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Designing a transportation solution

For bikes, inside a car

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

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Gothenburg June 4th, 2018

Malin Eriksson and Elin Franzén

Master of Science Thesis IMSX30

Designing a Transportation Solution
for Bikes, Inside a Car

Master's Thesis in Industrial and Materials Science

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Abstract

The aim of the project was to investigate and map out the needs and demands of the road bike cyclists and mountain bike cyclists and to develop a concept for transportation of a bike inside a personal vehicle. The project was made in collaboration with Thule which is the core brand of Thule Group. The finished concept was to be in line with Thules mottos and be suited for the target group, the cyclists. Cycling is one of Thules biggest markets today and in combination with that the car industry is constantly changing, this project was of high interest for all parts involved. In Sweden, a country with diversity in weather, it is not possible to cycle during the winter period. The dedicated cyclist then travels abroad and many of them bring their own bikes. It is then important to be able to protect the bike during the travel and to consider the different kinds of transportation means; airplane, car, bus and train. However, due to the car industry, with cars having more complex shapes, it may become more important to transport products inside the car and it might not even be possible to mount solutions on the exterior of car.

The project started with a pre-study where the purpose was to investigate and find out what the cyclist today desires and needs. The answers were analysed and then summarised to design goals and they were the foundation in the concept development. The ideation generated innovative ideas and ended up in a final concept, Thule ProTour.

The final concept is the result of how the ultimate bike transportation case would be constructed and designed. It is functional and easy to understand and use and it has been developed with sustainability in mind. The aspect of keeping the bike safe from damage has been implemented to a great extent due to the high relevance it has on the target group. The safety aspect in combination with the other design goals has resulted in Thule ProTour.

Table of Contents

1 Introduction	1	3.2 Concept Development	28
1.1 Background	2	Ideation	28
1.2 Purpose/Objectives	2	Developing of Concept Ideas	30
1.3 Research question	2	Evaluation	35
1.4 Limitations	2	3.3 Development of Final Concept	35
1.5 Process	3	Form	35
2 Methods & Execution	5	Protective Areas	36
2.1 Pre-study	6	Opening and Closing	37
Literature and Theory	6	Possibility to Lock the Case	38
Technical Research	6	Materials	38
Market Research	6	Handles	38
User Research	7	Storage	39
Affinity Diagram	8	Flexible Case	40
Persona	9	Wheels	41
User Scenario	9	Inside of Case	41
Expression Board	9	4 Thule ProTour	47
Design Goals	9	4.1 Thule ProTour	48
Eco Strategy Wheel	9	4.2 Product Specification	48
2.2 Concept Development	9	4.3 Product and Company Resemblance	49
Ideation	9	4.4 Usage	51
Evaluating of Concept Ideas	10	4.5 Materials and Manufacturing	52
2.3 Developing of the Final Concept	10	4.6 Sustainability	53
3 Results and Analysis	13	4.7 Design FMEA	54
3.1 Pre-study	14	4.8 Verification of Thule ProTour	54
Literature and Theory	14	5 Discussion	59
Technical Research	14	6 Conclusion	65
Market Research	16	References	68
User Research	19	Appendix	70
Affinity Diagram	23		
Analysis of User Studies	24		
Persona	25		
User Scenario	25		
Design Goals	26		
Expression Board	27		
Eco Strategy Wheel	28		

1 Introduction

In the introduction chapter, the aim of the project is described together with a background to the aim and the research questions.

1.1 Background

48 percent of the Swedish population cycle each week (Svensk Cykling, 2016). Cycling is increasing in Scandinavia, both as a training form and for commuting. Between 2012 and 2016, the sales of bikes increased with nearly 20 percent (Sjöström, 2016). Many want to bring their bike on vacation or to the summer house. To transport the bike with car, there are several options to place the bike on the exterior of the car. There are solutions that are mounted on the roof racks, on the tow bar in the back of the car and solutions that are mounted directly on the trunk door. However, due to changes in the car industry, with cars having more complex shapes, it may become more important to transport products inside the car. In the future, it might not be possible to mount the bike on the trunk door due to the use of lightweight materials. Furthermore, tow bars might not be as common on electric cars due to the decreased driving range with load on the tow bar (Söderholm, 2017).

In Sweden, a country with colder and snowy autumns and winters, it is not possible to cycle during the whole year and many dedicated cyclists travel abroad during the winter and early spring to bike. To be able to transport the bike by plane, cyclists use bike transportation cases to protect the bike. Transportation cases can also be used when transporting bikes inside the car, which both protects the bike and the car interior. However, trunk spaces get narrower on newer cars and even with the back row of seats folded, it is not always possible to fit in more than one case.

Thule helps people to transport their sports equipment and belongings in a simple manner. Thule is a part of Thule Group and is one of the leading companies in the world within the Sport and Outdoor Goods sector (Thule Group, 2017).

1.2 Purpose/Objectives

The aim of the project is to investigate and map out the needs and demands of the target group and to develop a concept for transportation of a bike inside a personal vehicle. The concept should be suited for the target group and be in line with Thule's mottos: "Bring your life" and "Active life, simplified".

1.3 Research questions

How should the ultimate bike transportation solution be developed and designed to fit two bikes inside a personal vehicle?

Which customers would they attract with this transportation solution and what does the customers want to achieve with the solution?

1.4 Limitations

- The project does not take into consideration any other bike types than mountain bikes and road bikes.

- The final concept will not be a finished product and will therefore not to be fully tested according to e.g. Thule's high safety requirements.
- The target group is cyclists that transport their bikes with car.
- The market will be limited to the Swedish market only.

1.5 Process

This project has been done as an Industrial Design Engineer project where the project group have had a holistic and objective approach. The users' input have been the important part of the project and the user study has been a central part. The process has included various methods and iterations which were of relevance to that occasion in the project.

The process has been divided into five phases (see figure 1.1):

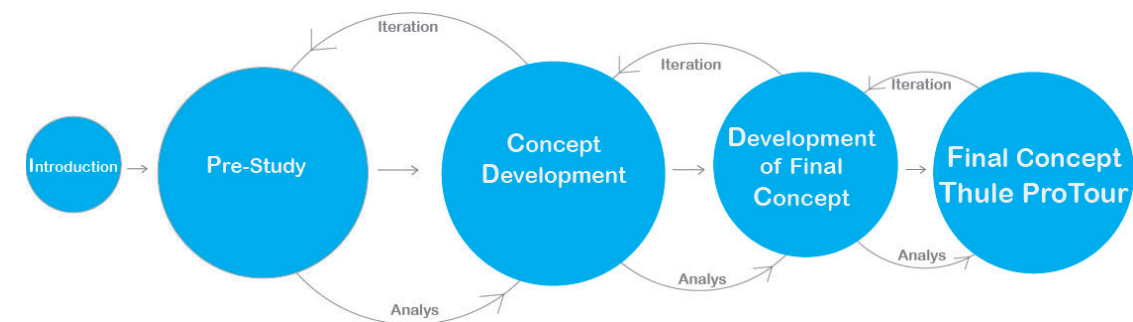


Figure 1.1. Process picture

In the introduction, the research questions were formulated and the project was framed. In the pre-study relevant information was gathered through a survey study, user tests, visits to stores and research online. In the concept development ideas were generated and evaluated with regards to the design goals that summarized the results from the pre-study. Several iterations were made during the concept development to refine the ideas and to explore a wide range of ideas. In the development of the final concept, the concept was refined, and all details were decided. In the last phase, the final concept was brought together, and a 3D model of the final concept was created. Between the phases iterations were made, though to a varying degree. The iterations gave deeper understanding which created a circular view on the process as well as the linear view. When iterating a new analysis was often made of the previous phase to either verify the result or find new information which could be of use in the next phase and then brought forward. The amount of work time was divided differently between the phases due to the importance of the phase and the amount of work that was expected. The quickest phase was the introduction. Then the pre-study and the concept development which followed was the largest phases. The two last phases were also large though not as the two previous.

2 Methods & Execution

In this chapter, the methods used in the project are explained and described. First the methods used in the pre-study are explained, then the methods used in the concept development phase and finally the methods in the development of the final concept.

2.1 Pre-study

The methods used in the pre-study phase were chosen to collect relevant data about the area.

2.1.1 Literature and theory

To research about the bicycling trends and transporting bikes, a literature and theory study was conducted. Information was gathered from previous master theses and online searches.

2.1.2 Technical Research

To understand the objects included in this project, a technical research was conducted regarding bikes, bike transportation solutions inside the car and bike travel cases.

Bike Components and Construction

The bike consists of several different parts which some being easier to adjust than others. To understand what differentiates the parts on the bike and between different types of bikes, a technical research was performed to complete a small dictionary with bike terms.

Bike Racks Inside the Car

On the market today, there are some bike racks mounted on the inside of the car available. To understand the important factors to consider with transportation of bikes inside the car, these racks were explored.

Bike Travel Case

The components necessary on bike travel cases were also explored to understand how they are built. Different models of bike travel cases have been investigated to see what differentiates between them.

2.1.3 Market Research

To investigate the current market situation, several researches were made. Firstly a market research was conducted in Gothenburg, then a bicycling show was visited, before Thule's existing product portfolio was researched and lastly a benchmark online on competitors was conducted.

Market Research in Gothenburg and Stockholm

The market research was performed to investigate which bike transportation solutions were available to gain knowledge about these to get inspiration to the future work. To research the market in Gothenburg, stores that sell bike transportation solutions were visited. The stores were selected with regards to their range of bikes and bike transportation means. The available transportation solutions and bikes were discussed with a shop assistant to retrieve further information. The Swedish Bicycle Show in Stockholm, was visited to investigate the trends on the cycling market and explore

competitor brands. This bike show is the largest one in Sweden, which offered a wide range of bike company exhibitors. Focus was on the retailers selling Thule products and competitor brands. Interviews with the exhibition staff was conducted and their thoughts regarding the Thule products were discussed and compared with products from competitors. Furthermore, many photos were taken to use later on in the process as inspirational material.

Benchmarking

A benchmarking online was constructed with the purpose to retrieve more information on which bike transportation solutions inside the car and bike travel cases there were on the market. The goal was to find out which brands and how many different solutions there were available online.

Design Format Analysis

Design format analysis, DFA, was used to find which elements that were characteristic for Thule products. Seven Thule products from different product categories were chosen and analysed to find which design element or design cue that each product had. The design cues that were seen most on the products were seen as the most important ones (Warell, 2006). The result of the DFA was used later in the project when designing the transport solution.

2.1.4 User Research

This project was conducted as a user-centered design project where the users' needs and demands were investigated. To collect data, different methods were used and these are presented below.

Retailer Interviews

To understand what merchandise retailers have available and what they prioritise in their stores, semi-structured interviews in a qualitative manner were conducted. Semi-structured interviews can give a more conversational feeling and the participants can be more comfortable (Martin and Hanington, 2012). A couple of questions were prepared, but much space was given for following up interesting answers. Five stores around Gothenburg were visited and these were:

XXL Sisjön
Sportson Vasagatan
Cykelhuset i Högsbo

Team Sportia Frölunda Torg
Biltema Sisjön

Survey Study Online

To collect data from cyclists across Sweden, a survey was created with questions regarding bicycle transportation. The survey was constructed with questions that needed to be answered with one-choice, multiple choices and short texts. The questions were thoroughly worked through as well as the structure of the questions. The survey was designed to be easy to understand due to the simple and clear structure the survey

had. Depending on some of the answers the participants entered in the survey, different follow-up questions would occur. This to eliminate confusion and ensure that the result would be more correct. The survey was posted on five different Facebook groups and on one online forum. The places it was posted were:

happyride.se	Fredrikshofs Cykelklubb
Hisingens Cykelklubb	Chalmers Cykelklubb
Göteborgs Cykelklubb	Vi som älskar landsvägscyckling

Usability Study with Observation

To understand how users, interact with the bikes and use the transportation solutions, a user study with 10 cyclists was conducted. The aim of the study was also to evaluate the usability of three bike travel cases. During the study, it was observed how the users interacted with bike travel cases. The users performed a series of sequences of interest for this project. During the study, the user interacted with the different bike cases and the user was to load the bike into two of the bike cases decided by the test leader. The bike's wheels and the handlebar were taken off before the test started, since it could have been hard for users to do this and the bike was not the product to be tested. During the test, the users were asked to speak loudly about what they were doing, why they did what they did and how it felt. Through this, a more thorough understanding to why they did as they did was possible and qualitative data could be gained.

2.1.5 Affinity Diagram

To analyse the data from the survey study, an affinity diagram, also called KJ - diagram, was created (Martin and Hanington, 2012). The method was used to structure the short text answers from the survey to find areas to use in the continued work (see figure 2.1). The answers were printed out and answers with similar meanings were grouped together.



Figure 2.1. Preparations for the affinity diagram.

2.1.6 Persona

To describe the target group found from the survey, a persona was created. By using a persona to represent the target group, it can be easier to understand and relate to the target group (Martin and Hanington, 2012).

2.1.7 User Scenario

A user scenario was created to describe the problems found with transporting bikes today. The scenario focused on a longer transportation of the bike. The purpose of the user scenario was to highlight the problem areas and create an understanding regarding the problems.

2.1.8 Expression Board

Expression boards are used to visualize expressions that the concept should have (Wikström, 2014). Each picture has a purpose to represent a specific aspect. Aspects that should be represented are form, artefact, metaphor, colour and material. All pictures should also represent and express the brand itself. The results from the pre-study was used as input when the pictures to the board were chosen. Three sentences were written to explain the wanted expression of the expression board.

2.1.9 Design Goals

After summarizing all the insights from the pre-study, the results from the affinity diagram and the results from the user tests, design goals were created. These were used as guidelines in the development of the final solution.

2.1.10 Eco Strategy Wheel

To minimize the impact the solution has on the environment, an eco strategy wheel was conducted. It is structured as a circle with different areas marked out where improvements might be possible. The areas are: improve the functions, decrease the effect during usage, decrease the amount of materials, choose the right material, improve the lifespan, improve the production, improve the end of life handling and improve the distribution (White, St Pierre and Belletire, 2013).

2.2 Concept development

In the concept development phase, innovative ideas were created with a focus on keeping a broad perspective which would create a large amount of ideas. Brainstorming sessions were conducted and a Pugh Matrix was used to evaluate the ideas and take the final decision.

2.2.1 Ideation

To begin the ideation phase and start exploring a wide range of ideas, brainstorming in different contexts were used. Brainwriting (Wikberg Nilsson, Ericson and Törlind, 2015) was used as a starting point. 10 areas chosen to ideate around were written on 10 different papers. The areas used were: *two bikes, flexible, storage, an extra*

function, protected, safety, from A to B, quick, solution plus car and simple. During the brainstorming sessions, no one was allowed to criticize anyone and crazy ideas were encouraged. During 5 minutes, each group member wrote their thoughts on how a transportation solution could look like with regards to the specific area. The paper was then sent to the next participant and a new area was chosen to ideate around.

After the Brainwriting session the ideas were discussed before the ideation moved on to a more traditional form of brainstorming, Braindrawing (Wikberg Nilsson, Ericson and Törlind, 2015). During this session, the same areas were used to ideate around, but this time with sketches instead of words and longer sessions. Printed underlays of bikes were used to investigate the most optimal form of the transportation solution to fit the bike. To boost the creativity, the method Dark Horse (Wikberg Nilsson, Ericson and Törlind, 2015) was used in between some of the Braindrawing sessions. The method promotes crazy ideas, think outside the box and come up with new possible ways to solve the problem. After each Braindrawing session, the ideas were discussed and the most promising ideas were chosen to be saved and used to create concept ideas.

The concept ideas were created through sketch sessions where the different ideas were put together, refined and evaluated. Printed underlays of car trunks were used to explore and evaluate how the concept ideas would work in the car. After a large amount of concept ideas and some iteration, some concept ideas were chosen for further refinement.

