Next generation gate seating

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DIVISION OF PRODUCT DEVELOPMENT | DEPARTMENT OF DESIGN SCIENCES
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MASTER THESIS

Green Furniture Concept

KNIGHTEC

Next generation gate seating

User centred product development of a modular seating system for gate environments

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Abstract

This project is based on product development of Green Furniture Concept's module based seating system, Ascent, targeted towards airport environments. The project started with an open brief aimed at developing an add-on for the bench series, based on user needs. The project lasted for 20 weeks. The design process used is based on the Double Diamond process which divided the work into four parts: Discover, Define, Develop and Deliver.

The first 10 weeks were spent on Discover and Define. User needs were identified by doing observations and interviews. Observations were executed at three different airports and other public indoor environments. Interviews were conducted with four people. Two pilot tests were conducted before the interviews. Three of the interviewees had experience from flying with work and two were parents of younger children. Also, an airport cleaner and a traveller process owner from Swedavia was consulted.

The other half of the project was spent on developing concepts based on the found user needs. Concepts were developed by brainstorming, sketching and modelling in SolidWorks. The product evolved from an add-on to an entire module of the bench. The new module is designed with consideration to the Ascent series, to blend in while adding extra functionality. It utilised the look of picnic benches and is designed to facilitate computer work at gate environments.

Keywords: Modular seating, Airports, Gate environment, Product development, Double Diamond

Sammanfattning

Detta projekt är baserat på produktutveckling för Green Furniture Concepts modulbaserade bänksystem, Ascent, som är riktat till flygplatsmiljöer. Projektet inleddes med en öppen brief som syftade till att utveckla ett tillbehör för bänkserien, baserad på användarbehov. Projektet utfördes under 20 veckor. Designprocessen som användes är baserad på Double Diamond-processen, som delar upp arbetet i fyra delar: Discover, Define, Develop och Deliver.

De första 10 veckorna var Discover och Define i fokus. Användarnas behov identifierades genom att göra observationer och intervjuer. Observationer gjordes på tre olika flygplatser och i andra offentliga inomhusmiljöer. Intervjuer genomfördes med fyra personer. Två pilottester genomfördes inför intervjuerna. Tre av de intervjuade hade erfarenhet av att flyga med arbetet och två var föräldrar till yngre barn. Även en flygplatsstädare och en resenärsprocessägare från Swedavia konsulterades.

Under andra hälften av projektet utvecklades koncept baserat på de definierade behoven. Koncept utvecklades genom brainstorming, skisser och modellering i SolidWorks. Produkten utvecklades från ett tillbehör till en hel bänkmodul. Den nya modulen är designad för att passa in i Ascent-serien, samtidigt som den ger extra funktionalitet. Den liknar utseendet på picknickbord och är utformad för att underlätta datorarbete i gate-områden.

Nyckelord: Modulära bänkar, Flygplatser, Gate-område,
Produktutveckling, Double Diamond

Acknowledgments

This report is the result of a Master Thesis project in Mechanical Engineering with Industrial Design. The project has been conducted for Green Furniture Concept and Knightec AB, at the Division of Product Development, Department of Design Sciences, Faculty of Engineering at Lund University.

We have received valuable help and feedback from several persons during this project and would like to give a special thanks to:

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All interviewees, for taking your time and for sharing your experiences.

Lund, June 2020

Axel Hanssen Bothin and Hanna Petersson

Table of contents

1 Introduction

In this chapter the project background, outsourcer and brief will be displayed.

1.1 Team background

The design team consisted of Axel Hanssen Bothin and Hanna Petersson. This project serves as their master thesis in Mechanical engineering with industrial design. The education has given the team knowledge about product development from the perspective of both a mechanical engineer and an industrial designer.

1.2 Project background

Every day millions of people travel around the world with airplanes (ICAO, 2018). Airplanes are used as a mean to travel long distances in a time efficient way. And just as bus-stops serve as waiting halls for buses, airports serve as waiting halls for airplanes. Hence millions of people visit airports every day, and the time they spend there varies by a lot. For some it is as little as just passing through the security checkpoint and board the plane. Others wait around for hours.

The recommended time of arrival at airports varies depending on location, destination and airline but according to SAS, they recommend between 30 minutes up to two hours before boarding (SAS, 2020).

During this wait, passengers can entertain themselves in two different “zones”, the commercial areas and the waiting areas. The commercial areas are what generates a large portion of the airport’s income (Simple Flying, 2018) and is often strategically developed to maximize consumption. It makes sense for the airport to focus on and improve the commercial areas, but it is of similar importance to improve the waiting areas as well. Not every traveller has an interest in consumption and some would rather wait at the

gate until boarding. According to Julián Diaz, chief executive of Switzerland's Dufry, "only 16 per cent of the passengers going through an airport buy something" (Financial Times, 2017).

This project took off in the idea of enhancing the experience for travellers waiting in gate environments.

1.3 Knightec

Knightec AB is a consulting company within technology and was the outsourcer of the project. Knightec is an organisation consisting of four areas of expertise (Quality & Management, Systems, Technology and Dewire), 700 employees and ten offices around Sweden (Knightec AB, 2020).

Knightec provided the team with two supervisors and work space at their office in Lund.

1.4 Green Furniture Concept

The project was aimed towards Green Furniture Concept (GFC) which is a furniture design company with focus on sustainable seating in public interior areas. GFC produces their products in a sustainable way which they have defined with four cornerstones: Chemical Awareness, Design and Resources, Reforestation and Post Sales Responsibility (Green Furniture Concept, 2020).

GFC has provided the team with a supervisor along with supporting materials.

1.4.1 **The Ascent series**

Ascent is GFC's latest series of interior seating, launched in March 2020 (Green Furniture Concept, 2020). It is a modular beam seating system designed mainly for airport gate areas. Ascent was developed as an alternative to traditional airport beam seating and is presented in Figure 1.1.

Figure 1.1: Demonstration of all modules in the Ascent series (Green Furniture Concept, 2020).

1.5 Project brief

The mission of the thesis was to understand what needs people experience in a gate environment at airports. Based on the found needs, a new add-on was to be developed to GFC's Ascent series.

1.6 Scope & goal

The project was carried out over 20 weeks, with start in January 2020, at the department of Design Sciences, Faculty of Engineering LTH, Lund University.

The initial goal was to deliver a prototype of an add-on with a final design and manufacturing schedule.

1.7 Initial requirements

The add-on would be designed as a part of the Ascent series, therefore the add-on had to follow the aesthetics and modularity of the series.

As the Ascent series fulfil the sustainability requirements according to The Nordic Ecolabel and exclude SIN-listed substances (Green Furniture Concept, 2020), the add-on also had to fulfil these requirements.

The add-on had to be mass producible and fulfil European standard EN 16139:2013 (Swedish Standards Institute (SIS), 2013), to ensure that the product could manage loading cases occurring at interior public spaces.

2 Methodology

This chapter covers the overall design process used for the entirety of the project. It also explains the theory of the design methods used.

2.1 Design process

The project was based on the Double Diamond process to find user needs and develop a product adapted to those needs (Design Council, 2020). It is an iterative process divided into four phases: Discover, Define, Develop and Deliver, as illustrated in Figure 2.1. Each part will be described further in the sections below.

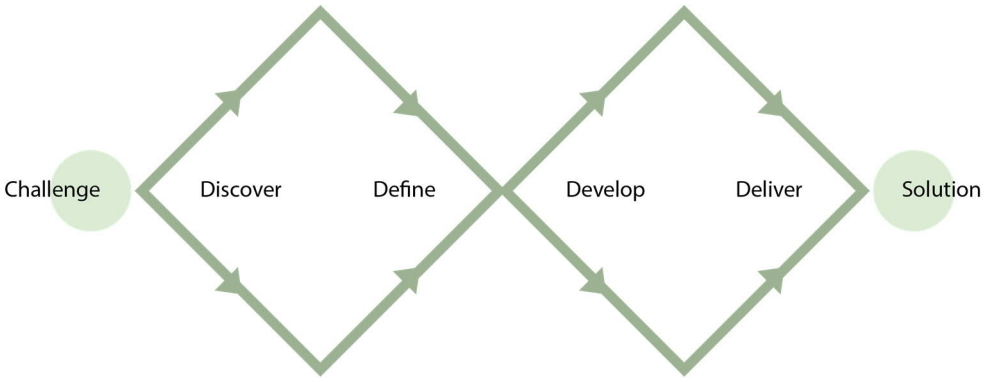

Figure 2.1: Illustration of the Double Diamond process.

2.1.1 **Discover**

In the first phase, Discover, the aim is to get a broad understanding of the task. To gather knowledge about the users and their behaviours as well as needs, but also to get inspiration and more information about the problem (Stiftelsen Svensk Industridesign, 2020). In this phase methods like stakeholder mapping, image boarding, benchmarking, observations and interviews were used.

2.1.2 **Define**

The aim of the second phase, Define, is to get an overview of all the information gathered in the Discover phase to find patterns in behaviours and insights (Stiftelsen Svensk Industridesign, 2020). Affinity diagrams were used to sort key findings from observations and interviews into categories.

2.1.3 **Develop**

In the third phase, Develop, all gathered information and inspiration is used to generate concepts (Stiftelsen Svensk Industridesign, 2020), this was made through brainstorming for each of the found user needs and insights.

2.1.4 **Deliver**

The fourth phase, Deliver, is the final phase in the design process. In this phase, the created concepts are presented and tested (Stiftelsen Svensk Industridesign, 2020). The Develop and Deliver phases are iterated until desired results are achieved. Sketches and 3D models were produced and user tests were conducted to develop the selected concepts.

2.2 Methods

2.2.1 **Stakeholder mapping**

Stakeholder mapping is a method used to help focusing on user centred thinking throughout the project (Hanington & Martin, 2012, p. 166). It is suitable to do in the beginning of the design process and can work as guidance throughout the project. It is a method where all key constituents that might have an interest or stake in the outcomes of a design process are identified. The stakeholder map shows the hierarchy and relations between the stakeholders, with the end users in the centre of the map.

2.2.2 **Image board**

An image board is a collage of images and illustrations, made to work as inspiration and visually communicate a defined aesthetics, context or user group (Hanington & Martin, 2012, p. 100).

In this project the image board worked as a tool to explore and get an understanding for the aesthetics of the Ascent series.

2.2.3 **Benchmarking**

Benchmarking is used to gather inspiration and understand the strengths and weaknesses in similar products on the market. Typically benchmarking is used to compare parameters between different products of similar purpose. (Ulrich & Eppinger, 2014, pp. 178-179)

In this project a benchmarking was executed both in the early stage of the Discover phase to understand what other companies offer as add-ons and during the Develop phase to gather information about appropriate dimensions for the selected concept.

2.2.4 **Observations**

Semi-structured observation is a useful method to collect information when developing a product within a field that is new to the design team (Hanington & Martin, 2012, p. 120). It is performed by immersing the design team in a certain situation. Semi-structured implies that the observation can have guiding questions as a starting point, but the design team can still observe the situation with an exploratory mind.

Due to the open brief in this project, semi-structured observation was a suitable method to use when gathering insights and inspiration in the Discover phase.

2.2.5 **Interviews**

Interviews are conducted to collect data about a topic from the perspective of the intended target group. Semi-structured interviews allow the interviewee to speak freely about their experiences with guiding questions to steer the conversation. It is important to not pre-empt an answer by asking

the questions as a suggestion, hence an interview guide should be constructed beforehand. A semi-structured interview guide includes both closed end and open end questions as guidance during the interviews. Therefore, the collected data is mainly qualitative. (Preece, Rogers, & Sharp, 2015, pp. 234-235)

Semi-structured interviews were conducted with key persons identified during the stakeholder mapping, to understand and find user needs.

A pilot study of the interview guide was executed before the interviews were conducted. A pilot study works as a trial run before the real study begins. This is important to prevent mistakes and ensure the quality of the study (Preece, Rogers, & Sharp, 2015, p. 230).

It was chosen to conduct interviews in person to the extent it was possible, since it facilitates the registration of expressions and body language of the interviewee (Hanington & Martin, 2012, p. 102).

2.2.6 **Affinity diagram**

Affinity diagrams are an inductive method, which means that details from the observations and interviews first are clustered into sub-themes and then grouped into overall themes (Hanington & Martin, 2012, p. 12). In this way, the user needs can be identified.

Affinity diagrams were used at the end of the observations and interviews to get an overview of the gathered information and inspiration.

2.2.7 **Brainstorming**

Brainstorming is a method used to generate many ideas. The method can be executed in several ways, but it is important to not criticise any ideas during the brainstorming sessions. Instead, crazy ideas are appreciated and the evaluation is done after the session. (Wikberg Nilsson, Ericson, & Törlind, 2015, p. 125)

The type of brainstorming method used is called braindrawing and was executed during the early stages of the Develop phase. During a braindrawing session the participants draw sketches of their ideas. Afterwards they discuss each idea, try combinations of ideas and categorise them in themes (Wikberg Nilsson, Ericson, & Törlind, 2015, p. 129).

2.2.8 **Sketches & 3D modelling**

Sketches is an important tool during the concept generation, since visualizations facilitates the communication of ideas (Ulrich & Eppinger, 2014, p. 180). In this project, sketches were made on paper and in Adobe Illustrator during the Develop phase. Sketches were also made of cardboard and in SolidWorks, to investigate concepts in three dimensions.

2.2.9 **User tests**

Testing can be used both in the first and second half of the Double Diamond process, to ensure that the problem is fully understood or a new design fulfils the user's expectations and needs. It can be useful to let a pair of people test the product, since this allows them to discuss their experiences and ideas naturally with each other. (Norman, 2013, pp. 228-229)

In this project user tests were executed during the Develop phase to identify important dimensions and ensure that the selected concept was designed for the users.

2.3 Structure of the chapters based on Double Diamond

In Figure 2.2 the distribution of the chapters according to the Double Diamond process are depicted.

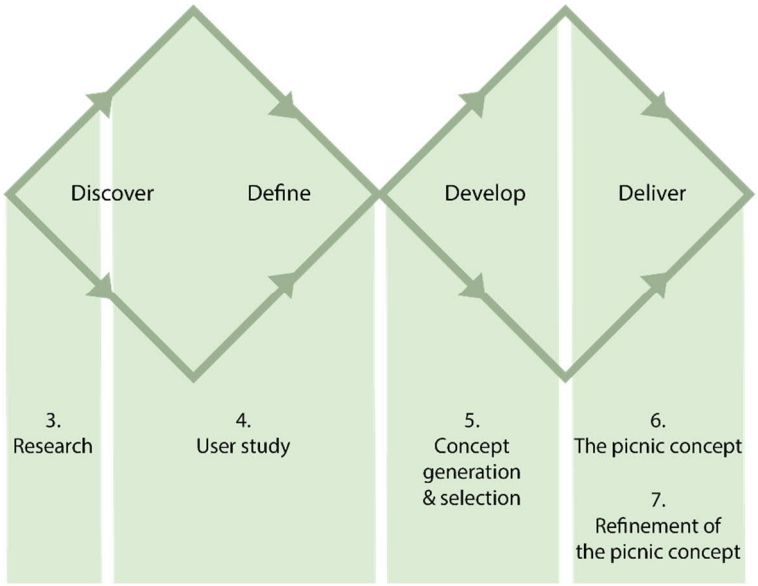

Figure 2.2: How the chapters are distributed in the Double Diamond.

2.4 Time plan

A time plan was conducted based on the four phases of the Double Diamond process and an initial time plan can be seen in Figure 2.3.

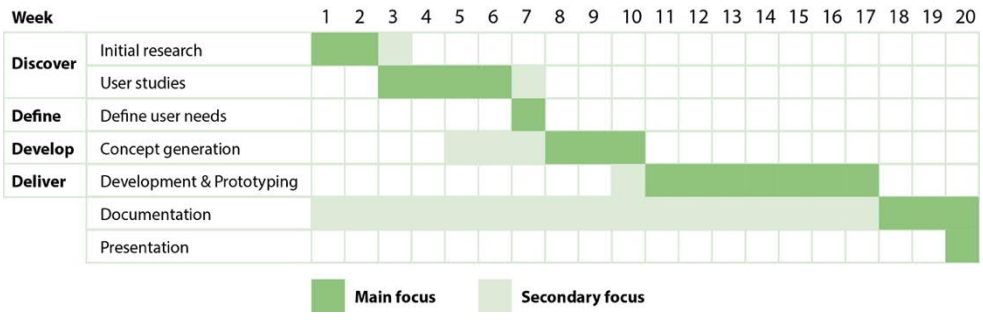

Figure 2.3: Initial time plan for the project.

3 Research

In this chapter the first part of the Define phase in the Double Diamond process will be displayed. The methods presented in this chapter are stakeholder mapping, image board and benchmarking.

3.1 Stakeholder mapping

A stakeholder map was created according to Figure 3.1, to get an overview of the people to have in mind when designing the new add-on to Ascent. Airport passengers were set to end users and divided into three categories; purpose, age and travel distance. The stakeholder map also included people with direct and indirect contact with Ascent.

