there was a difference of opinions with regards to this time aspect. One participant believed that the society had become too efficient. This participant claimed that it was neither acceptable, nor allowed to even relax for ten minutes. All participants further criticised today's excessive use of mobile phones on board of public transportation, which was argued to both decrease social interaction and render passengers unaware of their surroundings. As an example, this supposedly led passengers to not register and show respect to passengers with special needs (such as elderly or pregnant individuals). Furthermore, one participant believed that it was positive to be able to spend the available travel time on something meaningful, such as on replying to work-related emails. This participant further argued that efficient use of the available commuting time could relieve some of the stress generated upon arrival at work. Moreover, some participants mentioned that it was desirable to increase the convenience of working or studying on board of public transportation. The following quotations aim to illustrate the two described views on time on board of public transportation:

"Today our society is stuck on the idea of making everything as efficient as possible. You're not even allowed to relax ten minutes on the tram..."

"My tram takes ten minutes. During this time I usually answer urgent emails so that I feel less stressed upon arrival at work."

The third area of discussion was related to important *environmental* aspects on of board of public transportation. Ventilation and temperature were examples of significant aspects that were identified in this particular discussion. Furthermore, the participants did not want to be on board of public transportation vehicles with poor air quality or bad odours, this because these environmental aspects were claimed to decrease psychological well-being. According to some of the participants these aspects together with overcrowdedness resulted in an increased perceived risk of being infected by sick fellow passengers, particularly during flu seasons. Moreover, it was concluded that public transportation vehicles had to look clean and fresh at all times to increase the experienced travel pleasantness.

The participants desired that the interiors of public transportation vehicles had smooth, large surfaces to simplify the comprehension of the perceived cleanliness of these surfaces. Moreover a relationship between this perceived cleanliness and behavior of passengers in public transportation was found. To increase the respect that users exhibit for public transportation vehicles and thus reduce vandalism, this perceived cleanliness was seen as crucial by the participants. The quotation below illustrates this view. Furthermore, in order to achieve cleanliness, the use of materials was identified as particularly important. Some materials that were perceived as dirty, such as the asphalt-like floor in Gothenburg's trams, could decrease the respect towards vehicles. These asphalt-like floors were further concluded to be difficult to clean because of the material in itself. Moreover, the participants of the dialogue claimed that passengers had more respect for city busses. The supposed reason for this was derived to appearance, material and layout of these buses. The layout of the buses were for example seen as more open which was argued to prevent people from littering. In addition, most city buses were concluded to be newer than the trams. For that reason most of the participants perceived the interiors of the buses to be cleaner than the trams.

"I believe that if a tram looks disgusting interior wise people are more likely not to have the decency of showing respect for its interior environment. If the interiors of trams were instead really nice looking and clean, people would perhaps want to maintain the same level of cleanliness".

The need for *Flexibility* was brought up when the participants discussed what they wanted to do on board of collective transportation if different travel times were available. One participant emphasised the need for interpersonal communication, as this participant commonly traveled with friends. However, the participant understood that this communication could disturb other passengers and therefore it was suggested by several participants that future vehicles could instead be divided into different sections. These participants proposed that different sections could accommodate different users with diverse needs. The quote below summarises this particular view. Examples of possible sections were sections for social interaction, sections for animals and quiet sections. For longer journeys the participants argued for the need of flexibility in terms of increasing the number of possible travel activities. Flexibility was seen as desirable to enable different activities, such as sleeping, working or socialising, at different times of journeys. Beds, tables, unloading surfaces, access to wi-fi and mobile chargers were some of the expressed amenities that were claimed to facilitate for different desirable activities.

"Different individuals have different needs, I imagine different units for different needs or smaller wagons divided into different sections."

The last discussed area of the dialogue was related to autonomous driving. The questions from the dialogue guide document aimed to examine how the participants perceived autonomous vehicles in general. The participating tram driver expressed skepticism to autonomous trams, this because drivers, in contrast to systems, were believed to anticipate or almost "feel" upcoming failures

or traffic problems. This particular participant did not trust that a system could possibly interpret all signals that it would require to be fully functional. However, most of the participants exhibited high levels of trust in autonomous systems with proprietary infrastructure, such as subway systems or cable railways. The alleged reason for this was because these systems do not need to interpret the surrounding environments. Interpreting environments was believed to be highly complicated and problematic, which was why the level of trust in these autonomous systems was low.

8.4 Product Expressions and Visual Design Philosophy

The words below illustrate the chosen product expression adjectives, sorted into the five linguistic groups by Krippendorff (2005). As an objective trait, the word *light* was chosen, this partly because the floor surface was limited to 12 square metres and partly because the GTS cabins were suspended in the air, rendering lightness an important character trait. *Clean* was used as an aesthetic trait, this due to the earlier concluded importance of a cleanliness and simplicity in the design. The adjective *Modern* was chosen as a way of being able to break free from the prevailing norms of today's public transportation, in order to create an entirely new experience for collective transportation. The modern expression was also a demand from the GTS Foundation. Furthermore, *Spacious*, *Calm* and *Safe* were chosen as emotional traits. These three traits were all identified as important factors in the user studies. Finally the adjective *Comfortable* was chosen as the interface trait. This because comfort was highly valued among the studied users, particularly for longer journeys.

Objective: *Light*
Aesthetic: *Clean*
Social Assessment: *Modern*
Emotion: *Spacious, Calm, Safe*
Interface: *Comfortable*

By combining the expressions above into sentences a visual design philosophy could be created for the primary target group. This philosophy was however used as a way of steering the ideation process for both target groups. To increase compliance with the needs of the secondary target group, variable comfort, increased space and a perceived time efficiency were added functions.

"The design should aim to be modern, spacious, light and clean in its expression.
The overall experience should evoke a sense of tranquility and safety for the users and at the same time provide an adequate degree of comfort as well as a certain level of novelty in relation to existing means of airport transportation."

8.5 Expression and Inspiration Boards

Both an expression board and a formal staring board were generated to facilitate the design of an interior seating environment for the primary target group that expressed the desired product expressions. These two boards can be found below. The boards include for example slightly organic forms and products that were perceived as comfortable, clean and calm.

▲ *Figure 28: Expression board. The references for all images are available in the reference section.*

▼ *Figure 29: Formal starting board. The references for all images below are available in the reference section.*

8.6 Staging and Layout Experimentation

Prior to knowing the procedure of the staging study, the participants were asked to describe two travel experiences in wide terms. Because of the earlier defined target groups, the experiences of interest were airport transportation and some self-chosen longer train journey of approximately three hours. Moreover, the participants were also asked to describe how these experiences would optimally be in the future. The results of these initial interviews can be found in 8.6.1 below. The participants were later subjected to the two scenarios (see Appendix 5 for details), corresponding to journeys matching the journeys of the primary and secondary target groups, and were finally asked to design the layouts for these groups. The result of this is described and illustrated with figures in section 8.6.2. Based on the results from the staging studies, the experimentation, ideation and selection of different layouts is presented in 8.6.3-4 for the primary target group and in 8.6.5 for the secondary target group.

8.6.1 Initial Interviews

Transportation to Airports - Primary Target Group

All of the interviewees preferred cars over public means of transportation to the airport, due to time efficiency, flexibility and luggage convenience. Door-to-door transportation was regarded as the optimal transportation by all participants. The main identified issue with public transportation to airports was the perceived trust in timeliness.

Most of the participants highlighted that carrying luggage through several public transportation vehicles in order to reach the airport was both cumbersome and stressful. An interviewee even used to contemplate on how to be able to get off the airport bus after having stored heavy luggage on racks positioned high above the floor level. Another interviewee described the issue of having to share storage space of luggage with strangers on board of airport transportation vehicles, concluding that reachability was a problem due to passengers' different final destinations and that stacking of luggage was therefore not desirable. Furthermore, stacking of luggage was also seen as inappropriate if any luggage was fragile. In addition, all the participants emphasised the importance of being able to oversee brought luggage. The findings of the initial interview indicated that closeness and oversight of cabin luggage is especially important, whereas proximity to larger luggage is not equally important. However, several interviewees did not want to place larger luggage in non visible storage areas, particularly not in compartments that are only reachable from the outside of any given vehicle.

Some of the interviewees further stated that the required activities prior to boarding at airports, including security controls, were stressful and caused nervousness. Depending on the chosen airway company, stress related to poor service design could also be more or less common. An example of problems related to this is not knowing how to check in luggage or receive tickets at the airport. A conclusion is therefore that it could be preferable to counteract some of this perceived stress on the way to airports by means of design. In addition, the participants wanted both to be reminded not to forget any luggage on board of collective airport transportation and to have clear instructions of how to use a specific means of transportation. If these instructions were not readily available together with simplicity of use, a more convenient transportation alternative would instead be chosen.

Long-distances-transportation - Secondary Target Group

In line with earlier findings, timeliness and reassurance in the case of delays were regarded as important by all the participants. It was concluded that timeliness cannot be seen as anything else than a basic demand that should be met at all times. Furthermore, the participants also described the need for an increased seamlessness, that is not having to change too many times from one vehicle to another.

Unloading of belongings, such as jackets, shoes and luggages was deemed to be significantly more important for longer distances, as was oversight and proximity of

belongings. Stacking of luggage and belongings of different individuals was not preferable. Moreover, the participants did not want to disturb other passengers. Encroaching on others' personal space, for example by reclining too far, was seen as inappropriate, although this easily could occur in today's means of transportation. Additionally, personal space, leg and seating space and the ability to move freely was seen as vital for longer distances. One interviewee described the unpleasantness of being seated close to windows because of the risk of other passengers blocking the way to the center aisle for several hours. In addition, another interviewee argued that smaller transportation cabins or train compartments would result in a more pleasant travel experience, this because the perceived privacy would be increased at the same time as the noise level would be reduced.

The participants also emphasised the lack of sufficient unloading space for work purposes. The today available table areas in for example trains were seen as inadequate and unstable, even for single computers. The participants desired larger surfaces with room for more belongings and work equipment than computers exclusively. In line with earlier findings, charging facilities and internet were also argued to be necessities. Moreover, several of the interviewees wanted to be able to buy something to eat or drink. Finally, an interviewee stated that it was important knowing the availability of different facilities on board, such as bistros, toilets and entertainment areas.

8.6.2 Result of the Staging Scenarios

Scenario 1: Transportation to Airports
Most of the participants in the staging study expressed directly after boarding the cabin that it was important to quickly be able to get rid of their luggages. All the participants began the first scenario by carrying the cabin luggage to the preferred seating position, which indicates the importance of proximity to and oversight of luggage. On questioning where larger luggages would optimally be placed, most subjects answered that the back of the vehicle, close to the entrance, was the most appropriate area. Furthermore, some of the participants expressed that it would be preferable not having to lift the luggage at all and that secure fastening of it was important, this to avoid having to hold on to the luggage throughout the whole journey. One participant desired the floor surface to be completely flat to facilitate for boarding, luggage handling and to improve accessibility. Another subject expressed the importance of a wide entrance to simplify luggage handling. Having a wide entrance was further identified as an important need for wheelchairs as well, which was however found to be at the cost of reducing the available interior space. In addition, when the subjects were given bulky and fragile items, these were either placed in front of the chosen seat or in the vicinity of the same area. Some of the participants put their hands on these items to further increase sense of security. One participant emphasised the importance of designing luggage storage that enabled quick disembarking upon approaching the airport.

All the participants kept their outerwear on throughout the whole first scenario. Furthermore, most of the participants rapidly generated rows of seats in the front of the cabin with generously proportioned legroom. These generated seat rows were positioned towards the direction of travel. The reason for this was to avoid having to sit backwards and to be able to get a good view outwards.

Depending on the context, the test subjects designed the layout differently. For example, when the subjects imagined themselves traveling with friends or colleagues, four seats were most commonly positioned against each other in two rows, similar to existing layouts in public transportation today. The difference from today's layouts, however, was that that the distance to the other clusters of passengers was much larger.

Upon asking if the layout should be any different if traveling with strangers instead of with friends, most of the participants changed the layout completely and spread out the seats to generate more distance and space between each passenger. The layouts from these modifications resulted in layout solutions nearly identical to existing layouts in trams or buses. One subject, however questioned the "spreading" of seats completely, stating that it would generate seclusion, resulting in distrust

▲ *Figure 30: Example of one layout design from Scenario 1, created by two test subjects.*

and fear of fellow passengers. This particular statement was concluded to be especially important to consider in the layout experimentation phase to come. It was evident that personal space was regarded as important for all the subjects. The participants described the lack of personal space or distance between each passenger in today's public transportation as uncomfortable and stressful. For example, some of the subjects felt unable to use phones or computers in public transportation due to the risk of being observed by nearby passengers. This need for personal space was also observed during the staging scenarios, where chairs sometimes were positioned further apart than in today's public transportation interiors where two chairs often are adjacent to each other.

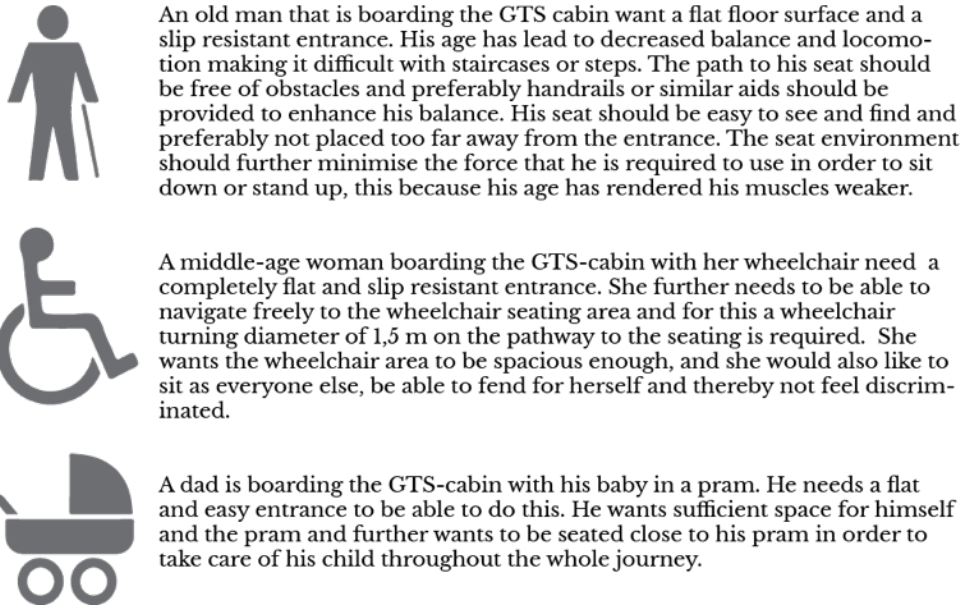
To increase accessibility for wheelchairs and prams most of the subjects converted two regular seats into foldable seats. These seats were placed close to walls to ensure safety in the case of any sudden deceleration. What was however concluded when the subjects had to design a layout with space for a wheelchair user and a parent with a pram at the same time as 10 other passengers, was that the available surface area seemed insufficient. When asking the staging participants to make room for these two users, the total number of passengers decreased substantially.

Furthermore, the subjects preferred traveling with other passengers, mainly because of price sensitivity. If the cost of traveling alone would have been sufficiently low, most participants expressed that they would have chosen to travel alone. However one participant stated that traveling alone in collective or public transportation would defeat the purpose of utilising collective means of transportation in the first place. When asking the subjects to reflect on the impact autonomous driving would have on the experience of traveling in GTS cabins, some subjects desired something indicating that everything worked faultlessly to feel more in control. Other subjects believed that trust in GTS as a system would be based on its perceived reliability and earlier experiences of traveling in GTS cabins. Finally, one participant in the first scenario wanted the experience of the interior environment to be changed based on the flight destinations of the on-board passengers. The participant exemplified this by describing that the interior could become warmer in terms of lightning and that soothing background music could be played on low volume, if a group of friends were for example going to Rhodes.

Scenario 2: Weekly Commuting
When being subjected to the second scenario most of the participants' layout designs indicated that the number of passengers needed to be substantially reduced from 12 in order to generate sufficient levels of comfort and space. Seeing that one of the identified problems for longer distances commuting was the inability to move freely, this expressed need for increased space was deemed to be necessary to generate a pleasant travel experience. All, except for one of the test subjects positioned their seats far away from the seats of the 1-3 imagined fellow passengers.

Furthermore, all participants created considerably much more spacious seating environments than the environments built in the first scenario. One of the subjects built a bed-looking furniture, consisting of three chairs, while two others established footrests with cushions. Moreover, the subjects described the seating environment with terms such as adjustability and comfortability. In addition some of the participants emphasised that it was important to be able to stretch and move during the longer journey, while others desired larger and more flexible surfaces to facilitate for working on board. Amenities, such as electricity and internet were seen as basic requirements for longer traveling distances together with facilities such as toilets. Whereas all subjects placed the seating environments in the front with the intention of receiving a good view, toilets were unanimously placed in the rear part of the cabin to avoid being observed when going to the toilets.

In line with the findings from Scenario 1 the subjects desired to have easy access to luggage storage as well as to have even better oversight of their belongings. Some of the participants expressed the need for removing and storing outerwear. One of the participants even wanted the possibility to store shoes somewhere, in order to get more comfortable. Moreover, some of the participants requested a more subdued lightning without the risk of glare and more embracing or private seating environments.