2.2.2 Evaluation of concept ideas

The ideas that came up during ideation were discussed with regards to feasibility and connection to the design goals and evaluated with regards to them. For the final concept ideas, a Pugh matrix with the design goals as criteria were used. Pugh matrices are used to evaluate how well an idea or concept solves the problem with regards to stated criteria (Johannesson, Persson and Pettersson, 2013). A product is chosen as reference and give the score 0 on each criterion. The ideas are then evaluated against the reference and given the score 1, 0 or -1 on each criterion depending on if the idea is better than the reference, equal to it or worse than it with regards to one specific criterion. When all ideas have been evaluated with regards to each criterion, the scores are summed up and each idea has a final score.

Thule Pro XT was chosen as reference product and given the score 0 for each design goal. The ideas were then all compared to the reference product and given a score for each design goal. The final score was used to determine which idea to move forward with.

2.3 Developing of the Final Concept

During the development of the final concept, focus was on creating a solution that solved all the design goals. First, the concept idea was analysed and problems to solve and details to decide were listed. During sketch sessions, each problem area got a

limited time to come up with options on how to solve problems with all the areas. The solutions to the problems were evaluated with regards to the design goals and how it would be possible to realise the solutions.

Form

The form of the case was tested with a cardboard model in a Volvo V40 to make sure that the case could fit into the car trunk of a small combi car (see figure 2.2). The form of the cardboard model was changed until two models could fit into the car at the same time.

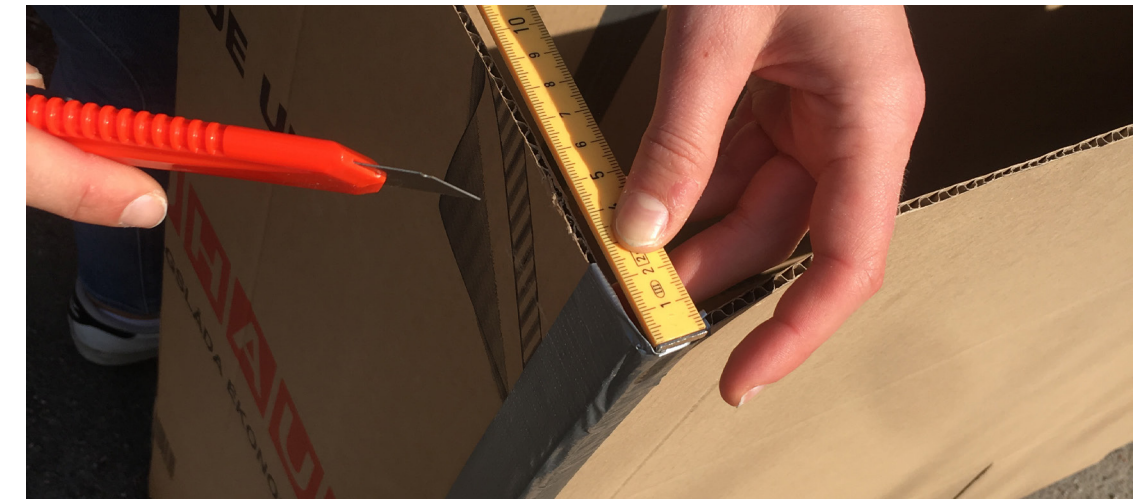


Figure 2.2. Creating the mock-up of the real size.

User Test

The goal of the test was to investigate how the users would prefer to move with the final concept and where they wished to interact with the case. This was achieved through testing the placement of the handles. It was tested with 10 people to see how and where they would want to place the handles. A cardboard box in the real size was used to place out handles with tape and the users could place the handles wherever they wanted. The test consisted of three scenarios. In the first, they should place a handle so that they could move the case on four wheels. In the second scenario, the participants were asked to place the cardboard handles how they wanted as if they were walking with the case on two wheels. In the last case, they were asked to place the handles so that they could lift the case up into a car trunk.

Design FMEA

To verify that the product would be feasible to manufacture and that the wanted appearance would be achieved, a FMEA, failure mode and effect analysis, was conducted. The FMEA was also used as a tool to predict if decisions taken could be considered as potential risks for the appearance of the product and how high or low the risks would be. Each relation between two parts were evaluated and if a relation was a potential risk it was written down in a FMEA table. In the table, the effect, the probability and the visibility was noted. Then a calculation was made and a number, which symbolised the risk with the relation, was achieved. Lastly, a precaution was taken minimize the risk for the relations that got the highest score (Dagman, 2017).

3 Results & Analysis

In this chapter, the results and analysis from the pre-study, the concept development and the finalisation is presented.

3.1 Pre-study

The results from the pre-study are described below.

3.1.1 Literature and Theory

Road bikes, or racing bikes, are bikes with narrow wheels and are used to bike fast during long distances on paved roads (Bikeradar, 2013). Mountain bikes are designed to endure rougher terrain and are used to cycle in forests, on dirt roads and on other roads than paved roads (Mountainbike Online, 2018).

During the last couple of years, it has gotten more popular to combine vacation with training and mostly cycling. Mallorca is one of the most popular destinations and is suited for both professional and intermediate cyclists. On Mallorca, there are several different companies that arrange training sessions for all the different kinds of cyclists (Bergkvist, 2018).

When travelling abroad to cycle, it is often possible to rent a bike at the destination, but many dedicated cyclists still choose to bring their own bike. When flying and bringing a bike, there are some important factors to consider. Firstly, the bike needs to be well protected in a bike travel case or a cardboard box with protection around the bike frame to make sure that it does not get damaged when handled by the airline personnel. Secondly, many airline companies have a weight limit of 23 kg, if the case weighs more fees may be added (Skyscanner, 2016). To fit the bike in a bike travel case, the bike needs to be disassembled to different extent. Different types of bike transportation cases demand different parts to be removed. For some components which are fragile, extra protection could be needed to keep them safe (Juden, 2012).

Furthermore, regarding transporting bikes with cars, many solutions today are mounted on the exterior of the car. This leads to an increase in fuel consumption. Transporting the bike on the roof has a higher impact on the fuel consumption than transporting on the back of the car due to the aerodynamic effect and transporting the bike inside the car does not affect the aerodynamic (Henriksson, 2017).

3.1.2 Technical Research

This chapter explains the findings from the technical research.

Bike Components and Construction

Road bikes and mountain bikes are two bikes similar to each other with regards to which components they consist of. However, when it comes to weight and size, the mountain bike frame is bigger and it is built to resist more force as it is mainly used on dirt roads.

The main part of the bike is the frame that consists of the top tube, the down tube, the fork, the seat stay, the chain stay and the seat tube. On the frame, the handlebar, the seat post, the pedals and the wheels are mounted.

The wheels are connected to the frame by either a through axle or a quick release axle. The through axle goes through holes in the fork and when using the quick release axle, the fork is open to the hole where the quick release axle is fitted in and then tightened. Bike frames are made in different sizes from 49cm to 62 cm for road bikes and 33cm to 56cm for mountain bikes. The sizes stand for the distance between the top of the seat tube and the centre of the crank (see figure 3.1) (Bikester, 2018). With the seat tube increasing so is the rest of the frame proportionally. The length of the wheelbase varies depending on brand and model and is not always available from the retailers. The distance varies from around 90 cm (Bianchi Store, 2018) to 120 cm (Salsa Cycle, 2018). The bike wheels vary in both diameter and width, mostly depending on which type of bike it is, mountain bike or road bike. The biggest wheel size used is 29" which is about 73.7 cm in diameter (Bikeradar, 2018), but the retailers visited said that the most common size for road bikes is 28".

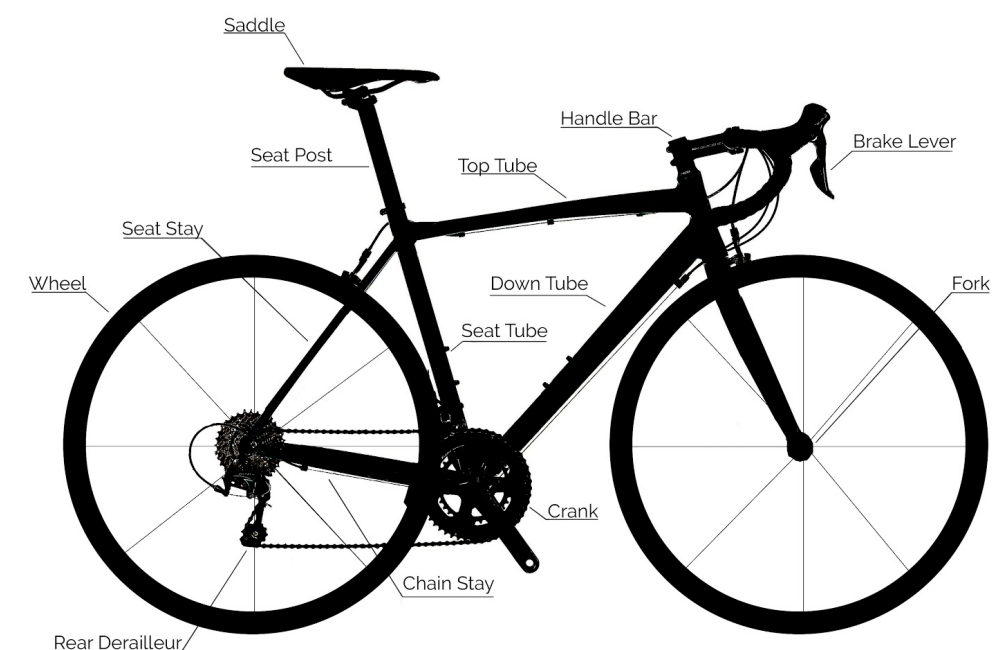


Figure 3.1. Bike Anatomy

Bike Racks Inside the Car

Bike racks inside the car consist of a rack with a connection where the fork can be fastened when the front wheel is removed. The racks can transport one to four bikes. Some racks reach all the way to the back wheel of the bike where the back wheel can be secured with a strap. On the solutions where the racks do not support the back wheel, the back wheel can move around.

Bike Travel Case

In general, it can be said that bike travel cases consist of an outer shell in fabric or plastic. The shell can be in either one or two pieces and closes with some form of closing mechanism, e.g zipper or buckles. The number of wheels on the outside of the case differ. They can have either two on the same side of the case or two wheels on both sides. Wheels also differ in the way they turn. Some are constructed to be able to turn 360 degrees and others are locked and can only move forwards or backwards. The cases usually have a designated place for the bike wheels to be placed, either a specific pocket or a specific wheel bag.

The technical construction to hold and secure the bike frame inside the case varies between locking the frame where the wheels are and strapping the frame to the side of the case. The inside of the case sometimes offers a way to store parts that have been removed from the bike.

Material

Bike frames are made of steel, aluminium, carbon fiber or titanium. Steel frames are getting less popular on road bikes and mountain bikes since they weigh more than aluminium and carbon fiber. Aluminium frames are lighter than steel, but not as strong which make the diameter of the tubes larger to give more strength to the frame. Carbon fiber is a strong, light material that does not rust. However, it is an expensive material and is therefore used on more expensive bikes. Titanium is a very light material which can be found on very expensive bikes (Dellensten, 2018). In Tour the France, there is a minimum weight limit of 6.8kg which is a low weight for bikes (Hurford, 2016). Travelling with the lightest allowed bike with a case that weighs 17kg would mean a total weight of 23.8kg. This weight would extend the maximum weight that many airline companies have for bikes (see chapter 3.1.1). It can be assumed that bikes made in other materials than carbon fiber or titanium will exceed this weight limit as well and it is therefore crucial that a bike travel case is so light that the bike and the bike travel case does not exceed 23 kg.

3.1.3 Market research

The market research that was conducted in Gothenburg, Stockholm and through the internet is presented below.

Market Research in Gothenburg and Stockholm

The visited stores in Gothenburg sell bike racks that are mounted on the roof and on the tow bar (see figure 3.2). Two types of roof mounted racks were found. On the tow bar the most common bike rack found was a simpler solution, shaped like a V, where the bikes hang in the frame. In two stores, larger tow mounted racks were found. Two stores had bike travel cases. One store had both hard and soft travel cases and the other one only had hard travel cases.



Figure 3.2. Bike Racks.

The visit to the Swedish bicycle show in Stockholm, showed that electric bikes is the most dominating trend in the cycling industry right now. Out of all the bikes at the exhibition it was estimated that around 60% of the bikes were electrical. Only two different brands for bike transportation solutions were seen, but no bike transportation solution for the inside of the car or bike travel cases. However, it was easy to ask questions regarding bikes and it was inspirational to see the trends which are represented in Sweden now. The inspiration was later used in the ideation (see figure 3.3).



Figure 3.3. Visit at the Swedish Bike Show in Stockholm.

Benchmarking

Thule sell three different cases with different functions, Thule RoundTrip Transition, Thule RoundTrip Pro XT and Thule RoundTrip Traveler (Thule, 2018) (see figure 3.4). These can be divided into three groups depending on the structure of the case. These are hard, semi-hard and soft bike travel cases.

The hard travel case is made in hard plastic and is the most expensive product category. Thule RoundTrip Transition is considered to belong in this category. Semi-hard travel cases are made in harder fabric with extra structure and the bottom is usually made in hard plastic. Thule RoundTrip Pro XT is considered to belong in this category. The soft travel cases are made in harder fabric and do not have any extra frames inside. Thule

RoundTrip Traveler is considered to belong in this category. Furthermore, the cases are in different sizes and the largest one of Thule's three cases is the Thule RoundTrip Transition case which is also the heaviest.

To place the bike in Thule's travel bike cases the user must disassemble the bike. The bike frame should be separated from the two wheels and the wheels are to be packed in separate soft wheel bags which are included in the purchase of the bike travel case. Furthermore, the seat post, the handlebar and pedals should be removed from the frame. These three parts need to be removed with tools.

Figure 3.4. Thule RoundTrip Transition, Thule RoundTrip Pro XT and Thule RoundTrip Traveler.



Included with Thule RoundTrip Transition and Thule RoundTrip Pro XT is an integrated bike stand (see figure 3.5). With the stand, it is possible to disassemble and assemble the bike in a comfortable way. The front wheel is removed and the quick release or through axle is removed and then fitted in with either the 9mm, 15mm or 20mm adapter to secure the fork to the stand. The lowest part of the frame, where the crank is, is placed on a rubber square and secured to the stand with a strap. The rear wheel, the seat post, the handlebar and the pedals can then easily be removed and the bike is ready to be packed in the case, while still on the bike stand.

Figure 3.5. The Bike Stand.



When benchmarking the market of bike travel cases, it is seen that the market is wide and there are many different brands. There are two cases which weigh 17kg, Elite Vaison Bike Bag (Vanillabikes, 2018) and Thule RoundTrip Transition. The lightest cases are the Canyon Bike bag (Canyon, 2018) and the Radon bike bag (Radon, 2018) that both weigh 2,1 kg. The heaviest cases are hard cases and the lightest ones are soft cases. The dimensions of the cases vary from 109 cm to 153 cm in length, from 20 cm to 50 cm in depth and 78 cm to 103 cm in height (see Appendix D).

On the market today, there are several different rack solutions for transporting the bike inside the car. Racks inside the car connect the fork to the rack with the front wheel removed. BikeInside (BikeInside, 2018) is a company that offers a solution for one bike

and with Saris Traps Triple Track (Saris, 2018), it is possible to mount four bikes at the same time.

Design Format Analysis

The results of the DFA showed that the main characteristics on Thule products are shapes with curvature, minimalistic design, visible Thule logo, colour contrasts to show where to interact and aluminium and hard plastic as materials (see figure 3.6).