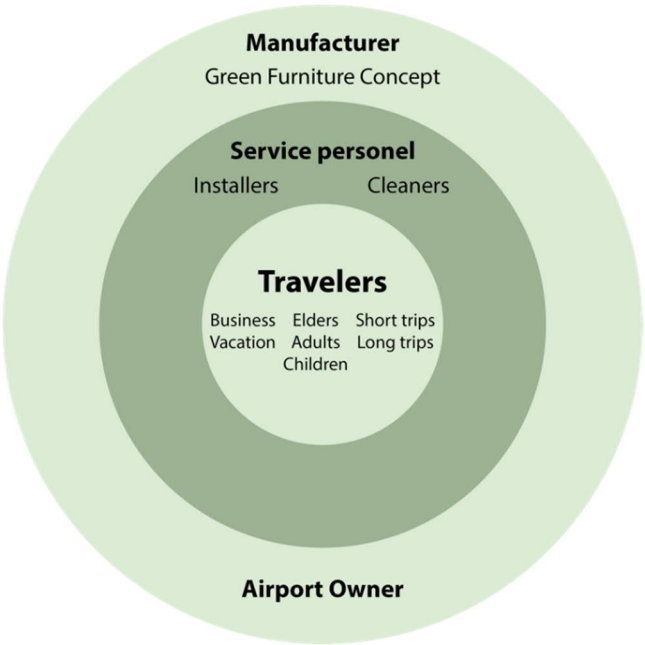

Figure 3.1: Depiction of different stakeholders.

3.2 Understand Green Furniture Concept & Ascent

To get a better understanding of the dimensions, proportions and design of the seating system, CAD files of Ascent were examined. Renderings of the series and an early stage segment of the real bench were studied with the aim to get a feeling for the aesthetics of the Ascent series.

3.2.1 **Modules of Ascent**

The seating system consists of different modules, varying between straights and bends that allow the customer to assemble unique configurations to better shape the seating for the environment. The modules presented in Figure 3.2 are designed to be aesthetically seamless, meaning when assembled they visually create one single unit. The different modules can come with varying heights of the backrest which creates a wave pattern along the seating.

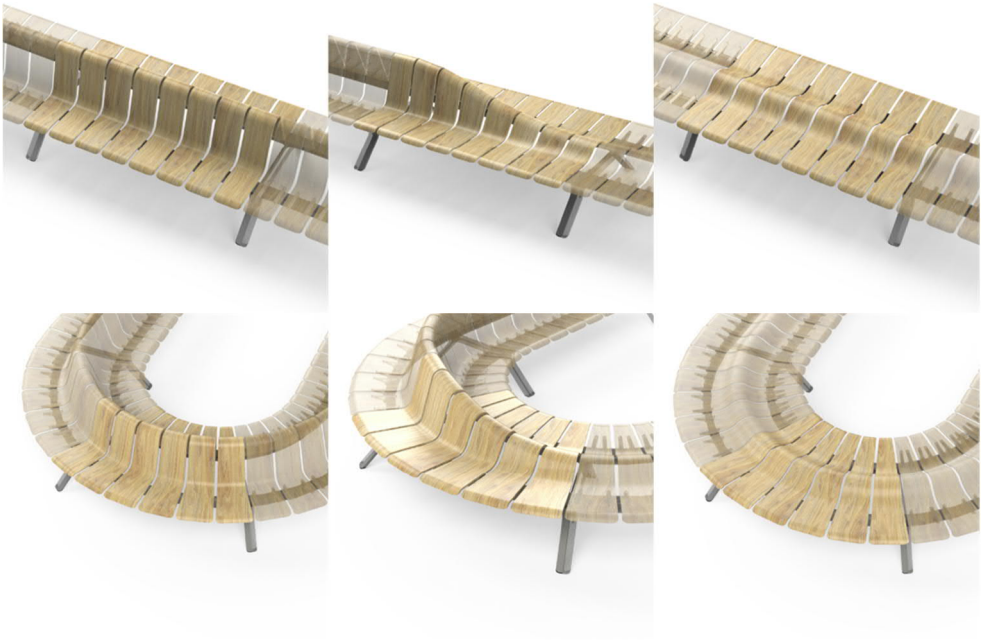

Figure 3.2: Modules of the Ascent series. From left to right: Ascent Double Back, Ascent Double Rise and Ascent Double Bench (Green Furniture Concept, 2020).

3.2.2 **Components of Ascent**

The constituent components of Ascent that has affected this project are listed below and shown in Figure 3.3.

- Steel legs, that are attached at each end of every module.
- Aluminium beams, which carries the seats and add-ons and follows the shape of the module.
- Seating clamps and add-on clamps that are attached on the beam.
- Seating slats, that create the shape of the module.

On top of these components, GFC offer add-ons, such as smaller tables, armrests, chargers and end pieces shown in Figure 3.4.

Figure 3.3: The constituent components of Ascent (Green Furniture Concept, 2020).

Figure 3.4: Different add-ons of the Ascent series (Green Furniture Concept, 2020).

3.2.3 **The experienced feeling of Ascent**

Words related to Ascent were noted and based on those, the image board seen in Figure 3.5 was created to visualize the feeling of the system.

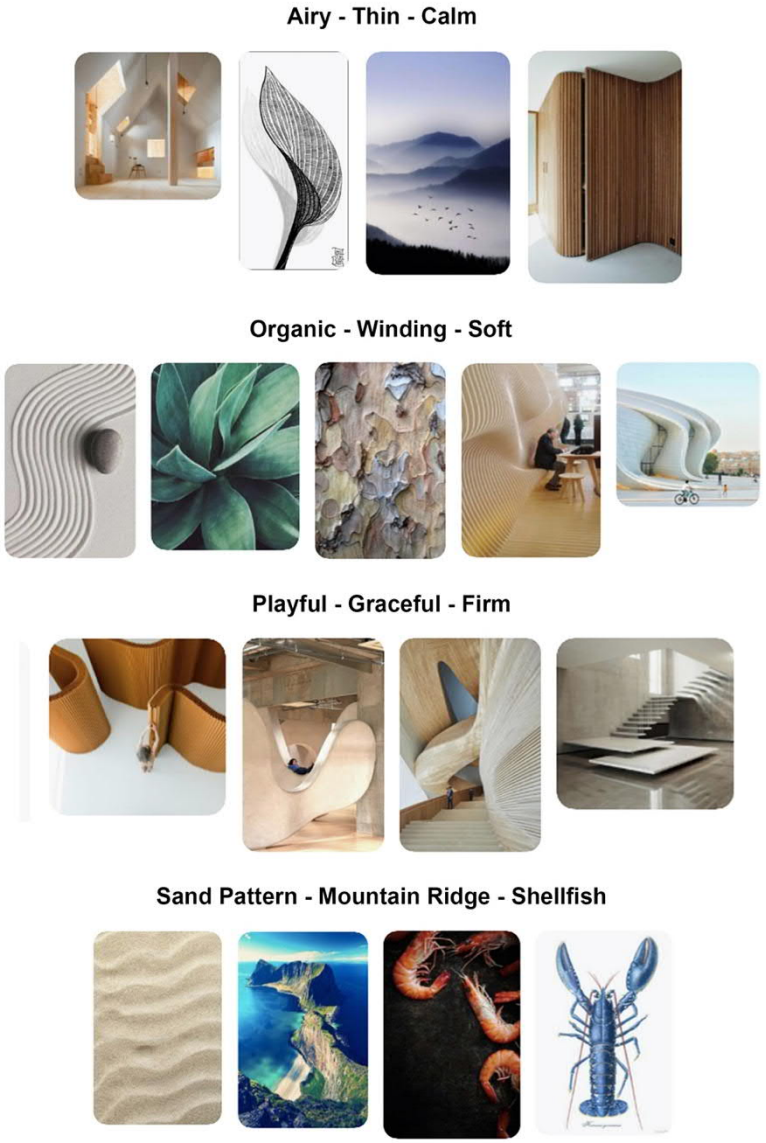

Figure 3.5: The experience of Ascent in an image board.

Other products by Green Furniture Concept were also examined to get an understanding of the vision the company has with their products. It was concluded that their products are best suited in large open-plan areas, where they can enhance the architecture.

3.3 Benchmarking

A benchmarking was done by searching for companies online, with focus on airport seating and furniture. The aim was to gather inspiration and answer the following questions:

- What does airport seating from other companies look like?
- What type of add-ons exist on the market?
- What does GFC and other companies have in common and what differentiates them?

3.3.1 **Insights**

Currently GFC and their competitors offer similar add-ons to their seating systems. The most common add-ons were tables, armrests, cup-holders and power outlets. Also, planters, dividers, advertising screens and plants were found. Some companies offered working booths and telephone booths. Some of the found add-ons are presented in Figure 3.6.

Most of the companies offer modularity in their products. Most companies with focus on airport seating utilises beam seating design, which offers modularity in terms of what you attach to the beam.

Ascent differentiated itself from traditional beam seating by utilising seamless design. This was also found in the Landscape series by Zoeftig, as seen in Figure 3.6 (g-h).

The companies that were used for benchmarking are Zoeftig, OMK Design, IMAT, Arconsas, Kusch+Co and Marcus Pedersen.

Figure 3.6: Some of the add-ons from the benchmarking. From left to right, upper to lower: (a) Cup holder, armrests and power outlet (Arconas, 2020). (b) Modular bench configuration (Zoeftig Ltd, 2020, p. 14). (c) Modular bench configuration (OMK Design, 2020, p. 38). (d) Priority seat (Zoeftig Ltd, 2019). (e) Phone booth (Marcur Pedersen, 2013). (f) Side table (IMAT, 2020). (g-h) Advertising screen, planters and power outlets (Zoeftig Ltd, 2018).

4 User study & user needs

In this chapter, conducted observations and interviews from the Discover phase will be presented. The key findings and user needs in the Define phase will also be displayed.

4.1 Observations

Observations were conducted at public interior areas and airports to gather inspiration and insights. The focus of the observations was behaviour of people and furnishing of rooms.

Three different airports were visited; Sturup Malmö airport, Bromma Stockholm airport and Arlanda Stockholm airport. The team flew from Sturup to Bromma, and from Arlanda to Sturup. In this way, the team experienced several aspects of travelling with plane, including check-in and luggage management.

Other public interior areas in Malmö and Lund were also observed, mainly to gather inspiration from locations with similarities to airports.

The following questions were in mind during the observations:

- How are directions and flow of people created?
- How are rooms divided into different sections?
- Where do people gather and why?
- What are people doing?

4.1.1 **Public interior areas in Malmö & Lund**

The different public interior areas visited are listed down below. At each location behaviour of the visitors and how space was created was observed, notes and photos were taken.

- Public Library, Lund
- Lund Central Train Station

- Public Library, Malmö
- Malmö Central Train Station
- Hansa Shopping Mall, Malmö
- Triangeln Shopping Mall, Malmö
- Triangeln Train Station, Malmö
- Emporia Shopping Mall, Malmö

4.1.2 **Sturup Malmö airport**

At Sturup airport, the observations spanned between 11:00 and 13:30 on a Wednesday. Thirty minutes was spent in the public space and the rest of the visit was spent inside the security checkpoint. The approach was to quickly scan all sections and then spend time in different spots to get a feeling of the surroundings. The previously mentioned questions were discussed, notes were taken and findings video-taped or photographed.

4.1.3 **Bromma Stockholm airport**

The observation at Bromma airport lasted for approximately 30 minutes from 14:35 on a Wednesday. This was partly due to the small size of the airport and partly due to fatigue. The same procedure, as at Sturup airport, was used during the observation at Bromma.

After Sturup and Bromma airport, it was decided to spend more time at Arlanda to increase the chance of finding insightful realizations.

4.1.4 **Arlanda Stockholm airport**

The visit to Arlanda airport was planned to last for 5 hours but due to delay and cancellation of the flight the visit was prolonged, between 16 and 22:30 on a Tuesday. Arlanda is a larger airport, than the two previous ones, with 5 terminals. During the observation, time was spent at Sky City, a large area with hotels, restaurants and waiting areas before the security checkpoint at Arlanda airport. Time was also spent at terminal 4, where the flight back to Malmö departed from. The same approach as the observation at Sturup airport, was used at Arlanda.

4.1.5 **Key findings**

4.1.5.1 How sections in a room were created

Creating atmosphere and different sections in a room, can be done by combining different furniture, materials, colours and shapes. It was noticed that directions in a room often follow the shape of furniture and occur in the empty space between the sections.

It has been observed that e.g. draperies, bookshelves, fences, benches or plants can be used as divider between sections in a room,

One way to encircle a section of a room, is to use the floor. A carpet or shift in floor type, can indicate that you are entering a new section, as seen in Figure 4.1. Another way to create a section is to use the ceiling. In that case, different sorts of lighting or a lower ceiling can be used over a certain section. It was observed that a lower ceiling can be created by hanging lamps, plants or shaped wire net, as presented in Figure 4.1.

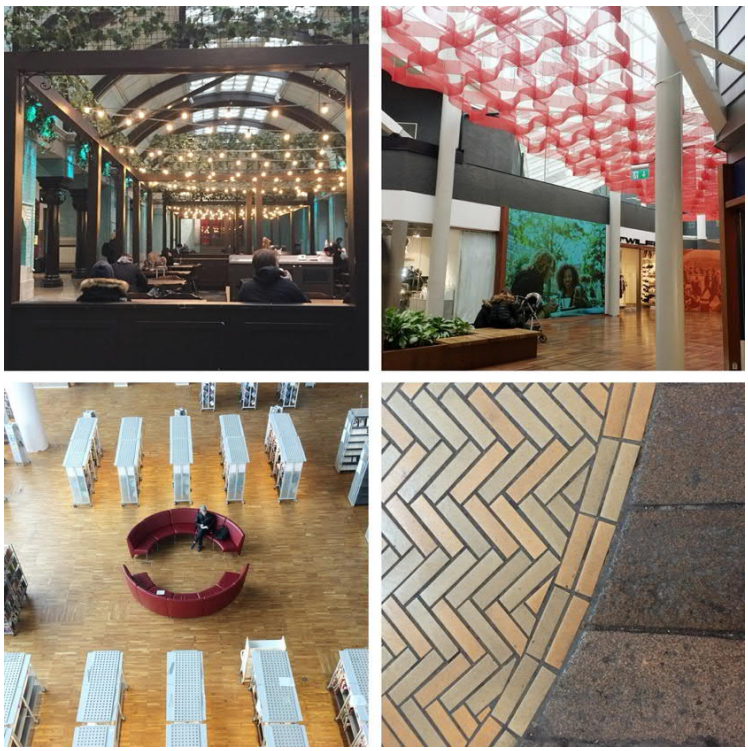

Figure 4.1: Left to right, upper to lower: (a) Café section, Malmö Central station. (b) Roof hanging structure, Triangeln shopping mall. (c) Couches enclosed with book shelves, Malmö Public Library. (d) A change in floor pattern at Malmö Central station.

4.1.5.2 How and where passengers spend time at the airport

The gate area was to a large extent calm and quiet. The few passengers there were seated sparsely at the benches, as seen in Figure 4.2. As the time for boarding approached, the gate area was filled with passengers traveling with the flight, as seen in Figure 4.3. This increased the level of noise and movement in the area.

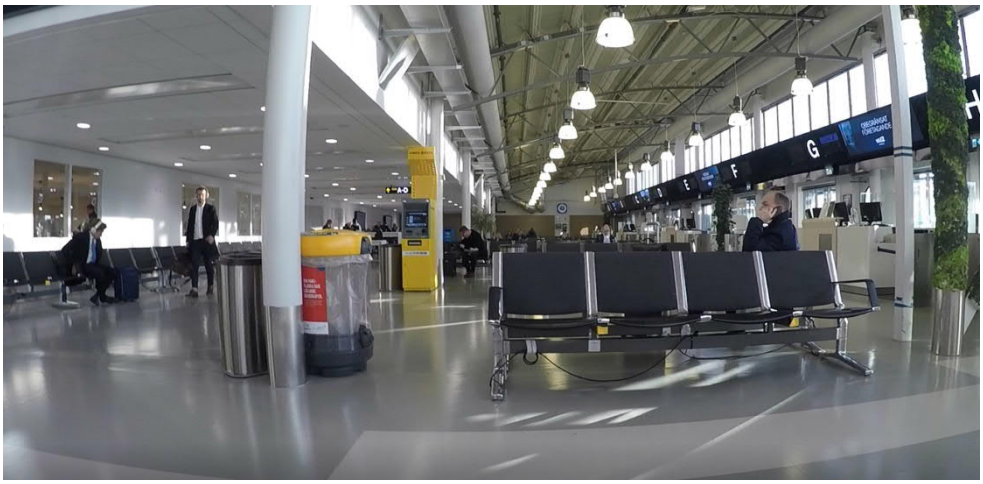

Figure 4.2: Passengers sparsely seated at the gate area.

Figure 4.3: A gate area just before boarding.

The activity and the number of passengers in the commercial areas varied between the three airports. At Arlanda airport, a lot of passengers were seated at the restaurants and in Sky City. Generally, Arlanda airport was more vivid, with a lot of movement and noise. Sturup and Bromma were much calmer both in the commercial areas and around the gates. It can be assumed that this difference depends on the size of the airports, since Arlanda airport is a larger airport compared to the other two. The observations were conducted during different hours and weekdays. This probably affected this observation as well, since it is highly possible that the number of passengers varies during the day and week.

4.1.5.3 Where people work

It was observed that several passengers were working in the gate areas while waiting, often with a computer in their lap. At all three airports, tables and power outlets were absent at the gate seating, as shown in Figure 4.4. An exception was seen at Arlanda airport, where tables with bar stools and power outlets were placed along the windows at one side of the gate area, as seen in Figure 4.5. At these tables, passengers worked or charged electronic devices. Due to the placement of these tables along the windows, a natural separation from the other passengers was created.

Figure 4.4: A gate area without tables and power outlets.