▲ *Figure 31: The scenarios that were used throughout the layout experimentation.*

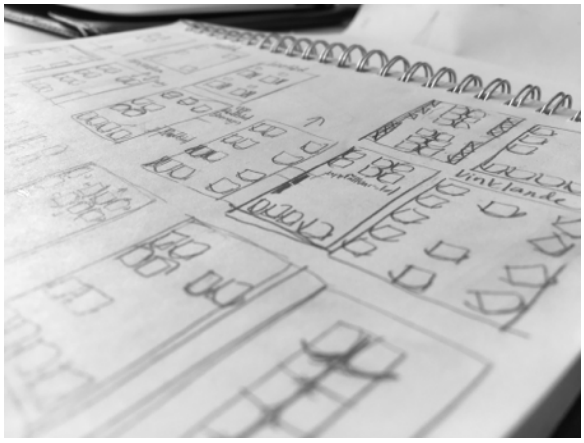
8.6.3 Layout Experimentation

A large amount of layouts were firstly sketched and secondly tested, using the staging equipment, such as foldable chairs, tape and cushions. Most of the sketched layouts were evaluated by means of utilising the method scenario-based evaluation as well as the previously created personas. The used scenarios can be found in figure 30 below.

In the initial phase of the layout experimentation layouts were generated by not taking all the defined limitations and requirements into account. This phase rather focused on creativity in order to enable the development of interesting concepts. For instance it was investigated how passengers could be positioned to facilitate for interpersonal communication as well as for solo travellers. All developed layouts were sketched by hand (see example of these sketches in figure 32) and evaluated in full scale by means of using the staging equipment. Furthermore, the staged layouts were photographed. Gradually, more and more requirements were included in the experimentation and evaluation process together with the defined scenarios below. Solutions and ideas from different staged layouts were finally combined with each other into four final layout concepts. These are presented and evaluated in the next chapter.

The different needs of the above described groups were contradictory several times throughout the layout experimentation. Because of this, the layouts were continuously reevaluated and changed on the basis of increasing the overall accessibility for all user groups.

Initially in the process the layouts were designed to accommodate twelve users, including a wheelchair user and a parent with a pram. However, it was concluded that it was impossible to make room for both a wheelchair and a pram at the same time in a cabin that was limited to 12 square meters, while maintaining a high passenger amount and still achieving sufficient comfort levels. Therefore the decision was made to focus the development on generating a layout that instead had a combined wheelchair- and pram seat. Moreover, personal space and luggage



▲ *Figure 32: Sketches from the layout experimentation.*

proximity were considered to be important aspects in order to increase travel pleasantness for all passengers. It was found that cabin luggage was preferably placed in the vicinity of the seated passengers. Different solutions for placement of cabin luggages were therefore evaluated by means of staging. The figure below illustrate an example of this experimentation of luggage storage positioning. Other evaluated placements of cabin luggages were for example under the seats. During the evaluation of these placements, overturning risks as well as the perceived sense of security and oversight were evaluated.

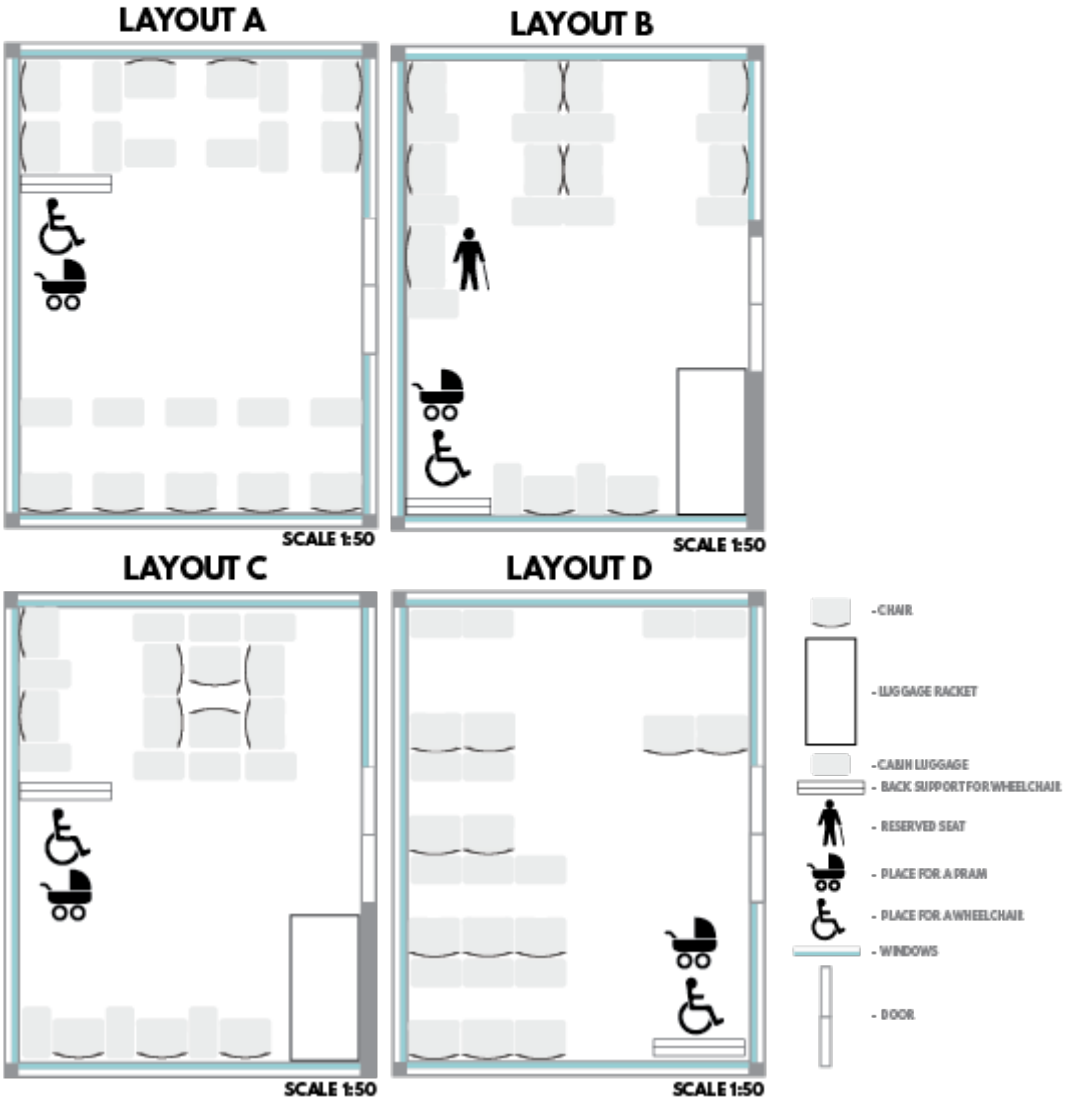
▲ *Figure 33: Experimentation of luggage storage positioning.*

8.6.4 Layout Selection

The four most appropriate interior layouts, all of which were generated from the layout experimentation, are visualised in the illustrations A-D in the figure below.

To allow for evaluation of these layouts criteria were firstly chosen and weighted in a concept evaluation matrix. Criteria that were deemed important were given high scores. Examples of important criteria were space for wheelchairs, personal space, oversight of luggage and evacuation potential. Each of the layouts were given scores on how well they fulfilled or could fulfil each requirement and the total accumulated scores for each of the concepts were finally calculated and summarised in Table 1 on the next page. The result indicates that the accessibility ratings were highest for Layout B, which were closely followed by Layout D. Layout B received the highest scores mainly due to the fulfilment of the wheelchair turning diameter of 1.5 meters and space availability, but also because this particular layout resulted in reduced stigmatisation of wheelchair users. It was seen as important that wheelchair users could be seated in the same direction as other passengers, and not facing the rear of the cabin as in today's public transportation.

Furthermore, Concept B had the highest accumulated scores in the personal value category as well. This could be deduced to the expected proximity and oversight of cabin luggage, as well as the potential of oversight of larger luggages in this concept. Moreover,



▲ *Figure 34: Illustration of the four evaluated interior layouts. The layouts are further drawn in the scale 1:50.*

seeing that the storage space for cabin luggage was positioned between all of the seats an increased level of personal space was anticipated as well. As for the last criteria group, "other", most of the concepts received similar ratings, except for Layout C that received the lowest scores due to the prediction of problems related to evacuation. This problem was mainly attributed to the inconvenient seating placement in the upper right corner of Layout C. Moreover, Layout B and D were both anticipated to provide all passengers with good views.

If analysing the total accumulated scores, Layout B was considered to be the preferred alternative. Therefore this concept was chosen to be the foundation for the initial development of the GTS cabin interior for the primary target group.

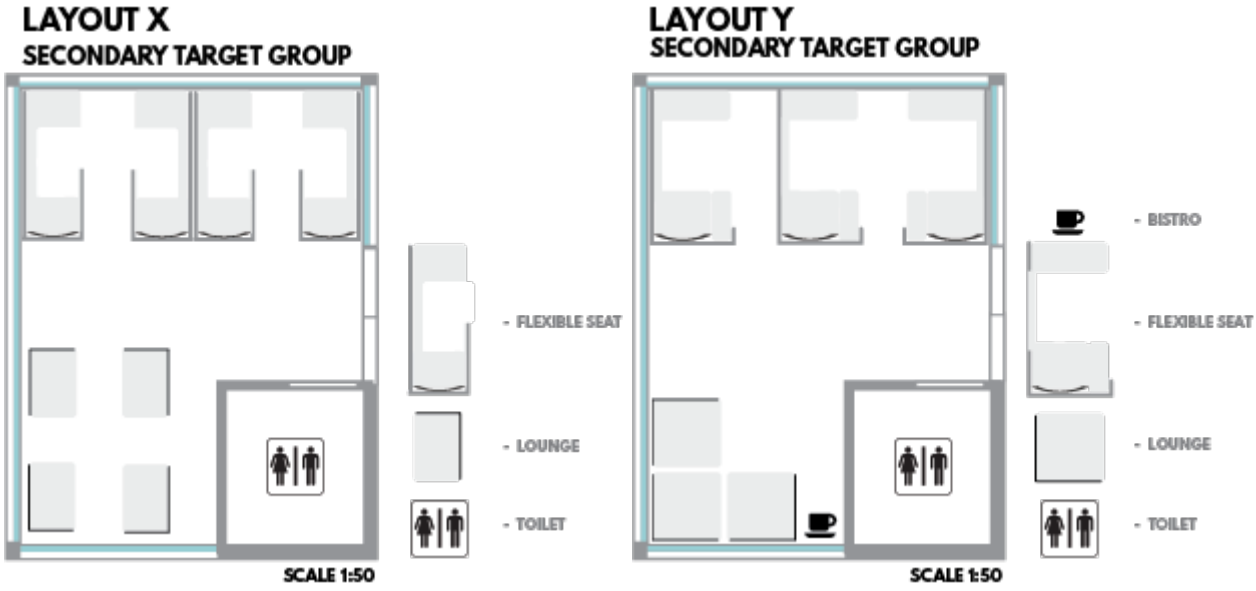
▼ *Table 1: Evaluation matrix.*

REQUIREMENTS	WEIGHT	A	B	C	D
Accessibility					
Available space for wheelchairs and prams	5	1	3	1	3
Turning circle, 1.5 meters for wheelchairs	3	3	3	3	2
No obstacles, free way	4	2	2	1	2
Enable sufficiently broad entrance	5	3	3	3	3
	Total	37	47	33	44
Personal Value					
Personal Space	4	2	3	2	0
Proximity and availability of cabin luggage	3	2	3	1	3
Oversight of luggage	5	2	3	2	1
Legroom	3	3	2	2	2
Minimise nausea	2	1	2	1	3
	Total	35	46	29	26
Other					
Enable evacuation	5	3	2	1	2
Provide view for everyone	3	1	3	1	3
	Total	18	19	8	19
TOTAL SCORES		**90**	**112**	**70**	**89**

8.6.5 Layout Experimentation and Selection - Secondary Target Group

As described earlier, the interior for the secondary target group did not have any requirements on accessibility. The development of this secondary interior instead focused on increasing the degree of comfort and on generating a pleasant, multi-functional environment for weekly commuters. This interior was further not restricted by any requirements on passenger amounts. Instead, the interior and the seating measurements were evaluated on the basis of the anticipated levels of comfort. Some of the desires of the secondary target group were however considered throughout the layout experimentation for the weekly commuters. These desires included for example the ability to work, sleep, socialise and move freely, as well as the availability of a toilet. Parallel to experimenting with the layout in the cabin an idea of multi-functional seats was developed. Furthermore, some layouts and seating environments, including different seat measurements, were tested and discussed. This phase of the layout experimentation resulted in several layout concepts. Two of these concepts were finally evaluated against each other.

The first layout, that included the multi functional seat, can be found in the figure below (see Layout X). In this layout, four private and flexible seats that all allowed for sleeping, working and relaxing, were placed in the the frontmost part of the cabin. Cabin luggages in this layout could be stored in front of the seats, or in the frontmost part of the cabin, between the seats. A lounge area with inviting low chairs was positioned in the backmost part of the cabin to offer the passengers a more social area. This was argued not only to stimulate interpersonal communication between friends or colleagues, but also to encourage communication between two or more strangers. Moreover, a toilet was placed in the back of the cabin. Although the overall idea of the design was seen as interesting, the available space was nevertheless anticipated to be inadequate. The reason for this was the increased need for comfort during longer journeys. The interior was therefore changed accordingly and the final layout design for weekly commuters accommodated three, more generously proportioned, multi-functional seats in the frontmost part of the cabin. This final layout can also be seen in the figure below (see Layout Y). Furthermore, the lounge area was also modified. Instead of accommodating four chairs, three chairs were positioned in the lower left corner. The ordering and layout of these chairs were further changed between the two concepts. This was believed to generate a more available and inviting atmosphere. In addition to this, a bistro was also added in the vicinity of the lounge area, to further increase travel pleasantness.



▲ *Figure 35: Illustration of the two evaluated interior layouts for the secondary target group.*

8.7 Initial Development of the Interior Seating Environments

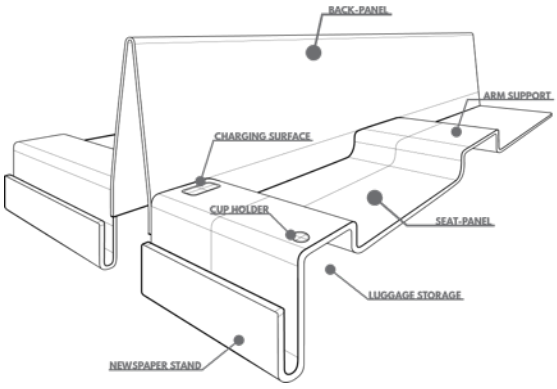
The initial development of the first GTS cabin interior was an iterative process in which the ideas went through various cycles of brainstorming, sketching, discussions and development. The ideas revolved around the conceptualisation of selected layout B (see 8.6.4) and aimed to generate a pleasant experience for passengers between Uppsala and Arlanda Airport. Moreover, different ideas and forms were discussed in relation to manufacturability and their expressions, in relation to the previously defined expressions (see 8.4) and established expression boards (see 8.5).

8.7.1 Primary Target Group

The sections below describe the process of ideating the interior seating environment for the primary target group.

Development of Panels

The idea of utilising panels to conceptualise the chosen floor layout rapidly emerged during the design phase. The sketched panel below (see figure 36) consists of two parts; one seat panel that provides seat areas and arm supports, and one panel that constitutes the back support. Furthermore, the arm supports in the seat panel are multifunctional. The spaces underneath each of the arm supports are intended to securely keep cabin luggages in place. By making the storage of luggage into an integral part of the seat panel, the overall expression of the seating environment is perceived as more clean. The end of the seating panel is designed to accommodates newspapers. Moreover, the arm supports are also intended to be equipped with surfaces for wireless charging of phones and tablets. In addition, the back supports are slightly angular to improve ergonomics. However, to further increase level of comfort and to achieve the desired expression, seats had to be added on top of these panels as well (please refer to the next section for the seat development). Nevertheless, the angular back panels allow the mounting of s-shaped seats or seats with angular back supports.



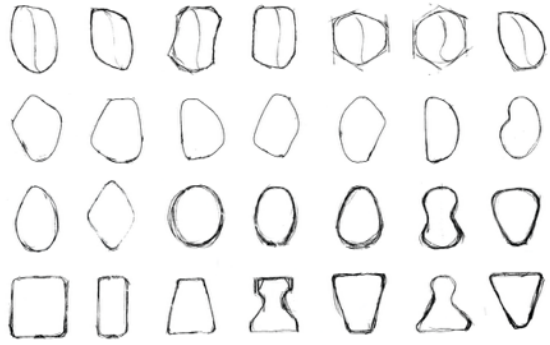
▲ *Figure 36: Illustration of the developed panels.*

The panels are design elements that are both suspended from the floor. This immensely simplifies the cleaning underneath the panels. By means of suspending these design elements a more spacious and light expression can be achieved. However, to avoid distrust in rigidness and durability both the material choice and the thickness of the panels are significant. A plausible construction of these suspended panels would be to design a structure on the panels' b-surfaces that could support the weight of both the passengers and panels. Furthermore, the seats should be easily replaced and mounted on both the panels. To facilitate for seat assembly the lowermost part of the back panel does not have any curvature. Moreover, the panels consist of simple and regular shapes. Repetition is used to change seating configurations. All used radii are set to the same value to simplify manufacturing. Seeing that dust can easily accumulate in corners and narrow spaces, these radii together with the overall design of the panels further simplifies the process of cleaning. In addition, the panels will not extend higher than the lowermost parts of the windows, to ensure all passengers outward views at all times.

Development of a Seat

The initial development of the seat was introduced by means of sketching different simple shapes. Both organic shapes and soft transitions were tried out during this initial phase. In figure 37 below a selection of some of the generated shapes can be found. These simple shapes were later used as inspiration when generating more detailed perspective sketches of different chair concepts (see also

figure 38 for a selection of these perspective sketches).