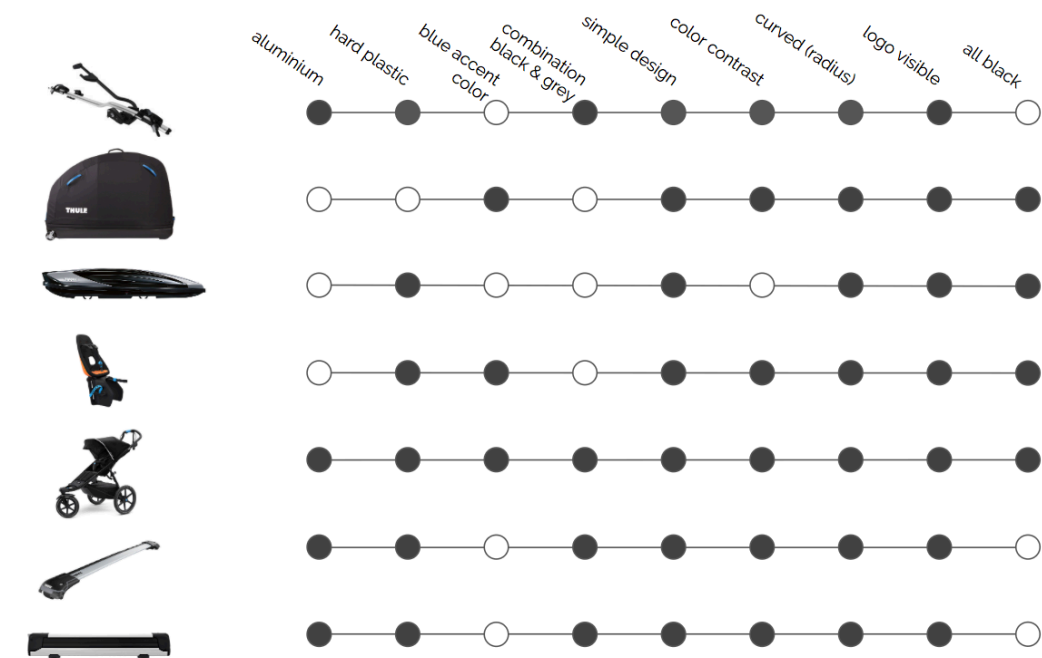


Figure 3.6. DFA

3.1.4 User Research

In this chapter, the results from the user research is presented.

Retailer Interviews

The results from the retailer interviews are summarized below with the answers from each question. The interview template can be found in appendix A.

All stores said that they sell to everyone from families and beginners to people who have biked during several years. However, none of the stores had bikes for the professional cyclists. One retailer explained that these cyclists are demanding since they know very well what they want and are picky with their choices. Today, it is easy to order parts online and it is too expensive for the stores to have the specific components the professionals want, in stock.

There are two different ways to connect the fork to the wheels, through axle and "quick release". Quick release is popular on road bikes and through axle on mountain bikes, but through axle is today seen on road bikes as well. A through axle is safer in the sense that it provides a more stable connection between the fork and the hub since it goes through a closed hole. Forks adjusted for quick release axles, are partly open in the bottom to make it possible to remove the wheel without removing the axle itself.

All the stores had some type of bike racks and most stores had the simpler tow mounted bike rack that is shaped like a V. This solution was recommended for those who do not bike very much or do not have too expensive bikes. Other solutions that the stores had were roof mounted solutions and platform tow mounted solutions. The retailers said that it is important to think about how many bikes that should be transported and what the bikes weigh before buying a bike rack. Electric bikes are getting more popular, but these weigh more than normal bikes.

The stores had a much smaller selection for bike travel cases compared to bike racks. Only Sportson had a bike travel case in the store during the visit. XXL and Cykelhuset sell bike travel cases, but did not have them in the store during the visit. Neither of the three stores sell many cases, one said that it is more usual that the customers buy them online. They recommended hard travel cases for flying with the bikes to give the bike the best protection. XXL also sells soft travel cases.

Survey Study Online

The survey online resulted in 405 answers after one week before the survey was closed. The survey and all the results can be found in appendix B.

The Target Group

Most participants were between 40 and 65 years old and 81,2 percent were men. The living situation was divided almost equally between houses, condos and terraced houses. The majority identified themselves as intermediate cyclists and biked 3 to 5 times a week. They had access to a car and 64,3 percent had a station wagon. Few participants had a sedan which was positive due to the limited luggage space those have. The result showed that the participants that transported more than one bike at a time also owned more than one bike.

Bike Transport Solution

The result showed that the most common bike transportation solution was tow bar mounted bike rack for more than one bicycle. The second most popular solution was the roof mounted bike rack with frame holder. When asked what brand the transport solution was from, Thule was over-represented which shows that the majority are familiar with the Thule brand. The largest reasons behind the purchase of the specific bike solution was functionality, quality, placement on the car and price.

Transport Inside a Car

Even though the majority had a bike transport solution, the need and demand for transporting bikes inside the car is large. It would make transportation simpler and practical according to the answers. Several are also scared of theft and transporting the bike inside a locked car would reduce that fear. The bike does not get as dirty as it does when mounted on the rear and the users do not need to reach up to the car roof to attach the bike. When asked if the users could imagine transporting the bike inside the car, a

total of 84,4 percent said that they could but that there could be some difficulties. The aspects lack of space, dirt inside the car and damage to the car interior were seen to be important.

Travel with Bike

The result showed that two thirds of the participants travel with their bike, but only one third have a bike travel case. The reasons were mixed, some thought it was space inefficient and others did not see the need for it. There were also optimists who said they just had not found the right bike case yet. Many of the participants also said that they would like to travel by train with the bike, but since this is not possible on some trains today, they wanted a solution that makes it possible.

User Study with the Travel Cases

The results of the observations of the interaction with the bike travel cases are described below. The bike was mounted on the bike stand that comes with Thule RoundTrip Transition and Thule RoundTrip Pro XT when the test started (see figure 3.7). The user study questions can be found in appendix C.

Thule RoundTrip Transition

Thule RoundTrip Transition was the first case the participants tested. They said that the travel case looked large, heavy and that it was too much bigger than the bike. The test started with the case being closed and the first task was to open the case. They all struggled with the buckles to open the travel case, one participant said that they looked like the buckles on snowboard boots, but they did not function the same way as them.

When they figured out how to open the case, the lid fell off for most of the participants. They assumed that the lid was fastened to the case and therefore they were not prepared when it fell off. When the case was open, they had to remove the rail with the bike on from the rest of the bike stand to load the bike in the case. None of the participants understood directly how this should be done and when finding the tab to unsecure the rail they thought that they should pull the rail straight up or slide it out. However, this does not work, the rail needs to be angled towards the user to remove it. After a couple of attempts, they could separate the parts.



Figure 3.7. Picture from user test.

Loading the bike stand into the case went very smoothly for the participants and they thought it was easy. When being asked if they thought the bike was secured enough, they all grabbed the frame and tried to move the bike and said that they would like to secure the bike to the case higher up on the frame as well. The bike wheels were easily put into the wheel bags by every participant and they liked them. Loading the wheel bags in the case was also simple, some would like indications of where they should be placed, but everyone placed one bag on each side of the frame. One wanted to be sure to place the larger rear wheel on the opposite side of the crank where there were more space, but the rest did not take any notice of the different wheels. When putting on the lid, the participants struggled again with understanding how the buckles worked. They were then asked to walk a bit with the case and it felt good for the majority. Some said that it was a little unbalanced due to the size and they would like it to have four wheels so they would not have to pull and lift it on two wheels.

Thule RoundTrip Pro XT

The second case that was tested was Thule RoundTrip Pro XT. When looking at it, the participants said that it was smaller and seemed smoother than the hard case and many would prefer to buy this over the other. The case was completely open, one side was standing up and one was laying on the ground. When placing the bike in the case, all but one participant, stood at the same side as the part laying down. They thought this was uncomfortable as they needed to lift this side to reach the case and they did not want to step on the side of the case. The one that stood on the other side, thought it was much easier, even though it was a little hard to see where the rack should be connected. The case is almost 10 cm narrower than the hard case, and one thought the case was good for road bikes, but doubted that her mountain bike would fit in it. However, the participants appreciated that the case was possible to fold as it made it much easier to store. When they walked with the case, they thought it felt nice, a bit more unstable than the hard case due to the shorter distance between the wheels, but easier since the case was much lighter. They would have appreciated if the case had more wheels to make it easier to walk with it.

Competitor Bike Travel Case

The third case that was tested was a red Evoc Bike travel bag. This case was only tested through looking at it and interacting with it, but not with the bike inside. The participants thought the design was more interesting than the other cases. They found the fabric to be a bit thicker and more structured than the fabric on Thule RoundTrip Pro XT and they thought the fabric on the Evoc bag was better. They also liked that the wheels could be placed in pockets on the outside of the case. However, they would have wanted the case to have a stiffer frame to make it “stand by itself”.

Usability

From the test, it could be seen that the integrated bike stand that is included in both Thule RoundTrip Transition and Thule RoundTrip Pro XT, lack in guessability since it

was hard for the users to understand how it worked the first time. However, they had good learnability and the users liked the bike stand when they used it more.

Interviews with Users

Depending on the car, the participants said that they would either want to transport the bike on the tow bar or inside the car. The roof is a bit complicated if the car is high and it takes up wind. Most of them do not want to disassemble the bike any more than removing the front wheel. Today, all but one user transports inside the car with the front wheel off and the last transports his bike on the tow bar.

The biggest advantages with transporting the bike inside the car are that the bike is safe, it is simple, and the bike does not get dirty. One said that it is comfortable to have it inside the car if one wants to stop on the way. The disadvantages are that the car gets dirty, it takes up space and some parts needs to be removed to fit into the car.

They all said that it was important that a bike transportation case is easy and that it is fast to load and unload the bike and that the bike is secured and safe in the case. Other factors that are important are that the case is easy to clean, that more things can fit into the case, that the case is not too heavy and that the case is not too expensive. Many said that they would like to put tools, the helmet and shoes in the case.

3.1.5 Affinity Diagram

The affinity diagram resulted in three areas, bike rack, bike travel cases and inside the cars, with regards to how the bike is transported (see figure 3.8).

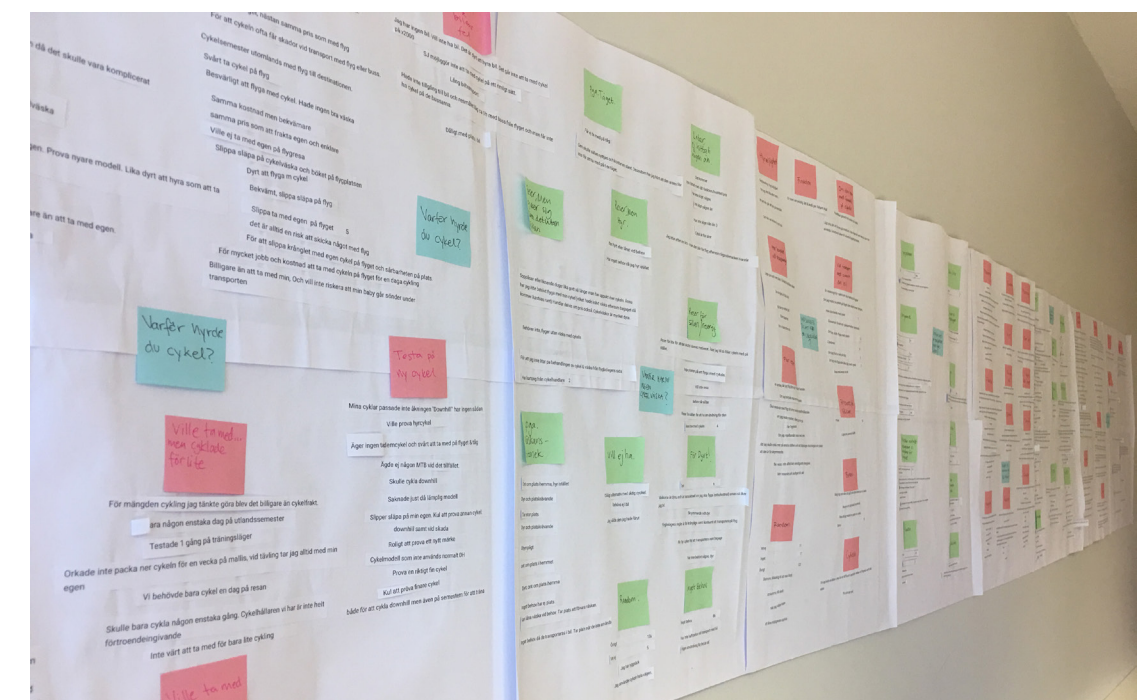


Figure 3.8. Affinity Diagram.

Bike racks

The bike racks need to be designed to make it simple for the user to secure the bike and make it clear for the user that the bike is secured enough and it should feel stable.

The racks are placed outside the cars, and it is therefore important that the rack has the possibility to lock the bike to the rack. One participant said, “It should have a better lock/safety, it is probably not too hard to open the current lock...” about his current bike rack. The bike rack should also be mounted in a way and function so that the car does not get damaged or scratched by the bike. If more than one bike is mounted on the rack, it is important that the bikes do not scratch or damage each other. When the bike rack is not in use, it should be easy to store. If the bike rack is large, it needs to be foldable in some way.

Bike Travel Cases

Bike travel cases need to provide an easy way to load and unload the bike from the case and the bike must have full protection when placed in the case. The participants also stated that it was especially important that the wheels and the crank were protected. Pockets on the case for the removed parts from the frame and for additional tools and equipment was wanted. The case should not weigh too much and many said that it would be good if the cases had four wheels to make it easy to move the case on floors. Some stated that they wanted to be able to carry the case on the back or on the shoulder for shorter distances. To make it easier to store the case when it is not in use, the case should be able to decrease in volume by for example folding it. The case should also be available at a reasonable price. A bike stand to use for repairing and working with the bike was wanted.

Transportation Inside the Car

When transporting bikes inside the car, it is important to keep the car clean and to protect the interior from getting damaged by the bike. It is also important that the bike can be transported without causing any danger towards the passengers by being secured or mounted in a case and it should not affect the visibility for the driver. The bike needs to be well protected and loading the bike in the car should be easy and should demand as little disassembly as possible.

Insights from Survey Study

The results from the survey study were analysed and the most important insights were:

- Safety, the bike should be safe against theft and damage and should not cause any danger for the passengers.
- Dirt and damage, the car needs to be protected from the bike so that it does not get dirty or damaged.
- Simple, the solution should be easy, comfortable and smooth to use.
- Storage, needs to be able to be stored in a good way when not in use.

3.1.6 Analysis of User Studies

The results from the user studies were analysed and the most important insights were:

- The bike needs to be and feel safe.

- It must be simple to transport the bike and easy to understand how the product should be used.
- As few parts as possible should be necessary to remove.
- Bike travel cases should be possible to push and not necessary to carry all the time.

3.1.7 Persona

The persona Carl, is a fictive person who represents the target group and the typical user.

Carl (see figure 3.9) is 45 years old and works as a doctor. He lives in a condo in Stockholm together with his wife, their adult kids have moved out of the condo. He cycles a couple of times each week, normally he starts from home, but he likes to go further away once a week. Then he takes his bike in the car and sometimes a friend joins him. He has two road bikes that he alternates between and a mountain bike. Since the weather in Sweden does not invite to cycling all year around, he goes abroad on cycling trips a couple of times each year.



Figure 3.9. Persona.

3.1.8 User Scenario

Below, the scenario that describes how transporting bikes with plane and car could happen and which problems that have been found with those transports.

Carl has been biking with road bikes for many years. Each year he goes to Mallorca to kick off the spring season with a week full of challenging biking in warmer temperatures. As usual, his good friend joins him on the trip and he brings his own bike as well. They go to the airport in separate cars, even though they live very close. This since both bike cases do not fit together in either of their cars.

When doing the check-in the feeling of unsafety hits Carl. This feeling will not go away until landing in Palma and having the bike right in front of him. When having landed and checked that both bikes are undamaged, they go to the car rent disk to find a car that is big enough to fit both their cases.