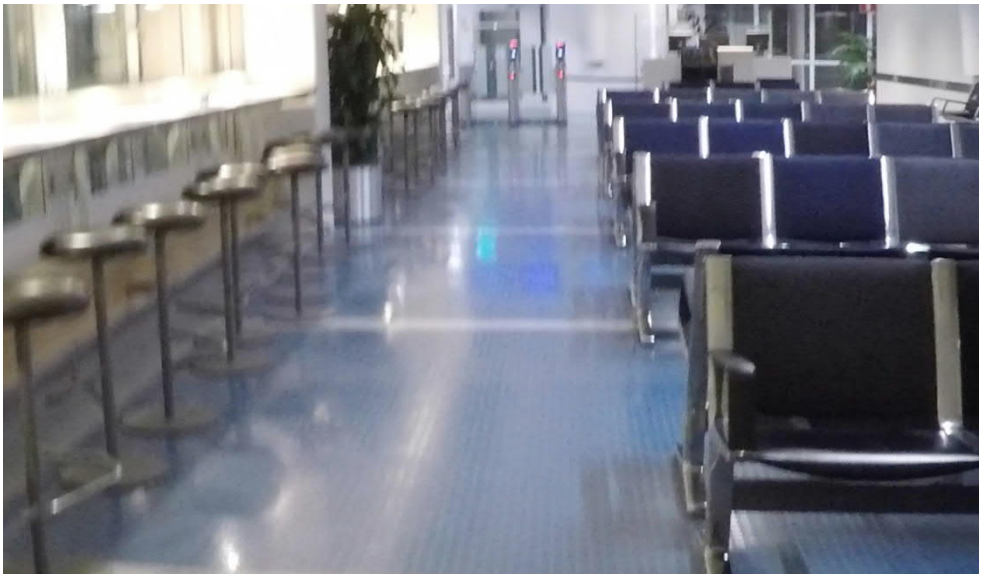

Figure 4.5: Table with bar stools and power outlets along the windows.

Some passengers worked at the cafés in the commercial areas. The cafés were more homely furnishing compared to the gate areas, as seen in Figure 4.6, with the possibility to charge electronic devices.

At the café at Lund Library, visitors who worked or studied, were seated along the walls, while the visitors socializing were seated at the tables in the middle of the room. An assumption is that people prefer to be seated with their backs free and with an overview of the room, since this can create a feeling of safety.

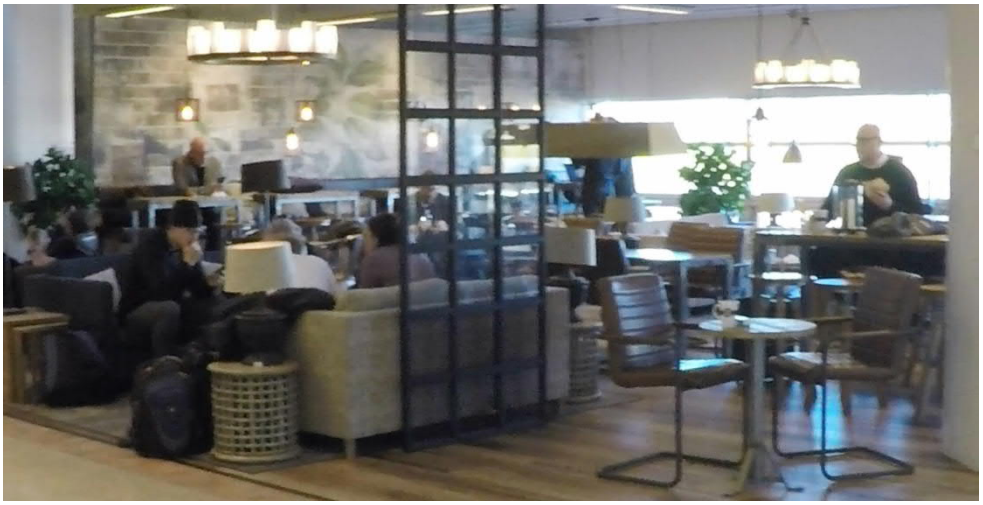

Figure 4.6: Passengers waiting at a café in the commercial area.

4.1.5.4 Green Furniture Concept at airports

According to GFC they create space with their interior. This was observed at the airports, where different configurations of their Nova C series were placed. At Arlanda and Sturup airport, the Nova C benches were used together with other furniture to create space and enhance the atmosphere, as seen in Figure 4.7(a). This can be compared to how a segment of a Nova C bench was placed at Bromma airport. The segment was standing alone in a narrow space, as seen in Figure 4.7(b), which made the bench just stand in a room rather than creating the room.

Figure 4.7: A comparison between uses of GFC's Nova C series. Left: (a) Nova C configuration at Sturup airport. Right: (b) Nova C single module at Bromma airport.

4.1.5.5 Other findings

At Arlanda airport there was a coffee cup left on the gate seats. A banana peel was also found at a table close to the gates, as shown in Figure 4.8. It was noticed that there was a lack of easily accessible trash bins around this gate.

Figure 4.8: Trash left behind at Arlanda.

4.2 Interviews

- A total of two pilot tests and four interviews were held to understand the target groups and their behaviour at airports.
- A phone call was held with an airport traveller process owner to understand the needs of airports. His area of responsibility was punctuality, logistics and the equipment at the gates.
- A conversation was held with a cleaner working at Arlanda airport to see his perspective.

The interviews were held in person and were recorded with audio and transcribed into text format. The interviewees were recruited through personal contacts. All interviews were conducted with a semi-structured interview guide. The first pilot test was held with a classmate. After the pilot test, it was decided to change the formulation of some of the questions to encourage more of an open dialogue. For each successive interview, some minor changes were done to the interview guide due to new insights. The base for the interview guides can be found in Appendix A.

The phone call and the conversation were more spontaneous, thus were not recorded and the questions were more unstructured.

4.2.1 **Interviewees**

1) The first interviewee was a middle-aged woman who had experience from flying with work. She flew between two and ten round-trips with work per year and the locations varied between Europe, Asia and America. She mentioned that she flew less than once a year for vacation.

2) The second interviewee was a retired man who had experience flying with work from around ten years ago. He flew around 12 times a year during that time, mostly within Sweden and between Sweden and England. The last five years he had only flown privately with three round-trips this last year.

3) The third interview was with a mother of two children at the age of three and five. She had experience of occasional vacation flights with them.

4) The fourth interviewee was a man with younger children who frequently flies with work within Sweden. He flies around 20-30 times per year with work. He has also flown with his children.

4.2.2 **Key findings**

4.2.2.1 Travelling with business

The interviewed business travellers tried to optimize their airport visits. They did it by being there for as short a time as possible, to not having to be away from home more than necessary. If they were at the airport for a longer period, they worked while waiting, to not have to recoup lost working hours later. Interviewee 4 said:

> *"The first thing I do when I get inside [security check point] /…/ It is... Where can I find a seat where I can sit more secluded and get some work done with my laptop."*

If they worked at the airport, they preferred to work where it was calm and quiet. Often they end up working at the gate, with the computer in their laps, even though it is not an ergonomic position, as interviewee 4 described it:

> *"I usually end up at these long rows of benches and... You sit a little half-assed there with the computer in your lap and people around you, making it somewhat hard to focus."*

If the business travellers at the same time want some coffee, the situation becomes inconvenient, since they then have to keep things on the floor to manage. Another problem they mentioned was to make business related phone calls at the airport, due to the risk of potentially sharing sensitive information in a crowded place.

> *"Some phone calls could be a bit sensitive and then you don't want to sit at an airport with a whole bunch of people around you"*

They appreciated when the airports included design and culture in the furnishing, since this gives the passengers a more vivid and interesting airport visit. Interviewee 1 described an appreciated airport:

> *"Generally speaking, it was very tasteful. And then of course, it's inspired from their culture which makes it tasteful in that way. It makes you feel - I am here now, in another country, not just any other airport."*

4.2.2.2 Travelling on vacation

When the interviewed travellers are on vacation, they are more likely to be at the airport well in advance, since the routine is different than during business travels. They want to spend time with their travel companions and are more interested in the commercial areas. They mention that they are more forgiving if problems or delays occur during vacations, compared to when it happens during business trips, because they in general are in a more positive and less stressed mode, as interviewee 2 described it:

> *"Often you try to optimize your time more. You're away from home a lot, you want to go home. But if you only travel a couple of times a year it doesn't really matter if you arrive home an hour earlier /.../ That is, you are a lot more flexible if you only do it occasionally. That's one thing I feel strongly about, the things you do regularly should work"*

4.2.2.3 Travelling with children

According to one of the interviewed parents, interviewee 3, the main focus during airport visits was to take care of and entertain her children, so the children did not disturb other passengers:

> *"Otherwise they just run around which is annoying for others and that is quite stressful. So, if they find something interesting they keep calm and amused. "*

The parent mentioned that if a playground is available the children can be occupied there. To entertain the children in a quieter way, they can be given an electronic device. If an electronic device is used as entertainment during the trip, the possibility to charge must be available, this can be stressful according to interviewee 4:

"...what you entertain them with on the way to the airport, like that time in Florida or at the airport if you must wait a couple of hours, it is an iPad. That's it. And you get this panic – 'Don't drain all the battery now, because you will need it on the airplane as well'. So, you want to be able to easily connect to a charger."

The parents also emphasized the importance of available seating with the possibility to sit and lie down, so the children did not have to stand up if they needed rest:

"... when you fly during night /.../ and have children who are moody you need somewhere to sit, preferably somewhere to lie down"

4.2.2.4 Comfortability

When passengers must spend a lot of time at airports, e.g. when in transfer or in case of delays, it is important to be able to sit comfortably while waiting. Interviewee 1 did not expect the airports to have beds or extra comfortable couches, but appreciated when it was possible to sit back with armrests or headrest:

"...for me it's not too important, as long as you can sit comfortably. And by that I don't mean slouch in a couch, cause that's not the purpose of airports but you must be able to relax. Feel like you can sit there for half an hour without getting the taste of wood in the butt"

It was also mentioned that the passengers wanted to have control over their luggage while resting.

4.2.2.5 Perspective of the airport owner

According to the traveller process owner, it was desirable that the passengers spend as much time as possible at the commercial areas, as long as the punctuality of the flights did not get affected. This was desired since a large part of the airport's income was generated from the commercial areas.

It was mentioned that they have limited number of tables around the gate environment due to improbability that passengers bring food to the gate.

When it comes to the furnishing of the airport, the travel process owner said that their seating was mainly chosen with consideration to the number of passengers they could seat, but also from a maintenance perspective - that parts easily could be cleaned and be replaced if something breaks. Besides the practical aspects, the airport tried to choose furniture to enhance the atmosphere. This was observed at both Sturup and Arlanda airports where different interiors divided sections with cosmetic design choices, such as plants, lights, materials and structure.

4.2.2.6 Perspective of a cleaner

The cleaner explained that they have large areas to maintain and the gate areas should be cleaned about three times a day, therefore they have short time to clean each area. The cleaner also mentioned that it was desirable to clean when as few passengers as possible were at the gate area, since a lot of people made it more difficult to reach all the surfaces that needed to be cleaned. Additionally, the cleaner did not want to unnecessarily disturb the waiting passengers. According to the cleaner, Sunday afternoons was the most crowded time during the weeks and therefore the most inconvenient time to clean the gate areas.

During these conditions, the cleaning must be done quickly. The cleaner mentioned that as few narrow spaces as possible would facilitate the cleaning, since these areas were difficult to wipe clean and dirt easily gathers there.

4.3 User needs

The insights from observations and interviews were summarized as user needs, categorized in different user groups, with help of an affinity diagram.

4.3.1 **Business travellers need**

- To work comfortably with a computer and coffee
- To be able to make phone calls in privacy
- To escape distractions while working.

4.3.2 **Travellers need**

- To be able to sit comfortably
- A stimulating airport experience

4.3.3 **Children need**

- A stimulating surrounding
- Comfortable sleeping option

4.3.4 **Airport owners need**

- A clean gate environment
- To generate income
- Simple maintenance
- To provide enough seats for passengers waiting to board
- Space efficiency

4.3.5 **Cleaners need**

- Easily cleaned room and furniture

5 Concept generation & selection

In this chapter the third phase in the Double Diamond process will be presented. The Develop phase included concept generation based on the defined insights from previous phases.

5.1 Concept generation 1

Concept generation was done for each of the defined passenger user needs through sketching and brainstorming. While generating ideas, the needs for airport owners and cleaning staff were kept in mind but not in focus, due to the early stage of idea generation.

At this stage, it was avoided to dig deeper into solutions of each concept. Therefore, the concepts were visualized as sketches of principle rather than actual solutions of the respective need. During the concept ideation, the following questions were in mind:

- Will the concept be attached to the bench or stand independently in conjunction with the bench?
- What shapes and expressions naturally exist within the Ascent series?
- How does the concept satisfy the expressed needs?

The concepts were categorized into the categories presented in the section below.

5.2 Summary of concepts from concept generation 1

5.2.1 **Privacy - remove distraction of movement**

The concepts in this category included different dividers creating privacy sideways and from behind, attached in between slats or freestanding, as presented in Figure 5.1. It was realised that a divider cut the aesthetic flow in

the Ascent unit, therefore it was explored how the aesthetics could be preserved. This was done by exploring with shapes and dividing the bench into smaller units.

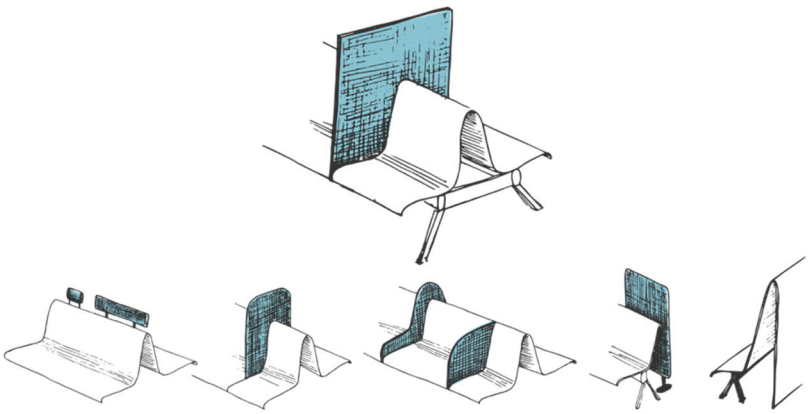

Figure 5.1: Sketches of different dividers.

5.2.2 **Privacy - remove distraction of noise**

It was explored what a modern phone booth could look like, if placed at a noisy airport environment. The phone booth concept would be independent of the bench, as seen in Figure 5.2, and reuse elements of Ascent to match the aesthetics. It was explored what could accompany a phone booth and what level of technology could be used.

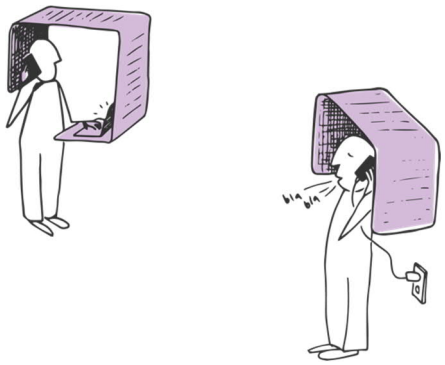

Figure 5.2: Sketches of a phone booth.

5.2.3 **Table surfaces**

Table surfaces with different areas depending on whether they would work for laptops and/or coffee cups were explored. The different concepts were attached in between slats, freestanding or a slat exchanged to a table, as seen in Figure 5.3.

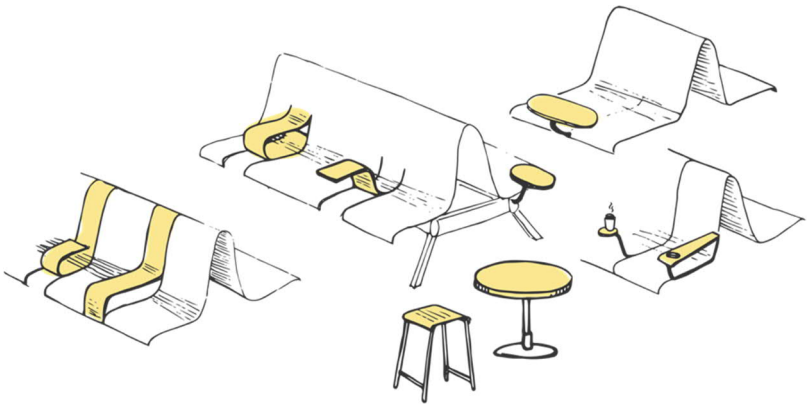

Figure 5.3: Sketches of different table surfaces.

5.2.4 **Combination of privacy and table surface**

It was explored how plants could work as dividers and at the same time be combined with a table surface. One slat was exchanged to a planter with different types of table surfaces attached, as presented in Figure 5.4.

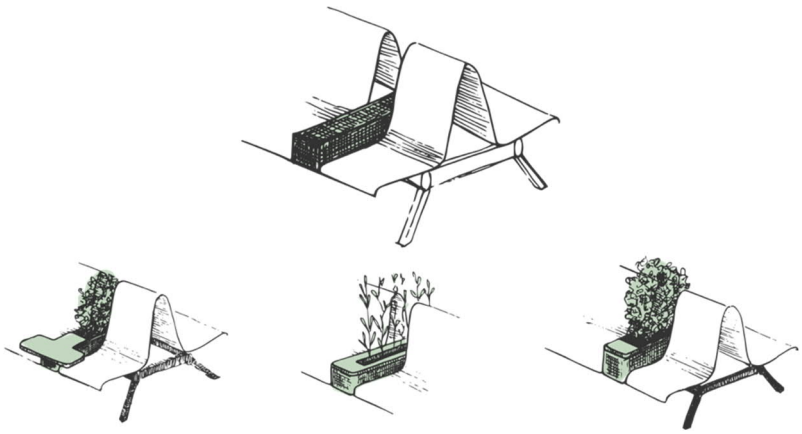

Figure 5.4: Sketches of planters in combination with table surfaces.