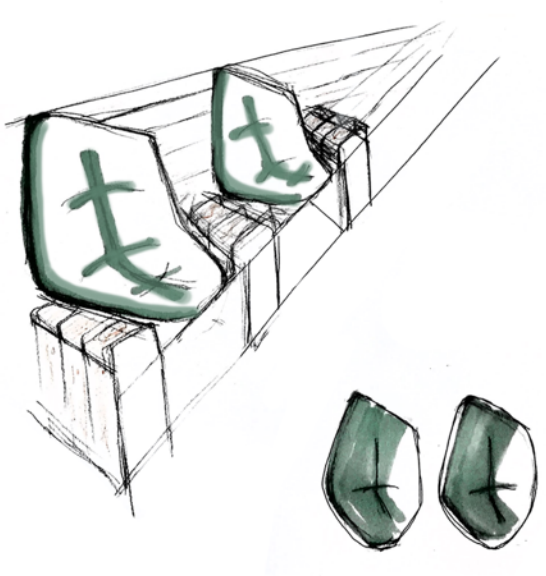
▲ *Figure 37: Exploration of different seating shapes.*

▼ *Figure 38: A selection of the sketched perspective seats.*

The perspective sketches that were found to match the desired expression of the seat were selected from the perspective sketches and made in clay (see also figure 39). This was done to evaluate the shapes in three dimensions, on the basis of the generated silhouettes. The expression of the clay models were discussed and these models were sketched in perspective together with the designed panels in order to enable interpretation of the overall expressions. A seat with obliquely cut top edges of the back support and tapered edges on the seating surface was finally selected (see figure 40). This particular seat was chosen due to its perceived simplicity and asymmetry or directionality. Moreover, the tapering of the seating surface was aimed to increase the expression of lightness.

▲ *Figure 39: Image of different seat models in clay.*

The slightly organic and directional seats interrupts the regularity of the panels (see figure 36), while still maintaining balance through repetition. This results in a more vivid expression. However, the main aim of the angled edge or directionality of the back support is to draw attention towards the arm supports. The directionality is intended to clarify which arm support that belongs to which chair, and further implicitly emphasise the available space for each passenger. In this way the in-built personal space of the panels can be more easily understood.



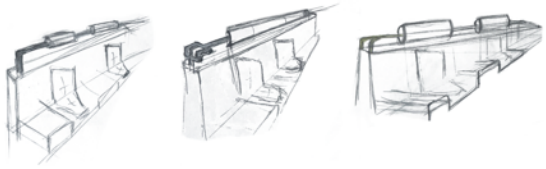
▲ *Figure 40: Perspective sketch of the final seat.*

Development of Details

The development of details included for example the development of handrails, fastening solutions for wheelchairs and prams, a ticket machine, standing rails, a foldable seat as well as luggage racks and shelves. These details were developed by means of sketching and brainstorming.

▲ *Figure 41: Sketches of different handrails that aimed to improve balance for passengers.*

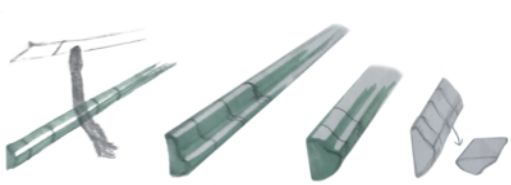
Three different kinds of handrails for balancing purposes were developed. The first was a smaller type of handrail that could provide balance for passengers with reduced mobility. The second was a larger handrail intended to be placed on top of some of the back panels, in the case that two back panels were positioned against each other (see also fig. 41 and 42). The third handrail was intended to be used to simplify alighting and descending to the seats for passengers with reduced mobility (see fig. 43).



▲ *Figure 42: Sketches of different solutions of a larger handrail.*

▼ *Figure 43: Sketches of different handrails that were intended to be positioned adjacent to priority seats.*

Furthermore, different fastening solutions for wheelchairs and prams respectively were developed. For example, one idea was a roller-coaster-like fastening of passengers in wheelchairs, in which a shoulder harness was lowered and pressed lightly against the passengers' breasts. Another idea was to secure wheelchair passengers and prams with the use of ordinary seat belts. It was further seen as important that the solution enabled wheelchair users simple fastening that did not require help from others.



▲ *Figure 44: Sketches of different standing supports.*

Since a high degree comfort was not strictly needed for shorter journeys, several ideas of standing supports were also developed. These supports (examples can be seen in fig. 44 above), can if desirable, be added in the final interior. It was however seen as important by the project customer that all passengers were seated throughout the entire journey. Moreover, a foldable seat for a parent with a pram was developed. This seat was later integrated into part of the back panel that was designed to accommodate wheelchair users. This was further done to increase flexibility, and to possibly enable seating for other user groups as well, if neither a wheelchair user, nor a parent with a pram is present in the cabin.

8.7.2 Secondary Target Group

In the design of the interior for the secondary target group form elements from the interior for the primary target group were reused. The difference was however that the secondary interior had to express a higher degree of comfort. The design of this secondary interior seating environment was developed in parallel with the layout experimentation.

Development of Panels

Each seat is embraced by surrounding panel surfaces (see also figure 45). On one side of the seat the panel is obliquely cut and directed towards the floor to improve the view for all passengers. On the other side of the seat, the panel only extends a short distance to generate a sense of personal space while avoiding the creation of a confined space. This small extension also enables passengers to have oversight over the remaining cabin interior. Apart from adding to the expression of comfort, the embracing panel is intended to provide passengers with pleasant and relaxed personal spaces where the needs for both sleeping and working can be easily met. The second panel, on which the seat is mounted, has the same shape and radii as the seat panel for the primary target group. However, the arm support for the secondary target group is made narrower than the arm support for the primary target group. Moreover, the seat area is made wider for the secondary target group to enable an increased level of comfort. In addition, a third panel is also added. This last panel is intended to enable unloading of belongings and further function as an adjustable table for work related purposes.

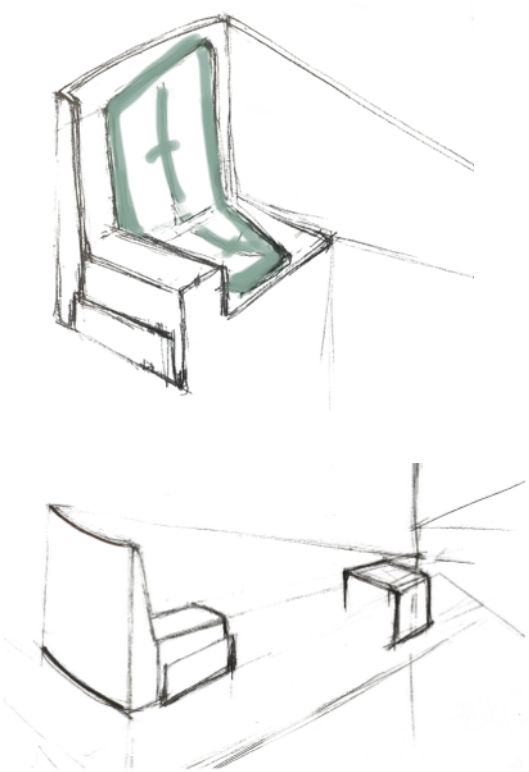
The space in front of each seat is intended to function as storage space for cabin luggages. Cabin luggages can either be stored under or in the vicinity of the table. Seeing that the space underneath the arm support cannot accommodate cabin luggage it could instead be used for smaller bags, like handbags or laptop cases.

Development of the Adjustable Seat

The shape of the chair that was developed for the primary target group was found to meet the functional requirements in this secondary interior environment as well, with some modifications. The chairs for the secondary target group are given more ergonomic expressions and larger dimensions to increase level of comfort. Moreover, a directionality is also given to these chairs to indicate that it is comfortable for passengers to rest their heads on the longer panel. In addition, head cushions can easily be mounted on the longer panel surface to provide users with alternative sleeping or resting positions.

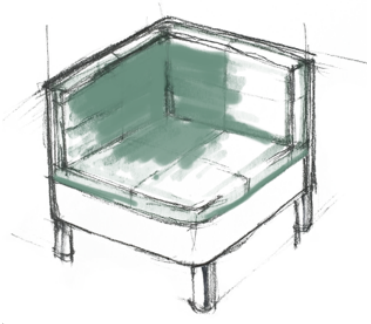
Development of a Social Area

Inviting pieces of furniture were desired to encourage interpersonal communication in the lounge area of the cabin. The selected concept that accomplished this was a quite low square shaped lounge chair (see also fig 46) that was designed with larger radii than the radii used in the surrounding seating environments. This was done to create contrast between the two sections of the cabin interior (the lounge area and the personal space area). Furthermore, the chosen chair had a simple and clean design in order to generate calmness. Moreover, cushions were added in order to entice passengers into interpersonal communication with strangers or colleagues over a cup of coffee or tea.



▲ *Figure 45: Perspective sketches of a seating compartment.*

▼ *Figure 46: Perspective sketch of a lounge chair.*

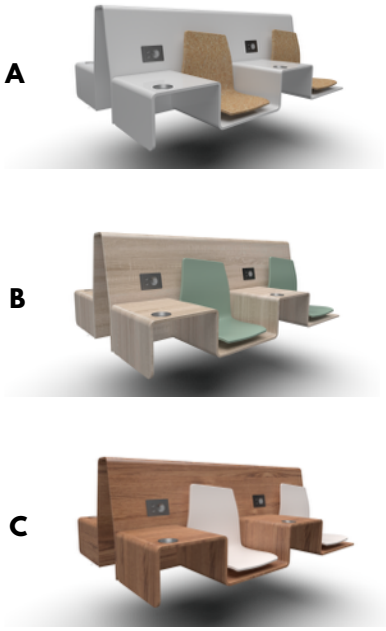


9. CONCEPT DEVELOPMENT - PRIMARY TARGET GROUP

The following sections present both the finalisation and materialisation of the seating environment for the primary target group.

9.1 Semantic Evaluation of Seating and Panel

Three different material-combination concepts, as shown in the renderings A-C below, were evaluated against some of the earlier defined product expressions (see section 8.4) to decide on the most suitable direction for the final part of the concept development. In order to simplify the process and to only evaluate the different panels together with different seating, all of the renderings below have the same materials for both the power outlets and the cup holders. Furthermore, the ten test participants were asked to base their evaluations solely on their perceptions of the panels and seatings. In addition, the participants were also asked about their first impressions of all the concepts prior to evaluating each concept.



▲ *Figure 47: Renderings of three materialised concepts of seating environments.*

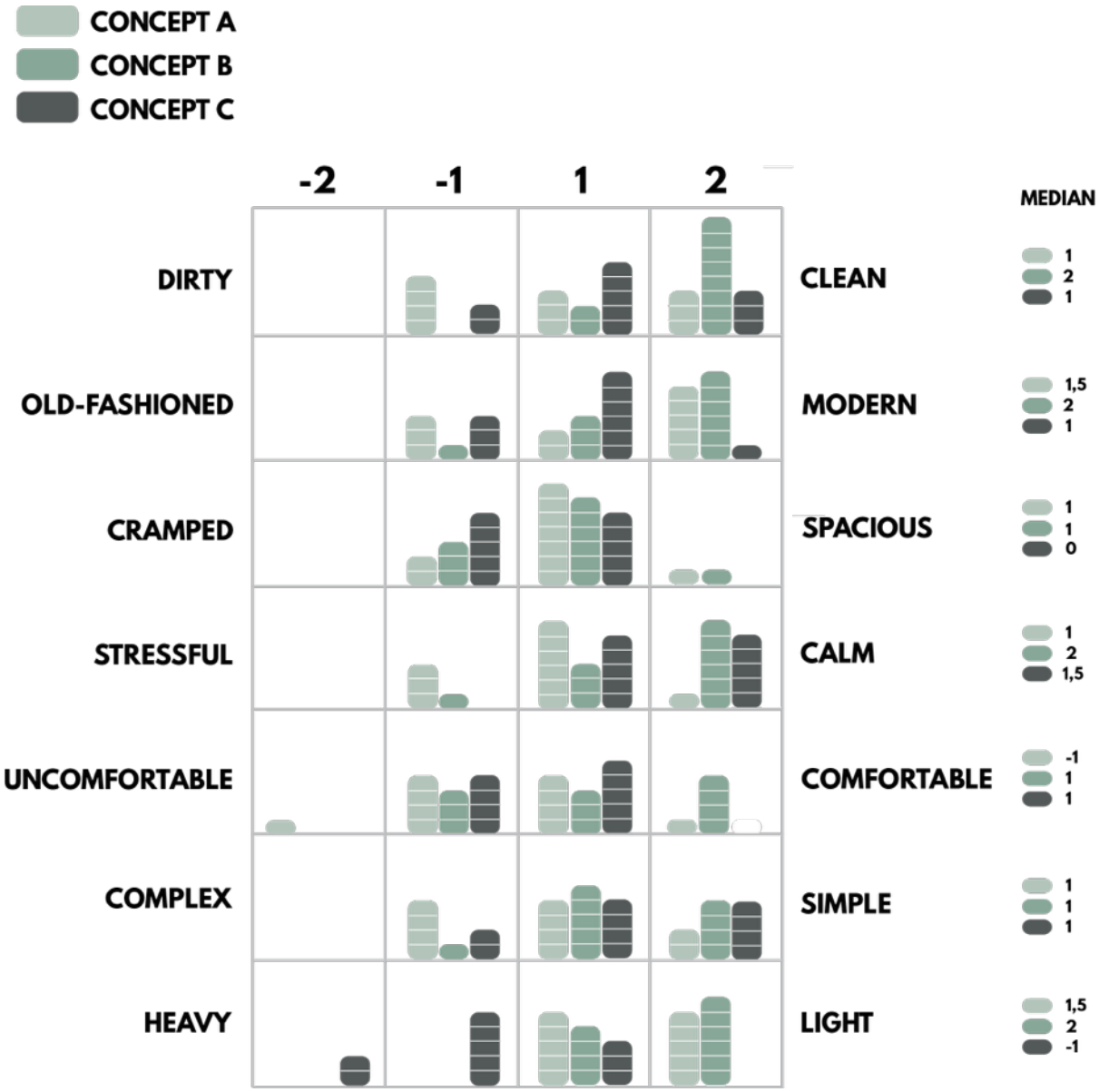
In Concept A, the panel was given sheet metal surfaces, with white, glossy finishes, this in hope to generate a modern and clean expression. The seating material in the first rendering was cork. The reason for this choice was partly because cork was seen as a natural and contemporary material (that is gradually more common in newly designed pieces of furniture) and partly to evaluate if cork chairs would be perceived as soft and more inviting.

In Concept B, the panel consisted of light, bent oak laminate surfaces, treated with soap, to create a matte and soft surface and to generate a modern and light expression. To complement the wooden surfaces in rendering B, the material of the seating was determined to be grey-green coloured matte polypropylene. In line with findings in theory the green colour was chosen in order to create a harmonic and inviting expression, but also because green was found to be a relatively culturally neutral and timeless colour.

In contrast to the two lighter concepts, the panels in Concept C were dark-brown bent oak laminate surfaces. The seats in the last concept were given off-white, matte, polypropylene surfaces, this to generate contrast but also in hope to balance out some of the darkness from the panel as well as to create a cleaner expression.

The illustration below visualises the result from the semantic evaluation, in form of the distributions of the semantic evaluations for Concept A (in grey colour), Concept B (in green colour) and Concept C (in brown colour) respectively. Seeing that the distribution of Concept B is evidently more concentrated around higher ratings, Concept B was identified as the most preferred and appropriate alternative. Concept B was seen as very clean, modern and calm. The participants' first impressions of Concept B confirmed these results. Concept B was described with terms such as "calm", "modern", "harmonic", "clean", "lounge", "nice" and "light". After the semantic evaluation the participants were also asked to choose a favourite concept. 70 % of the participants chose Concept B.

▼ *Diagram 6: The result from the semantic evaluation.*



Moreover, Concept B scored the highest on the expression "comfortable". This was found to be related to the perceived softness and calmness in this concept. Concept A was perceived as slightly more spacious than Concept B. The spaciousness that was perceived in this concept was found to be related to the white and glossy metallic surface. The participants' first impressions of this concept were described with words such as "cold", "fragile", "plastic", "hospital", "sterile", "spacious" and "innovative". The perceived fragility was deemed to be related to the cork seating, whereas the whiteness created associations to hospitals. These expressions were seen as undesirable. Furthermore, concept A was also deemed inappropriate, considering the fact that cork, regardless of its naturality, is a scarce material that is not suitable in a public environment due to its inability to repel some substances it would be commonly subjected to.

Concept C was perceived as quite heavy and gloomy, due to the darker material choice of the panels. However, some participants believed this concept to be modern and warm. However, many participants did not consider Concept C to be spacious. If comparing to the distribution of the expression "comfortable" between Concept B and C, fewer participants perceived Concept C to be comfortable.

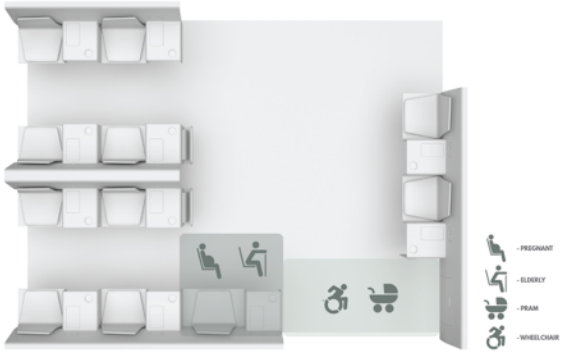
▲ *Figure 48: The selected colour scheme.*

Based on the semantic evaluation a colour scheme (see above) could be generated. This included the green colour of the seats as well as the soap treated oak of the panel, both from Concept B. Seeing that the final interior will need wall paint as well as floor material and details, a more neutral colour was desired that could complement the already chosen colours. The complementing colours were therefore set to three different shades of grey. These colours were found to match both the light-greyish oak and the green colour of the seats.

9.2 Interior Floor Plans

The illustrations below visualise the final interior floor plan of the developed seating environment. The first illustration aim to clarify the placement of priority seating for elderly-, pregnant- and wheelchair users as well as for parents with prams. As can be seen the available space space for all these user groups is sufficient. Elderly and pregnant passengers have access to priority seating directly in front of the entrance, extensively simplifying navigation. The open floor space without obstacles in the vicinity of the door offers wheelchair users a generous turning diameter of 1,5 m. Furthermore the combined wheelchair and pram seating area provides sufficient space for users with these aids.