In the hotel room the two cases take up much space, which is annoying and inconvenient. The vacation runs fast and before they know it, they are back in Sweden. Once again, storing the case, in Carl's condo, is a big problem.

3.1.9 Design Goals

The important insights from the user study and the survey study have been analysed and aspects to consider when designing a bike transportation solution for the inside of a car for the specific target group have been summarized as design goals.

The solution should:

- Fit into cars

Two bikes and two persons should fit into the car at the same time. Due to variations in cars, the scope has been limited to station wagon and SUV cars.

Reason for goal: The survey showed that most people transported 1-2 bikes at a time and station wagon and SUV were the two most common types of car.

- Safety regarding the bike.

The bike should be safe regarding theft, damage and dirt.

Reason for goal: The survey showed that users wanted to have better locks on their bike transportation products, they were worried about scratching the bike against other bikes and they did not want their bikes to get dirty (specific for road bikes).

- Safety regarding the car.

The car should be protected from damages made by the bike, the bike should not soil the car and the bike should not cause any danger to passengers in the car.

Reason for goal: The survey showed that users had a positive attitude towards transporting the bike inside the car but some were worried that the bike would soil the car or damage the car. Some also stated that they wanted the bike to be secured so that it would not cause any harm in case of an accident.

- Easy storage

Should be able to decrease in size when not in use to make it possible to store easier.

Reason for goal: The survey showed that users considered many of the existing products on the market too big to store anywhere.

- Simplicity

The product should be easy to understand and quick to use. The simplicity should make the product feel effortless to use.

Reason for goal: The user study showed that users had problems with understanding how the bike should be loaded in the case.

- Create an extra value for the user

Add a value which would increase the customers desire for the product.

Reason for goal: There are many different brands that offer bike travel cases and to be the obvious choice for the users the product must give the user an extra value.

- Easy and comfortable to move around with the product

It should be easy to walk with product at airports, stations etc. and the handles should provide a good and comfortable grip.

Reason for goal: The survey and the user study showed that the users thought the existing product was uncomfortable to walk with and many would prefer the possibility to pull the bag on 4 wheels instead of two wheels.

- Weight

If a case, it should weigh less than Thule Pro XT (8,8kg), Reaching for <8,8kg

Reason for goal: The survey and the user test showed that the users want the case to be as light as possible and many airlines have a weight limit at 23kg.

- Express high quality look and feel

Will be achieved through material and design choices.

Reason for goal: Thule as a company is known for their high-quality products and this product must therefore have high quality.

- Follow Thule's mottos.

Active life, simplified and Bring your life

Reason for goal: To attract the Thule customers, the product must be in line with and express Thule's mottos.

- Fit in to Thule's product portfolio

By following Thule's design guidelines.

Reason for goal: By fitting in to Thule's product portfolio the product will be a true Thule product.

- Few parts to remove

As few parts as possible should be necessary to remove from the bike

Reason for goal: The user study showed that the users did not want to remove parts from the bike, mostly due to lack of knowledge on how to put the parts back on in the right way and to make it as quick as possible to load the bike.

3.1.10 Expression Board

The expression board (see 3.10) gives the viewer an idea of how the solution should be perceived and the three sentences below, describe the wanted expressions in the expression board:

- *Express safety through a robust material with a structured surface and a cohesive form.*

- *The form should be perceived as fast with distinct and upwards going lines to encourage movement.*

- *The solution should be easy, quick and portable, which offers freedom to bring your bike wherever you wish to go. The usage should be easy through obvious functions which leads to time saving and no struggle. Through an effective volume, the solution makes it possible to bring your bike.*

Figure 3.10. Expression Board.



3.1.10 Eco Strategy Wheel

How the final concept should be designed from a sustainable point of view was analyzed with the Eco strategy wheel. It resulted in that the factors to consider in this project were: the lifespan, the material used in the product and improvements in the production. These three factors were brought forward in the project to use in the development of the final concept.

3.2 Concept development

In the chapter below the results from the concept development phase of the project are described. It includes the first ideas, development of concept ideas and four concept ideas that were further refined and evaluated.

3.2.1 Ideation

Through Brainwriting, ideas with regard to the chosen areas came up and the ideas varied depending on which area was written on the paper. One of the ideas were a puzzle/Lego solution which focused on how to fit two bikes together in the car with some form of protection between them. The solution was eliminated due to that the form of the case was not optimal and became too big for the car trunk (see Appendix E). Many ideas regarding how to keep the bike and the car safe were created and the safety aspect was brought into the rest of the sessions because of the importance of it. An idea to use air to protect the bike came up and was brought forward due to the innovative aspect it had. Furthermore, the aspect of locking the solution in different ways was investigated. One idea was to lock the bike case inside the trunk and use a code lock to open it. Also, to use a car alarm on the bike case which was unlocked with the car key was made, though not brought forward due to the high cost it would add on the end product. There were other ideas which were to lock the case with straps or other means

to the inside of the car. These ideas were also eliminated and restricted to only having locks on the case. The ideas was brought forward with regards to the importance of the lock aspect, though further work was required to make the ideas function (Appendix E).

Two other ideas were the importance of giving an extra value to the user as an extra function or an extra feature on the solution and to create a flexible solution that could fit to each specific bike. The aspect to create a bike case which was flexible in either, length, width or height was discussed. Ideas on all three aspects were made and the most optimal way to make a bike case flexible was through experimenting with the length. This idea was brought forward and further discussed later in the ideation face. Furthermore, ideas regarding the extra value aspects were made. An idea was the bike transport solution could be used as something more, e.g. a folded table. This was not brought forward since it did not improve the transportation of the bike and did not solve any discovered need or add extra value for the target group. However, many ideas on creating a case had already been generated and a travel case would also contribute to an extra value for the customer (Appendix E).

Ideas regarding the aspect of storage were: folding the solution, hanging it up in the ceiling and picking the solution apart when not in use. These three ideas all solved the problem that the target group had brought up, though the folding idea was considered to be most feasible and was therefore brought forward in the process (Appendix E).

During the Braindrawing sessions, underlays of trunks were used to sketch the ideas in the car which made it easier to understand the ideas and evaluate their feasibility. One idea that was created was an integrated case in the car, which could be used when the rear seats were folded. The problem with the idea was how much space the solution would take up when not in use. Another idea was to create a flexible case that could expand in width by having hard sides and an expandable material in the middle. The issue with this idea was how to make the case stay in the smallest possible size when a small bike was inside. An idea to have one case for the bike frame and one separate wheel bag was also created. The case would then be easier to fit in the car, but it might be inconvenient if other means of transportation are going to be used. A solution only for the car was created with a carpet with strips of velcro on the bottom and with a connection for the fork on top. With this idea, two bikes could be transported at once. The carpet was included in the solution to protect the car from dirt. The puzzle idea from the Brainwriting session was further developed through sketches and included tracks to connect two bags to each other.

The ideas were all discussed with regards to the design goals and many were eliminated due to lack in performance with regards to safety and storage. The degree of innovativeness was also considered in the screenings.

3.2.2 Developing of Concept Ideas

After many sketching sessions, evaluations, refinements and screenings, only four concept ideas remained. These are presented below.

Concept idea 1

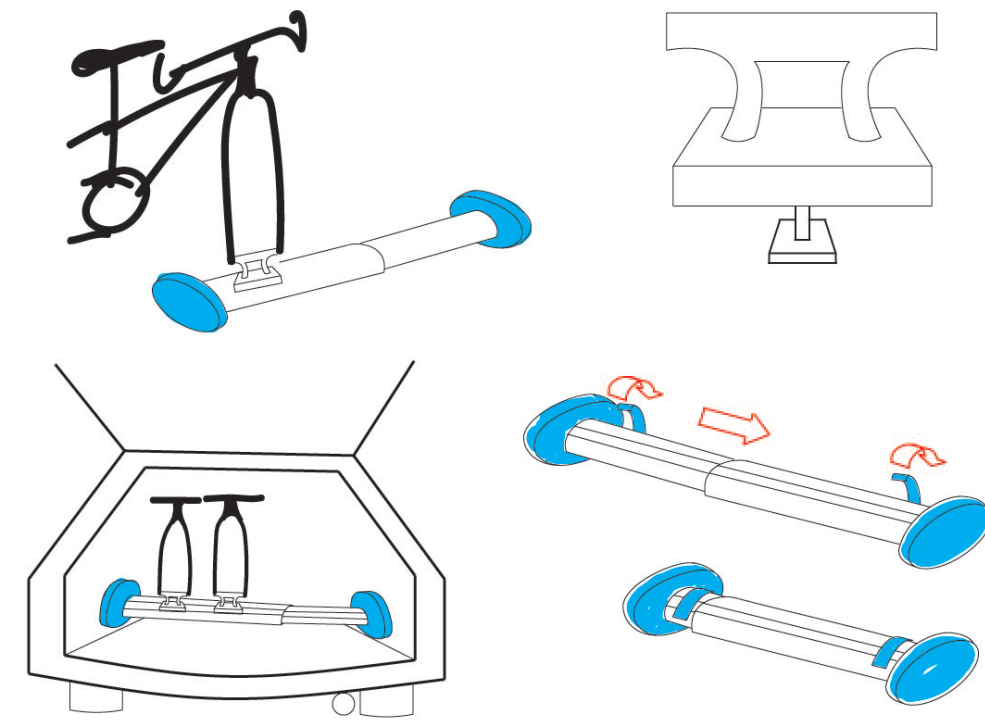


Figure 3.11. Concept 1.

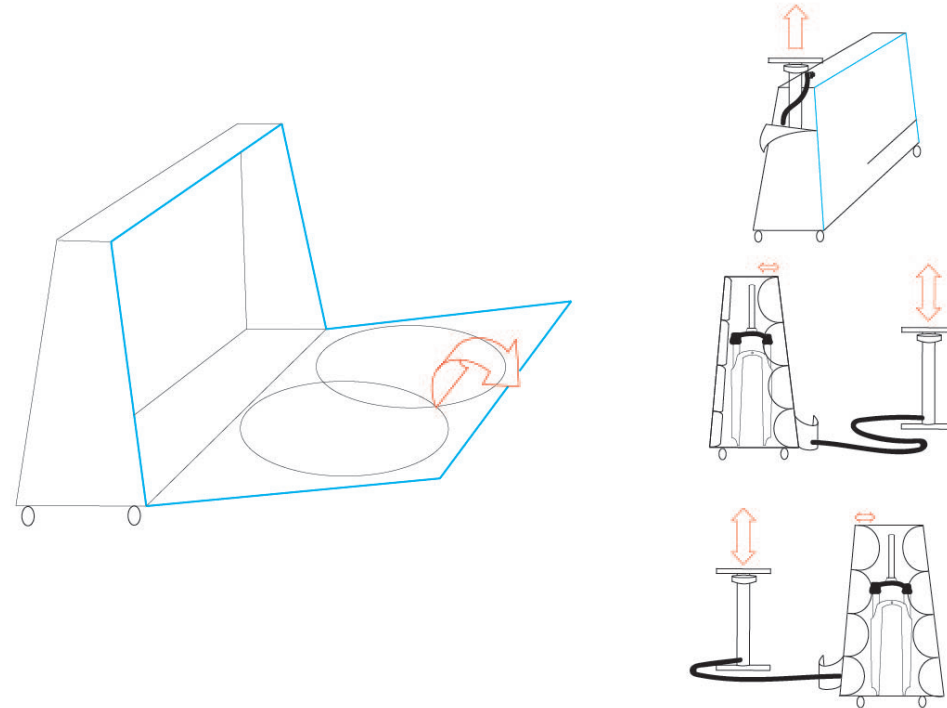
This is a solution (see figure 3.11) which is created to fit the trunk of a station wagon or SUV car which was an important aspect from the early stage. Furthermore, it is designed to be simple and quick to use and solves the problem with transporting two bikes inside a car in an excellent way.

This concept idea solves the design goal regarding fitting at least two bikes in the car at the same time. The rail makes the solution safe and with the bike inside the car it is safe against theft. Since it is small and very portable it is also easy to store. Its resemblance with Thule's roof racks create a high-quality value towards the user and the solution does not require the user to remove more than one part from the bike. Furthermore, it comes with one bike wheel bag which reduce the dirt inside the car.

To use, it the rail is first placed in the trunk and the blue rubber parts are pushed to the sides of the trunk. To secure them, a knob is turned to push them in enough to make them stay in place during the whole trip. When the front wheel is removed, the fork is secured in the fork connection and the bike is safe.

Concept idea 2

Figure 3.12. Concept 2.

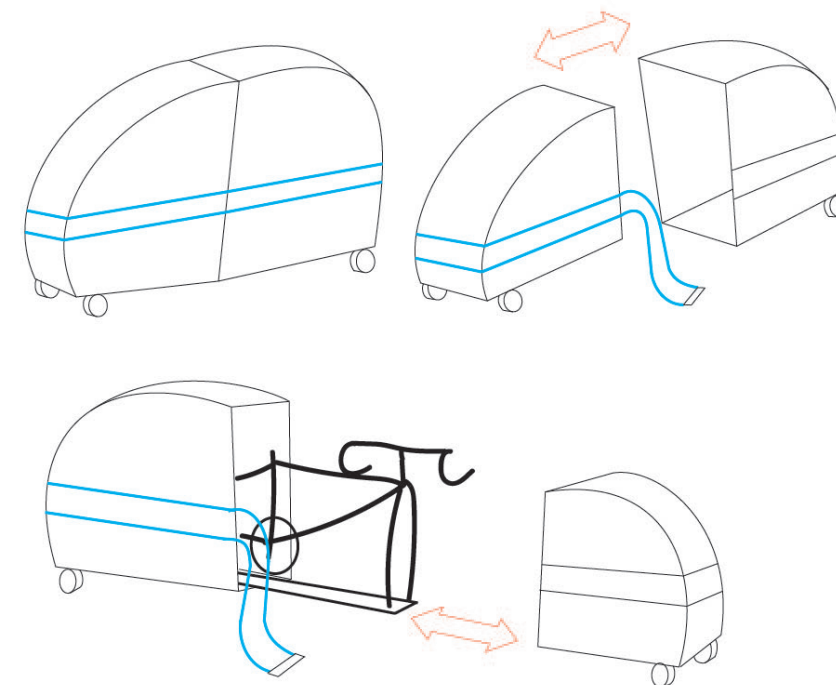


This concept idea (see figure 3.12) solves the aspect regarding safety of the bike in an innovative way. The concept idea is that the pockets of air protect the bike from hits and bumps. The shape is developed to, in an optimal way, fit two cases in a car trunk. When the case is transported by car, the pockets of air are not inflated. However, when flying and in need of extra protection, the user can inflate them and give extra protection to the bike. The case will be easy to store because it is a soft case when the airbags are not inflated and can thereby be folded into a small package. The concept is easy to use and understand. The innovative aspect with this concept is that it also comes with a branded bike pump. The user will feel that the case has something extra and that it is not only a bike case.

The wheels, the handlebar, the pedals and the saddle are removed before the bike is placed in the case and fastened with straps. The wheels are placed on one side of the case before the case can be closed easily with a zipper. If the case is in need of much protection, the pump is taken from its pocket and air pockets inside the case are filled.

Concept idea 3

Figure 3.13. Concept 3.