5.2.5 **Utilise the end of a bench module**

Several types of endings to the bench were explored, as presented in Figure 5.5. The concept would allow different table surfaces and dividers at the end of the bench, utilising the profile of the aluminium beam as an attachment point.

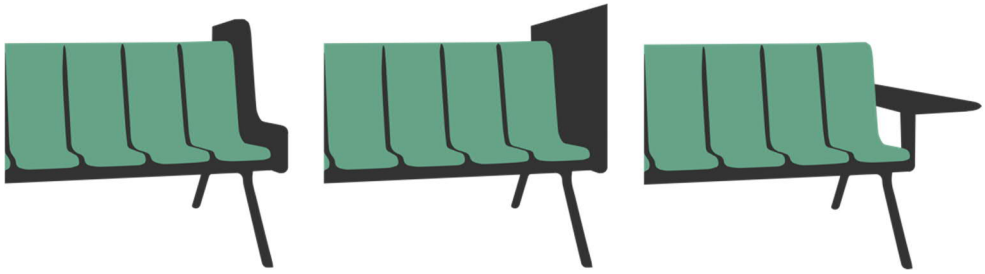

Figure 5.5: Sketches of alternative end pieces.

5.2.6 **Playful design for a vivid environment**

It was explored how Ascent could be shaped into playful animals, since Ascent itself is an organic pattern associable with many different animals. One alternative is presented in Figure 5.6.

Figure 5.6: Sketches of playful design.

5.3 Consultation with Green Furniture Concept and Knightec

In consultation with supervisors from GFC and Knightec, it was decided to continue with the concept generation with focus on concepts involving exchange of one slat to an add-on. This direction of the development was selected because; it did not limit concepts to one single need, it had potential to integrate several functions in one solution and it limited the design possibilities to make it easier to delve into concepts.

5.4 Concept generation 2

Further concept generation within the concept “Exchange one seating slat to an add-on” was conducted. All needs were still taken into consideration during the concept generation process. A concern during this process was to retain the aesthetics of Ascent with the added concepts. To do this, many shapes of Ascent were re-used while designing.

5.4.1 **Test of heights**

Quick tests within the team were conducted to get a feeling for suitable heights when designing armrests, tables and dividers, as seen in Figure 5.7. Chairs with dimensions like Ascent were lined up to simulate the bench. Cardboard, boxes and wooden planks were used to simulate the height of different add-ons, such as armrest, table and divider. See Appendix B for an overview of the test and the insights obtained.

Figure 5.7: Exploration of different heights.

5.4.2 **Exploration of shapes**

To create concepts that blend into the flow of Ascent, shapes were explored in Adobe Illustrator. The approach was to reuse existing profiles of Ascent to create patterns, which could be translated into add-ons, as presented in Figure 5.8, Figure 5.9 and Figure 5.10. It was also used to illustrate concepts quickly and test different designs of the concept before taking it to 3D modelling, as seen in Figure 5.11 and Figure 5.12. With this approach, many alternatives could be produced fast.

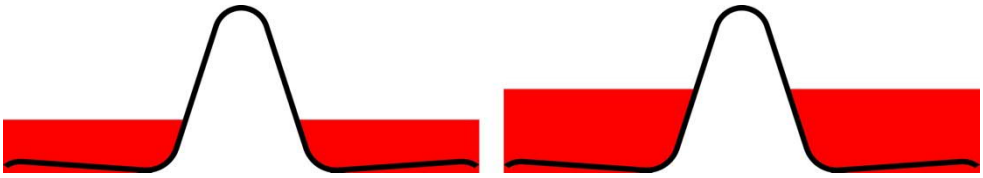

Figure 5.8: Illustrations to get a feeling of weight and height.

Figure 5.9: Reuse of existing shapes to create tables.

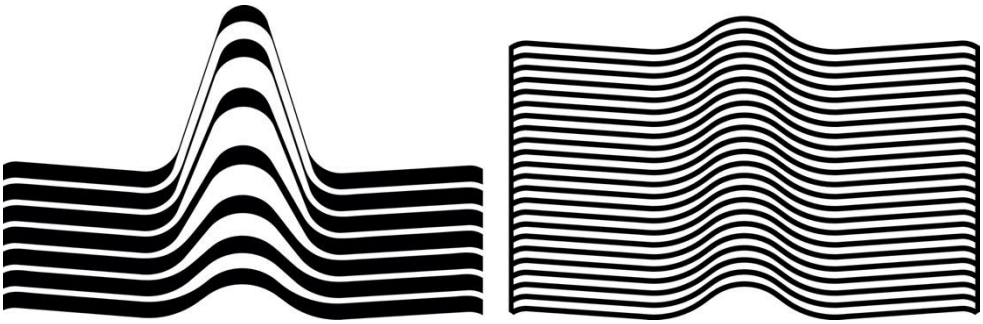

Figure 5.10: Reuse of existing shapes to create patterns.

Figure 5.11: A fast way to test different alternatives.

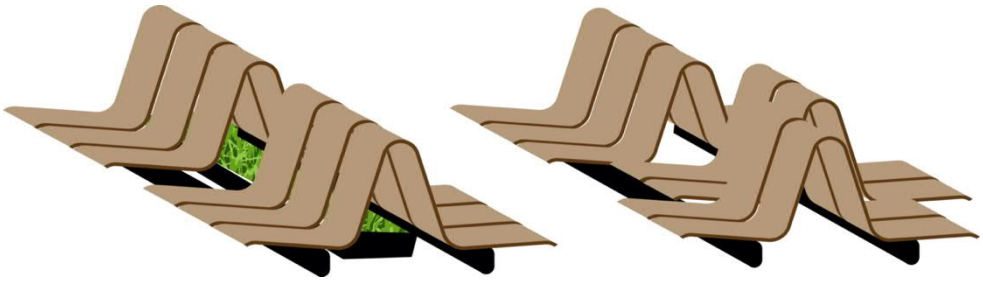

Figure 5.12: Concept sketches before 3D modelling.

5.4.3 **3D-modelling and cardboards**

Cardboard models were created to switch environment from computer work, as seen in Figure 5.13. The purpose was to get a feeling of dimensions, but the quality was considered insufficient. Instead, interesting and relevant concepts were 3D-modeled and assembled with Ascent in SolidWorks. It was also done to better see if the concepts matched the flow and aesthetics of the Ascent series.

Figure 5.13: Cardboard models.

5.5 Summary of concepts from concept generation 2

5.5.1 **Tables & armrest concepts**

Figure 5.14 illustrates a table and armrest concept with similar profile as Ascent. Another version of it utilises the top as a flower pot which resembles a mountain ridge. It was however considered to be too thick, which contradicts the airy feeling of Ascent established with the image board.

Figure 5.14: Left: Armrest that follows the profile of Ascent. Right: Armrest with added flower pot.

Another approach to the concept was a more rounded version with a hollow side which added lightness and two usable surfaces, as seen in Figure 5.15. Also here, a flower pot was added on the top to have it follow the shape of the backrest.

Figure 5.15: Side table with flower pot.

One concept had one part table surface and one part seat surface, as presents in Figure 5.16 and Figure 5.17. In this way, the table could be used as a backrest for the seat and different shapes could be created by changing direction of the table. It was explored if the concept could be made even lighter by cutting it in beams.

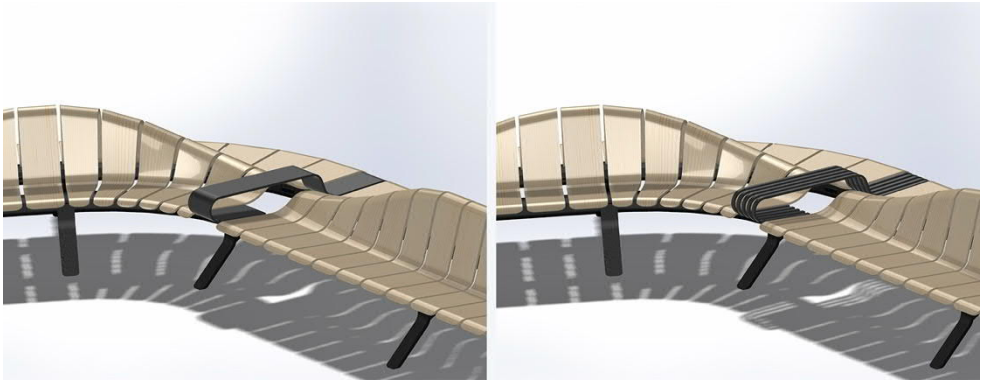

Figure 5.16: One half table and one half seat.

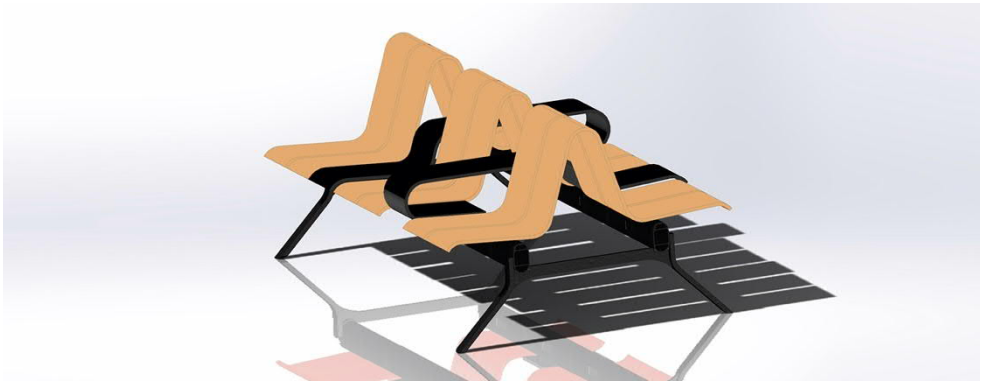

Figure 5.17: One half table and one half seat, next to high backrests.

The concept did not fully fit in with the high backrests which inspired other versions as seen in Figure 5.18.

Figure 5.18: Side tables trying to blen in with the high slats.

Other concepts were inspired by the shape of the high slats upside down and from and angle and these were explored with different heights. These concepts would serve as side tables and was best fitted on the lower slat heights, as shown Figure 5.19.

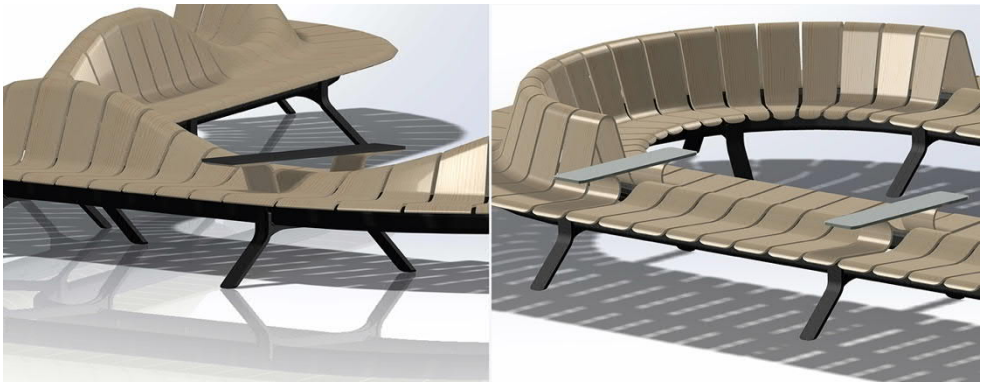

Figure 5.19: Side tables inspired by the shape of a high slat.

Another thought was to replace the backrest with a table, so that it could be used for both purposes, as presented Figure 5.20. In this way, the table would not use any additional space. This idea was evolved to extend over many seats to create a working station within the bench.

Figure 5.20: Tables replacing the backrest.

5.5.2 **Cup holder concept**

Another thought on adding functionality without using up space was to put a hole through a slat to create a cup holder, as seen in Figure 5.21. This concept could also be used for other things such as chargers but it was realised that GFC already has done this in previous series.

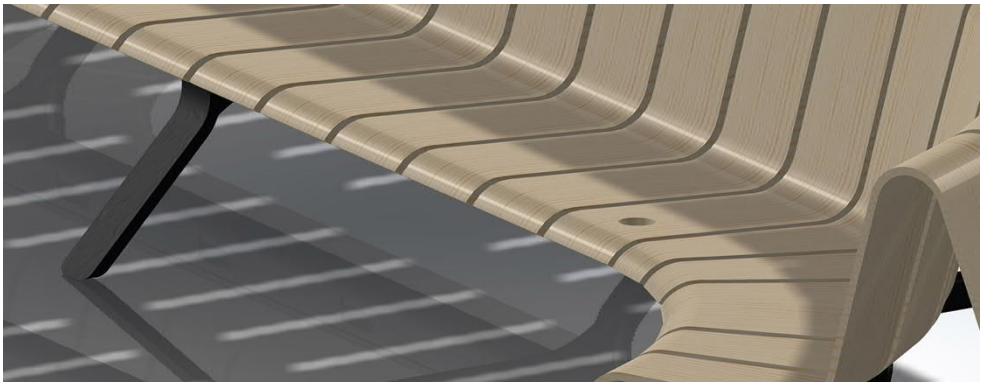

Figure 5.21: Cup holder created by removing material.

5.5.3 **Transition between high and low slat**

A design concern during the process was to fit concepts between high slats without causing an aesthetic clash. Hence, different concept for transition between the highest slat and the lowest slat was developed. One concept was a wall with different patterns or a flowerpot, as seen in Figure 5.22. Another concept is presented in Figure 5.23 and utilised the hollow area underneath the seats for placement of a waste bin or plants.

Figure 5.22: A wall as transition between high and low slats.

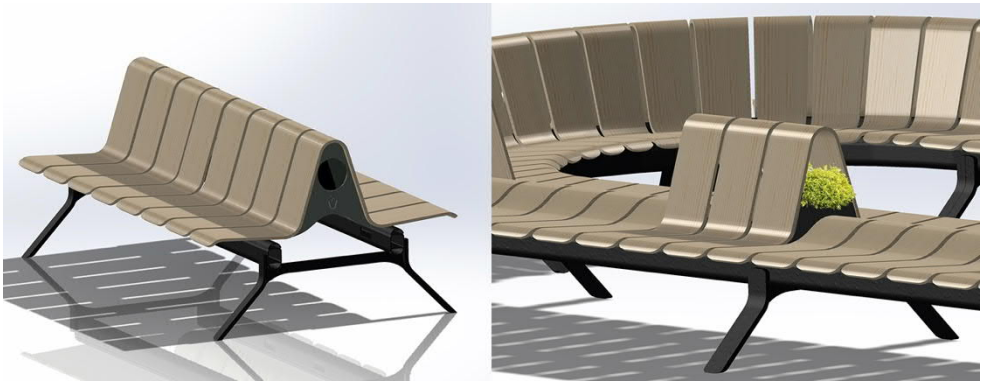

Figure 5.23: Using the space under the high slats to create a transition to the low slats.

5.5.4 **Dividers**

To create separation between the seats, screens were designed with similar shapes as Ascent, as presented in Figure 5.24. The first divider that replaced an entire slat was considered too thick and heavy and dividers that were placed in between slats cut the flow of Ascent.

Figure 5.24: Different dividers.

It was explored how plants can work as dividers, as shown in Figure 5.25. In the figure to the left, a negative of the slat profile was used as a plant pot. It was used to create division while still retaining the visual flow of Ascent. Another concept combined table surface with a larger plant to create a seperation with added functionality.

Figure 5.25: Plants as dividers.

It was also explored if dividers could be naturally created by offsetting modules from eachother, as shown in Figure 5.26. This thought process led to a design of a seat which on one side created a secluded recliner seat and on the other side a perch.

Figure 5.26: Left: Offsetting modules as dividers. Right: Recliner as divider.

5.6 Concept selection

Concept selection was performed by first making a top list of the concepts with the following in mind:

- What need does the concept solve?
- Does GFC solve this need already?
- Is the concept innovative?
- How much room for improvement exists for the concept?

All concepts were presented to Knightec and Green Furniture Concept. Along with their opinions a decision was made. It was agreed upon that the concept which showed most potential was the concept that integrated a working table within a single module. This concept, called the picnic concept, was selected. The idea with the picnic concept was to create a space efficient working place at airport gate areas. Therefore, the area that usually was taken by the backrest was replaced with a table, as presented in Figure 5.27.

Figure 5.27: The selected concept, the picnic concept.

6 The picnic concept

Considerations, research, user testing and development of the concept will be displayed in this chapter.

The concept is reminiscent of outdoor picnic benches and they were therefore used for benchmarking. A major concern about the picnic concept was that the dimensions of Ascent could cause usability and functionality problems.

6.1 Considerations

Due to the restricting dimensions of the existing modules and current design, this concept could not fully follow standard dimensions for picnic tables. A principle illustration of significant distances is presented in Figure 6.1. To make the concept functional a list of considerations was constructed.

1) To be able to comfortably sit down independently of clothing choices and mobility, you should be able to sit without stepping over the seat surface.
2) The width of the table must be larger than an average computer to avoid worrying about it tipping over.
3) Avoid a negative horizontal value between the table edge and seating edge. A negative distance means that you cannot stand upright between the seat and the table, which also makes it more difficult to sit down.
4) The leg space must be large enough to allow for comfort.
5) The seating and beams must connect with the current modules at the end points to achieve a seamless look.