The second illustration below indicate the potential placement or storage areas for larger luggages. In the upper right corner of the layout, space is left for the placement of storage of larger luggages. However, this storage still has to be developed. To better make use of the available space and to accommodate bulky or inconvenient belongings shelves are intended to be placed close to the roof, above two of the seating rows that are positioned alongside the longer interior walls of the cabin. These shelves can further be seen in the illustration below. Moreover, cabin luggages can be placed between the seats of all passengers, under the arm supports of all seating panels.

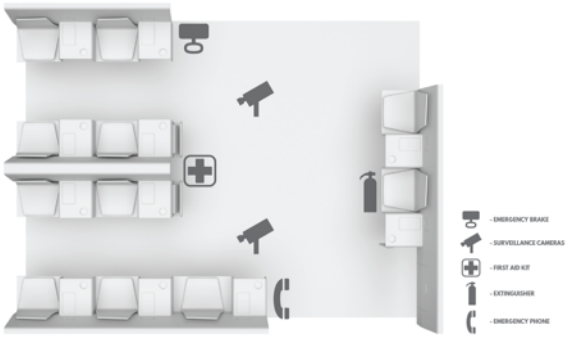


▲ *Figure 49: Placement of priority seating in the final layout.*

▼ *Figure 50: Storage possibilities for larger luggages.*

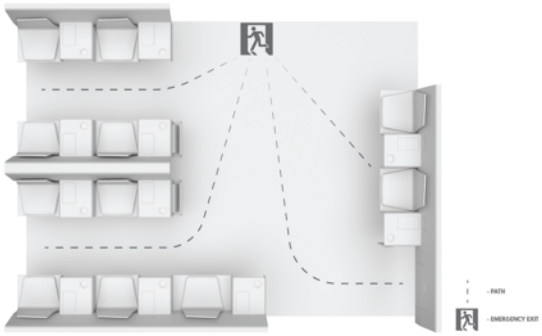
The symbols in the third illustration show suggested placements of the safety equipment that was anticipated to be necessary in GTS cabins. The safety equipment was further positioned in the interior layout by means of taking recommendations from Svensk Kollektivtrafik (2016c) and the result from the user studies into account. Depending on type of cameras used, a maximum of two surveillance cameras are needed in order to cover the entire interior of the cabin. A sign that informs passengers of the surveillance cameras should also be used as a preventive measure, to increase the perceived sense of security. This was viewed as important by the participants of the dialogue. Moreover, one or several fire extinguishers can be placed underneath the seat panels. A suggestive placement of a fire extinguisher can be seen to the right in the figure below. The space under this particular seat was anticipated to be the most available and accessible space for most of the passengers. Furthermore, an emergency phone is placed on a height of 1,10m in order to increase accessibility for wheelchair users. The emergency phone is positioned close to the intended exit as on today's transportation systems, thus matching to current knowledge of passengers. A first aid kit is placed in the middle of the cabin to increase its accessibility as well. In addition, trash bins (not illustrated below) can be placed on the wall between the seat rows in the front of the cabin as well as close to the exit.

The fourth illustration shows the free pathway from each of the seat rows to a suggested emergency exit. Even if emergency exits would be placed elsewhere this layout would facilitate evacuation because of the achieved even distribution of passengers. During the layout selection phase the potential of evacuation was one of the evaluation criteria. The final layout was viewed as the most appropriate layout from an emergency point of view. In this layout no obstacles or luggages hinder evacuation. Additionally, in the case that evacuation is needed passenger congestion is minimised due to the even distribution of passengers.



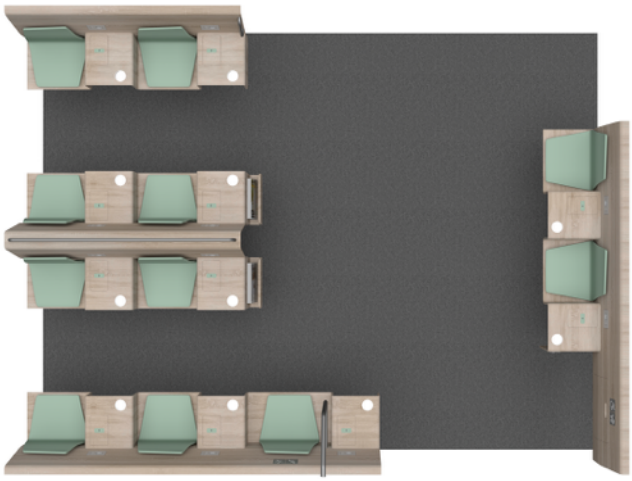
▲ *Figure 51: Suggested placements of safety equipment.*

▼ *Figure 52: Evacuation paths from the seats to a proposed emergency exit.*



9.3 Materialisation and Visualisation

In this section the detailed product development, including dimensioning, materialisation and visualisation of the final concept, is presented. The selection of measurements for the different seating panels and seats was made by taking both the anthropometric measurements (Appendix 10) and the measurements from the requirement list (Appendix 7) into consideration. For the evaluation of the final concept based on the list of requirements, please refer to Appendix 11. The illustration below visualises the top view of the final seating environments for passenger transportation between Uppsala and Arlanda Airport.



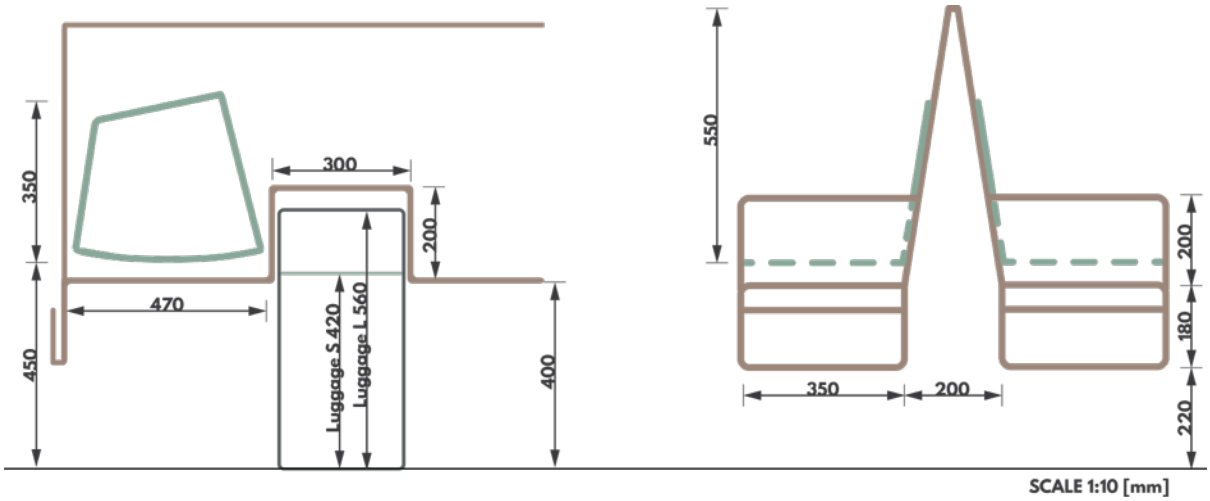
▲ *Figure 53: Top view that illustrates all of the four materialised seating environments.*

9.3.1 Design of Panels

Initially in the process of designing the panels detailed drawings with dimensions (see figure below for example) were established to facilitate for the proceeding computer aided modelling and visualisation. All of the four final seating environments (see figure 53 above) make use of two panels; one back panel, that is placed behind the back support of the chairs, and one seat panel, that is positioned underneath the seating areas of the chairs. Furthermore, the seat panels provide users with arm supports as well as with luggage storage for cabin luggage (see also illustration 54 below). Each of the panels are either made of soap treated oak- or white ash laminates. This material choose was done on the basis of the earlier conducted semantic evaluation of colours and materials. The panels will further be cold pressed in order to enable the desired shapes.

Seat Panels

All the seat panels (see example of one of the seat panels in the figure 55 below) have smooth radius transitions between their otherwise flat surfaces. The flat seat surfaces facilitate the process of assembling and replacing chairs and the flat arm support surfaces provide passengers with unloading areas. The flat surfaces further simplify future chair redesigns and allow for the adding of new functionality or other desired amenities. Moreover, the designed arm supports are multifunctional and provide users with space for storage of cabin luggage as well as luggage proximity.



▲ *Figure 54: Drawings of the seating environments. The dimensions shown above were reused for all panels.*

▲ *Figure 55: One of the seat panels with priority seating. One seat area has increased space for improved mobility.*

This was found to be important in the user studies. In addition, the width of the arm supports also increase the interpersonal distances between all passengers. If analysing all chosen dimensions the personal space is, in accordance with theory, increased in relation to the available space in current means of transportation. Moreover, all seat widths are at least adapted after anthropometric measurements between the 5th and 95th percentile of the Swedish population. Finally a perceived symmetry and thus balance is generated through repetition of the two form elements (an arm support and a seat surface). This repetition also adds to the uniform and clean expression, and ultimately results in a more clear gestalt.

On the top of all arm supports, wireless charging surfaces are available for charging of phones and tablets (see also figure below). These amenities are chosen on the basis of the results from the user studies, that indicated the high use of mobile phones as well as the needs for WiFi and power outlets on board of transportation to airports. Moreover cup holders in deep drawn aluminium are also available for the users. Because of the relative form simplicity of the seat panels, other components or details could easily be added.

▲ *Figure 56: Top view of the arm support with a wireless charging surface and a cup holder.*

Back panels

The rendered image below illustrates one of the designed back panels. This particular panel is intended to be assembled with the seat panel in figure 55 above. Both these panels, together with three seats, all constitute the seating environment that is placed against the wall on the opposite side of the suggested entrance. Furthermore, the back panels are given curvature to better match the the shape of the seats' back supports. The bottom parts of the back panels further has no curvature. Instead these parts of the panels are flat to facilitate assembly of the panels and the chairs as well as to avoid gaps between different components. The top elements of the back panels were initially rounded (as can be seen in figure 36). However, to increase unity by better matching the expression of the seat panels, these top elements are instead made flat. Moreover, the transition between the the curved surfaces of the back panels and the flat top surface is given the same radius as the radii that is used in the seat panels. In addition, the areas of the back panels that are positioned over the arm supports are equipped with power outlets and two usb sockets. The placement of these amenities are made with regards to the gestalt law on element proximity.

▲ *Figure 57: Illustration of the back panel that corresponds to the seat panel in figure 55 above.*

Construction and Manufacturing of the Panels

▲ *Figure 58: Different panel thicknesses. From the left to the right: 20 mm, 15 mm and 10 mm.*

The thickness of the laminate surfaces was evaluated by means of visualising different thicknesses in Alias AutoStudio. The aim of this was to find a thickness that was perceived as durable enough while still maintaining the objective trait 'light'. Thicknesses of between 15 and 20 mm were perceived as too heavy, whereas a thickness of 10 mm was perceived as too thin and unstable. Therefore the final thicknesses was determined to 12 mm.

A manufacturing process that was identified to be a suitable and efficient way of manufacturing the panels was wood laminating proceeded by cold pressing, drilling and sawing. Wood laminates can be created by molding and bonding together multiple sheets of veneer with the use of adhesives. The generated laminates can finally be cold pressed to generate the desired form of the panel pairs. This can be achieved by forcing the laminates into molds in which the laminates are kept for 24 hours (Thompson, 2007). To increase resistance to scratches and shocks the finished panels can be lacquered. Wood laminate was further chosen as the panel material because of the results from the semantic evaluation. Moreover, the light, soap treated oak was perceived as modern, luxurious and Scandinavian. However, for cost and weight optimisation purposes, the wooden laminates could be replaced by plastic laminates with the same expression.

All panel pairs (the different back and seat panels) are intended to rest on frames (see figure 59 below for an example of this) that are made of a more durable material than the laminates. These structural frames are intended to strengthen the seat areas as well as to take up the loads of passengers. The frames are suggested to be fixated onto the interior walls. Furthermore, these frames will also be used for the purpose of assembling all panel pairs. Moreover, to simplify the process of manufacturing, some of the panels are duplicates of each other. However, to further increase manufacturability, all panels could consist of smaller modules. One such module could for example be the arm support and seating area of the seat panel. This is however due to further development.

▲ *Figure 59: Illustration of a fundamental structural frame that will carry the panel pairs and the passengers.*

Figure 60 below finally shows the assembled panel pairs that constitute the seating

environment with room for a priority seat for elderly people and individuals with reduced mobility. By means of material use and thus similarity the two panels together result in a clear gestalt. In addition, the overall expression is perceived as simple, clean and modern.

▲ *Figure 60: Illustration of one of the panel pairs with priority seat.*

9.3.2 Design of Seating

A drawing of the chair, that included dimensions based on the anthropometric measurements of the Swedish population, was made after the selection of the final chair design (see also 8.7.1). This drawing was used together with a clay model to enable modelling in Alias Autostudio. The chair is intended to be produced in polypropylene by means of injection molding (see below for a more elaborate description). The colour of the chair is set to greyish green, this due to the high ratings of this colour in the semantic evaluation. Furthermore the choice of colour is also reinforced by theory on colour experience, indicating that green is a culturally neutral and timeless colour that further can be perceived as calming.

Shape of seat

The asymmetric shape of the topmost edge of the back support (see figure 61 on the next page) results in a perceived directionality that draws the attention of passengers towards the combined arm support and cabin luggage space, when the chair is mounted on the panels. This directionality further indicates the areas of personal space for each of the passengers, in hope to generate a feeling of privacy for the passengers. This was concluded to be important in the user studies. The directionality also draws the attention towards the arm supports, each of which provide single passengers with charging facilities and cup holders (see also figure 63 on the next page). The seat area of the chair is further tapered (see figure 62), which generates a sleek and light expression. When mounted on the panels, the silhouettes of the seats interrupts the regular, but rounded expression of the panels, rendering the overall expression more harmonic and calm. Furthermore, to increase seating comfort for all passengers the seat surfaces are slightly s-shaped as well. While this modest shaping does increase the perceived comfort, the actual seating comfort is not decreased for passengers with reduced mobility.

▲ *Figure 61: Illustration the seat in different views.*

▼ *Figure 62: Top view of the seat, which indicates the tapering of the seat area.*

Construction and Manufacturing of the Seats

The most applicable production technology that was found for the manufacturing of the seats was injection moulding. This particular technology can result in excellent surfaces and a high degree of form accuracy. Injection

▲ *Figure 63: Close-up on the seats and one of the arm supports.*

moulding is however only suitable for high volume production, due to the cost of tools (Thompson, 2007). Furthermore, the seats are intended to be made in greyish-green-dyed polypropylene (PP). PP can be injection molded into organic shapes, is tough, has good resistance to fatigue and chemicals and is slightly flexible upon compression (British Plastics Federation, 2016). These properties are all together required in public environments. Moreover, when a passenger sits down on a seat made of PP, the seat will slightly adapt to the contours of the passenger's body, which will further increase the comfort level. The hope is that this in turn will result in positive reactions from passengers, because the passengers' perceptions of the material, contrasts their actual use of the seat. This sensory collision was denominated incongruence in theory. In addition, the PP is intended to be given a semi-matte finish to better match the chosen natural wooden material of the panels.

Even though PP is a versatile thermoplastic it is non biologically degradable or compostable (British Plastics Federation, 2016). Despite the high recyclability rate of fossil-fuel based PP, the environmental impact of using fossil-fuel based materials can be seen as unjustifiable. To increase sustainability, bio-based PP could be used instead of fossil-fuel based PP. Bio-based PP can be produced from several raw materials, such as corn, biomass or vegetable oil, and be given the same properties as fossil-fuel based PP (Gotro, 2016). However, the main challenge with bio-PP, according to Gotro, is the lack of production efficiency, which drives up the costs in relation to fossil-fuel based PP.

9.3.3 Design of Luggage Storage

A quick conceptual storage shelf for luggages that are larger than cabin luggages, was developed as well (see figure below). However, to better match the proportions of the designed seating environments this concept was concluded to be in need of further development. Nevertheless, the aim of the concept was to simplify handling of larger luggages. This handling was in particular seen as problematic among passengers on board of "Flygbussarna" due to the need for high, unergonomic lifts of luggages onto luggage racks. These lifts were further hindered by the placement of pipes that were positioned ten centimetres above the shelves, which were intended to secure and prevent luggage overturning. In order to simplify luggage handling as well as to secure luggages a simple mechanism was designed for the conceptual shelf below. In the lower section large luggages can be directly positioned on the floor. When this section has been filled with luggages, the lower handle can be pulled downwards to secure all stored luggages. The users are further helped by a handle mechanism. The handle arms are equipped with gas cylinders that facilitate the process of pulling the handles up- and downwards. To secure the two desired positions of the handle arms, electromagnets are placed at the two extreme positions (the lower handle in the figure below is in its upper extreme position). Moreover, one of these electromagnets can be disabled when the GTS cabins are operating to enable automatic securement of luggage. The upper handle, securing luggage placed on the shelf works similarly to the lower handle.

The two sides of the conceptual shelf are made in glass, partly to enable all passengers oversight of their luggages and partly to clearly visualise the functionality of the handles. Apart from the rotatable handles that simplify loading of luggage, the shelf is positioned on a height of 1050 mm from the floor surface (the luggage racks on board of "Flygbussarna", are positioned 1550 mm from the floor surface) to further improve ease of luggage handling. The lower section of the shelf is primarily intended for the most heavy luggages and for luggages of passengers with impaired strength.

▲ *Figure 64: A conceptual luggage shelf and its intended placement in the interior.*

▲ *Figure 65: Suggested overhead luggage shelf.*

Moreover, the figure above illustrates a proposition of a simple overhead luggage shelf, that is intended for storage of inconvenient or bulky luggages, similar to overhead storage units on today's trains. This shelf consists of a wooden frame that holds a glass sheet.