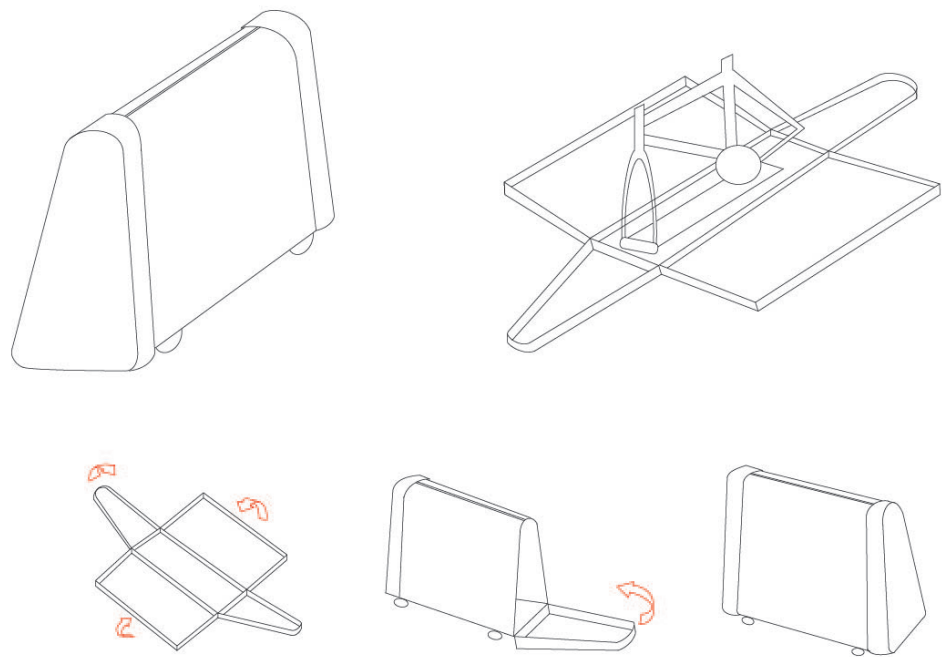


The third concept (see figure 3.13) focuses on making a case that can protect the bike in an optimal way. It is made of hard plastic which makes the case safe against impacts from all directions. The case has its opening vertical through the case and when it is open the bike can slide into the case when on the bike stand. The vertical opening makes it possible to place one half in the other when the case is not in use. This results in that the total volume the case takes up when not in use is only half of the original volume. The case does not have any sharp corners which can damage the car interior when in the trunk. Thule's blue accent colour is used on the strap and buckle to close the case.

After the front wheel has been removed the bike is placed on an integrated bike stand where it is possible to remove the rear wheel, the handlebar, the pedals and the saddle. Then the bike stand is slid into the case and the bike stand leg are slid in on the side of the case. The other part of the case is then slid on the bike and straps with buckles are used to secure the two parts to each other.

Concept idea 4

Figure 3.14. Concept 4.



The last concept (see figure 3.14) is a semi-hard case with a hard bottom, harder short sides and the rest of the case is made of a sturdy fabric. The concept provides good protection for the bike and the car is protected from any damages. Since the larger parts of the case are made in fabric the case will be light-weight and storage would be improved since the case can be made flat without the bike inside. The bike stand that comes with the Thule products today is used to fasten the frame to the bottom of the case securely. The silhouette of the case is designed to make it possible to place two cases on top of each other inside the car.

The wheels are placed on one side of the bike which makes it possible to place other bike gear, such as a helmet, shoes and tools, on the other side of the case, in pockets and with straps. The case is easy to understand and use. This thanks to its clear contrasts to show where to interact and the few steps to perform to close or open the case.

3.3.3 Evaluation

The occasion when the solution is being used should also be considered when evaluating the four concept ideas. Cyclist travel both short and long distances with their bikes and with different transportation means. Shorter distances require super easy and quick solutions and preferably, not more than one or two parts should need to be disassembled from the bike. Thule’s existing exterior products are then the obvious choice and are already today used to a large extent according to the questionnaire survey. If the user wants to transport the bikes inside the car without putting screws in the trunk, they would probably just put the bike in the car. The final concept is supposed to solve the longer distance travels and fit two bikes at the same time inside the car. Furthermore, the solution should protect the bike which allows it to be transported by other means than only car. The final concept will not solve shorter transportations. This was considered when evaluating the concepts in all stages.

The concept ideas were evaluated with a Pugh Matrix (see figure 3.15). The result was that concept idea 3 got a lower score than the reference and concept idea 1 got only 2 points. This lead to both concept ideas being eliminated. Both concept idea 2 and concept idea 4 got 6 points, and to choose which concept to continue with, a discussion in the project group and with the company took place. The decision to move on with Concept idea 4 was taken as it fit better into the brand portfolio and allowed for faster loading of the bike into the case.

Design Goals	Thule Pro XT	Concept Idea 1	Concept Idea 2	Concept Idea 3	Concept Idea 4
2 bikes should fit in to car	0	1	1	-1	0
The bike should be protected	0	-1	1	1	0
The car should be protected	0	-1	1	-1	1
Offer smooth and practical storage	0	1	-1	-1	0
Simple and Easy Usage	0	1	0	1	1
Create more value	0	-1	1	0	1
Weigh less than 13kg	0	1	0	-1	0
High Quality	0	1	1	1	1
Follow Thule Motto	0	0	0	0	0
Comfortable to move with	0	-1	1	0	1
Few parts to be removed	0	1	1	1	1
Fit in to Thule's product portfolio	0	0	0	-1	0
TOTAL	0	2	6	-1	6

Figure 3.15. Pugh Matrix.

3.3 Development of Final Concept

In this chapter, the development of the final concept is showed and discussed.

3.3.1 Form

The form was tested in a Volvo V40 (see figure 3.16) to ensure that two cases would fit into the car at the same time. A cardboard box with the desired form was created with the same dimensions as Thule RoundTrip Pro XT has, since it is possible to fit in two Thule RoundTrip Pro XT in the car. The model did not fit in the first time, so the short and long sides were cut so that they got a steeper angle inwards. Finally, the two models fit in the car with greater marginal than Thule RoundTrip Pro XT. This change made the case fit and made it be perceived as stable and safe. The final dimensions were set to 126x88x30cm where the depth of the case varied from 30 cm to 20 cm and the length

from 126 cm to 100 cm. This made the case large enough to fit all the found mountain bikes and road bikes. The case had a smallest possible size that was limited by the bike frame and the wheels (see chapter 3.1.2).

Figure 3.16. Picture of the model in a Volvo V40.



Protected Areas

After evaluation, it was discovered that if the protective material was placed like a frame around the short sides of the case, the case felt lighter than if the whole side would have protective material. This led to the case not only feeling lighter, but also actually being lighter.

Other placements of the protected material were also investigated and different ideas on how the protection could be placed across the case were sketched (see figure 3.17 and 3.18). Some of the ideas gave the case a new unwanted expression and some did not feel like they gave enough protection. It was decided to add protective material on the sides of the zipper that close the case. On the opposite side of the zipper, ideas on how to protect the wheels were investigated. It was decided to have the protective material on the inside on the case instead of on the outside to give better protection to the wheels and to keep the “back side” of the case simple.

Figure 3.17. Suggestions for the placement of the protective material.

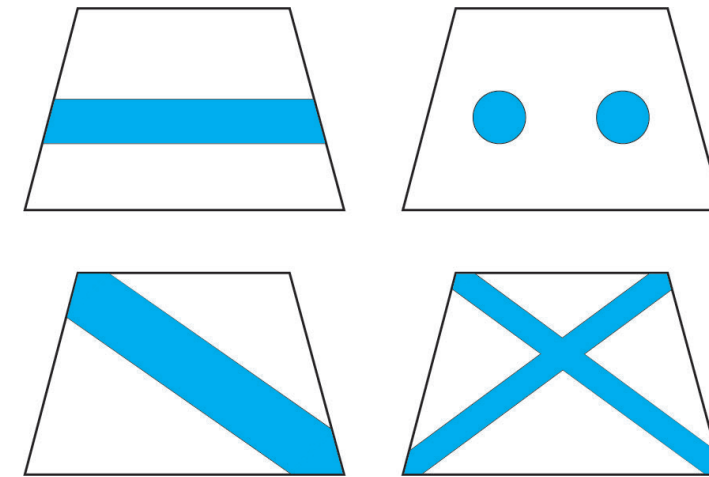
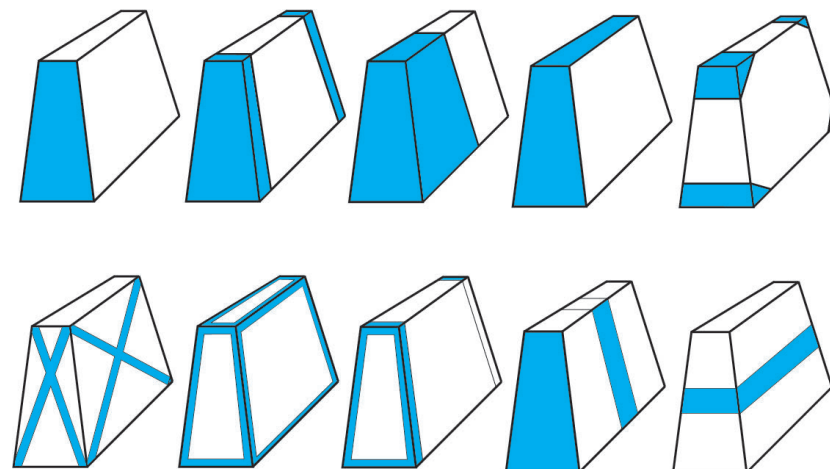


Figure 3.18. Suggestions for the placement of the protective material on the long sides.

3.3.2 Opening and Closing

The opening and closing of the case needed to be easy to understand and quick and easy to use. Ideas on how to open the case on different places on the cases were investigated. These were having the opening on the top of the case, on the bottom of one of the longer sides or on the middle of one of the longer sides. When the opening was on either of the long sides, the case got a more interesting expression, and it gave opportunities to place pockets on the shorter side of the opening.

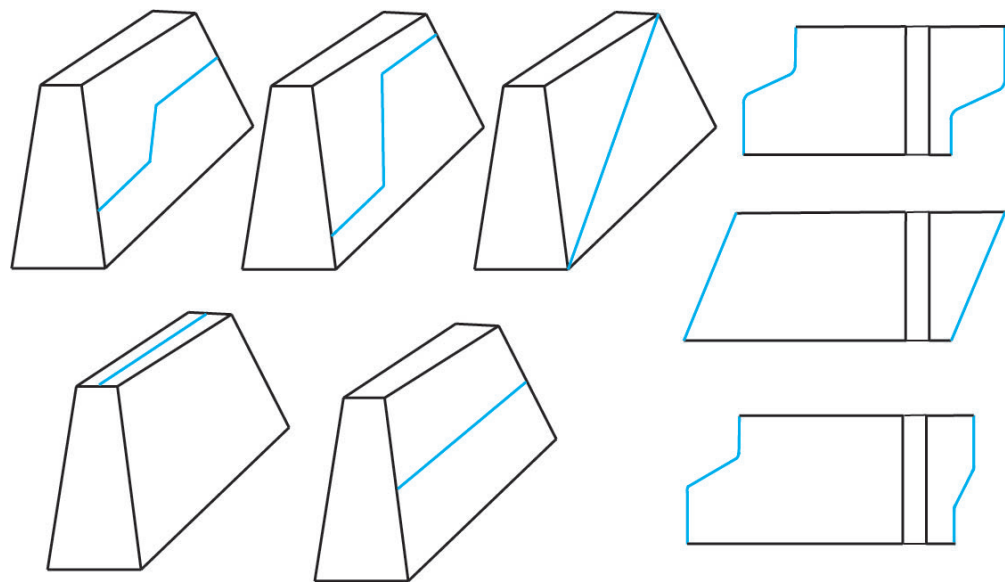
Which closing mechanism to use was also investigated. Ideas on how to close the case were buttons, zipper, velcro, lacing and buckles. Buckles could not be used to close all sides and it was not guaranteed that it would keep the case completely closed. It was therefore eliminated. Buttons and velcro could easily open by accident and the velcro would wear down with usage. These were therefore eliminated. Both zippers and lacings were feasible mechanisms to close the case and keep it closed. However, lacings would take longer time and the usage would therefore be slower and this mechanism was therefore eliminated and zippers chosen to move on with.

Thule’s roundtrip series for skis (see figure 3.19) have an opening as a symmetric wave or s form. To give the concept case a resemblance of other Thule products, ideas on how to add this feature were generated (see figure 3.20). After evaluation of the ideas it was decided to put the shape on one of the long sides of the case, starting in the middle. This placement gave the s-shape much attention. Furthermore, it was not too far down to make it uncomfortable for the user to close the case. In addition, the placement allowed for space inside the case to place pockets to put the removed parts in. The case then also got a unique design which has not been seen on the market and would make it stand out.



Figure 3.19. Thule Round-Trip bag for skis.

Figure 3.20. Sugestions for the opening and closing of the case..



3.3.3 Possibility to lock the case

In the survey, it was clear that cyclists want to keep their bikes safe and this also applies when they travel with it. To increase the protection against theft, and thereby increase safety, it was therefore decided to have locks on the case. One idea was to put traditional zipper locks on the case. These has holes in the handles of the zippers and can be fixed together with a padlock. The other idea was to have locks that are seen on suitcases today were the zipper handles are fit into holes and opened with a code. Depending on how the zippers close, two or more locks will be needed. The locks will be TSA approved to make it possible for the airport personnel to open the case when going through customs without destroying it.

3.3.4 Materials and Manufacturing

The case needs to consist of a couple of different materials to achieve the wanted structure of the case. The protective material needs to be a harder material to give protection to the bike inside the case while still being light enough. A similar material to the material Thule uses on their SafeZone pocket areas on backpacks today would be optimal. The long sides need to be in fabric to make it possible to fold the case for storage, but still rough to make it protective, similar to the fabric on the Evoc bike bag. The inside of the case needs to be made of a material that can be cleaned easily from dirt and grease, similar to the material on the inside of the Thule Roundtrip Traveler. The bottom should to be made of a harder plastic material to give a strong foundation to the case and to make it possible to attach the other parts to it. Thule’s existing material selection and manufacturing methods would be preferred to use since they are well tested and works well for similar products.

3.3.5 Handles

The user test with the cardboard model and handles showed that 8 out of 10 preferred to have a handle on the top of the case when rolling the case on four wheels (see figure 3.21). One wanted to have the handle on the far end of the top and one did not want any handle. It was decided to place a centred handle on top of the case.

The result for pulling the case on two wheels, was more divided. All wanted to have the handle on the short side of the bag, but on different heights. In general, the shorter test participants wanted to have the handle lower than the longer test participants. Two of them wanted to have a longer handle in the shape of a loop. They said that it gave them a more natural grip. The conclusion from this test was that a handle on the edge was needed.

The last test was to carry the case, and it had the most spread out results. Many participants said that it was hard to say where they wanted the handles because they thought the case was larger than other bags they had used before. The conclusion from this was that the users want to have handles, but they do not know where. It was therefore decided to place one handle on the side of the case to use for lifting and carrying the case.

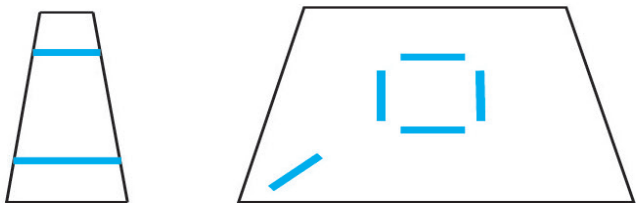


Figure 3.21. The result from the user test.

The participants though, said that all the handles did not need to have the same appearance, but there should be handles on each side to make it possible for both left and right handed persons to carry the case. After testing, it was seen that it was possible to lift the case from two different sides and the most important was that it should not matter which short side was placed the furthest in, in the car. This was solved by having handles on both short sides.

How the handles should look and feel where not included in the test with users. Ideas on how these should be were sketch and inspiration was gathered from Thule’s products. The handles could be made of softer plastic with grip areas in rubber to give the user a nice grip. However, since the space in the trunk is limited, the handles should be as tight against the case as possible (see figure 3.22).