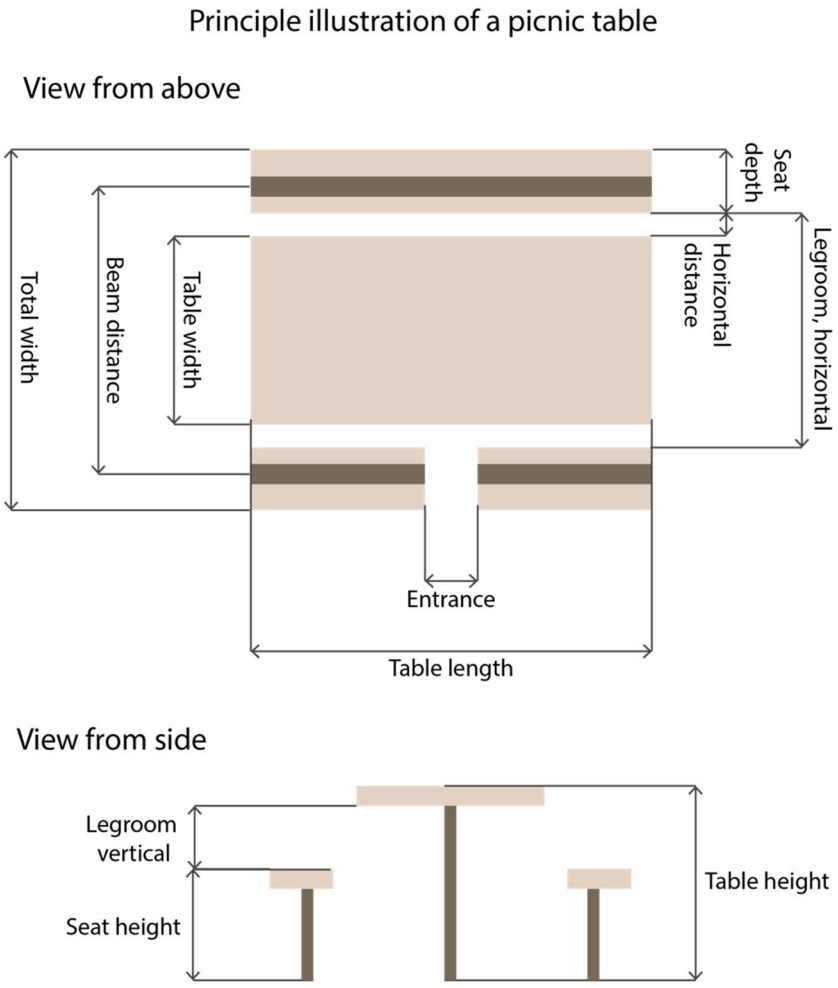

Figure 6.1: Principle illustration of significant distances.

6.2 Standard dimensions

To design a functional picnic table, research was executed to find recommended dimensions for seating adjacent to tables. The following dimensions were found (Norberg, 2011):

Dining area

- Table height: 72-75 cm
- Distance between seat and table surface: max 30 cm
- Table surface per person (set with plate, cutlery and glasses): 60x35 cm

- Seat height: 41-45 cm

Workplace

- Table height: about 75 cm, slightly lower when working with computer
- Seat height: 41-45 cm
- Seat surface: 40x50 cm

To get a better understanding of the required table surface for computer work and dining, the area of a larger laptop and a dining tray from a lunch restaurant were measured. The laptop and the tray had the area of 27x39 cm and 33x43 cm, respectively. User tests were also conducted according to section 6.4.

6.3 Benchmarking of picnic tables

A benchmarking was done to get an understanding for the dimensions of picnic tables and gather inspiration of how picnic tables without backrests can be designed. The benchmarking was performed partly by collecting data from product sheets, partly by measuring picnic tables available in the public areas in Lund.

6.3.1 **Result from benchmarking**

The interesting dimensions from the benchmarking are presented in Table 6.1 and were used as a guideline during the development of the picnic concept. The dimensions are illustrated in Figure 6.1 and a detailed overview can be found in Appendix C.

Table 6.1: Maximum and minimum values for relevant dimensions.

Dimensions	Minimum [cm]	Maximum [cm]
Table-Seat distance, vertical	22.5	33
Table-Seat distance, horizontal	7	24
Seat, depth	19	50
Seat, height	42	54.5
Table, width	66	110
Table, height	70	81
Legroom, horizontal, per person	47	61
Legroom, vertical	24	30
Entrance distance	19	26
Total width, bench-table-bench	150	190

6.4 User tests

6.4.1 **Approach**

Picnic tables available in the public areas in Lund were tested by the team. The focus was to test entrance sizes and legroom. Tests were also conducted with two test subjects where quick prototype benches were built to test specific dimensions.

The test subjects were two females of similar age, body types and culture. They both knew each other beforehand. The execution of these tests is explained below.

6.4.1.1 Test of the horizontal distance between bench and table

A bench was placed approximately 9 cm from a table. The test subjects stepped over the bench to take a seat. They were instructed to communicate their experiences and how it felt to sit at this distance from the table. Notes of their comments were taken. The same test was then performed at 15 cm.

6.4.1.2 Test of legroom

Two benches were placed at 54 cm from each other. This distance was chosen since it corresponded to the distance between the beams on a module from the Ascent series. A table was placed between the benches. The test persons sat opposite each other at the benches. What they experienced and how their legs were positioned was noted. The same test was then performed with 90 cm between the benches.

6.4.1.3 Test of table width

The test persons sat opposite each other with a table in between, as presented in Figure 6.2. The test persons were told to communicate their experiences about the table width and in which situation they thought the table would be suitable. The widths tested were 26 cm, 52 cm and 78 cm.

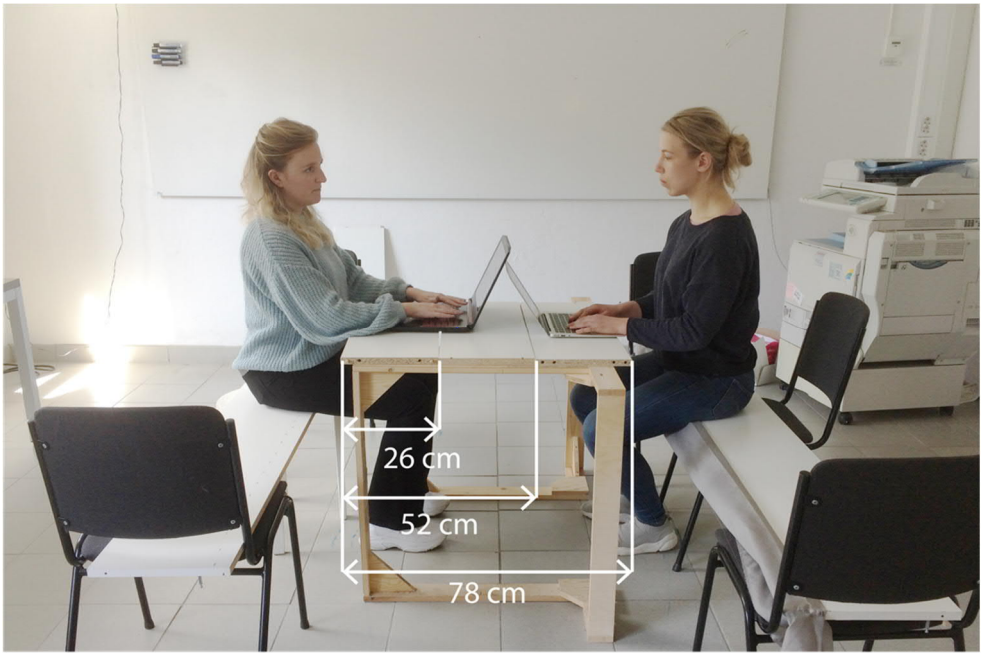

Figure 6.2: User test of table width.

6.4.2 **Insights**

6.4.2.1 Test of existing picnic tables

In the test, it was realized that the possibility to stand between the bench and the table facilitated, both when entering the bench from the side and when stepping over it. Hence, the horizontal distance from bench to table was the dimension that primarily affected the usability. A horizontal distance from bench to table of 14 cm and more was experienced as convenient. A horizontal distance of around 9 cm worked as well, but became less convenient since it was more difficult to stand up right between bench and table at this distance.

In addition to the horizontal distance between bench and table, the seating depth affects the usability when stepping over the bench. One of the tested picnic tables had a seating depth of 50 cm, which was too wide to step over in a convenient way. All other benches had a seating depth of 19.5-30 cm, which was more suitable.

For the tested picnic tables, the legroom was never experienced as a problem when sitting opposite another person. The shortest measured legroom was 47 cm per person.

6.4.2.2 The horizontal distance between bench and table

The test persons thought it was easiest to step over the bench when the horizontal distance between bench and table was 15 cm. A distance of 9 cm worked as well, but was not as convenient as the wider distance. However, they found the distance 9 cm more convenient if they would work with a computer on the table. According to them, 15 cm was less comfortable in such a situation.

6.4.2.3 Legroom

At a width of 54 cm between the benches, the legroom per person was 27 cm. This distance was experienced as *"too close for strangers, but could work with friends"*. To avoid stepping on each other's toes, the test persons sat with their feet under the seating, so the angle between thigh and shin was less than 90 degrees.

6.4.2.4 Table width

According to the test persons, a table width of 26 cm was an interesting experience because it was narrower than a standard table. The width would be suitable when taking a coffee with friends. The test persons mentioned that they preferred to sit obliquely to each other due to the narrow legroom.

A table width of 52 cm was appropriate in situations where you were socializing with the persons around the table, but felt too narrow when working opposite each other.

A table width of 78 cm was wide enough for two persons working opposite each other, as seen in Figure 6.2. There was no need to stretch over the table when showing something or discussing with the other person, which the test persons appreciated. It was noticed that the test persons preferred to place their hands differently while using a computer, hence the desired table width varied depending on the user.

The test persons mentioned that a table length about 75 cm was preferable while working, to have space for e.g. computer, notepad and coffee.

6.4.3 **Required dimensions**

The insights from the research, benchmarking and user test were used to identify and set requirements for the critical dimensions, according to

Table 6.2

Table 6.2: Required dimensions for the picnic concept.

Dimension	**Value [cm]**	**Based on**
Sit ergonomically		
Seat, length	>50	The Ascent series
Seat, depth	19-50	Benchmarking
Seat, height	44	The Ascent series
Bench-Seat distance, vertical	22-30	Research, Benchmarking
Step over the bench		
Bench-Seat distance, horizontal	7-15	Benchmarking, User test

Table 6.3: Cont.

Enter from the side of the bench		
Bench-Seat distance, horizontal	0-15	Benchmarking, User test
Entrance distance	>19	Benchmarking
Two persons seated opposite each other		
Width, legroom per person	>45	User test
Working surface		
Table, height	Ca 72	Research, Benchmarking
Table, width for two persons opposite each other	>60	Research
Table, length per person	Ca 75	User test

6.5 Sub concepts

Since the original concept would not allow for comfortable seating, three configurations of the concept were developed, based on three different principles.

1) The module will have the same width and length as current modules.
2) The module will have the same length as current modules but be wider.
3) The seating and table will extend over many modules.

To test the applicability and dimensions of the three principles, different models were designed in SolidWorks and Adobe Illustrator. The models were preliminary designed with regards to the fifth constraint in section 6.1 only. When designing the models the profile of current seating was used, but the backrest was removed. The seating was cut as close to the beam as possible, with regards to current assembly methods. A rounding was added to the inner edge to make the seat symmetric. The profile of the seat can be seen in Figure 6.3.

Figure 6.3: Illustration of the seat attached to the beam.

6.5.1 **Concept 1**

The first concept would have the same length and width as current seating modules and follow the general shape of current modules, as seen in Figure 6.4. This allows for use of existing legs and beams. What must be re-designed were the:

- Seats
- Table
- Table attachment

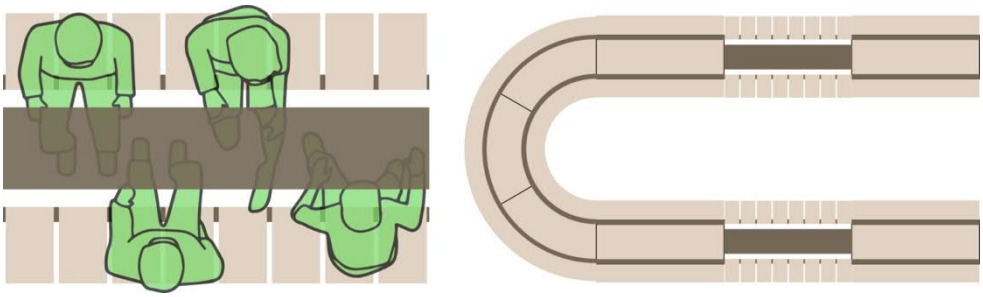

Figure 6.4: Illustration of concept 1 from above. Left: One module of concept 1. Right: Concept 1 together with other modules in the Ascent series.

From measurements, it was concluded that the maximal leg distance was 41 cm. This caused the table to have a maximal width of 41 cm, due to consideration 3 in section 6.1

The advantage of the concept was that it did not take up more space than current modules. It blended in with the shape of Ascent. However, the margins were so small that the design possibilities were few. The legroom was too narrow for allowing people to sit opposite each other, this reduced the number of possible seats.

6.5.2 **Concept 2**

The second concept would have the same length as current seating modules but with a bulging width, as presented in Figure 6.5. This created a greater distance between opposite seats, making it possible to sit opposite each other. The bulge had tentatively been designed according to the 60 degree beams already existing in the Ascent series. With this design the maximal leg distance was 87 cm at the bulge and 41 cm at the ends. What needed to be re-designed were the:

- Seats
- Table
- Table attachment
- Beam

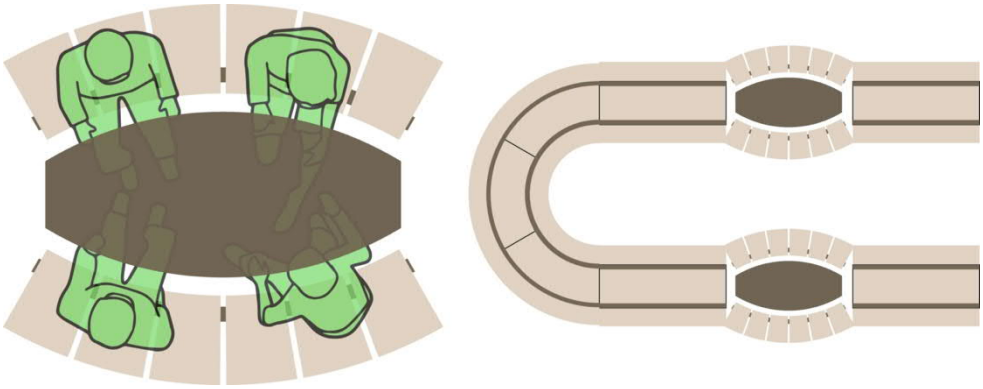

Figure 6.5: Illustration of concept 2 from above. Left: One module of concept 2. Right: Concept 2 together with other modules in the Ascent series.

6.5.3 **Concept 3**

The third concept was based on existing bends being used to create protrusions with multiple modules, as seen in Figure 6.6. This would allow the same beams and legs being used. However, to build a bulge of this type, a very large floor area was required. The concept was also very similar to the existing Nova C Bench series which GFC manufactures. For this reason, it was decided to not move forward with this concept.

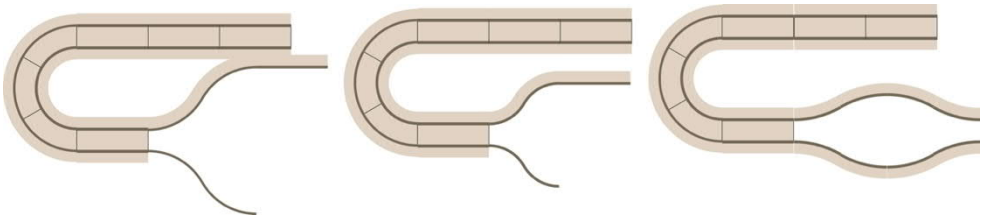

Figure 6.6: Three different variants of concept 3, together with other modules in the Ascent series.

6.6 Entrances

In both concept 1 and 2, entrances are needed to be able to sit without stepping over the seat. From the benchmarking, it was found that the width of such entrances ranges between 19-26 cm. Three ideas of how the entrances could be arranged was created.

6.6.1 **One entrance in the middle per side**

This would give a total of four wider seats, as illustrated in Figure 6.7. The seats would be larger than a regular sized seat but too small for two people. Therefore, a module would offer 4 seats, except for couples or children. The approximate seat width would be: 85 cm for concept 1 and 70-85 cm for concept 2.

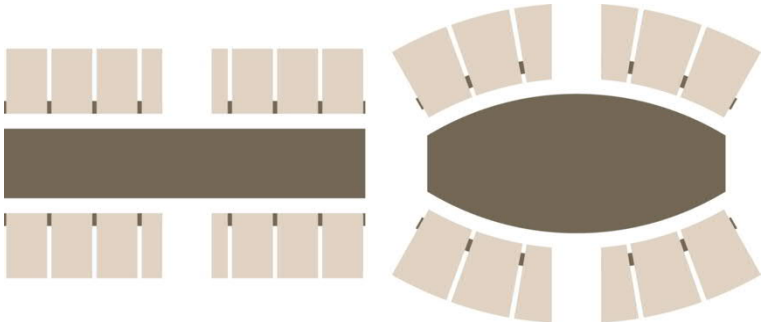

Figure 6.7: Concept 1 (to the left) and 2 (to the right) with one entrance per side.

6.6.2 **Two entrances per side**

This solution could provide a total of 6 seats with a width of about 50 cm, as seen in Figure 6.8. However, this would require the bench to be divided into three sections which requires attachment between each section.