9.3.4 Design of Details

Handrails for Increased Balance

Handrails were primarily identified to be required in order to provide certain user groups, such as elderly passengers, with balance when descending or ascending to the seats. Moreover, a handrail between the two middle panel pairs (see figure below) was considered to be essential in order to prevent the colliding of passengers due to the relative low height of the panels. However, by means of prototyping and testing this risk was concluded to be low. Nevertheless, a handrail was added to the middle panels as a preventive measure. Moreover, the initial part of this handrail had the potential of increasing the balance of passengers that are moving inside the cabin. Therefore, different handrail shapes were generated and visualised with computer aided modelling, as can be seen in the figure below.

▲ *Figure 66: Illustration of the middle back panels with three different types of handrails.*

Securement of Wheelchairs and Prams

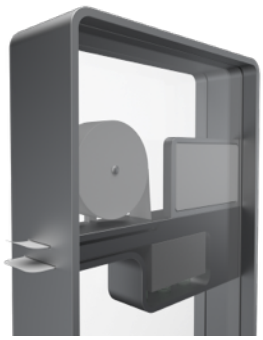
Securement of wheelchairs and prams was seen as important. Therefore, different concepts for such securement were developed. The final securement consists of two sets of single-hand-maneuverered seat belts, positioned on each side of the space intended for prams or wheelchairs. This simple solution was chosen because the securement could be adapted to suit the needs of both wheelchair users and parents with prams. Moreover, the seat belts are intended to be easily accessed and used by the two user groups to increase independency of these users.

▲ *Figure 67: Rendering of a simple safety belt buckle on the seat panel adjacent to the priority seat for wheelchairs and prams.*

Ticket Machine

Due to the high degree of airport security in combination with currently increased safety risks at airports, some flight passengers exhibited surges of anxiety prior to arrival at airports. In hope to reduce some of this anxiety a conceptual idea of ticket machine was generated (see also illustration on the next page). Assuming that the service design of GTS journeys has been carefully designed in the near future, the payment system will either be fully automatic or make use of some smartphone application or physical smart cards in combination with some ticket reader. In the case of the two latter payment alternatives, passengers could choose to show either a personal smartphone or smart card to the reader. By means of this action, an onboard ticket machine could print both boarding tickets and potential luggage tags (see figure below) for larger luggages, if desired by the passengers. Moreover, for this to work efficiently automatic check-in lanes

for luggages would have to be available in the vicinity of the GTS station at Arlanda Airport. In addition, the aim of the printing opportunity is to streamline the process at the airport, thereby reducing congestion of people at airports and thus also decreasing the risk of airport attacks.



▲ *Figure 68: Rendering of a schematic ticket machine.*

Digital Information Display

Furthermore, a suggestion of a digital information display was also designed. This can be seen in the figure below.

▲ *Figure 69. Design suggestion of a digital information display.*

9.4 Final Visualisations

9.4.1 The Four Developed Seating Environments

The four figures below illustrate the final seating environments and their respective placements in the interior of the GTS cabin.

The first seating environment is illustrated in figure 70 below. The flat seat panel surface that is positioned under the left seat is in this environment widened to conform to needs of individuals with reduced mobility. To indicate that this seat is a priority seat, two symbols that illustrate passengers with reduced mobility, are placed above the seat, on the back panel. Furthermore, the signage has sufficient contrast to its surrounding environment. Moreover, the priority seat is placed directly in front of the entrance of the cabin to facilitate orientation and movement for prioritised users.

The figure below visualises the seating environment that is positioned directly adjacent to the entrance. The back panel used in this environment is further duplicated and used twice in the middle seating environment as well. Moreover, the seat panel of this particular environment can be used for two to three of the four seating environments.

▲ *Figure 70. The seating environment positioned against the left wall of the cabin.*

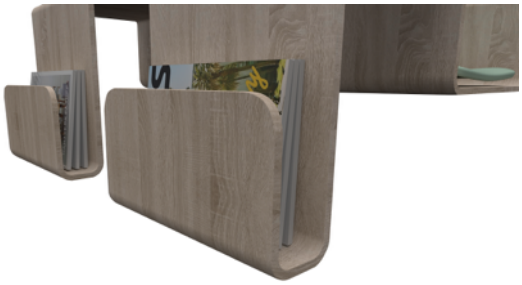
▼ *Figure 71: The seating environment positioned against the right wall of the cabin.*

The seating environment illustrated by figure 72 has priority seating either for a wheelchair user or a parent with a pram. Similarly to the initially described seating environment with priority seating, the priority seating in this environment is also indicated by two symbols, one of a wheelchair and one of a pram. Both wheelchairs and prams can be securely fastened by the use of two sets of safety belts, on of which is visible on the rightmost part of the seat panel. The other set of safety belt will be positioned on the wall on the direct opposite side of the first safety belt. To allow seating for a parent with a pram, a collapsible chair is provided with the simple pull of a handle recessed into the back panel.

The final seating environment (see figure 73 below) is positioned in the center of the cabin's front. The seat panels in this environment are slightly continued from the arm supports and shaped into magazine holders (see figure 74 below). These holders are positioned towards the center of the cabin, making travel- and lifestyle magazines available for all boarding passengers.

▲ *Figure 72: The seating environment in the back of the cabin, with priority seating for either a wheelchair or a pram.*

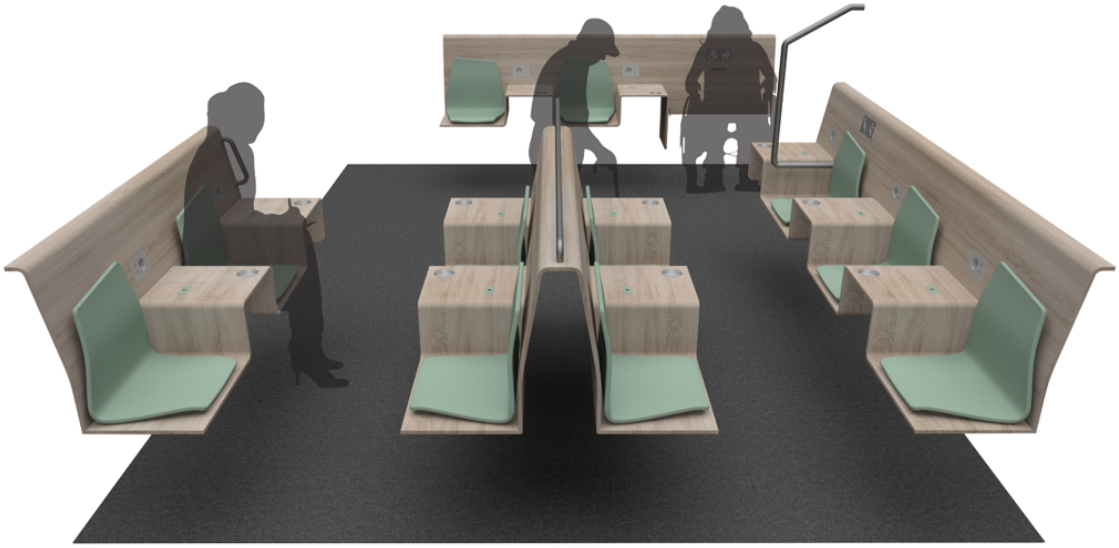
▼ *Figure 73: The seating environment in the middle of the cabin.*



▲ *Figure 74. Magazine holders on the middle seat panels.*

9.4.2 Interior Visualisation

The illustration below visualise the developed seating environments as well as silhouettes of potential users, to increase comprehension of the used scale.



▲ *Figure 75. Final visualisation of the interior seating environment for the primary target group.*

10. CONCEPT DEVELOPMENT - SECONDARY TARGET GROUP

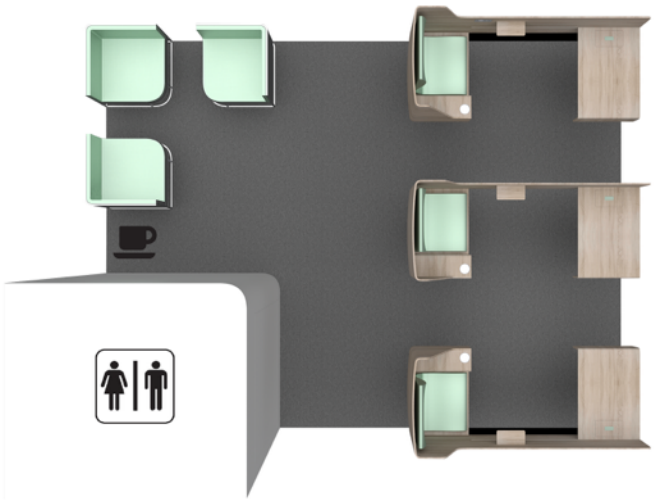
10.1 Interior Visualisation

The illustration in figure 76 below shows the final rendered layout for the secondary target group. This particular layout is intended to accommodate three passengers. All passengers have in this interior access to individual seating compartments (elaborated in 10.1) as well as a lounge area (elaborated in 10.2) and a toilet.

10.1 Design of Seating Compartments

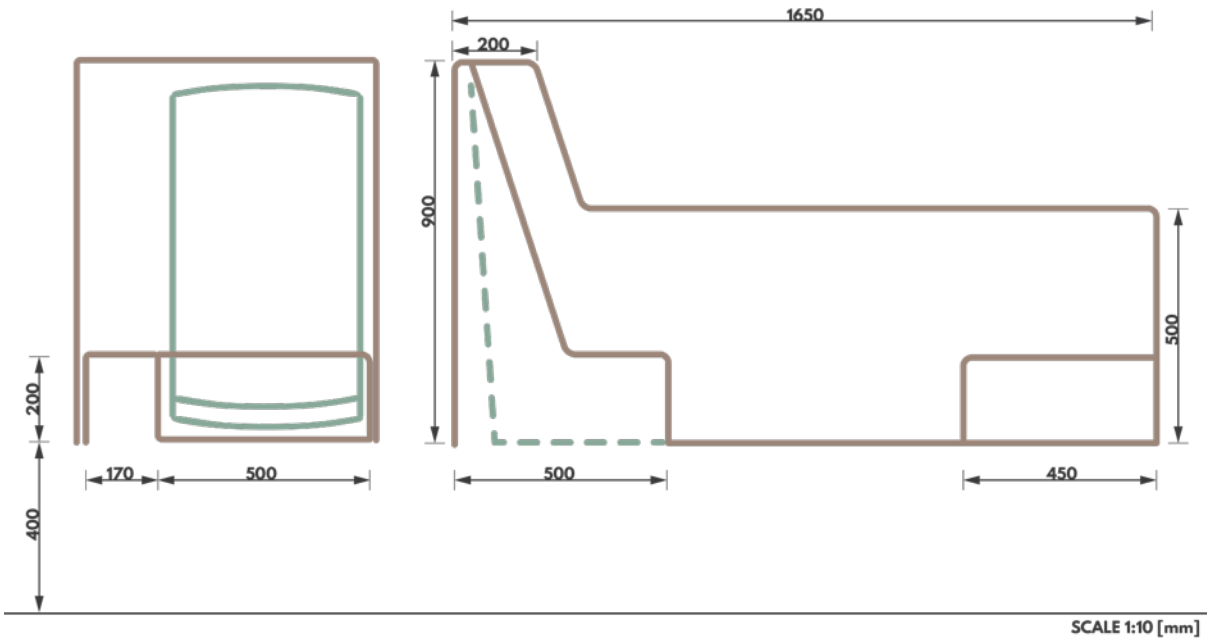
Detailed drawings of both the two designed panels, together with a chair and a table, were made in order to facilitate computer aided modelling. These drawings can be found in figure 77 below.

The initial idea was to accommodate four weekly commuters in the cabin for the secondary target group. However, after the layout experimentation it was concluded that an amount of three passengers was more appropriate in order to generate a high degree of comfort, which was required for a journey



▲ *Figure 76: Rendered illustration of the interior seating environment for the secondary target group.*

▼ *Figure 77: Drawings of the seating compartment.*



of two to three hours. The higher degree of comfort could be achieved by increasing the seat width, while maintaining the dimensions of the aisles between each of the seat compartments.

Each seat compartment consists of four parts; two panels (one seat panel and one back panel), one seat and one table. All these elements are found in figure 78 below. The seat is intended to provide better back support by extending to the topmost part of the back panel. To further increase comfort and to enable blood circulation of its users, the seat will be upholstered in fabric and allow for adjustable angulation of both the back and seat support surfaces.

▲ *Figure 78: Rendering of the seat compartment.*

The panels and the table will be manufactured by means of laminating proceeded by cold pressing. In the design of these seating compartments big radii are used. The width of the arm support is made small to enable the accommodation of three relatively wide seat compartments in a space limited to a length of 4, and a width of 3 meters. Furthermore, a large, movable and adjustable table is made available for the users. The initial position of this table is at the outermost end of the back panel, in front of the seat. Passengers can alongside a metal rail pull the table towards the seat to either create a work space or an area for unloading of belongings. Each table is equipped with wireless charging surfaces as well as power outlets. Moreover, a small shelf is positioned on the back panel, in the vicinity of the seat area for storage of mobile phones. In addition, a power outlet and two usb sockets can be found adjacent to this shelf.

10.2 Design of Lounge Seating

The lounge area consists of three chairs for the three accommodated passengers as well as a cafe corner. The chairs (see figure below) are square shaped with big radii in the middle of the back support surfaces as well as on the seating areas. This shaping was done in hope to increase the comfortability of sitting in three different directions. To invite passengers to the lounge area the three chairs are asymmetrically ordered, as if one chair is missing from the overall composition, and all chairs are given soft cushions covered in fabric. The three chairs are further perceived as a gestalt because of the gestalt law of closure. Moreover, the frameworks of the chairs are made of brushed aluminium.

▲ *Figure 79: Rendering of the chairs in the lounge area. Passengers can choose to sit in several directions.*

11. DISCUSSION AND CONCLUSIONS

During the pre- and user- studies many aspects were found to be problematic in today's transportation systems. Several individuals indicated that apart from the lack of trust they exhibited for many different transportation systems, a decrease in the perceived personal safety could result in high degrees of discomfort. Insufficient personal space and inappropriate behaviour of fellow passengers were both examples of what could lead to this discomfort. Commuters were further found to not be able to sleep easily on board of public transportation, this for example due to the risk of getting robbed of valuables. Moreover, the user studies were indicative of the need for cleanliness and simplicity in collective transportation. In addition, it was established that in order to design a pleasant experience on board of public transportation, modernity, spaciousness, tranquility and comfortability were all important aspects. However, this comfortability was found to depend on the traveling distance. It was concluded that shorter distances did not require the same level of comfort as longer distances did.

From the initially conducted studies it was also shown that passengers did not expect that much in terms of amenities in the interiors of today's public transportation to airports. For shorter travel times of 15 minutes to airports, users were not found to want to spend the available time on something in particular. These 15 minutes were more viewed as a time to relax and to look at the surrounding environment or fellow passengers. Furthermore, users commonly spent the available travel time on using their smartphones, reading and listening to music. The most common on board activity was the use of smartphones, which could explain why wi-fi and power outlets were constantly expressed needs in the user studies.

Moreover, for weekly commuters, that had longer traveling times, it was found to be increasingly more important to spend the available time on something meaningful. Examples of meaningful activities were working and entertainment. Seeing that the user studies were indicative of the need for a more efficient use of time, a more flexible interior was deemed appropriate, this to accommodate all different needs of weekly commuters. Additionally, several basic needs, such as eating and going to the toilet, were found to be more and more important as traveling times increased. Finally the ability of moving more freely together with an increased need for space and comfortability were all essential factors for weekly commuters between Stockholm and Gothenburg.

When developing the seating interior environment of GTS cabins for the primary target group it was important to take many different aspects into consideration. One aspects that differentiated this project from other transport design projects was the fact that the GTS cabins will be suspended. Therefore the users of these cabins could reasonably experience psychological aspects, such as fear of heights and nausea, all of which needed to be considered. For that reason the placement of windows for the exterior design need to carefully considered in order to not trigger acrophobia. However, through conducting field studies it was concluded that a window placement of approximately one meter above ground was appropriate. Therefore the back panels were designed to extend to this height. By adding handles on the arm supports the symptoms of acrophobia can be reduced in accordance to theory. To counteract nausea the seats were placed so that all passengers could be provided with forward views. Furthermore, the majority of seats were positioned in the frontmost part of the cabin. No seats were positioned in the the opposite direction of travel because this was found to lead to an increased risk of nausea.

Designing an interior "for all" requires balancing of many accessibility aspects. To accommodate for people with different disabilities, an open area without any obstacles was positioned in the vicinity of the door. Furthermore, the entire pathway from the door to the different seats for individuals with wheelchairs or prams was cleared from obstacles, this to increase reachability for individuals with disabilities but also to enable easy evacuation for all passengers. Moreover,

wheelchairs and prams were found to require very much space in the somewhat limited area of 12 square meters. Therefore this large open area was also important in order to facilitate the turning moment for these aids. The wheelchair seating area was further positioned in the same direction as the other passengers, as opposed by being seated in the opposite direction of travel as in today's public transport systems. This, together with the integration of the wheelchair seating in the designed wooden panel and the discrete and simple fastening was intended to make wheelchair users feel more independent and less discriminated.

From conducting the pre- and user-studies it was evident that personal space was viewed as important for Swedish individuals. This, both in order to feel safe and to perceive the travel experience as comfortable. To improve personal space, 30 cm wide arm supports were designed into the seating panels. These were intended to work as dividers between passengers. The distance between individual passengers was chosen in accordance with the theory about proxemics and results from user studies. Furthermore from the field studies and observations it was found that most of the passengers wanted to have their cabin luggages closely available and overseeable. This since some of their valuable belongings and travel documents were kept in these luggages. The arm supports were therefore designed not only to function as arm supports and dividers between passengers, but also as storage for cabin luggages. The elevated arm supports on the seating panels were designed to hold the luggages in place as well. By positioning cabin luggage storage in the direct vicinity of all seats the perceived control and sense of security of users could be increased, hopefully resulting in a more relaxed environment. Seeing that many users were observed to position their cabin luggages in the close proximity of themselves on board of "Flygbussarna", this storage area was deemed to be appropriate.