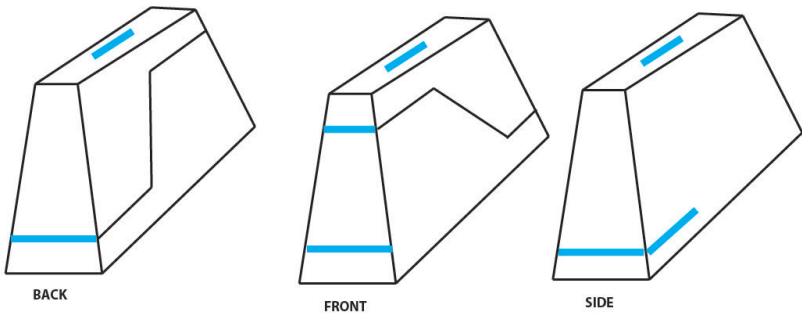


Figure 3.22. Suggestions for the placement of the handles.

3.3.6 Storage

In the design goals it states that the case needs to decrease in size when not in use to simplify storage. This is possible since the long sides of the case are made in fabric and can be folded. One ideas on how to do this were developed. One the short sides with the

protective material could be folded down in the hard bottom and the sides could then be wrapped around the case. Two straps with buckles would be used to hold the case in the smallest shape or a bag which the whole case could be fitted into would be included. When the case is folded, either in a bag or around itself, a handle or strap should be placed on the top to make it possible to carry the case easily.

3.3.7 Flexible Case

From the survey study, it was seen that the users wanted to have a bike travel case that was adjustable to their specific bike to give it optimal protection and to take up as little space as possible. Since bikes vary most in length and height, ideas on how to do this were generated (see figure 3.23). The difference in height varied 17 cm from the largest to the smallest bike, but the wheels on the largest to the smallest bike is more similar. The smallest bike frame height is 49 cm, but the most common wheel size is 28" which is about 70 cm. The largest frame has a height of 64 cm and therefore it was decided not to move on with this idea.

The idea of expanding the case in length could be made possible with zippers that when unzipped revealed extra material that made the case longer. The length of two 28" wheels next to each other is when overlapping in the centre of the wheel's minimum 105 cm. The largest frame is 119 cm long which makes the difference 14 cm. Through expansion material the case could be tighter around the smaller cases, but the difference would also give the case another expression and might make the case harder to understand. With the cardboard model, it was possible to fit in the largest bike and still fit in two cases in the car trunk as well. Therefore, it was decided not to have any expansion on the case.

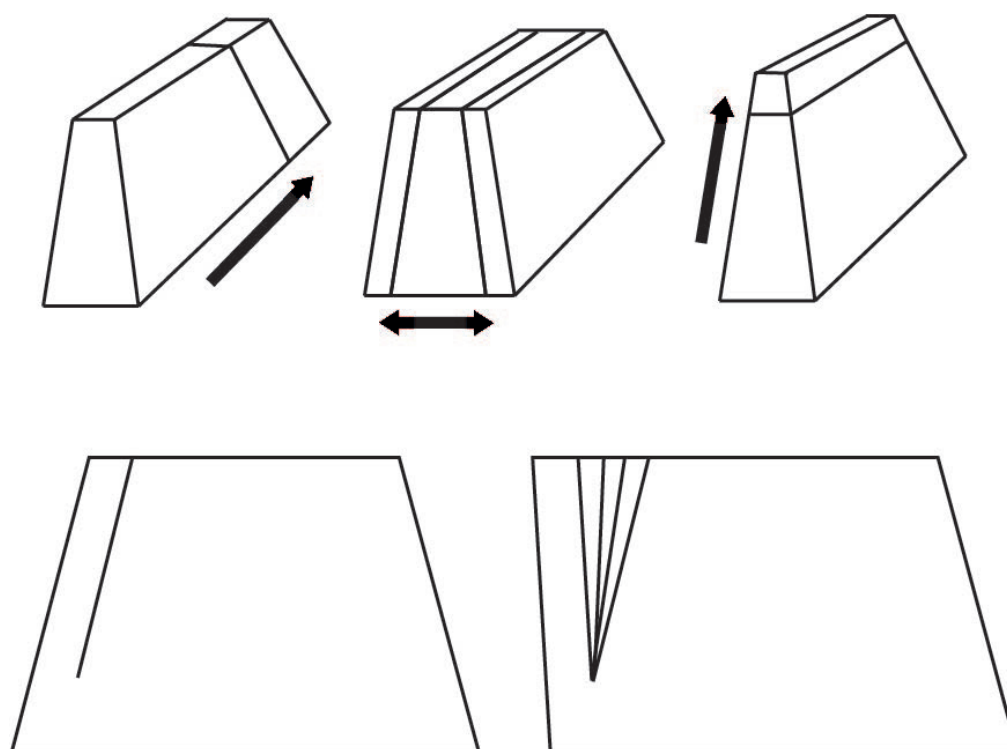


Figure 3.23. Possible ways to expand the case.

3.3.8 Wheels

During the user test with the two Thule cases and the Evoc case and in the survey study it was seen that the users wanted more than two wheels on their case. The reasons for it were that it demanded less effort from them since the case weighs around 20 kg when loaded with the bike. Having more than two wheels on the case would also make it easier to move around with the case when having something in the other hand as well. It was therefore decided to have more than two wheels. If three wheels could be sufficient was discussed, but too many negative aspects were found compared to having four wheels. For example, it would be less stable than four wheels, the quality of the "lonely" wheel would need to be higher compared to having two on each side, since it will get the twice the weight on it. Placing four wheels on the case was therefore decided.

Having four fixed wheels, that are fixed to only going forwards or backwards, having four 360° wheels, that can go in either direction, or having a mix of the two where explored. Having four fixed wheels would require the user to lift the case if wanting to change direction fast, this option was therefore eliminated. Having four 360° wheels would allow the user to move around with complete freedom. However, if the wheels are not aligned when starting to move the case, they might get stuck before they can turn which puts a lot of force on the wheel and is not pleasant for the user. On the user test where the handles were tested one aspect regarding travelling by bus or train with a case with four 360° wheels came up. Two participants had experience from suitcases moving around when the bus turned. This idea was therefore eliminated. The last option, with mixing fixed and 360° wheels and having two fixed in the back, similar to Thule's cases today, and two 360° in the front was explored. The fixed wheels in the back made it possible to carry the bag on two wheels if the ground would demand it. When walking on flat surfaces, e.g. in train stations or airports, all the four wheels would be used and it would be easy to move it. The two front wheels that are flexible makes it possible to change direction whenever wanted.

3.3.9 Inside of Case

How the inside of the case should look was ideated during many sessions. The functions to solve were where and how to secure the bike frame and the bike wheels, how to fasten the handlebar and where the removed parts from the bike should be placed.

To secure the bike frame, the bike stand from the other Thule cases could be used, or a fastening solution which allowed the user to twist the fork and handlebar could be fastened directly to the hard bottom. For larger bikes, it would not be possible to twist the fork and handlebar, since the bike would be too long. This option was therefore eliminated. The mounting set was appreciated by the users at the user test and from the participants in the survey study. The legs to the mounting set will be placed on the hard bottom where they are easy to access.

The bike wheels could either be placed on either side of the frame, or be placed partly on top of each other on one side of the case. If placing them on either side of the frame, it would need to be clear which wheel to place on which side since the rear wheel takes up more space than the front. It might also limit the options of placing pockets for other loose parts integrated in the case. Placing the wheels so that they partly cover each other would make it possible to place pockets on the other side of the frame. It was decided not to use the wheel bags that Thule uses today, but rather place the wheels on the interior of the case. Different ideas on how to do this were generated (see figure 3.24). One idea was to use elastic straps or a big net pocket which the wheels would be placed under to keep them in place. Another idea was to slide the wheels into two half pockets which would partly cover the wheel against the frame. To make sure that the wheels would not damage the frame it was decided that more protection was needed. The half pockets were therefore developed further into complete pockets where the whole wheels could be placed and closed with zippers. On the inside, protective material would be placed on centre of the wheel to protect the hub more, both against impacts from the outside of the case and protect the frame against the hub.

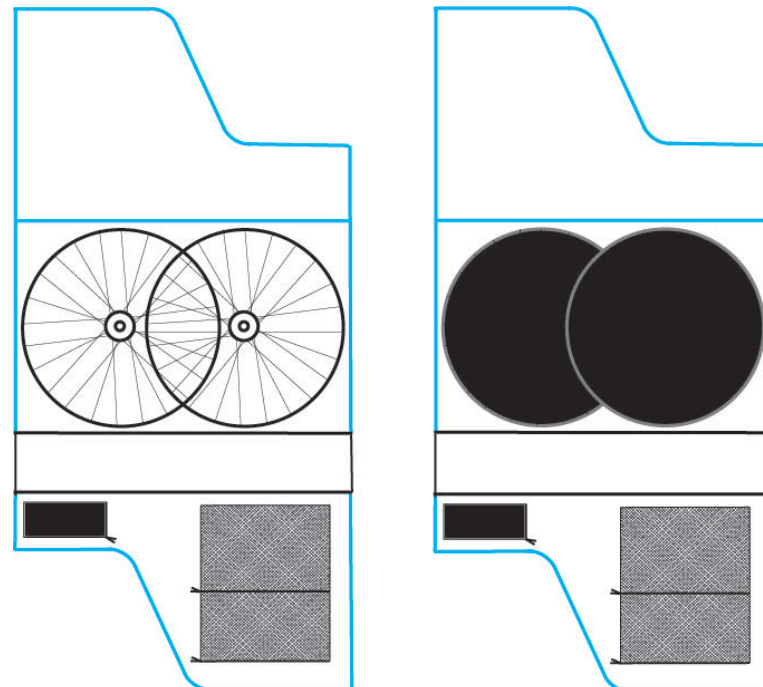


Figure 3.24. Possible bike wheel options.

The handlebar needs to be removed, but due to the brake and gear wires, the handlebar needs to be fastened close to its normal position, usually on the top tube. To be able to do this a fastening part will be included in the case. This part will be made of fabric and velcro and will be strapped around the top and bottom tube. Once this is strapped, the handlebar can be fastened with straps which will keep it in place (see figure 3.25).

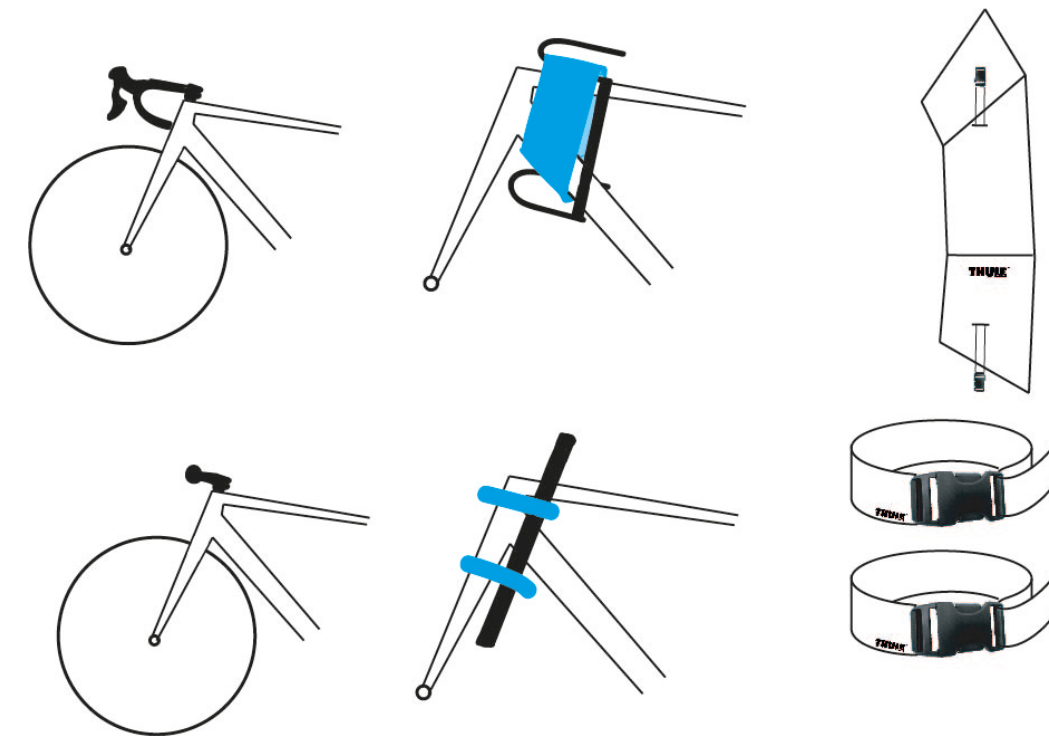


Figure 3.25. Possible pocket placement.

The saddle will be removed from the bike or pushed into the saddle tube, depending on the size of the bike and the users' preference. If the saddle is removed, it needs to have a designated place and it needs to be fastened somewhere to avoid it from laying loose in the case. It was ideated how it could be fastened to the interior of the case. One idea was to secure it with straps and one idea was to place it in a net pocket. The net pocket was evaluated to be a simpler way of fastening the saddle and it could also be used to secure other loose parts, e.g. bike shoes, helmet and pedals. Cyclists also have tools and extra equipment that could be placed in the pocket (see figure 3.26).

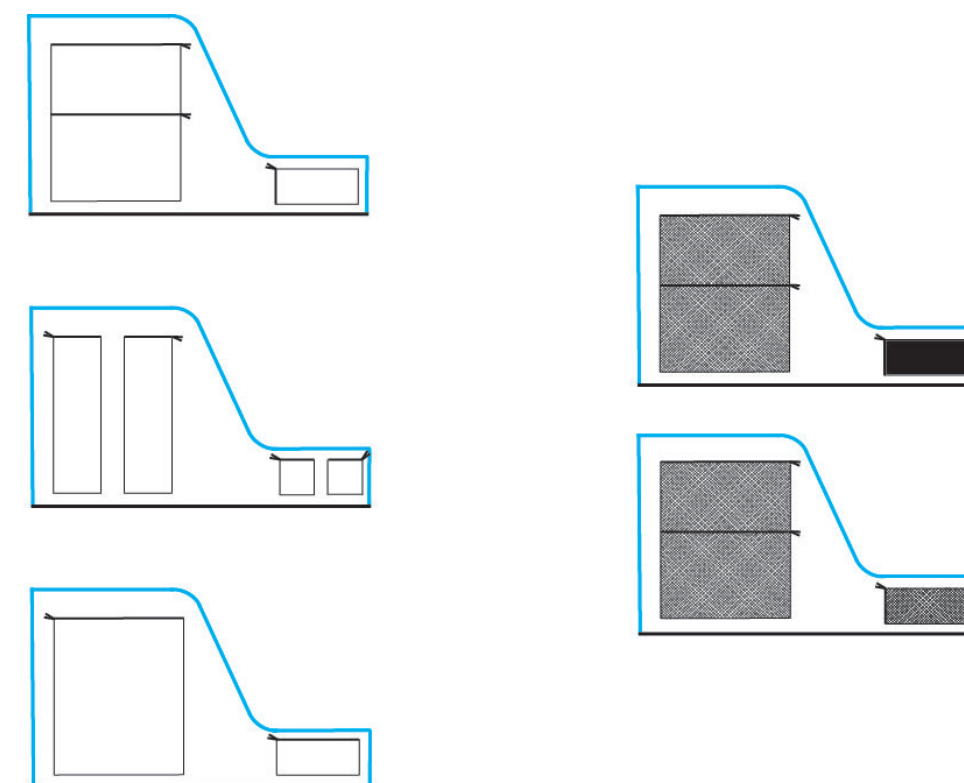


Figure 3.26. Possible pocket placement.