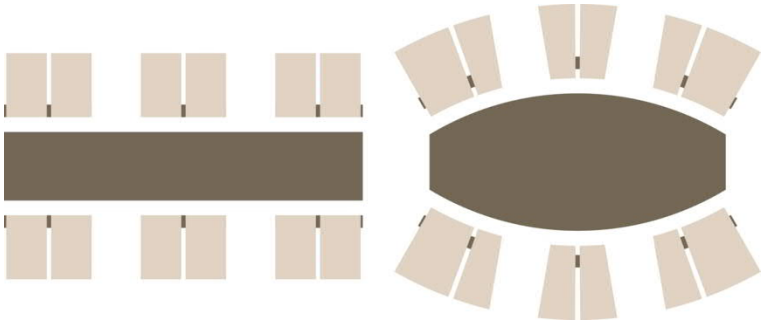

Figure 6.8: Concept 1 (to the left) and 2 (to the right) with two entrances per side.

6.6.3 **Entrances in zigzag formation**

This option was especially needed for concept 1. The zigzag formation presented in Figure 6.9 could be utilised so that people cannot sit directly opposite of each other. This solution required, just as with two entrances, attachments between each segment. The approximate seat width would be 50 cm on the side with two entrances and 85 cm on the side with one entrance.

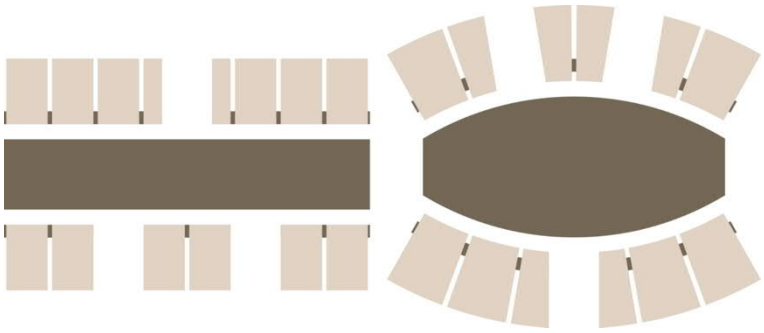

Figure 6.9: Concept 1 (to the left) and 2 (to the right) with zigzag entrances.

7 Refinement of the picnic concept

The elaboration of the picnic concept will be displayed in this chapter.

From assessment, concept 1 could work as an interesting coffee table, but the dimensions were too narrow to allow for comfortable seating. Concept 2 showed the most potential due to the increased legroom and table width. Since concept 2 had the possibility to fulfil the required dimensions and only needed 2 entrances, this concept was selected to develop further.

7.1 Problems with preliminary design of concept 2

The preliminary design of concept 2 acted as a proof of concept and displayed its viability as a working station or café table. However, it was of concern that the seating and beam could cause problems in a design and manufacturing aspect.

The preliminary design reused the existing 60 degree beams from the Ascent series. It was used because it is proven to be manufactural and has associated seat design. To integrate the beam into the new concept, the solution required some modifications. An attachment at the end of the beam was required to allow for a smooth transition between modules, as illustrated in Figure 7.1. Another problem was the transition between the seating slats. The end slats would need to be redesigned to tangent other modules. The transition area is represented in grey in Figure 7.2. The third problem was the entrance at the middle of the module, which would require a cut into the beam as well as the slats, this is presented in Figure 7.3.

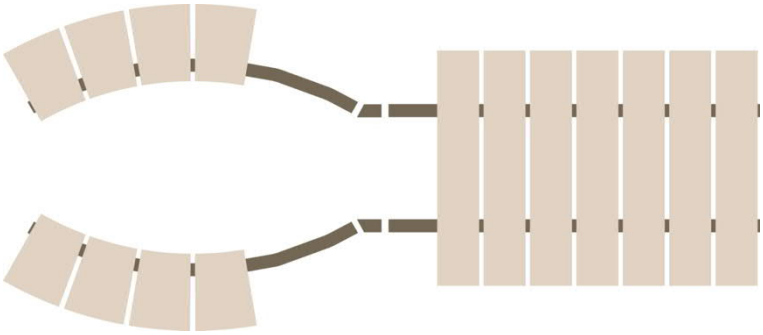

Figure 7.1: The 60-degree beam with end attachment.

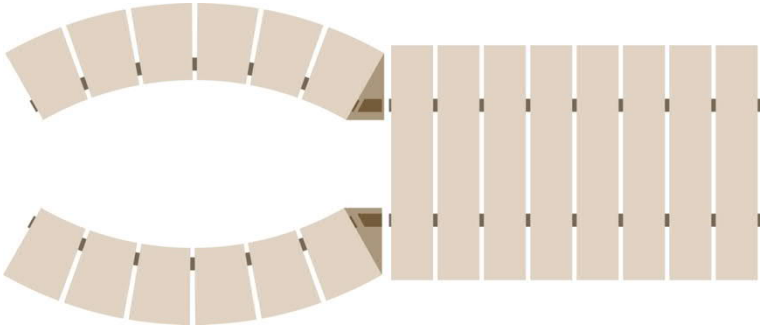

Figure 7.2: The transition from existing module to the new one.

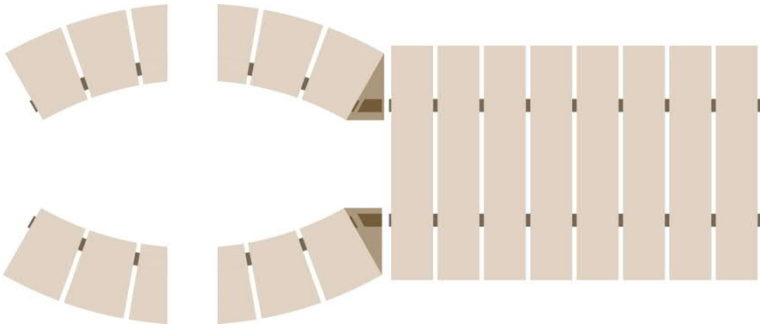

Figure 7.3: Concept 2 with one entrance per side.

These problems would require three different slat models, as seen in Figure 7.4, for a single module if the 60-degree beam were to be used, as well as the cut into the beam and end attachments for the beam. It was therefore decided to redesign the beam together with the slats.

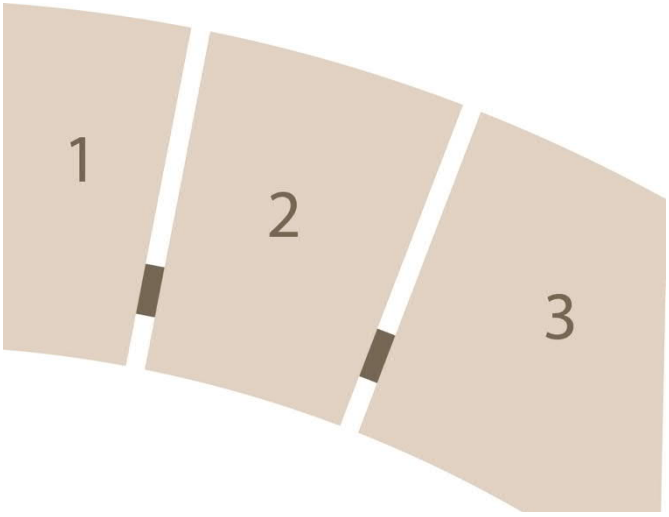

Figure 7.4: The three different slats required in the 60-degree beam design.

7.2 Slat design

It was of interest to keep current assembly methods and use the same aesthetics as in the overall Ascent design. This creates a relationship between beam and slats which causes the design of one to affect the design of the other.

The beam is manufactured by extrusion of an aluminium profile and then bent at certain positions to create a curve. It was assumed that the manufacturing methods used for the beam has more leeway than the manufacturing methods of the seating slats in terms of cost of customization of the shape.

7.2.1 **Principle behind main slat concept**

From a manufacturing and warehousing aspect, it was of interest to make the seating slats identical so that only one model is manufactured and used for every seating position. This is also in line with current GFC design and their modular thinking. To be able to achieve this result while simultaneously

using a bulge the slats must follow the pattern of two pairs of equally sized and tangential circles as shown in Figure 7.5.

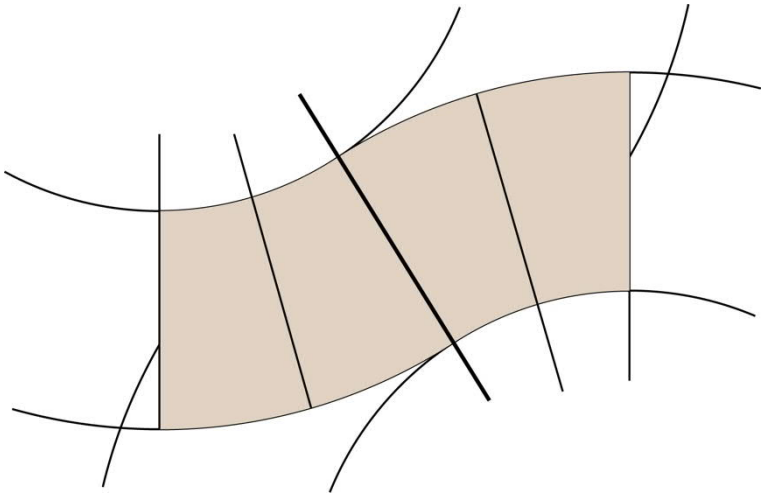

Figure 7.5: Pattern of one quarter of the bench.

The drawing creates a symmetry line between the upper and lower circle centre points. To achieve a seamless transition between this module and existing modules, three main criteria had to be fulfilled, depicted in Figure 7.6. In addition, two more criteria had to be fulfilled, as seen in Figure 7.7.

1) The outer edge of the seats must be in line with existing seat edges.
2) The end seat must be parallel with existing module end seats.
3) The beam must be in line with existing beams.
4) The module will have the same length as existing modules.
5) The module must have an entrance in the middle.

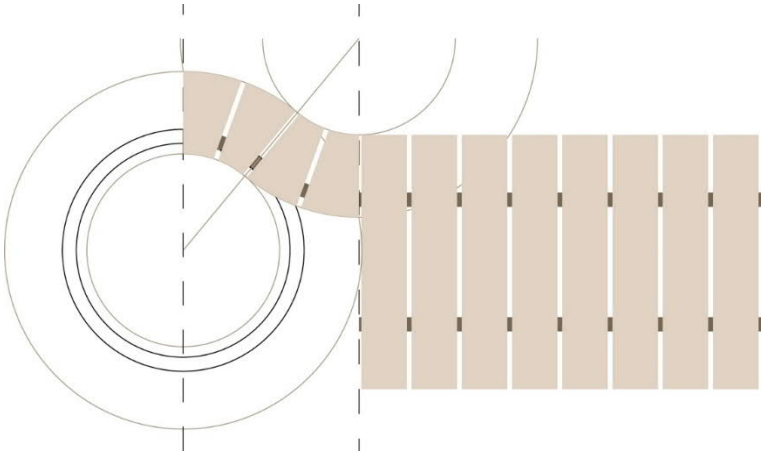

Figure 7.6: Illustration of criteria 1-3.

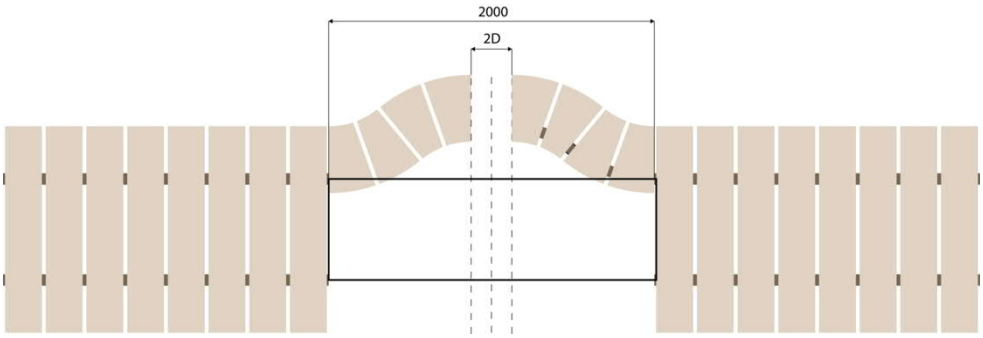

Figure 7.7: Illustration of criteria 4-5.

With the five criteria combined with the pairs of circles being equally sized and tangent along the symmetry line, the bulge U is determined by two factors; the angle α and the distance D, where D is half of the entrance space, as illustrated in Figure 7.7. The relation between the bulge U, angle α and the distance D are illustrated in Figure 7.8.

$$0 < \alpha < 90$$

$$U = \frac{2000}{2} - D \Big/ sin\frac{\alpha}{2}$$

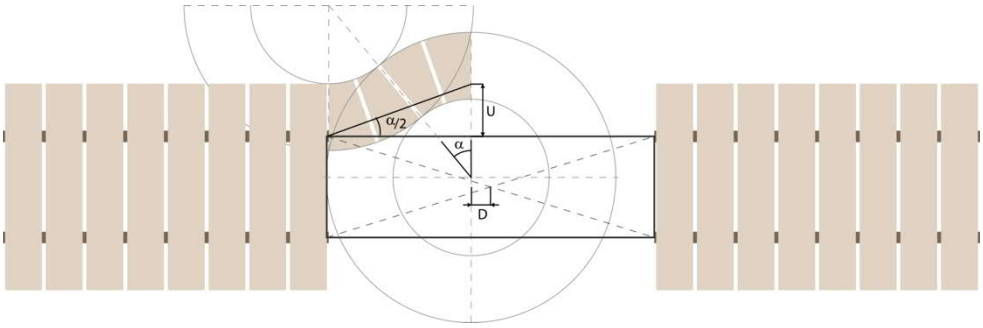

Figure 7.8: The relation between the factors that determine the bulge U.

With bulge U, it could be determined how much legroom that was achievable depending on the angle α. The legroom for one person is illustrated in Figure 7.9. From user tests and benchmarking it was concluded that 45 cm is desirable per person. With an entrance space of 25 cm the most suitable angle of α was therefore 40 degrees. The entrance space was preliminary set to 25 cm since this is the centre-to-centre distance for existing straight slats.

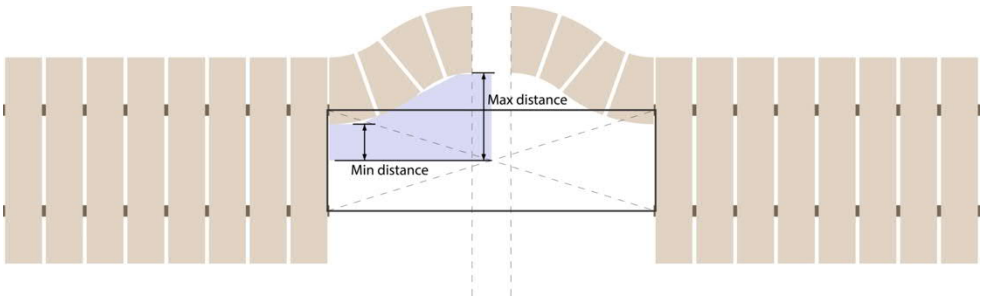

Figure 7.9: Illustration of the legroom.

It was decided to use four slats per quarter side. This gives each slat a width which most closely resembles current design while keeping the number of slats in a reasonable quantity.

7.2.2 **Transition slat configuration**

Without a crossing between the two first slats, the legs of the module were exposed, which can be seen in Figure 7.10. This makes the module not follow

the same aesthetics as existing design. Hence, it was determined to add a transition slat in the first slot, as seen in Figure 7.11.

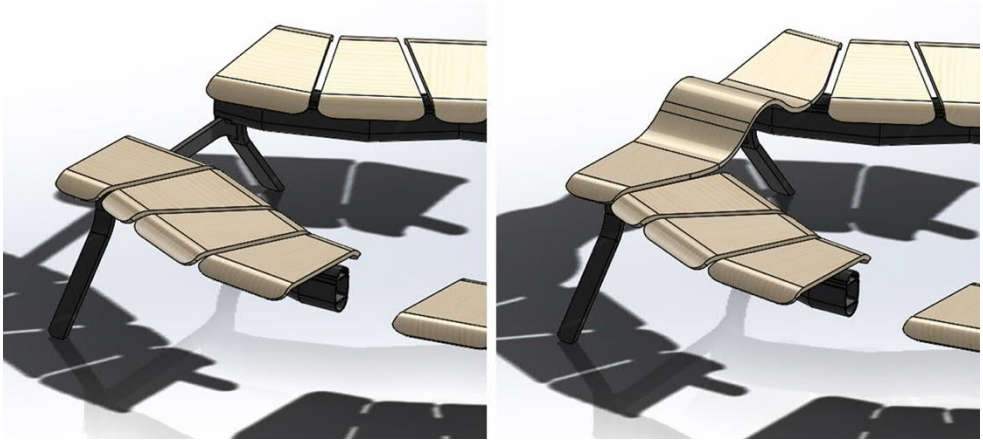

Figure 7.10: Left: CAD-model where the transverse part of the legs is exposed. Right: CAD-model with transition slat, to hide transvers part of the legs.