The green colour of the seats was selected to generate a relaxed environment on board of the GTS cabin. This was also in line with researched theory on colours. The green seat together with the panel in light, soap treated oak, was also the most preferable concept in the semantic evaluation. This final concept was further found to correspond to most of the desired product expressions, all of which were defined in 8.4 and based on results from user studies. The overall materialisation was for example found to generate the expression of cleanliness, modernity and calmness. All panels were further suspended 40 cm from the floor, this to create a light and spacious expression. Seeing that the GTS cabins will be suspended, this was deemed to be particularly suitable.

The proportions of the seats in the cabin for the primary target group could be made larger in order to increase the degree of comfortability, spaciousness and to accommodate individuals with even larger hip breadths. This was not done since a demand was that the cabins should accommodate twelve passengers in total. However, the dimensions of the designed seats corresponded to acceptable dimensions on seating, based on anthropometric measurements and the list of requirements. Seeing that vicinity to cabin luggage together with the need for personal space was found to be important, this was prioritised over increasing the level of comfort. Because the journey between Arlanda and Uppsala only will last for 10-15 minutes the chosen proportions were not seen as problematic, but rather as a good compromise to achieve a well designed interior seating area where all passengers are granted personal space.

The luggage storages underneath all the arm supports were also developed in hope to generate a better passenger flow and thus also a more convenient embarking and disembarking. The concept of positioning cabin luggage in the proximity of all passengers could decrease the risk of congestion when passengers simultaneously want to position or remove luggage from rackets, as in today's transportation to airports. Even though the project resulted in a suggestion of the functionality behind luggage storage for larger luggages, materialised into a luggage shelf, further development is needed with regards to luggage storage. To match the surrounding interior the proportions of the luggage storage need to be carefully considered. Furthermore a conceptual ticket machine was designed that made it possible

for passengers to print boarding passes and luggage tags on board of the cabin, this to increase efficiency and safety at the airport. However, this idea needs further development as well.

As mentioned above, passengers did not want to do anything specific on the route to the airport and they did not expect much when traveling with today's transportation system. Because the activity "using mobile phones" was found to be a common activity, wireless charging surfaces were positioned on the arm supports, and power outlets and USB-ports were recessed into cut-outs in the back panels. The charging amenities were further added in hope to evoke positive emotions among passengers because these are neither available in all means of public airport transportation of today, nor expected to exist. Nevertheless, the user studies clearly indicated this need. Moreover, cup holders were added as extra features.

The fact that interiors of public means of transportation have not changed extensively in a long period of time was incomprehensible at first. Perhaps, these interiors have changed by small increments while overall interior layouts have been kept the same, why these changes have gone unnoticed. However, in the end of project the reason for this lack of change and novelty in interior design of public transportation was derived to be the requirements and legislative demands on these interiors. The prevailing requirements and directives are many, and together they impede the development of novel interior- and layout designs. Throughout the work it was discovered that even smaller changes in the design of the interior or layout, that were aimed to enhance the experience for one user group, could adversely influence the fulfilment of requirements of other user groups. Moreover, the balancing of different requirements was particularly problematic during the layout experimentation phase. In this phase the method staging was a means of trying and evaluating different layouts. Furthermore, it is reasonable to assume that the design of the final seating environments were heavily influenced by this choice is method. If the props used in staging had instead been changed and the complete space of the outlined GTS cabin had been used to its full extent, the result from the staging might have differed. For example, the staging environment could have benefited from letting the users build complete interior environments aided by virtual- or augmented reality technology. However, staging as a method was still considered to be appropriate from a scientific point of view, this seeing that it resulted in several direct requirements and valuable insight for the final design. In addition, by means of using staging it was easily understood why the layouts in today's means of transportation are designed as they are. When designing interior layouts for passenger transportation in limited spaces, space efficiency is of the utmost importance, why seats are commonly ordered similarly in most means of public transportation.

The project was largely focused on the investigation of user needs as well as on the design of the seating environments for the primary target group. Even though it was highly challenging to design a layout and interior adapted after the needs of different user groups, the main goal of creating a pleasant travel experience for passengers between Uppsala and Arlanda was achieved by means of including the researched product expressions as well as considering many user needs in the final design.

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FIGURES

Figure 9: Existing PRT- and GRT-system.

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Figure 26: Visual Benchmarking.

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Figure 28: Expression Board

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Figure 29: Formal Starting Board

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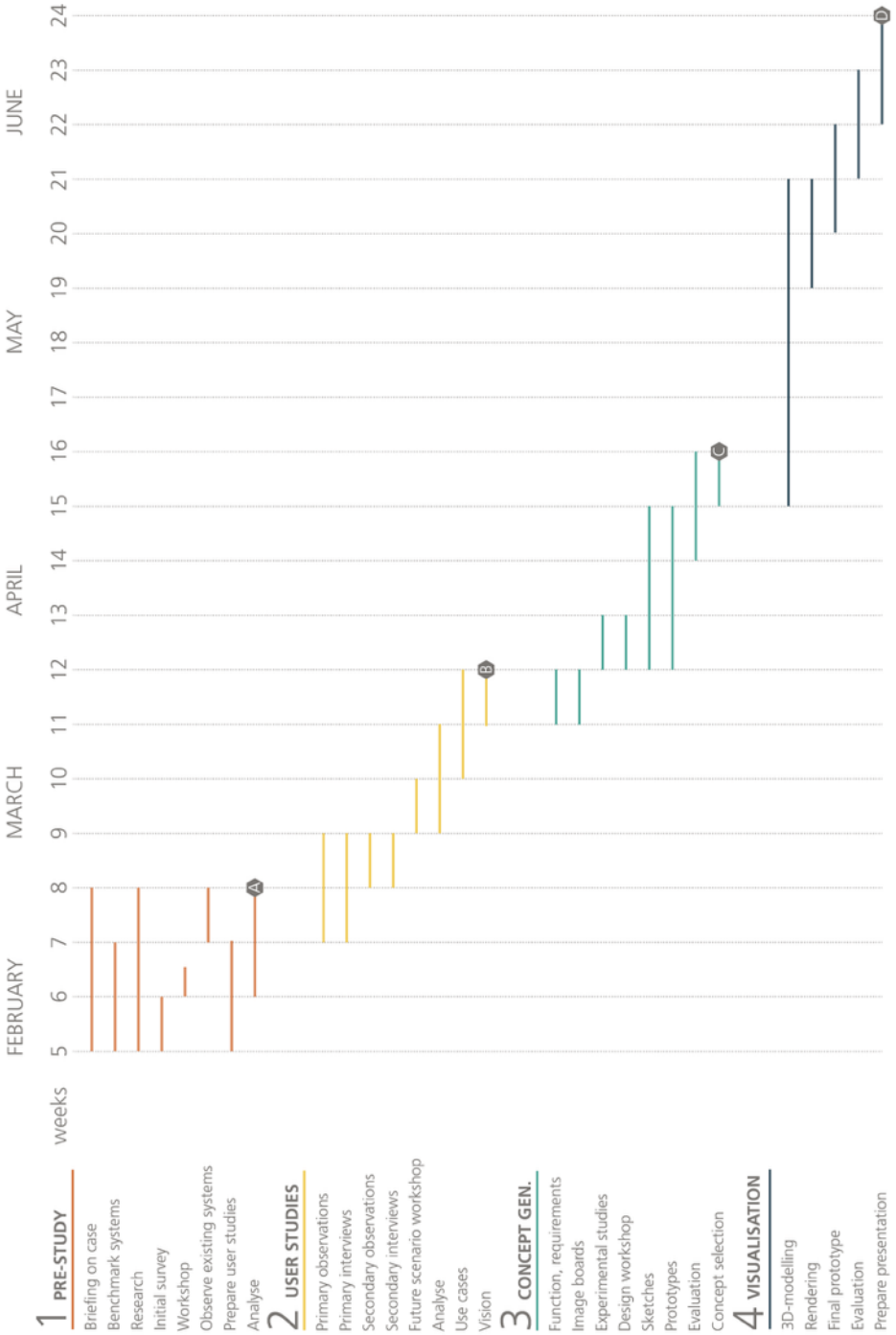
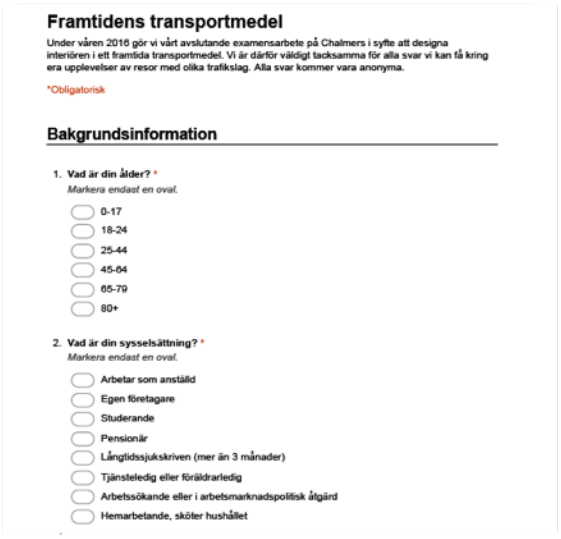
APPENDIX

Appendix 1: Gantt Chart



Appendix 2: Survey



Framtidens transportmedel

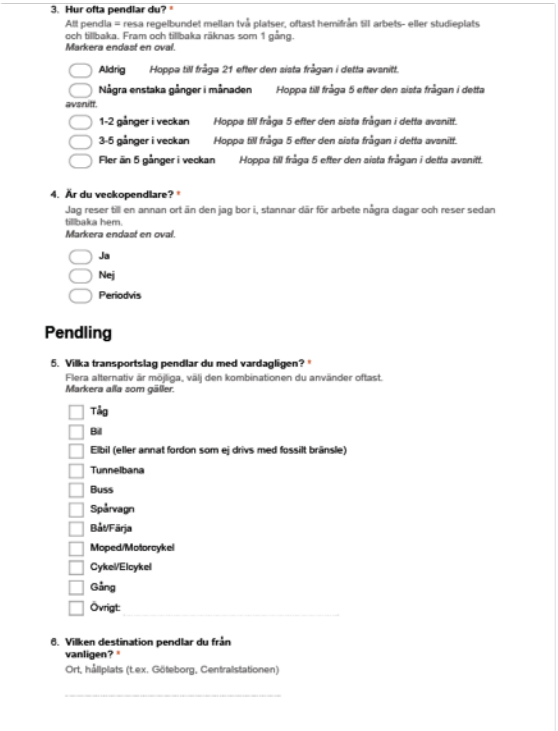
Under våren 2016 gör vi vårt avslutande examensarbete på Chalmers i syfte att designa interiören i ett framtida transportmedel. Vi är därför väldigt tacksamma för alla svar vi kan få kring era upplevelser av resor med olika trafikslag. Alla svar kommer vara anonyma.

*Obligatorisk

Bakgrundsinformation

1. **Vad är din ålder?** *
   Markera endast en oval.
   - ◯ 0-17
   - ◯ 18-24
   - ◯ 25-44
   - ◯ 45-64
   - ◯ 65-79
   - ◯ 80+

2. **Vad är din sysselsättning?** *
   Markera endast en oval.
   - ◯ Arbetar som anställd
   - ◯ Egen företagare
   - ◯ Studerande
   - ◯ Pensionär
   - ◯ Långtidssjukskriven (mer än 3 månader)
   - ◯ Tjänsteledig eller föräldrarledig
   - ◯ Arbetssökande eller i arbetsmarknadspolitisk åtgärd
   - ◯ Hemarbetande, sköter hushållet



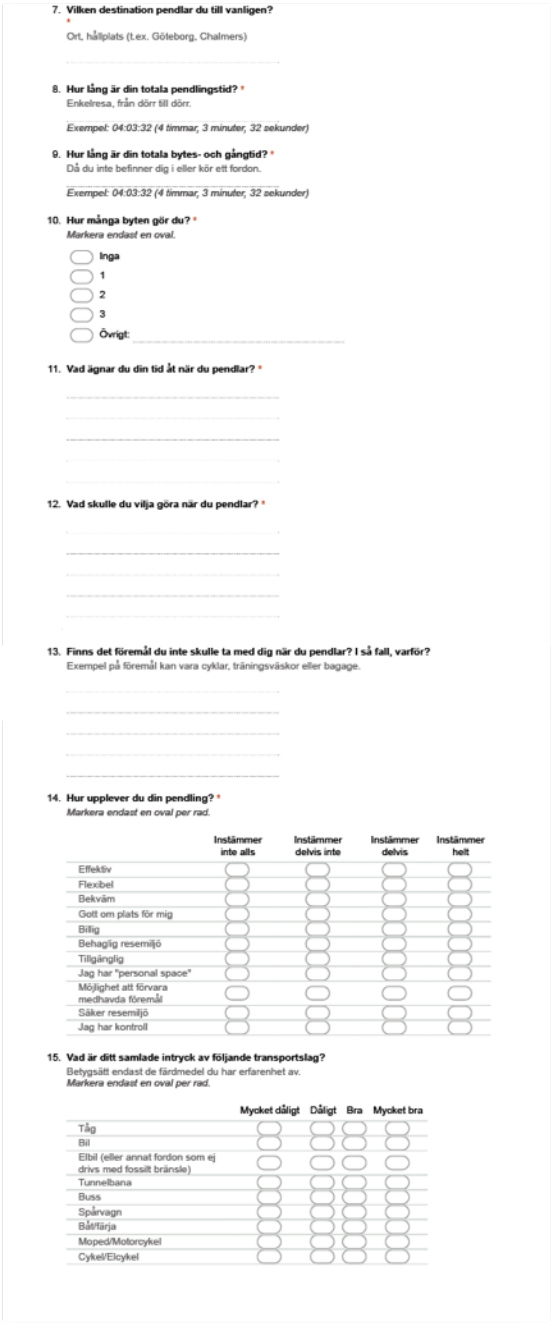
3. **Hur ofta pendlar du?** *
   Att pendla = resa regelbundet mellan två platser, oftast hemifrån till arbets- eller studieplats och tillbaka. Fram och tillbaka räknas som 1 gång.
   Markera endast en oval.
   - ◯ Aldrig — *Hoppa till fråga 21 efter den sista frågan i detta avsnitt.*
   - ◯ Några enstaka gånger i månaden — *Hoppa till fråga 5 efter den sista frågan i detta avsnitt.*
   - ◯ 1-2 gånger i veckan — *Hoppa till fråga 5 efter den sista frågan i detta avsnitt.*
   - ◯ 3-5 gånger i veckan — *Hoppa till fråga 5 efter den sista frågan i detta avsnitt.*
   - ◯ Fler än 5 gånger i veckan — *Hoppa till fråga 5 efter den sista frågan i detta avsnitt.*

4. **Är du veckopendlare?** *
   Jag reser till en annan ort än den jag bor i, stannar där för arbete några dagar och reser sedan tillbaka hem.
   Markera endast en oval.
   - ◯ Ja
   - ◯ Nej
   - ◯ Periodvis

Pendling

5. **Vilka transportslag pendlar du med vardagligen?** *
   Flera alternativ är möjliga, välj den kombinationen du använder oftast.
   Markera alla som gäller.
   - ☐ Tåg
   - ☐ Bil
   - ☐ Elbil (eller annat fordon som ej drivs med fossilt bränsle)
   - ☐ Tunnelbana
   - ☐ Buss
   - ☐ Spårvagn
   - ☐ Båt/Färja
   - ☐ Moped/Motorcykel
   - ☐ Cykel/Elcykel
   - ☐ Gång
   - ☐ Övrigt: _____

6. **Vilken destination pendlar du från vanligen?** *
   Ort, hållplats (t.ex. Göteborg, Centralstationen)
   _____



7. **Vilken destination pendlar du till vanligen?** *
   Ort, hållplats (t.ex. Göteborg, Chalmers)
   _____

8. **Hur lång är din totala pendlingstid?** *
   Enkelresa, från dörr till dörr.
   _____
   Exempel: 04:03:32 (4 timmar, 3 minuter, 32 sekunder)

9. **Hur lång är din totala bytes- och gångtid?** *
   Då du inte befinner dig i eller kör ett fordon.
   _____
   Exempel: 04:03:32 (4 timmar, 3 minuter, 32 sekunder)

10. **Hur många byten gör du?** *
    Markera endast en oval.
    - ◯ Inga
    - ◯ 1
    - ◯ 2
    - ◯ 3
    - ◯ Övrigt: _____

11. **Vad ägnar du din tid åt när du pendlar?** *
    _____

12. **Vad skulle du vilja göra när du pendlar?** *
    _____

13. **Finns det föremål du inte skulle ta med dig när du pendlar? I så fall, varför?**
    Exempel på föremål kan vara cyklar, träningsväskor eller bagage.
    _____

14. **Hur upplever du din pendling?** *
    Markera endast en oval per rad.

	Instämmer inte alls	Instämmer delvis inte	Instämmer delvis	Instämmer helt
Effektiv	◯	◯	◯	◯
Flexibel	◯	◯	◯	◯
Bekväm	◯	◯	◯	◯
Gott om plats för mig	◯	◯	◯	◯
Billig	◯	◯	◯	◯
Behaglig resemiljö	◯	◯	◯	◯
Tillgänglig	◯	◯	◯	◯
Jag har "personal space"	◯	◯	◯	◯
Möjlighet att förvara medhavda föremål	◯	◯	◯	◯
Säker resemiljö	◯	◯	◯	◯
Jag har kontroll	◯	◯	◯	◯

15. **Vad är ditt samlade intryck av följande transportslag?**
    Betygsätt endast de färdmedel du har erfarenhet av.
    Markera endast en oval per rad.