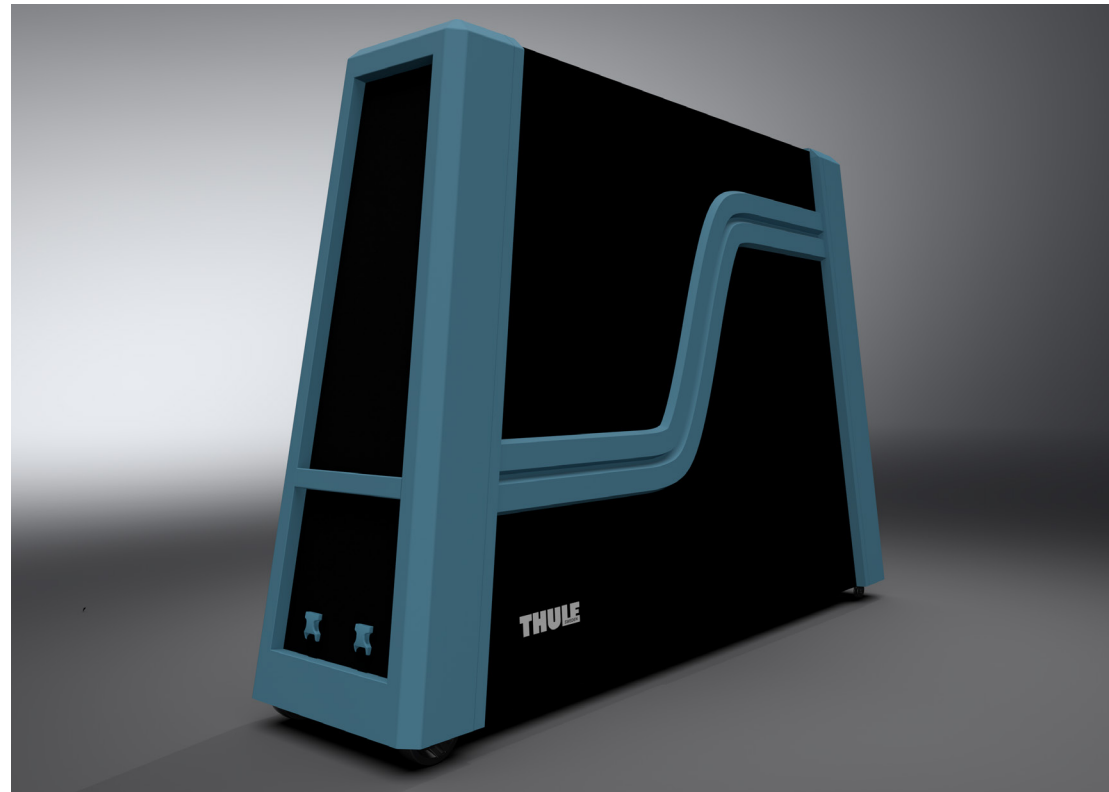
4 Thule ProTour

In this chapter, the final concept, Thule ProTour, is presented and the result is evaluated with regards to the target group and the design goals.

4.1 Thule ProTour

Thule ProTour is a bike travel case (see figure 4.1) that is especially developed to attract cyclists that travel with their mountain or road bike. The bike needs to be partly disassembled to fit into the case. The bike travel case offers protection to the bike and is at the same time light enough to make it comfortable to move around with.

Figure 4.1. Thule ProTour.

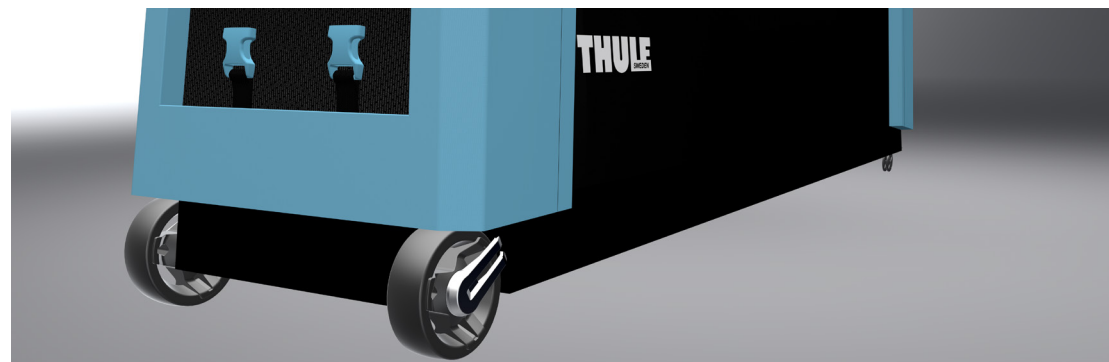


4.2 Product Specification

Thule ProTour has the shape of a rectangle with rounded chamfers on the short sides. Both the short sides and the long sides are tilted inwards, making the top smaller than the bottom.

Thule ProTour (see figure 4.2) consists of a hard bottom plate in plastic, long sides in structured fabric and short sides reinforced with protective material. The hard bottom has two fixed wheels on the back and two flexible wheels that can turn 360 degrees are attached to the front. Where the front wheels are fastened to the bottom, it is shaped so the wheels can rotate underneath the bottom to minimize the distance they extend over the edge of the case. The function of the bottom plate is to give the case stabilisation and to make function as fastening for the mounting set and the bike frame.

Figure 4.2. Details on Thule ProTour.



The long sides are black and made of fabric and these are sewn to the bottom. Each long side ends with a blue zipper that when zipped together closes the case. The reinforced short sides consist of a protective material that creates a frame around the edge. The protective material is blue and the hole that is created through the frame is covered of the same black fabric as the sides. The protective short sides also function as grip areas. The short sides have zippers underneath the protective material that zips together with the long sides to close the case completely (see figure 4.3).

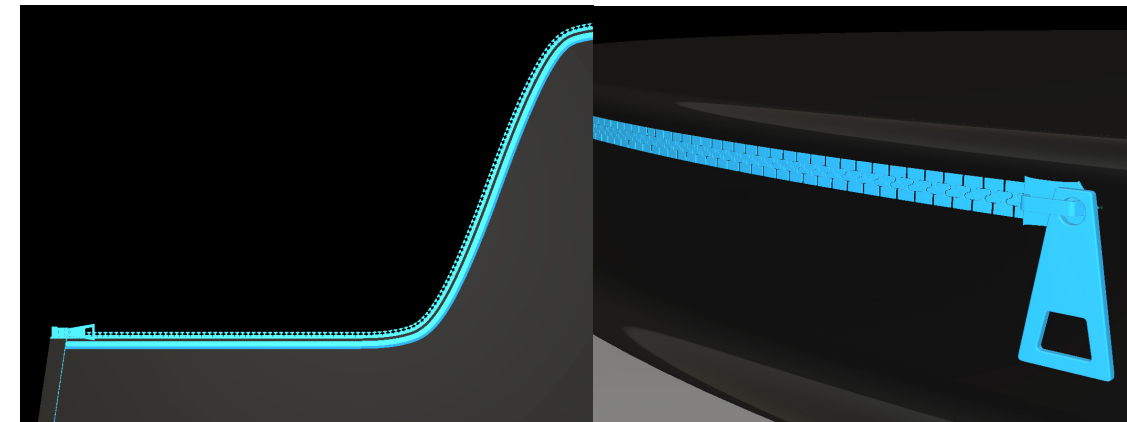


Figure 4.3. Zippers on Thule ProTour.

The inside of the case (see figure 4.4), is dressed in a hard-wearing material that is water resistant which allows it to be cleaned. On the on of the long sides, a large net pocket is placed and it is large enough to fit the pedals, the saddle, the helmet, the bike shoes and other tools or smaller equipment that the cyclist wants to bring. On the opposite side, integrated wheel bags are placed to protect the wheels and to protect the frame from being scratched by the wheels.

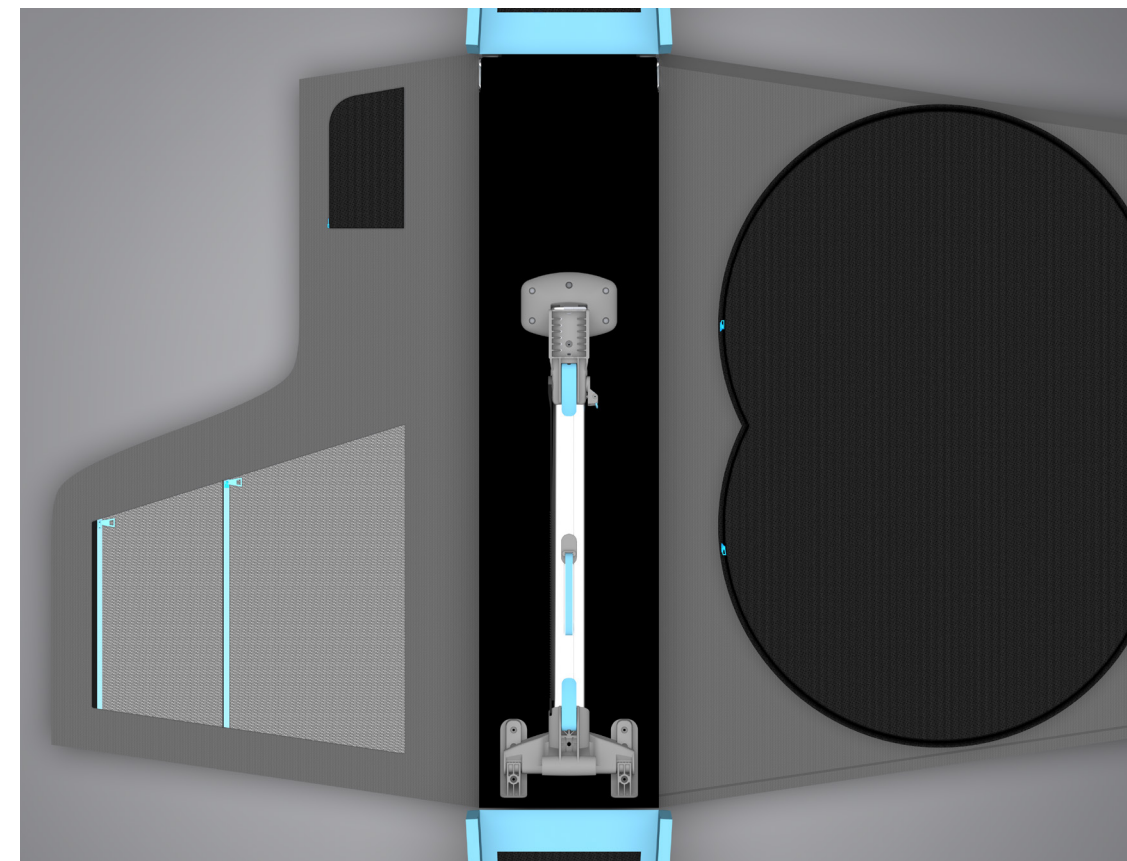


Figure 4.4. The inside of Thule ProTour.

On the exterior of case four proper handles are found. Centred on the top of the case there is one handle, on each of the short side one handle is found which is placed so that they continue the shape of the protective material on the long side. On the opposite side from the zipper one handle is placed as extension of the lower handle on the short side. A nametag holder has been integrated on the short side of the case where the user can slide in their nametag. It is protected by a plastic filter (see figure 4.5). The case can be locked with a padlock through the zipper handles (see figure 4.6).

Figure 4.5. (left) The name-tag holder on Thule ProTour.

Figure 4.6. (right) The lock on Thule ProTour.

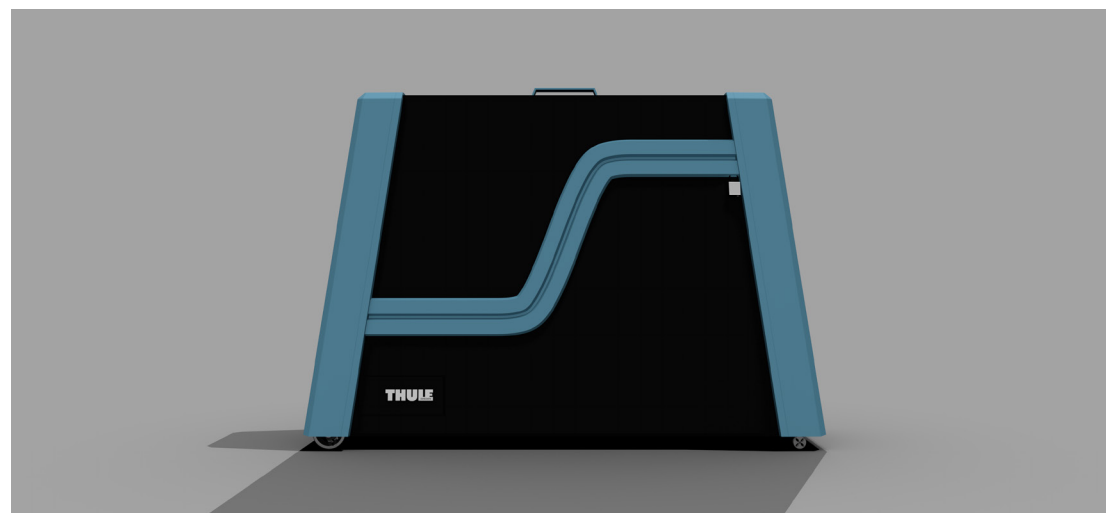


4.3 Product and Company Resemblance

From the DFA (see chapter 3.1.3) it was seen that the most important design cues were: colour contrast to emphasize interaction areas, large parts in black, visible logotype, curvature in the shape, simple design, aluminium and blue accent colour. The blue accent colour is seen on the zipper that closes the case and on the protective material zones. The main part of the case is black and with the areas to interact with being blue, there is a clear colour contrast that indicates the areas that the user should interact with. The case is made of a simple rectangle with chamfers and the case does not have decorative parts or prints. This makes the case having a simple design which is also in line with the other Thule products and the chamfers are rounded which can be seen on other Thule products as well. The visible, but discrete placement of logo makes it clear to the users that it is a Thule product.

The shape of the zipper can be seen on the Thule RoundTrip collection, which makes the case be perceived as a part of the current product portfolio (see figure 4.7).

Figure 4.7. Thule ProTour side view.



4.4 Usage

The usage of Thule ProTour, follows the mental model for the cyclists. First, the bike stand should be assembled through the three leg being placed in the adaptor and then knob is turned to secure them. Then the front wheel of the bike is removed and the bike placed on the bike stand (see figure 4.8). The fork is connected to the bike stand with either a through axle or a quick release axle, depending on which type the bike has. The rear wheel is then removed and both the wheels are placed in the integrated wheel bags in the case. The pedals and the saddle are then removed and placed in the net pocket on the side of the case. The handlebar fastening part should be placed on the top and down tube before the handlebar is removed. The handlebar should then be fastened to this part.

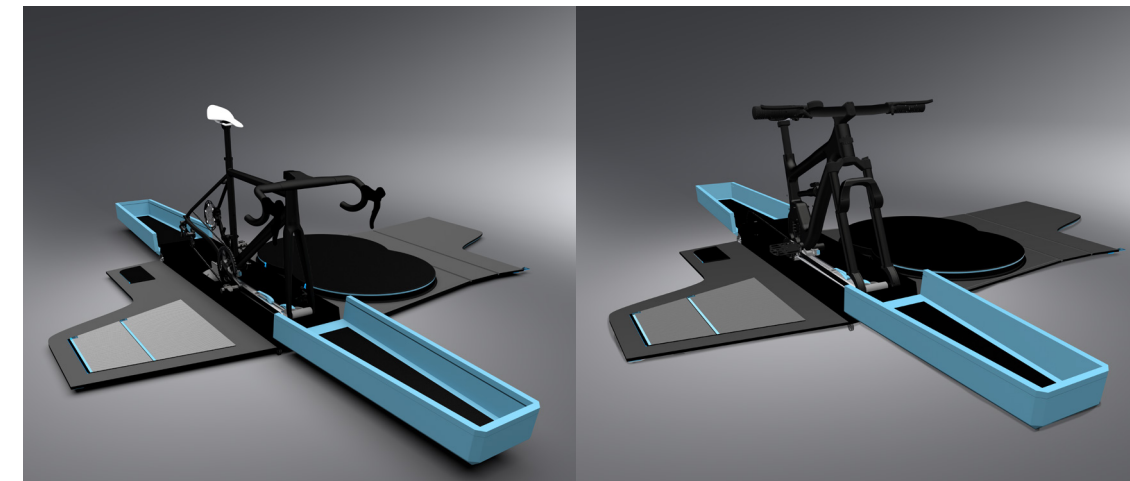


Figure 4.8. A road bike and a mountain bike in a Thule ProTour.