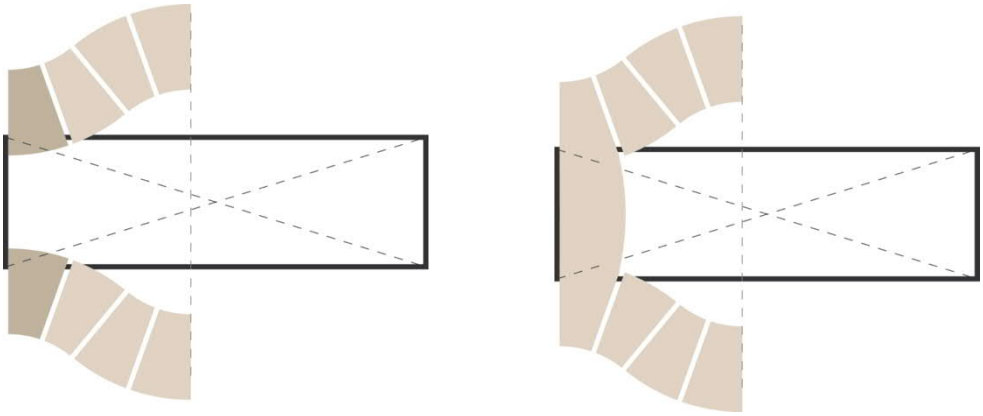

Figure 7.11: Illustration of the module without and with a transition slat, from above.

The transition slat serves the main purpose of covering the legs. Beyond this, it indicates that it should be used as a backrest seat. It can also be argued that it creates a smoother transition between the original modules and the picnic module. Because of the close resemblance with existing slats, it made sense in an economical aspect to design the transition slat in a way so existing manufacturing tools could be used. This led to reuse of the existing slat profile presented in Figure 7.12.

Figure 7.12: The profile used to the transition slat.

Because of the profile, an offset was created which caused the transition slat and the main slats to not align properly, as seen in Figure 7.13. This is due to the design principle of the main slats. As shown in Figure 7.14, the horizontal bend line of the transition slat causes an offset circle, which the main slats must tangent.

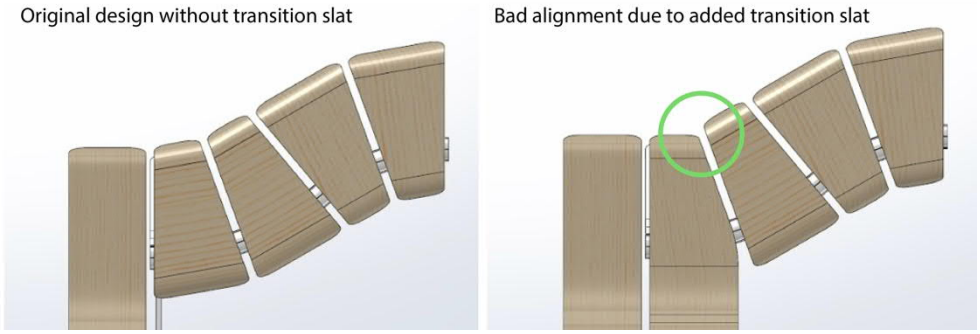

Figure 7.13: Comparison between module with four identical slats and module with a transition slat.

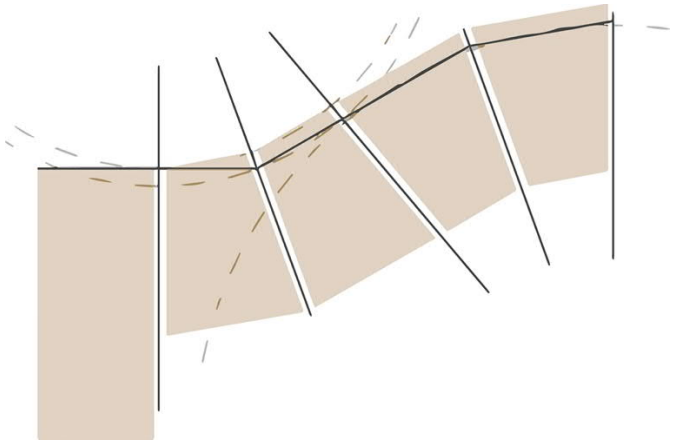

Figure 7.14: The cause of an offset in slats.

7.2.3 **Adjusted main slat configuration because of transition slat**

The main slats were reconfigured regarding this offset and were designed according to Figure 7.15. The centre of the upper circle was shifted horizontally to reduce the width of the transition slat. This also increased the entrance distance to 27 cm. The final design of main slat and transition slat can be seen in Figure 7.16.

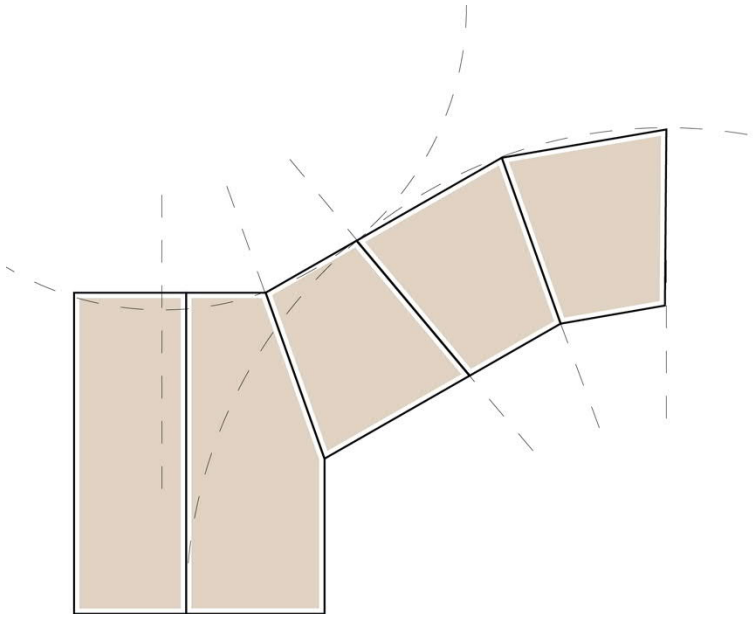

Figure 7.15: Illustration of how the main slat was adjusted due to the transition slats.

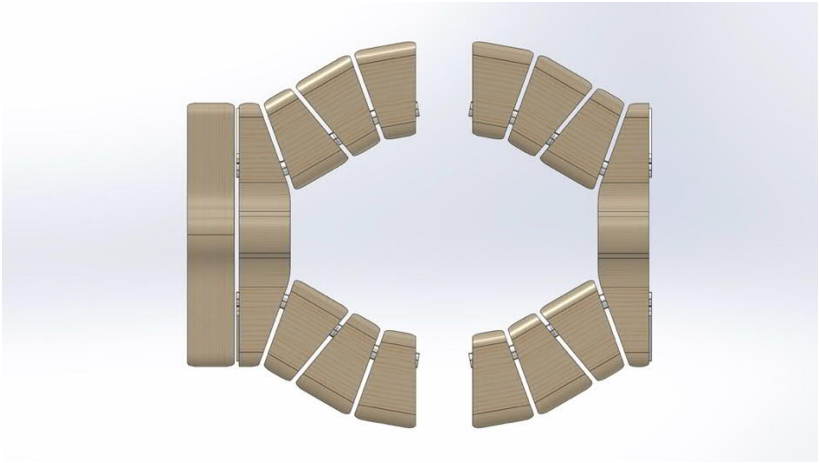

Figure 7.16: The final design of main slat and transition slat.

7.3 Beam design

The beam design is heavily affected by the shape of the slats with little room for adjustments. This means that the beam needs to be creased in two directions. When talking with the manufacturer, they mentioned that the easiest way to do this is with a bending machine that allows for both right and left bends. In addition, a curvature is required at every crease to reduce internal stress. The manufacturer recommended the radii of the curvature to be around 2.5 towards 3 times the width of the beam, as illustrated in Figure 7.17. In addition, they mentioned that longer straight parts between the creases facilitate the work.

If the design of the beam would follow the same style as GFC's current beams, it must follow the shape shown in Figure 7.18. This shape has the advantage that the beam is perpendicular to the side of the seats, which allows for mounting of external add-ons.

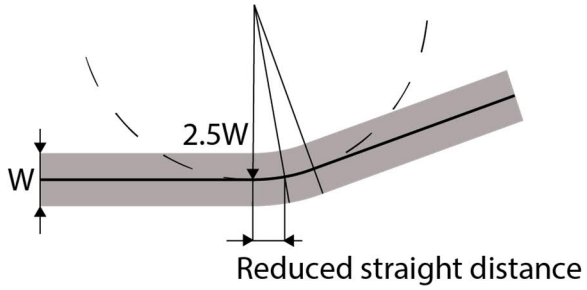

Figure 7.17: Illustration of the recommended bending radii.

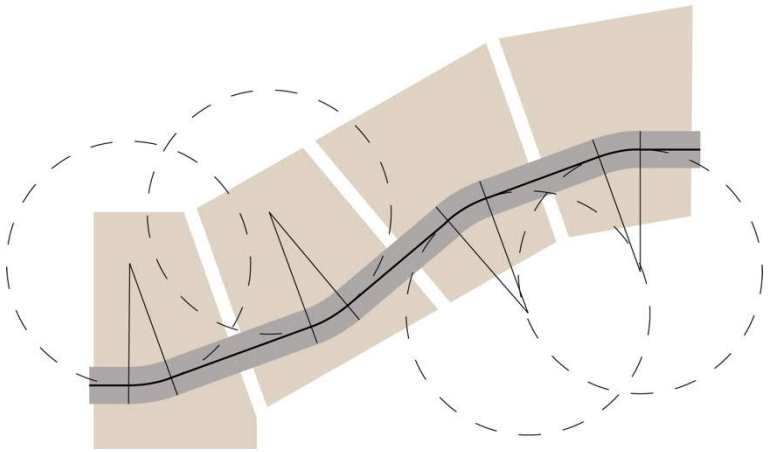

Figure 7.18: The beam bent in the same style as the existing 60-degree beams.

An alternative of the beam was designed with the minimum number of creases. This design utilises that the beam bends can be positioned between the slats. This results in longer straights and only two bends. The first bend had to be shifted horizontally to give more space for the seating clamp, which can be seen in Figure 7.19. Due to the position of the bends it is not possible to attach add-ons between the slats.

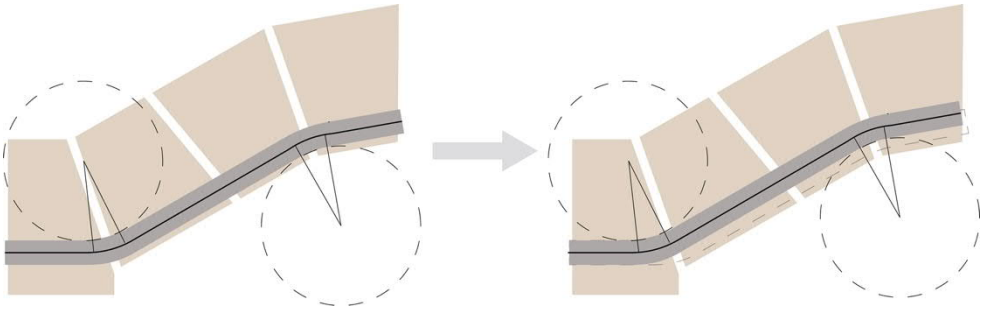

Figure 7.19: Comparison between beam with two bends and a shifted version of the same beam.

8 Result

The result is a proposal of a new module with the aim to facilitate computer work at gate areas and can be seen in Figure 8.1. The module can be seen together with existing Ascent modules in Figure 8.2 and Figure 8.3.

The module offers up to four table seats as a standalone. The transition slats offers half of a backrest seat on each quarter, so when the module is assembled with other Ascent modules, the number of practical seats are six.

The module has a length of 2 m and is 1.84 m wide, with a footprint of 3.2 m^2, as seen in Figure 8.4. As presented in Figure 8.5, the area inside the module is 1.2 m^2, allowing 0.3 m^2 of legroom per person. The longest distance between opposite slats is 100 cm and the shortest distance is 50 cm. The module has one entrance per side, with a width of 27 cm, which facilitates sitting down at the table.

Figure 8.1: The final picnic module.

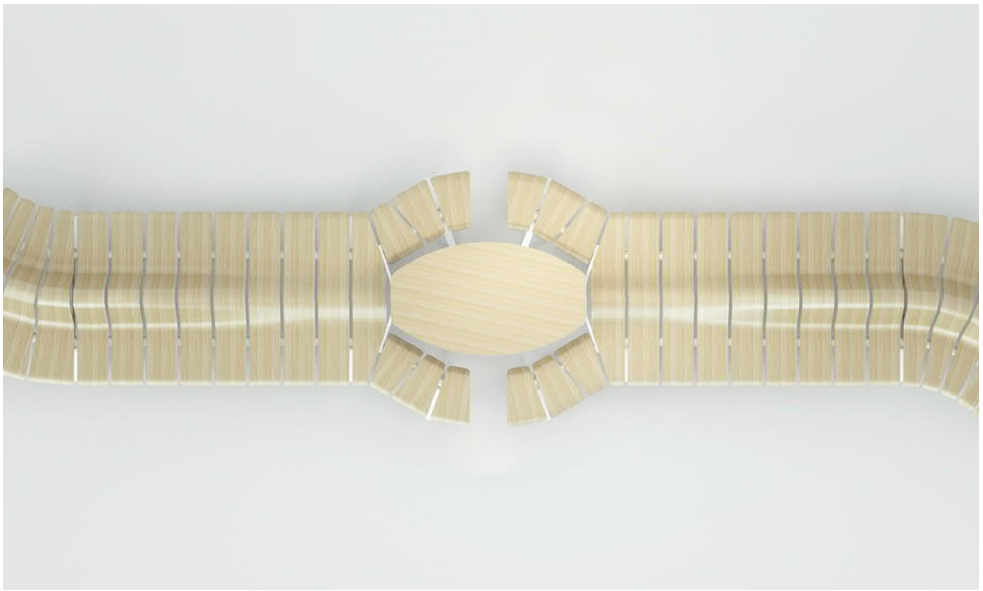

Figure 8.2: The module together with Ascent, from above.

Figure 8.3: The module together with Ascent, from side.

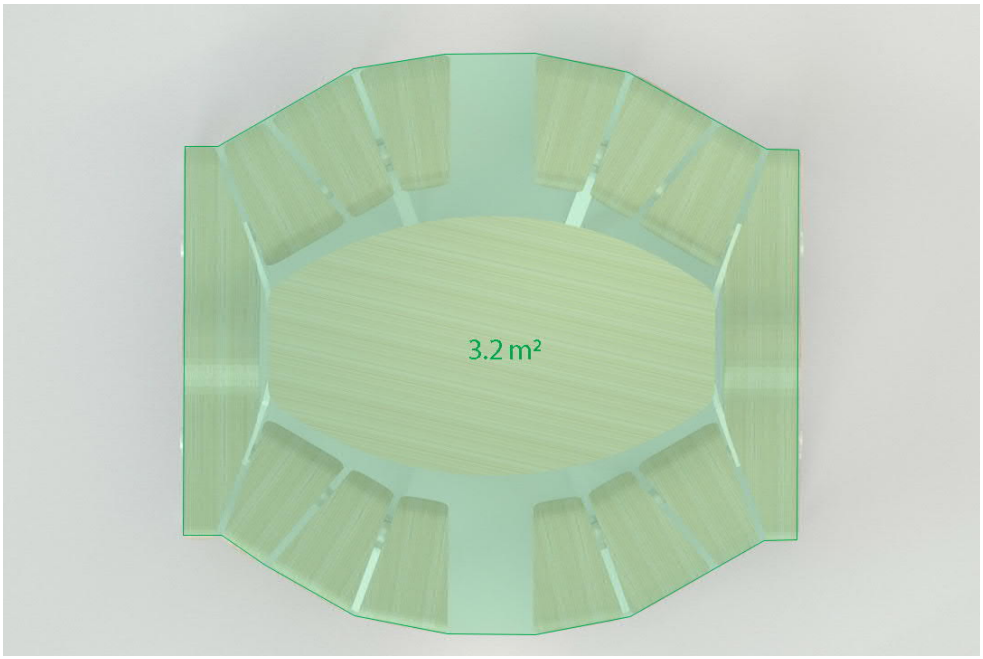

Figure 8.4: Total footprint of the module.

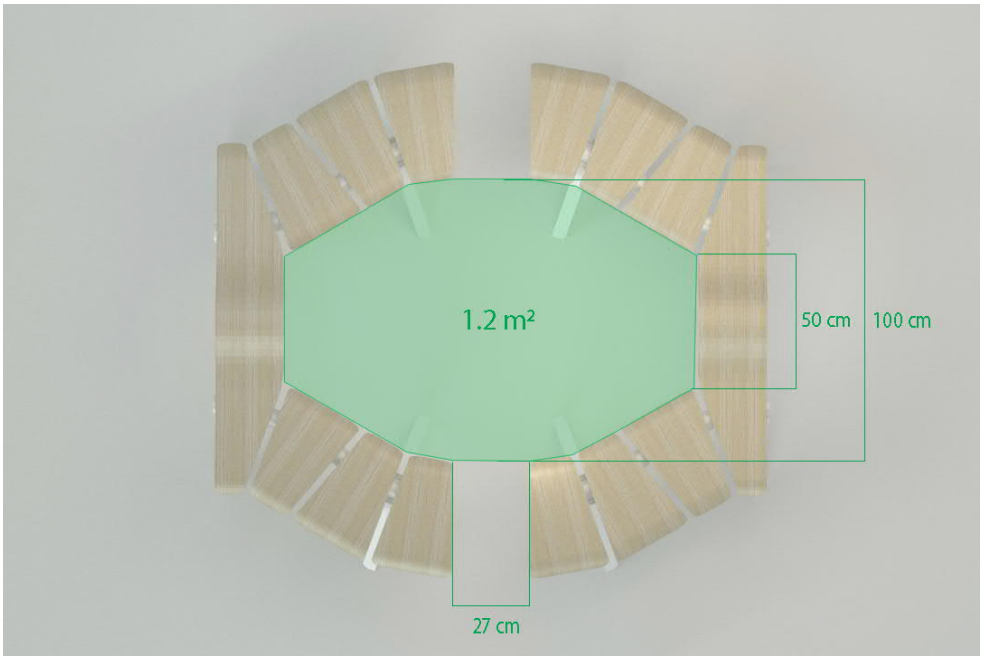

Figure 8.5: Legroom and entrance width for the module.