	Mycket dåligt	Dåligt	Bra	Mycket bra
Tåg	◯	◯	◯	◯
Bil	◯	◯	◯	◯
Elbil (eller annat fordon som ej drivs med fossilt bränsle)	◯	◯	◯	◯
Tunnelbana	◯	◯	◯	◯
Buss	◯	◯	◯	◯
Spårvagn	◯	◯	◯	◯
Båt/färja	◯	◯	◯	◯
Moped/Motorcykel	◯	◯	◯	◯
Cykel/Elcykel	◯	◯	◯	◯

16. **Vilket av nedanstående transportslag är mest problematiskt att pendla med?** *
Välj ett alternativ.
Markera endast en oval.

- Tåg
- Bil
- Elbil (eller annat fordon som ej drivs med fossilt bränsle)
- Tunnelbana
- Buss
- Spårvagn
- Båt/Färja

17. **Varför upplever du det som mest problematiskt?** *

18. **Vad upplever du mer som dåligt när du pendlar?** *

19. **Hur upplever du att åka med andra människor som du inte känner?** *

20. **Vad upplever du som bra när du pendlar?** *

Transport till och från flygplatser

21. **Hur många gånger flyger du på ett år?** *
Tur och retur
Markera endast en oval.

- Aldrig *Fortsätt till frågan 30.*
- Någon gång vartannat år eller mer sällan
- 1-3 gånger per år
- 4-6 gånger per år (var tredje till varannan månad)
- 7-12 gånger per år (mer än varannan månad men mindre än flera gånger i månaden)
- Mer än 12 gånger per år (flera gånger i månaden)

Transport till och från flygplatser

22. **Hur tar du dig till/från flygplatser?** *
Välj de alternativ som du vanligen använder dig utav.
Markera alla som gäller.

- [ ] Bil
- [ ] Buss
- [ ] Tåg
- [ ] Taxi
- [ ] Tunnelbana
- [ ] Transfer-buss
- [ ] Övrigt:

23. **Vilket alternativ väljer du oftast till/från flygplatser?** *
Välj ett alternativ.
Markera endast en oval.

- Bil
- Buss
- Tåg
- Taxi
- Tunnelbana
- Transfer-buss
- Övrigt:

24. **Varför väljer du vanligen det färdmedelet?** *

25. **Vad är ditt samlade intryck av följande transportmedel till/från flygplatser?**
Om du inte har en uppfattning på någon av alternativen så behöver du inte beskriva ditt intryck för just det resmålet.
Markera endast en oval per rad.

	Mycket dåligt	Dåligt	Bra	Mycket bra
Bil	◯	◯	◯	◯
Buss	◯	◯	◯	◯
Tåg	◯	◯	◯	◯
Taxi	◯	◯	◯	◯
Tunnelbana	◯	◯	◯	◯
Transfer-buss	◯	◯	◯	◯

26. **Vilket transportslag är mest problematiskt att resa till/från flygplatser med?** *
Välj något av de alternativ du vanligen använder.
Markera endast en oval.

- Bil
- Buss
- Tåg
- Taxi
- Tunnelbana
- Transfer-buss
- Övrigt:

27. **Varför upplever du detta transportslag som mest problematiskt?** *

28. **Vad gör du under tiden du reser till/från flygplatser?** *

29. **Vad skulle du vilja använda din restid till/från flygplatser för?** *

Framtidens transportmedel

Nedan följer en bild och en video på ett tidigt koncept (för närvarande under teknisk utveckling) av ett framtida transportmedel med magnetdrift. Kolla på bilden och scrolla igenom hela eller delar av videon för att förstå konceptet lite mer.

General Transportation System

http://youtube.com/watch?v=6UO26IYB8CI
Video: "Bubbles and Beams", Sika/Hans Kylberg

Tänkt dig att framtidens transportmedel ser ut som ovan.

Detta system skulle kunna ersätta och komplettera många befintliga trafikslag och man skulle som resenär kunna ta sig mellan två destinationer mer flexibelt och effektivt. I varje vagn kan det resa mellan 1-8 personer på valfri avgångstid och man kan välja på att resa privat eller publikt. Som resenär betalar man precis för det man använder. Systemet skulle halvera resetiden och det skulle samtidigt inte förekomma några byten. Ett sådant transportsystem kan användas både långa och korta sträckor. Man kan t.ex. pendla inom en stad, mellan Göteborg och Stockholm, eller ta sig till skidorten i Norge. Vagnarna ovan är självkörande.

30. **Vad är dina spontana tankar kring ovanstående koncept?** *

Det finns inga begränsningar på vad man som passagerare kan göra i en vagn i ovanstående system

31. **Vad skulle du vilja lägga din tid på vid kortare resor?** *
Upp till 15 min

32. **Vad skulle du vilja lägga din tid på vid mellanlånga resor?** *
Mellan 15-40 minuter

33. **Vad skulle du vilja lägga din tid på vid långa resor?** *
Mellan 1-3 timmar

34. **Vad skulle du vilja lägga din tid på vid längre resor?** *
Mer än tre timmar

35. **Vad är viktigt för dig ska finnas i kabiner i ovanstående system?** *

36. **Finns det något som skulle kunna finnas för att du alltid skulle välja att resa med ovanstående system?**
Det där "lilla extra".

Avslutning

Tack så mycket för din medverkan. Ditt bidrag betyder mycket för vårt examensarbete. Om du skulle kunna tänka dig att medverka i en djupare studie får du gärna lämna din email-adress nedan.

37. **Mailadress:**

38. **Slutligen, har du några övriga tankar eller funderingar?**
(Frivillig fråga)

Appendix 3: Interview Guide - Flight buses

Customer journey (Gbg-Landvetter-Destination)
Fylla i semantisk skala

Introducerande frågor
Hur och när känner du att du är på resande fot?
Vad är jobbigast med att vara på resande fot/resa?
Vad är bäst med att resa?

Värdera dagen innan

Inför resan
Hur förberedde du dig inför din resa?
Kan du beskriva din morgon/tillfälle innan resan?
Hur kände du dig i morses/inför resan?
Var något problematiskt inför resan?
Hur skulle din tillvaro kunna förbättras inför resan?

Rita ut på en skala hur du kände dig innan resan

Påväg till flygplatsen
Rita ut på en skala hur du känner dig

Beskriv hur du tog dig till flygbussen/flygplatsen?
Vad upplever du som bra/dåligt med att vara ombord på bussen?
Hur skulle din tillvaro kunna förbättras på väg till flygplatsen?
Vad behöver du för information när du reser? När vill du ha den?
Nu står ditt bagage på X plats nu, om du hade fått ställa det var du ville var hade du placerat det då? Varför?

Om du kan resa precis när du vill till flygplatsen och inte behöver tänka på byten vad skulle detta innebära för dig? Vad skulle du kunna göra då?

Inför flygresan
Nu när vi snart närmar oss flygplatsen, är du orolig över något?

Rita ut på en skala hur du känner dig

Customer journey (Destination-Landvetter-Gbg)
Fylla i semantisk skala

Introducerande frågor
Hur och när känner du att du är på resande fot?
Vad är jobbigast med att vara på resande fot/resa?
Vad är bäst med att resa?

Värdera dagen innan

Inför resan
Hur förberedde du dig inför din resa?
Kan du beskriva din morgon/tillfälle innan resan?
Hur kände du dig i morse/inför resan?
Var något problematiskt inför resan?
Hur skulle din tillvaro kunna förbättras inför resan?

Rita ut på en skala hur du kände dig innan resan

På väg till flygplatsen
Beskriv hur du tog dig till flygbussen/flygplatsen?

Upplevde du något som problematiskt?
Vad behöver du för information när du reser? När vill du ha den?

Rita ut på en skala hur du kände dig på väg till flygplatsen

Inför flygresan
När du var på flygplatsen, var du orolig över någonting?

Rita ut på en skala hur du kände dig

På väg hem från Landvetter
Vad upplever du som bra/dåligt med att vara ombord på bussen?
Hur skulle din tillvaro kunna förbättras på väg från flygplatsen?
Nu står ditt bagage på X plats nu, om du hade fått ställa det var du ville var hade du placerat det då? Varför?

Rita ut på en skala hur du känner dig

Om du kan resa precis när du vill från flygplatsen och inte behöver tänka på byten vad skulle detta innebära för dig? Vad skulle du kunna göra då?

Appendix 4: Dialogue Guide

Dialog

Tar emot och välkomna alla genom att ta en bit fika (Kolla utsikten och mingla)

- Tillåtelse att spela in diskussionen?

Sätter oss i sofforna och hälsar alla välkomna

- Presentation av examensarbete; framtida transportmedel, där vårt arbete fokuserar på interiör (kortfattat)
- Vi håller på med vårt examensarbete på master i industridesign på Chalmers, där vi har fått en viss yta i ett transportmedel, vårt uppdrag är helt enkelt att utveckla interiören och skapa en så bra upplevelse som möjligt . Vår utbildning är fokuserad på användarna. Därför vill vi med er idag, diskutera olika aspekter som är viktiga i kollektiv transportmedel som är viktiga att ta hänsyn till vid utvecklingen av denna interiör.
- Spelregler": Vi kommer under dialogen diskutera olika kategorier, däribland upplevelse, säkerhet, känsla vid självkörning, miljö och (säg de i rätt ordning). Vi kommer att ställa olika frågor till gruppen genom att rikta olika frågor till olika deltagare. Under tiden välkomnar vi allas åsikter och för att få lite ordning om flera skulle vilja prata samtidigt, är det bäst att räcka upp handen, så kommer vi se till så att alla får prata. Men först tänkte vi börja med en liten introduktion i och med att vi inte känner varandra, för de som inte redan minglat av sig tillräckligt.

Check in - Introduktion

- Kort presentation; Namn, bakgrund/yrke/vad man gör dagligen, hur man känner sig idag?

- **Scenario** - *Tänk er en framtid där kollektivtrafiken går sömlöst. Där förseningar, byten, tidtabeller och krånglande betalningssystem inte existerar. Där det inte finns någon stress kopplad till att missa anslutande förbindelser och där passagerare själva kan välja när de vill åka. I en sådan framtid överröstas inte vårfåglarnas kvittrande i morgonlugnet av bussarnas eller spårvagnarnas buller och gnisslingar. Resenärer i denna framtid behöver inte längre hålla i sig för kung och fosterland i något svåråtkomligt räcke i rusningstrafikens trängsel och de slipper definitivt att studsa fram och tillbaka likt pingisbollar vid hastiga accelerationer och inbromsningar. I en sådan framtid åker passagerare direkt till sina slutdestinationer och kan ägna tiden åt precis vad de vill!*

Frågeställningar under dialogen:

Uppvärmning

- Jobbigast och bäst med kollektivtrafik?
- Vad tror du gör en bra upplevelse i kollektivtrafiken? När du tänker på scenariot.

Upplevelse kopplat till tid (båda)

- Vad är viktigt för dig interiört när du åker med kollektivtrafiken ca 15 min?
- Vad är den optimala upplevelsen vid en kort resa på ca 15 min?
- Hur skapar man en ny upplevelse bortom dagens kollektiv trafikmedel?
- Vad är viktigt för dig interiört när du åker med kollektivtrafiken ca 3 timmar?
- Finns det något spännande man skulle kunna lägga tiden på under en resa på ca: 3 timmar? Vad skulle kunna fungera som underhållning?
- Hur utnyttjar ni tiden effektivt på tre timmar?
- Vad saknar man i dagens, vad ser man för möjligheter i de nya både positivt och negativt?

Miljö

- Vad är det för känsla man vill få när man kliver ombord ett kollektivtrafikfordon? Om man tänker på miljön/inredning
- Är det viktigt för upplevelsen i kollektivtrafiken att det är rent? Varför?
- Vad är det som gör att det känns rent?

Säkerhet och trygghet

- Vad är det som får en en att känner sig säker i kollektivtrafik?
- Hur skulle man kunna känna sig säkrare än vad man är idag?
- Vad behövs för att skapa trygghet och tillit (till att resa med främmande människor)?
- Hur undviker/förebygger man brott i kollektivtrafiken?

- Är det viktigt med personal space, när, hur och varför?
- I ett samhälle med ökad digitalisering är det viktigt att tänka på möten mellan människor. När man dessutom adderar aspekter från t.ex. jantelag, att man kanske inte vill störa eller besvära andra, kan man tänka sig att spontana interaktioner mellan människor minskar. Inte många i vår undersökning som beskrev att de var sociala med främmande människor. Vissa gillar till och med vad de beskriver som den "tysta överenskommelsen" ombord på kollektivtrafik. Hur kan man stimulera människor till att vara sociala med andra i kollektivtrafiken? Vill man detta? Varför/Varför inte?

Självkörande

- Tror ni att synen på säkerheten förändras i ett självkörande fordon(kollektivtrafik), då ingen chaufför finns tillgänglig? Hur ser man på att resa med främmande människor i självkörande fordon? Vad skulle göra att man känner sig säker?
- Vad behövs för att man ska lita på självkörande kollektivtrafik?
- Vi har fått respons från människor från en undersökning att de vill ha personlig service, hur uppnår man personlig service utan människor?

Avslutning och avrundning

- Är det något intressant ni har kommit och tänka på under dialogen som vi inte tagit upp? - vi är kvar här ett tag, så det är bara att komma fram.
- Innan vi går vill jag bara att vi avrundar genom att gå varvet runt, och kort berätta vad man tyckte om dialogen, och ifall det är något särskilt man tar med sig härifrån idag? Eller något som var intressant.
- Tacka så mycket.

Appendix 5: Staging Guide

Staging med syftet att få användarna att sätta sig in i ett framtida scenario, genom rekvisita får de vara aktiva och kreativa.
Var? Kan genomföras i ett grupprum, Usability-lab eller utomhus. (spelar inte så stor roll var man är så länge det finns plats och klimatet inte påverkar för mycket)
Rekvisita?

- Tamp/tejp för att göra konturer av vår yta på 12 kvm.
- Stolar som representerar säten. Eventuellt fällbara.
- Tejp för att kunna markera ut områden
- Ber användaren att ha jacka på sig innan ombordstigning.
- Resväska för att se hur man vill röra sig (hur mycket plats man vill ha).
- Ikeakasse vilket representerar en resa med skrymmande föremål. Fyll med något tungt/stort?
- Boards för att inspirera till idéer på vad man skulle vilja göra under sin resa. Även tomma lappar och pennor!

Urval? Blandade erfarenheter av pending, både till flygplats och som veckopendlare.
Genomförande - Filma och fotografera under genomförande!
Nutid inklusive fika (30 min)

- Deltagare får berätta kring hur deras resa till flygplats (15 min resa) ser ut idag, gärna så beskrivande som möjligt med allt från känslor, nästa steg i planering, till vad man gör under resan.
    - Hur skulle resan se ut om du fick bestämma (15 min resa)
- Deltagare får beskriva hur längre resor de gör ser ut idag (3h resa). *Exempel Gbg-Sthlm*
    - Hur skulle resan se ut om du fick bestämma (3h resa)

Framtid

- Presentation av nedanstående framtida scenario

Inledande Scenario - *Tänk er en framtid där kollektivtrafiken går sömlöst. Där förseningar, byten, tidtabeller och krånglande betalningssystem inte existerar. Där det inte finns någon stress kopplad till att missa anslutande förbindelser och där passagerare själva kan välja när de vill åka. I en sådan framtid överröstas inte vårfåglarnas kvittrande i morgonlugnet av bussarnas eller spårvagnarnas buller och gnisslingar. Resenärer i denna framtid behöver inte längre hålla i sig för kung och fosterland i något svåråtkomligt räcke i rusningstrafikens trängsel och de slipper definitivt att studsa fram och tillbaka likt pingisbollar vid hastiga accelerationer och inbromsningar. I en sådan framtid åker passagerare direkt till sina slutdestinationer och kan ägna tiden åt precis vad de vill!*

Förklaring av genomförande

- Med hjälp av rekvisita får deltagaren beskriva hur ett sådant scenario skulle förändra deras resa och hur hen skulle vilja att resan ser ut (först och främst fokus på resa till flygplats på 15 min). Deltagaren får använda rekvisita på valfritt sett, eller inte använda rekvisita, valfritt. Motivera val. Vi kommer ha två olika reslängder, likt det vi frågade om i början.

Scenario 1 (20 min)
Du är på väg till flygplatsen och ska resa till något spännande resmål/är på väg på tjänsteresa, och har tänkt att ta dig kollektivt in till flygplatsen, i den framtiden vi precis beskrev. Lev dig gärna in hur det var under den senaste nöjesresan/tjänsteresan som du tidigare beskrev!
Frågor

- Be deltagare att tänka högt och beskriva hur scenariet skulle förändra deras resa. (Be gärna deltagaren att använda sig utav rekvistan som finns tillgänglig)
- Miljöaspekter -vad vill man se, känna, lukta, mötas av när man stiger ombord?
- Deltagare får själva "rita upp" inom området hen vill ha tillgängligt. -Vad vill man göra? -Hur, var och i vilken riktning vill man sitta, varför? -Var vill man ha bagaget? -Och var vill man att medpassagerare ska befinna sig? Vyer/se ut? Känslor? Skillnad på hur man vill sitta själv till skillnad från när man reser med vänner/familj?
- Hur skulle du känna inför att du själv får bestämma att åka med eller utan någon?
- Skrymmande bagage - ge över IKEA-påse
- Hur skulle du känna inför att kabinen är upphängd? Fördelar/nackdelar/vad skulle du göra/hur skulle detta förändra din resa?
- Hur skulle du känna inför att den var självkörande? Fördelar/nackdelar/vad skulle du göra/förändra resa?
- Visa upp boards/lappar med saker man skulle kunna göra ombord för att inspirera.

Scenario 2 (20 min)

Det är måndag och du ska ta dig upp till Stockholm för att jobba i en vecka, och därefter återvända till Göteborg. Lev dig gärna in hur det är att åka upp till Sthlm för att jobba och de behov du kan tänkas ha på väg upp dit.