The parts that have been refined are the beam and slats of the module, as seen in Figure 8.6. They are designed so that no new manufacturing technologies nor materials are introduced. The design allows the beam and seat to utilise existing legs and seat clamps for assembly.

The module consists of four beam parts, 2 transition slats and 12 main slats, one table surface with attachments:

- The main slats are designed to be identical and each can be mounted on any seat position of the beam, except for where the transition slats go.
- The transition slat uses existing slat profiles of the Ascent series and is cut to align properly with the main slats.
- The beam is designed with two options:
    1. The first option requires four bends and allows add-on clamps to be attached in between the slats and is shown in Figure 8.6.
    2. The other option requires two bends which facilitate manufacturing but this option doesn't allow existing add-on clamps to be attached in between slats.

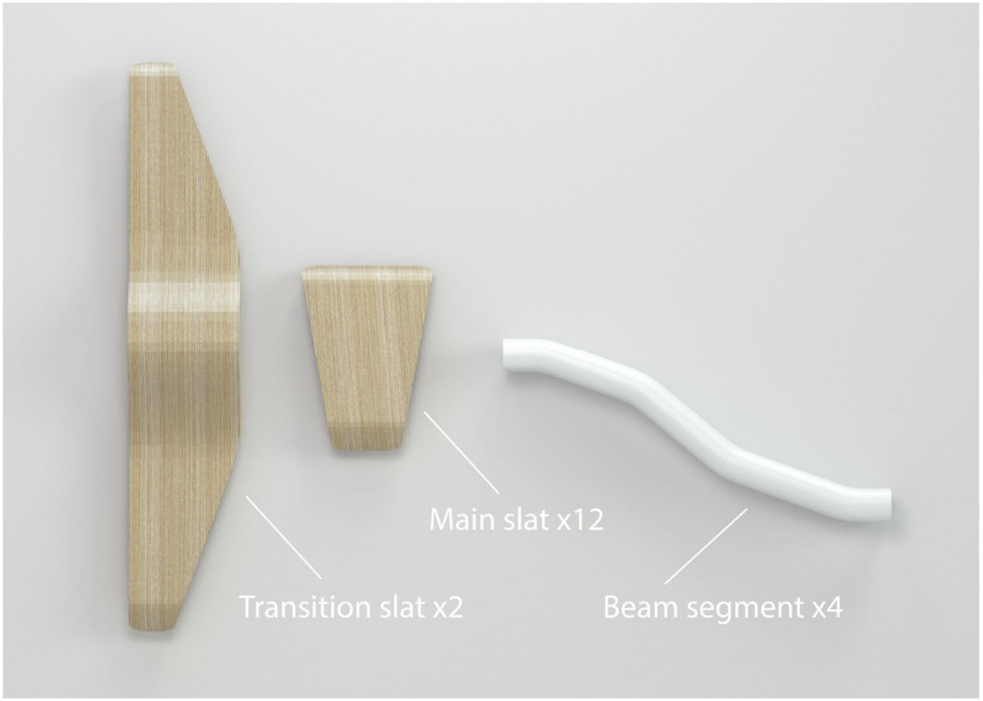

Figure 8.6: Refined parts of the module.

The table surface and its attachment to the beam is only created on a conceptual level. The table surface is attached to the beam to facilitate cleaning under the module, but also to keep the airy feeling found in the aesthetics of Ascent. The attachments use a similar shape as the existing table in the Ascent series, as seen in Figure 8.7. This shape was chosen, so the new module would feel unitary with the existing series.

Figure 8.7: The attachments between beam and table surface.

9 Discussion

In this chapter the process, methods and result of the project will be discussed.

9.1 Process & time plan

Collaboration has been a fundamental part of this design process. Both team members have therefore been involved and participated in all stages of the project.

The methodology applied in this project was the Double Diamond process. This methodology made it possible to have a creative process, where each phase could be designed based on insights from the previous ones. This was suitable for the thesis, due to the open project brief. The open brief allowed the project to go from creating an add-on, to making a whole module to the Ascent series.

This path led to changes of the original Double Diamond process and time plan, since additional research and user testing had to be executed during the Develop phase. Therefore, the planned prototyping phase had to be exchanged to user testing and development of the selected concept. The amount of parts that had to be developed within the concept made it difficult to reach the initial goal to deliver a final design with a manufacturing schedule within the time frame.

Except for the change from prototyping to further research, the final time plan overall looked like the initial one, as seen in Figure 9.1 and Figure 9.2, respectively.

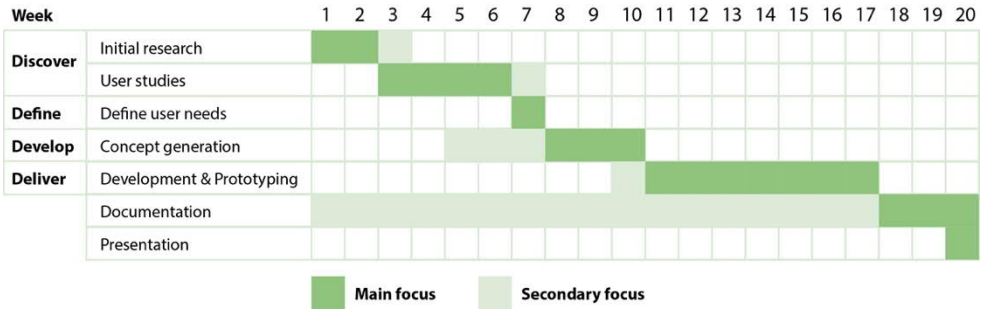

Figure 9.1: Initial time plan for the project.

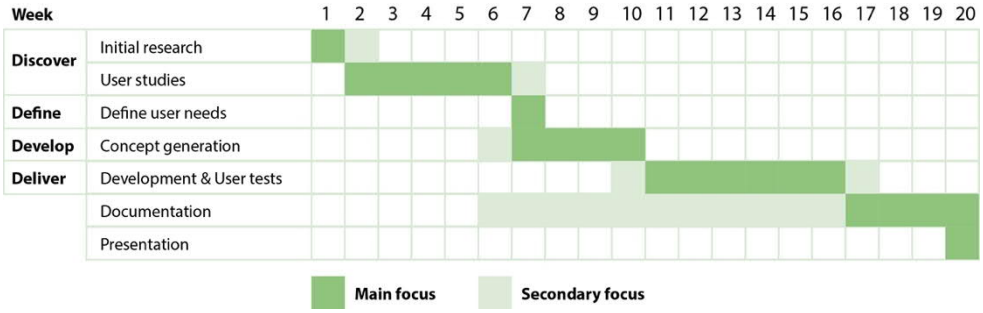

Figure 9.2: Final time plan.

9.2 Methods

9.2.1 **Observations**

The aim of the observations was primarily to gather inspiration and get an understanding for the airport environment. To get deeper insights, conversations with travellers could have been conducted. There is a possibility that these people are experiencing needs at the moment. Needs that would not be mentioned during an interview conducted at a later occasion, because these needs are too small to be memorable.

The observations worked great as a means to gather inspiration and insights but to better use the results from the observations as a decision basis during the concept selection, the execution could have been more statistically oriented, e.g. data could have been collected for the number of passengers waiting in the gate area. However, a large amount of data is required to obtain reliable statistics, which would be difficult to acquire during the few

occasions when the observations were executed. Instead additional research about airport behaviours and target groups could have been done.

9.2.2 **Interviews**

Interviews were mainly conducted with business travellers, since this target group are frequent flyers with great experience of airport environments. Thereby valuable insights could be gained from the interviews. To get a more nuanced picture of airport experiences and needs, interviews with people from other stakeholder groups could have been conducted, e.g. people traveling mainly on vacation, elderly people or persons with disabilities.

9.2.3 **User needs**

Several of the needs defined after the user study in chapter 4 had already in the beginning of the process been discussed. The result from the user study therefore became more confirming rather than insightful, even if some new insights were obtained. It is possible that more insightful discoveries had been acquired, if the user study had been more extensive.

Only Swedish airports were visited and only Swedish citizens were interviewed. This means that the insights and needs are heavily influenced by Swedish culture and behaviour, which has affected the direction of the project. How much this has affected the result is difficult to say, but it is certain that diversity would have resulted in a deeper foundation to build upon.

9.2.4 **Concept generation**

During the concept generation, the approach was to find solutions to the user needs and simultaneously adapt the concepts to the Ascent series. This made it difficult to have an open mind during the concept generation, since an idea could be ejected in an early stage if it seemed difficult to customize to Ascent. To improve the concept generation, it would be better to first focus on the user needs and the solutions for them. After this, it would be suitable to try customizing the ideas to the Ascent series.

9.2.5 **User tests & prototyping**

User testing was made in a hurry due to limited time. Therefore, they were performed mainly to ensure that the picnic concept was viable with regards to the Ascent series. The focus was to ensure that the given dimensions would allow for work. More extensive user testing should be conducted to prove if it's a good concept. Will people use it as intended?

The homogeneousness of the test group means that the tests lack significant data. Airport environments are visited by all types of people and the resulting design may exclude certain groups.

The test subjects knew each other beforehand that helped them feel more comfortable during the tests. The downside of this is that their perception of how close one can sit to a stranger is skewed by their relationship, hence the tests served better to establish that the concept works with friends.

The tests were based on rough quick builds with chairs, planks and scrap material. This limited what could be examined and for example, comfort of the seats could only be estimated based on similarities to existing products.

Although there was an initial desire to build a proper prototype, this was not done. The reason for this was partly due to time concerns but mainly because it could not be motivated at that stage of the project. The outcome of a proper prototype could not be justified since each aspect could be tested in a more time efficient way separately. This gave the opportunity to instead focus on the CAD-model and manufacturing details which took the concept to a much more detailed level. The time spent on CAD unfolded new problems which could be solved. The expectation is that the separate tests along with benchmarking were sufficient to establish that the concept works and that a proper prototype is more suitable at a later stage of the project.

9.3 Result

9.3.1 **Development of the picnic concept**

During the elaboration of the picnic concept, focus was on slats and beams. It was based on the assumption that the other required components would be easier to adapt. The starting point was to design all slats identical. This was based on the assumption that the tools for manufacturing of slats are more costly than the adaption of the beam. The assumption was based on intuition

and reasoning within the team and seemed self-evident at the time. More time could have been spent to investigate what affects costs.

This starting point created a tunnel vision which limited the design options of the slats and beam. Hence, other configurations were overlooked. It is difficult to assess whether or not the approach resulted in an optimal outcome without more information about affecting factors. The approach can be justified by the fact that there are other advantages to identical slats, such as warehousing and cognitive ergonomic when assembling the module.

Overall, we are happy with the result and believe that the approach taken was well suited.

9.3.2 **Usability of the concept**

The concept is meant mainly as a working station for business travellers. The expressed needs while working is to work in privacy, to have a calm surrounding with few distractions. Hence there is a contradiction by placing the picnic module in between regular seating. There are two factors that justify this choice:

1. The gate is a great place to wait due to the overview of information about the flight.
2. The gate areas was mostly calm and empty until minutes before boarding.

With those arguments, we consider that the concept is viable. However, the best way to understand the usability is to conduct user tests at airports to see whether or not the concept works as planned.

9.4 Further development

Before the picnic module can be put into production, there are several things that need to be developed further.

- The design allows usage of the existing legs in the Ascent series. Despite this, there are reasons to explore how alternative legs at the module's entrance can be designed, to blend into the Ascent series and at the same time not pose a stumble risk.

- The table surface and its attachment to the beam was only developed on a conceptual level in this project and need to be developed further.

- The Ascent series fulfils requirements from The Nordic Ecolabel and exclude SIN-listed substances. The requirements need to be verified for the new module, but they should be fulfilled, since the new module uses the same materials and manufacturing methods as Ascent.

- A prototype needs to be built so that further user testing can be executed. A prototype is also needed to test strength and durability. This is important to assure that the European standard EN 16139:2013 is fulfilled.

- The module is designed with regards to existing parts, manufacturing methods and tools to not increase the costs unnecessarily, but a proper economic analysis has not been done.

9.5 Comments from GFC regarding the assignment

The assignment was to investigate Ascent and develop a product, accessory or complement that fits in a suitable way in the series and expands the range. With such a broad brief, it is not always easy to come up with new creative thoughts, especially not in an industry you are new to.

You have managed to come up with several innovative concepts, some of which have been up as ideas with us before, but also some completely new ones. The picnic bench solution is such a new idea. Not only is it brand new and fits nicely into the Ascent series, it also complements the series in a way that makes the series unique and customizable.

In your pre-study, you concluded that business travellers would like to have somewhere to sit and work, preferably around the gate. At the same time, you concluded that airport owners rather retain passengers in the commercial areas instead. The solution you have developed fits in two ways in these points.

1. Business travellers with no interest in shopping have the opportunity to be in the gate areas, which gives more space in commercial areas for others.
2. The picnic bench solution fits nicely in the commercial areas as well, especially in and around a food court. Something that increases our market.

You have worked well to make the concept manufactural and easy to implement. This is by using the same manufacturing methods as we do today,

reusing many details and reducing the number of unique details. These are the cornerstones for us as a development department and you have caught them well.

10 Conclusion

Airports act as important hubs in the world and play a central part in many people's work. During the project, people's needs in this environment were explored and it resulted in a new module to the Ascent series, with the aim of enabling computer work in gate environments. The new module can also act as a meeting point for colleagues and friends.

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Appendix A Interview guides

All interviews were conducted in Swedish, since the interviewees were Swedish speaking. The interview guides were therefore written in Swedish.

A.1 Business travellers

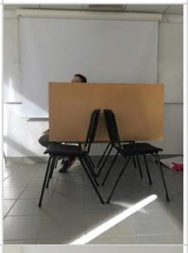
Hur många gånger har du flugit det senaste året?
I vilket syfte flyger du mest? Jobb, semester
Hur långa brukar resorna vara? Inrikes/utrikes? Med mellanlandning?
Flyger du mest ensam eller med andra?
Skiljer sig tillvägagångssättet om du reser med jobb/semester?
Vill du berätta om en flygplatsvistelse du minns?
Vad gjorde du?
Brukar det vara så det går till?
När var det?
Vilken flygplats var det?
Vad tycker du är viktigast på en flygplats? Utveckla.
Vad tycker du är bra att ha på en flygplats? Utveckla
Vad tycker du inte ska finnas på en flygplats? Utveckla
Vad märker man på flygplatser om man flyger mycket?
Vilken är den bästa upplevelsen du haft på en flygplats?
Vilken är den sämsta?

A.2 Parents traveling with children

Hur många gånger har du flugit det senaste året?
I vilket syfte flyger du mest? Jobb, semester
Flyger du mest ensam eller med andra?
Kan du berätta om senaste gången du flög med familjen?
Vad gjorde ni från att ni kom dit till att ni gick ombord?
När var det?

Vilken flygplats var det?
Vad tycker du är viktigast på en flygplats? Utveckla.
Vad tycker du är bra att ha på en flygplats? Utveckla
Vad tycker du inte ska finnas på en flygplats? Utveckla
Vad märker man på flygplatser om man flyger med barn?
Hur skiljer det sig från att resa själv?
Lekrum, var vill man ha dem som förälder?
Vilken är den bästa upplevelsen du haft på en flygplats?
Vilken är den sämsta?

Appendix B Test of heights

Approximate height from seat	Photo	Insight
64 cm		Awkward to just see the eyes of the person sitting on the other side of the divider. A divider should be high enough to shield from the person sitting on the other side of the divider.
40 cm		Approximately the same height as the backrest. This height was too low to act as a divider. But it was a suitable height if you wanted to rest your head in your hand. It could work as a table but was too high to properly work as a table.
24 cm		A height just above half of the backrest height. The height worked both for armrests and tables.
12 cm		The height was about one third of the backrest height. The height worked well as a table, but just too low to work as a proper armrest.

Appendix C Benchmarking of picnic tables

C.1 Outdoor benchmarking

Picnic table	1	2	3	4	5	6
Image						
Angle of the seat, in respect to horizontal plane [degrees]	0	0	0	0	0	0
Table-Seat distance, vertical [cm]	24	32	22.5	25	27	23
Table-Seat distance, horizontal [cm]	18	9.5	9	14	17	min 7 max 17
Seat, depth [cm]	25	50	30	23.5	19.5	29
Seat, height [cm]	44.5	45.5	44	44	44	45
Table, width [cm]	63.5	98	107	71	59.5	110
Table, height [cm]	72	81	70	72.5	74	72
Legroom, horizontal, per person [cm]	50	59	47	50	49	54
Opening distance [cm]	-	-	min 19 max 26	-	-	min 20 max 56

C.2 Internet benchmarking

	Picnic Table	Table height [cm]	Table width [cm]	Seat height [cm]	Seat depth [cm]	Total depth [cm]	Table surface thickness [cm]	Table-Seat distance, horizontal [cm]	Table-Seat distance, vertical [cm]	Legroom, horizontal, per person [cm]	Legroom, vertical [cm]
1		70				177	42				
2		75		45	19	150			30		
3		70	74	42	29	180	40	24	28	61	24
4		74	71	43	30	175	40	22	31	58	27
5		76	71	43	30	160	27	14.5	33	50	30
6		72	66	45		150	34		27		24
7		73		45		161			28		
8		72				190					
9		76		45		173			31		
10		75	82	43	41	182		10	33		
11		75	73	45	28	157		14	30		