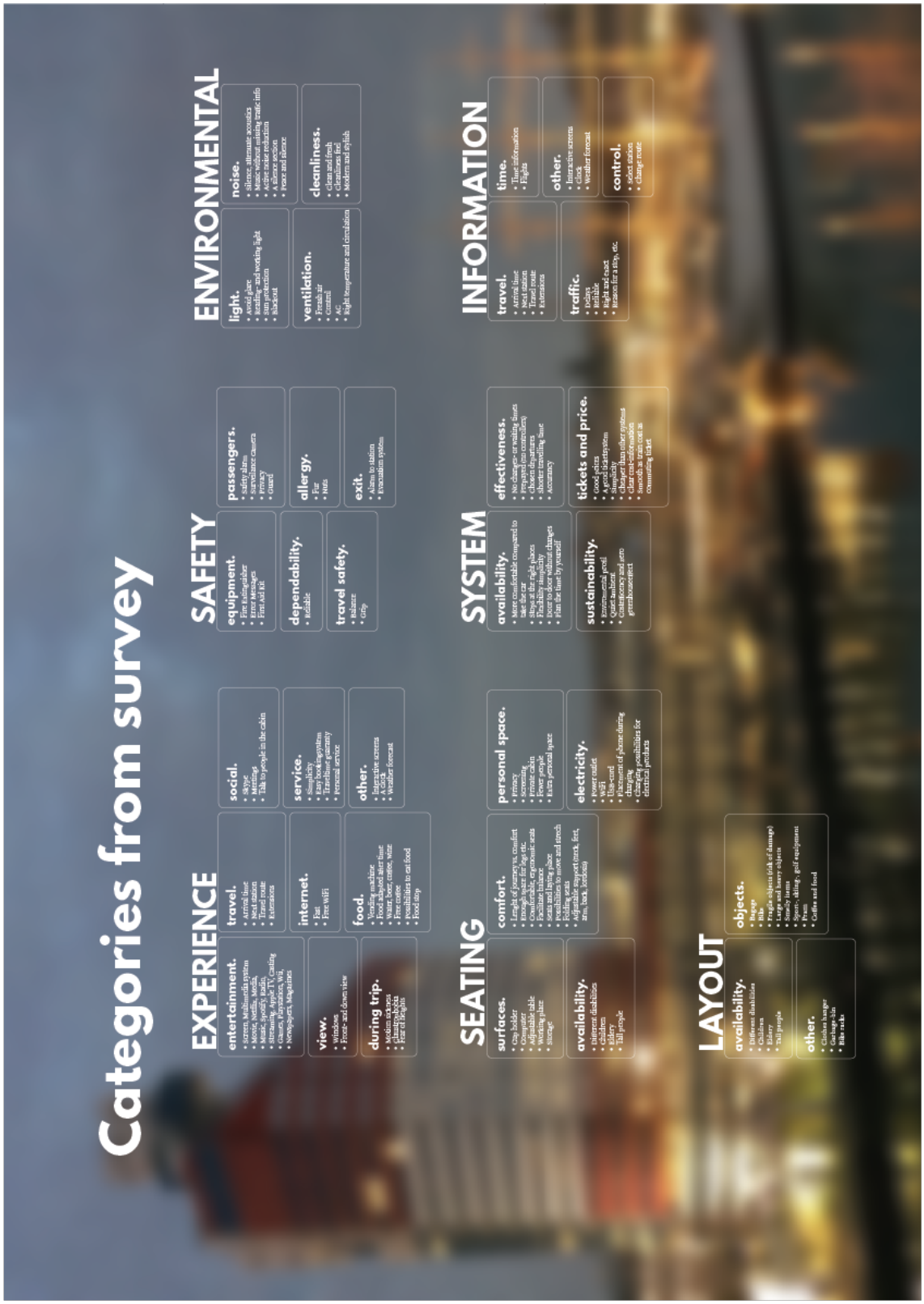
Frågor

- Be deltagare att tänka högt och beskriva hur scenariet skulle förändra deras resa. (Be gärna deltagaren att använda sig utav rekvistan som finns tillgänglig)
- Miljöaspekter -vad vill man se, känna, lukta, mötas av när man stiger ombord?
- Deltagare får själva "rita upp" inom området hen vill ha tillgängligt. -Vad vill man göra? -Hur, var och i vilken riktning vill man sitta, varför? -Var vill man ha bagaget? -Och var vill man att medpassagerare ska befinna sig? Vyer/se ut? Känslor? Skillnad på hur man vill sitta själv till skillnad från när man reser med vänner/familj?
- Hur skulle du känna inför att du själv får bestämma att åka med eller utan någon?
- Hur skulle du känna inför att kabinen är upphängd? Fördelar/nackdelar/vad skulle du göra/hur skulle detta förändra din resa?
- Hur skulle du känna inför att den var självkörande? Fördelar/nackdelar/vad skulle du göra/förändra resa?
- Visa upp boards/lappar med saker man skulle kunna göra ombord för att inspirera.

Övrigt

- Olika tider att man får bestämma själv när man vill åka?
- Avslutningsvis, har du några andra synpunkter?

Appendix 6: KJ-analysis



Appendix 7: List of Requirements

N0.	Requirement	Source
1.	Seats facing each other (reserved). Min measurements between reserved seats H=1500mm.	[1]
2.	Seats facing each other (Not reserved). Min measurement between reserved seats H=1300mm	[4]
3.	Seats in the same direction. Min distance between seats in the same direction. H=450-500mm	[4]
4.	Seat height. Ergonomic height from floor to cushion of seats 450<H<500mm	[4]
5.	Seat width. Min. width (w) of seats w>400mm and 450 for longer routes	[4]
6.	Seat depth. Min. depth of seats >350 mm and 400 for longer routes.	[4]
7.	Distance between individual seats (continuous seats). Min. available space for each seat. (In addition to seat width) 25 mm.	[4]
8.	Seat angle (back support). The preferable angle between the seat cushion and back support (a). 110<a<130 degrees	[7]

ACCESSIBILITY AND MOBILITY

NO.	Requirement	Source
1.	Flat and non-slip floor surfaces. Inclination **must** be minimized and the floor surface **should** be flat, firm, smooth and non-slip.	[2]
2.	Independency of users. Wheelchair users and individuals with disabilities **should** be able to travel without the help of others, and should be able to sit more freely relative to today's solutions.	[2]
3.	Turning circle wheelchair. Wheelchair users **must** be able to turn easily. The available turning circle, D. D>=1500mm	[5]
4.	Color contrasting indications shall be used to indicate obstacles and the entrance. Contrast of 0,4 NCS relative to the interior.	[1]
5.	Width of color contrasting at entrance W>100mm	[5]
6.	Handholds close to seat. For passengers with reduced mobility suitably designed and placed handholds **should** be available to facilitate entry and exit of the seat.	[4]
7.	Height of handholds. Handhold **should** be positioned at the sufficiently low height. H=max 1500mm	[4]
8.	Section of handholds. Handrails and handholds shall be of a section enabling passengers to grasp them easily and firmly.	[4]
9.	Length of handrails. Every handrail must provide a sufficient minimum length, L>100mm, to accommodate a hand. The radius R, of the handrail must be between two values; 20<R<35mm.	[4]
10.	Extra space for increased mobility. Passengers with reduced mobility should have 100% of the normal available space.	[4]

11.	Free choice of travel position. Passengers with reduced mobility should be able to stand during the travel.	
12.	Space for wheelchair. The available space for both wheelchairs and prams should have the measurements of L=1350mm and B=800mm	[5]
13.	Reduced risk of overturning (wheelchairs and prams). Wheelchairs and prams must be securely fastened.	[1]
14.	Accessibility for (wheelchairs and prams). The path between door and the wheelchair- and pram "seating" **should** not be blocked. Free passage	
15.	Reachability for wheelchair users. To ensure reachability for wheelchair users, the height of e.g. Emergency phones, **should** not be to high. A good height is 1100mm.	[5]
16.	Accessibility for visually impaired individuals. Visually impaired individuals must be able to navigate and get seated.	

SAFETY

NO.	Requirement	Source
1.	Emergency phone. Accessible for everyone, for instance one close to the wheelchair space and one close to the door. (Microphone center 1400mm from the floor).	[2]
2.	Fire Extinguishers. Space for at least one extinguisher. Should be protected, clearly indicated easy to grasp in an emergency situation.	[4]
3.	Emergency stop/brake. Available for everyone to grasp **should** be able to see even if there is standing passengers onboard.	[5]
4.	Emergency opening. Available for everyone to grasp and see.	[5]
5.	Emergency opening. Available for everyone to grasp and see. Wheelchair 800-1000mm	[5]
6.	First aid kit. Space for at least one first aid kit and available for everyone to grasp. Min. 7dm^3 min. measurement of 80mm.	[4]
7.	Easy access to door – emergency exit	
8.	Surveillance cameras. Surveillance cameras must cover the whole interior environment.	

LUGGAGE

NO.	Requirement	Source
1.	Minimum size of cabin luggage. Smallest possible luggage H=420mm, L=250mm and W=320mm.	[6]
2.	Maximum size of cabin luggage H=560mm L=250mm and W450mm.	[8]
3.	Maximum possible size of checked-in luggage H=860, L=360mm, W=580mm	[6]

ENVIRONMENTAL AND EXTRA FEATURES

NO.	Requirement	Source
1.	Door, min size of entrance exit doors H=1800mm and W=1200mm	[4]
2.	Cup holder. Every passenger should have access to a cup holder. Max diameter=72mm	[9]
3.	Newspaper there should be preferably one or two newspaper stands available. Magazine size W=300mm	[6]
4.	Toilet, minimum size of a toilet room. B=1200mm L=1350mm	[10]
5.	The lighting environment should not lead to glare.	
6.	Good ventilation. Heating/fresh air devices. Filter against dust and pollen.	[1]
7.	Everyone should have a view and be able to see through a window	[1]
8.	Materials should be chosen so that allergies are minimized.	[1]

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Appendix 8: Persona - Business

PERSONA

"I am looking for the ultimate and most comfortable traveling experience."

NAME Johan Nilsson
AGE 34
OCCUPATION Senior Business Controller at EY
LOCATION Uppsala
TIER Frequent air traveller
ARCHETYPE The planner

DESCRIPTION

Johan has recently been promoted to a senior position at EY and his workspace, that was previously limited to a small office cubicle in central Uppsala, has been expanded to cover the whole world. This means a lot of travelling and he therefore has to work whenever and wherever possible. Be it at the work in Uppsala, on the way to the airport, on the airport or on the plane. To be more precise, an ordinary week often consists of one and sometimes even two round trips, often between Arlanda and some European capital. On top of this, he often takes Sunday flights to be completely prepared for a new work week abroad. Johan uses his smartphone to answer his emails and to keep himself updated on last minute changes in his work, but also as a means of receiving all required travel information exactly when he need it.

GOALS

- Seeks a seamless and smooth traveling experience.
- Ability to work from any place and at any time.
- Is an internationalist that loves to explore new cultures and see new things to break out of everyday boredom.
- Wants to travel comfortably but not necessarily luxuriously.

FRUSTRATIONS

- Lack of information and reassurance in case of delays.
- Stressed by the risk of missing later connections.
- Disturbances, waiting times and tech bugginess.
- Inability to relax when constantly having to keep an eye on valuables.

MOTIVATION

ATTRIBUTES

Appendix 9: Persona - Leisure

PERSONA

"We want it to be a seamless travel from the point we go up at home and throughout the whole journey."

NAMES	**Eva and Gunnar Engström**
AGES	**67 and 65**
OCCUPATIONS	**New retirees**
LOCATION	**Uppsala**
TIERS	**Leisure travellers**
ARCHETYPES	**Spontaneous**

DESCRIPTION

Eva and Gunnar are both new retirees. They just decided to move from their big high maintenance house, where they raised their children, to a small apartment in a calm neighbourhood in Uppsala. Recently they also aquired a summer house with coast view. Most of their time is spent on working with this house in order to create a welcoming environment for their family, including their grandchildren to-come. A couple of weeks every year Eva and Gunnar are abroad. They want to travel to different destinations in order to experience what they both felt that they did not have time with while they were still working. While they are always excited about each journey, they tend to be a bit worried as well. They are worried about the security situation, their brought belongings and about finding their way and the correct information at airports and their final destinations.

GOALS

• Want to sit close to or have good overview of their luggage and be able to smoothly reach their belongings.

• Want to be able to ask for help and get personal service.

• Want a peaceful and comfortable journey to the airport where they can socialise with each other to be arrive in the right frame of mind.

• Need assistance to be able to maintain their balance.

FRUSTRATIONS

• Difficult to navigate at the airport.

• Get stressed by crowds and security checks.

• Having to carry around unwieldy and heavy luggage.

• Worried about missing connections.

MOTIVATION

ATTRIBUTES

Appendix 10: Anthropometric Measurements

Some anthropometric measurements were prior to the project deemed to be of particular importance for the design phase. Seeing that both the primary and second target groups consist mainly of Swedish citizens, the below measurements (in millimetres) correspond to the Swedish population.
(Hanson et. al, 2009).

Measurement	Women 5%il	Women 95%il	Men 5%il	Men 95%il
1. Hip Breadth sitting	363,55	466,67	334,04	448,75
2. Forearm-finger top length	394,45	480,76	440, 06	528,41
3. Knee-height	470,95	572,26	503,58	605,26
4. Buttock-knee length	540,61	647,45	561,33	665,38
5. Sitting height	834,98	949,40	884,31	1004,01
6. Lower leg length	401,16	493,82	433,30	537,81
7. Shoulder-elbow	308, 17	373,01	338,09	402,89

Source: Antropometri.se (2011). *Antropometri-räknare*. Retreived from: http://antropometri.se/calc.php [2016-05-05]

Appendix 11: Evaluation of Requirements

♦ - The concept need to be modified a bit in order to fulfil the requirement
✓- The concept fulfil the requirement

SEATING FUNCTIONALITY

NO.	Requirement	Evaluation
1.	Seats facing each other (reserved). Min measurements between reserved seats H=1500mm.	♦
2.	Seats facing each other (Not reserved). Min measurement between reserved seats H=1300mm	✓
3.	Seats in the same direction. Min distance between seats in the same direction. H=450-500mm	✓
4.	Seat height. Ergonomic height from floor to cushion of seats 450<H<500mm	✓
5.	Seat width. Min. width (w) of seats w>400mm and 450 for longer routes	✓
6.	Seat depth. Min. depth of seats >350 mm and 400 for longer routes.	✓
7.	Distance between individual seats (continuous seats). Min. available space for each seat. (In addition to seat width) 25 mm.	✓
8.	Seat angle (back support). The preferable angle between the seat cushion and back support (a). 110<a<130 degrees	♦

ACCESSIBILITY AND MOBILITY

NO.	Requirement	Evaluation
1.	Flat and non-slip floor surfaces. Inclination **must** be minimized and the floor surface **should** be flat, firm, smooth and non-slip.	♦
2.	Independency of users. Wheelchair users and individuals with disabilities **should** be able to travel without the help of others, and should be able to sit more freely relative to today's solutions.	♦
3.	Turning circle wheelchair. Wheelchair users **must** be able to turn easily. The available turning circle, D. D>=1500mm	✓
4.	Color contrasting indications shall be used to indicate obstacles and the entrance. Contrast of 0,4 NCS relative to the interior.	N/A
5.	Width of color contrasting at entrance W>100mm	N/A
6.	Handholds close to seat. For passengers with reduce mobility suitably designed and placed handholds **should** be available to facilitate entry and exit of the seat.	✓
7.	Height of handholds. Handhold **should** be positioned at the sufficiently low height. H=max 1500mm	✓
8.	Section of handholds. Handrails and handholds shall be of a section enabling passengers to grasp them easily and firmly.	✓
9.	Length of handrails. Every handrail must provide a sufficient minimum length, L>100mm, to accommodate a hand. The radius R, of the handrail must be between two values; 20<R<35mm.	✓
10.	Extra space for increased mobility. Passengers with reduced mobility should have 110% of the normal available space.	✓

11.	Free choice of travel position. Passengers with reduced mobility should be able to stand during the travel.	¢
12.	Space for wheelchair. The available space for both wheelchairs and prams should have the measurements of L=1350mm and B=800mm	✓
13.	Reduced risk of overturning (wheelchairs and prams). Wheelchairs and prams must be securely fastened.	✓
14.	Accessibility for (wheelchairs and prams). The path between door and the wheelchair- and pram "seating" **should** not be blocked. Free passage	✓
15.	Reachability for wheelchair users. To ensure reachability for wheelchair users, the height of e.g. Emergency phones, **should** not be to high. A good height is 1100mm.	✓
16.	Accessibility for visually impaired individuals. Visually impaired individuals must be able to navigate and get seated.	N/A

LUGGAGE

NO.	Requirement	Evaluation
1.	Minimum size of cabin luggage. Smallest possible luggage H=420mm, L=250mm and W=320mm.	✓
2.	Maximum size of cabin luggage H=560mm L=250mm and W450mm.	✓
3.	Maximum possible size of checked-in luggage H=860, L=360mm, W=580mm	✓

ENVIRONMENTAL AND EXTRA FEATURES

NO.	Requirement	Evaluation
1.	Door, min size of entrance exit doors H=1800mm and W=1200mm	✓
2.	Cup holder. Every passenger should have access to a cup holder. Max diameter=72mm	✓
3.	Newspaper there should be preferably one or two newspaper stands available. Magazine size W=300mm	✓
4.	Toilet, minimum size of a toilet room. B=1200mm L=1350mm	✓
5.	The lighting environment should not lead to glare.	♦
6.	Good ventilation. Heating/fresh air devices. Filter against dust and pollen.	N/A
7.	Everyone should have a view and be able to see through a window	✓
8.	Materials should be chosen so that allergies are minimized.	N/A