Now the bike rack of the bike stand should be separated from the bike stand and placed in the fastening part on the bottom of the case. A click sound will verify that the bike is secured properly. Once the bike is safely secured in the case, other equipment and tools can be placed in the pockets. When all things have been placed in the case it is time to close it. The side with the wheel is lifted over the bike and the other side is lifted up to meet it (see figure 4.9). The two sides are then zipped together, starting at the lowest edge. Then the protective short sides are zipped to the side with two zip-handles. The zip-handles meet where the zipper on the long side is. These are then locked in with padlocks on both sides of the case. After this the bike travel case is completely closed and the bike is safe inside.



Figure 4.9. One side folded on Thule ProTour.

When walking on smoother surfaces, e.g. train stations or airports, the case is moved on four wheels with one hand on the top handle. If any doorstep needs to be passed or if the surface is uneven, the case can be lifted up on two wheels by using one of the handles on the short side (see figure 4.10). When lifting the case into a car trunk or up on a check-in desk, the handles on the short side or the handle on the side can be used.

Figure 4.10. Man walking with Thule ProTour.



4.5 Materials and Manufacturing

Below follow suggestions for the material selection and the manufacturing methods used for producing Thule ProTour. The exterior of the case will be made in three different materials (see figure 4.11). The bottom of the case will be vacuum formed in ABS. The long sides will be made of a sturdy fabric, similar to the fabric that can be seen on Thule RoundTrip Boot Backpack. The protection material will be extruded in WPE 40HD from Wellplast AB. The inside of the case will be made in a water-resistant plastic, 600D-polyester, similar to the material in Thule RoundTrip Boot Backpack where the boots are placed. The possibility to clean the inside of the case will make it possible for the users to always travel with a clean case. The wheels will have rubber on the outside to provide good friction for the case and to minimize the sound. Thule's existing material selection and manufacturing methods have been used for the case since they are proven to work. The only new material is the corrugated plastic that have been chosen since it was well suited for the protective areas.

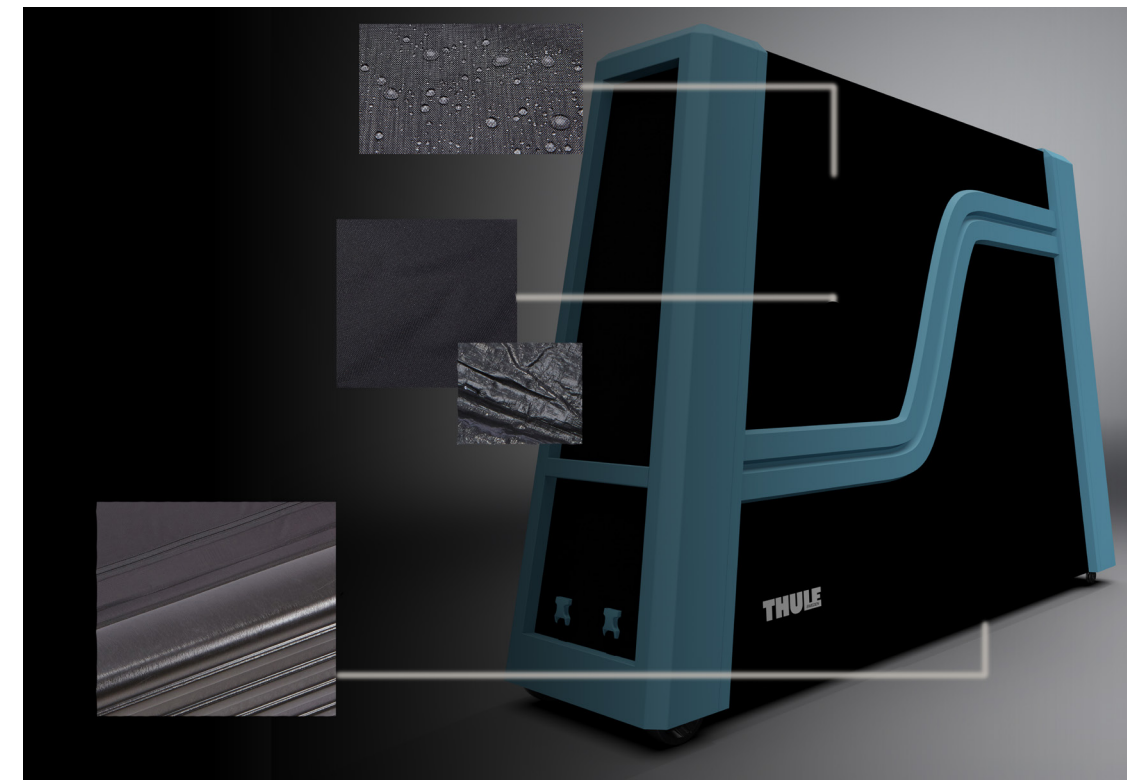


Figure 4.11. Material selection for Thule ProTour.

4.6 Sustainability

Thule ProTour (see figure 4.12) was analysed from a sustainable point of view with help of the Eco strategy wheel. It resulted in that the factors to consider in this project were: the lifespan, the material used in the product and improvements in the production. Thule works actively with sustainability and the environment by decreasing the effect during production through doing conscious choices of the material. Their products are also designed to have a long lifespan and have a low impact on the environment during the usage. Since this will be a Thule product, the same methodology will be applied in the manufacturing of Thule ProTour.

Thule ProTour is designed to last for a long time which is one aspect that makes it a good product from a sustainable point of view. Thule has a warranty on their products that they should be made of high quality, and this contributes to the case having a long life. The simple design and discrete appearance makes the case independent of changes in fashion.

As mentioned in the literature study, transporting goods inside the car instead of outside the car has a lower impact on the fuel consumption. By making it possible to transport the bike inside the car, it will not have an impact on the fuel consumption. Through making it possible to transport two cases at the same time in the car, it would only demand one car to transport two persons and their cases which is better for the environment.

All products have an impact on the environment that last throughout the whole product life. The product is made of different materials that needs to be separated to recycle the case which demands that the user uses a tool to disassemble it.

Figure 4.12. Thule ProTour on a train station.



4.7 Design FMEA

The Design FMEA showed that the most crucial relation to be careful with is the one between the long sides of the case and the protective material on the short side. If the case is wrongly packed or over packed, there is a risk that the long side goes over the short side and the things inside will not be protected by the protective material. If the protective material is not strong enough, the bike might get damaged. It is therefore important that this material is properly tested. Furthermore, the area with the protective material and the long side have a small risk of looking baggy and sloppy if not packed in the right way. This shows that there needs to be clear indications of how to pack the case correctly (see appendix F).

4.8 Verification of Thule ProTour

In this chapter, Thule ProTour is evaluated against the design goals, the expression board and the persona and user scenario to verify that it solves what it should.

Design Goals

● Fit into cars

This has been achieved through a smart form that fits in to the car and make it possible to place one case on top of another in a smart way.

● Safety regarding the bike.

The bike will be safe with regards to theft through the possibility to have the bike in the car and through the locks. The bike is safe inside the case and will not get damaged or dirty.

● Safety regarding the car.

By having the bike in a case, the car is protected from scratches on the interior and dirt from the bike.

● Easy storage

Through having soft sides on the case and the possibility to fold the case, it will be easy to store.

● Simplicity

When the case is opened, it is easy to see where all the parts should be placed, and the use of zippers to close the case is easy for the users to understand.

● Create an extra value for the user

By creating a light, but protective case that can be used when travelling with other means than only car, Thule ProTour gives the user an extra value. The smart solution to bring all the necessary gear in an easy way also contributes to this value.

● Easy and comfortable to move around with the product

Through having four wheels it will be easy and effortless to move the case on smooth surfaces. The handles will provide a good and ergonomic grip when the user needs to lift the case on two wheels.

● Weight

The case includes the same features as Thule Pro XT, but does not include as much hard plastic material which will make it weigh less.

● Express high quality look and feel

The case is made of quality materials and is perceived as high quality with the compact design.

● Follow Thule's mottos.

The lightness of the case and the ease of use makes it easy to bring the bike wherever the user wish to go and thereby lives up to the mottos "Bring Your Life" and "Active Life, Simplified".

● Fit in to Thule's product portfolio

The case has most of the significant design cues which makes it fit into their product portfolio.

● Few parts to remove

The user needs to remove saddle, handlebar, wheels and pedals which is the same as for most cases due to the limited space in the car trunk.

Idiom

The idiom on Thule ProTour express safety through the robust material on the short sides and its structured surfaces together with the cohesive form. The zipper on the long side creates a distinct and upward going line and does encourage movement which makes the user want to walk with the bike case.

Thule ProTour is easy, quick and portable which offers freedom to bring your bike wherever you wish to go. It is easy and quick to understand through clear symbols and few and thoughtful functions. It is portable in a simple way which encourage to an active life. See Thule ProTour in figure 4.13.

Figure 4.13. Thule ProTour in the expression board.



Persona and User Scenario

Thule ProTour makes it easier for Carl to travel abroad with his bike since it solves all of his problems. If both he and his friend has a Thule ProTour, they can drive in one car to the airport, and by renting a SUV or station wagon at the destination, they can be sure that both cases fit into the rental car. They do not need to worry that the bike could be damaged during the flight, since the bike is well protected inside the case. When they arrive at the destination, and at home, they can easily unpack and assemble the bike with help of the bike stand. The case can then be folded and the strapped and placed underneath the bed or in a wardrobe. The pockets inside the case makes it easy to bring everything they want to, and the equipment will not move inside the case.

Through these reasons, Thule ProTour fulfils the target groups' design goals and is attractive to Carl (see figure 4.14).

Figure 4.14. Carl with two Thule ProTour outside his house.



5 Discussion

In this chapter, methods and decisions that have been made throughout the project are discussed.

In this chapter, methods and decisions that have been made throughout the project are discussed.

Pre-study

When looking at the result from an holistic view, there are some aspects and decisions that are interesting to discuss. The questionnaire which was conducted in the early stage of the pre-study resulted in over 400 answers. It is considered as one of the most informative source in this project received from the target group. One aspect which is interesting to discuss is how one can rely on a survey which has been conducted online. It is important to critically review the answers to make sure that the participants have taken the survey seriously and not rushed through it. The survey was linked on serious websites to ensure that the participants were serious. When conducting a survey, it is hard to know if the participants represent the whole target group or if some part of the target group is missed. In the survey the contestants had to tell their age and gender and the majority of the contestants were men between 40 and 65 years old which have been observed to be the large group in the target group. This division of contestants together with the choice of websites the survey was linked from, it is assumed that the people who answered the survey represent the reality.

As a result from the pre-study design goals were determined. These were used when evaluating ideas and concepts. Their importance could be discussed and how relevant each of them was when developing a bike travel case. Firstly, safety, is one aspect which has been brought up many times during the project. Hence, this aspect is very important to consider and have been solved in a good way. Also that two bikes should fit into one car trunk, easy storage, simplicity and easy and comfortable to move around with are design goals which are seen as important as safety. However, there are design goals which have not been prioritised to the same extent. The design goal, few parts to remove, has been challenging to work with due to when not removing parts the case would automatically become bigger which stood in direct conflict with the goal to fit two of the solutions in a car. Much thought and work has been put into this design goal, however, to solve more prioritized goals it has not been completely achieved.

An aspect which was collected from the pre-study was the wish to make the solution as flexible as possible. This due to the different sizes in bike frame and also to make it easier to fit two bikes in the car trunk. It was experimented with though excluded in the final concept and the reason why could be discussed. The ideas were to have a flexible length on the case which offered the user to change the case lengths to what was needed to fit the bike frame. However, after trying to fit two bags in a Volvo V40, which is quite small, it was discovered that two cases in the biggest size fit. The discussion of only having the case in one size arose. If a small bike was loaded extra space would be available in the case, then the user could pack more bike equipment in the case. The consequences of removing the flexibility solutions on the final concept became positive in the view of the user. The confusion of how the function worked was removed.

Though, the idea of having a flexible case was something that is not available on the market today and could be interesting for Thule to investigate further in the future.

The design goals are based on the results from the pre-study and have affected the result. If other studies would have been made, the design goals could have been different and the result of the project would have been different. It is therefore of interest to discuss whether the studies performed were sufficient or not. The user test with the cases were done with only 10 participants which might be too few to draw conclusions. However, the results from the tests were similar and it is therefore likely to assume that more participants would not have changed the results significantly.

The choice of having design goals instead of a demand list, could have affected the outcome of the project. E.g if named demand list instead, the context could have been more easy to read and understand by the readers due to the more common name. However, the design goals have functioned as demands with the difference that most of them have not had measured to evaluate the goals objectively. It was discovered in this project to be an inspiring way to work with the needs that the target group had and not force to change them into something which only could have been evaluated by measures.

The design format analysis was made with a selection of Thule's product portfolio. The choice of products have an impact on the result, and thereby the design of Thule ProTour. The main characteristics which were entered in the DFA, could be discussed if being too general. If too general, the result could have become too wide and thereby not useful. The end result though, showed that it was useful due to using the main characteristics in the design.

Concept Development

In the concept development phase, many ideation sessions with focus on different methods and different areas were conducted. The ideation was first broad and open to narrow down more with time. However, it might have been better to keep the open perspective during more sessions before narrowing the focus to explore more ideas earlier in the process instead of going back and forth in the process. This could have made the ideation phase shorter, but in the end good ideas were generated within the timeframe.

The ideas were sketched, but physical 3D models were not created in the early stages. By making models of the ideas, it could have been easier to see potential and problems earlier and some ideas could have been eliminated earlier. However, making models is more time demanding and that was the reason to why more models were not made.

Final Concept

By making it possible to transport to cases inside the car, it is possible to go two people together in one car to e.g the airport instead of in two cars. The possibility to transport the cases inside the car has a lower impact on the fuel consumption which is better for

the environment. The case is mostly designed to simplify flying with the bike, but by loading the bike in a bike travel case it is possible to bring the bike with most trains in Sweden. This would make it possible to travel environmental friendly in Sweden or to other places in Europe when going on bike vacation as well. Hopefully, cyclists who enjoy to train hard in the environment also thinks about how to keep the nature as clean and healthy as possible and can contribute to a more environmentally friendly lifestyle.

Further Development

The final result of this project has been a concept for a transportation solution and not a finished product. The size of the case has been tested with the cardboard model, but in order to fulfill Thules safety requirements, more testing must be done with a real prototype in the right materials. It would be interesting to further develop the case and create a product series around Thule ProTour. This could be done through making a series which is designed to fit the less common bikes, e.g. bmx or fat bikes. Furthermore, the safety aspect could be extended even more and by creating different levels of strengths in the protection material, a series could be achieved and the highest level would include the strongest protection material. The highest level would then attract the cyclists which are extra careful about their bike and that appreciate buying the best bike accessories. The results from the DFMEA should also be taking into consideration for the further development of Thule ProTour to make sure that the final product has the wanted expression.

6 Conclusion

In this chapter, the result of the project is summerized and connected to the aim of the project.

Not all cyclists travel with their bikes with aircrafts or trains, but with the increasing interest for cycling as a training form, it can be assumed that the interest for travelling with bikes will increase as well. By developing a case that is especially designed for cyclists, it will be easier for cyclists to travel with their bike and Thule ProTour would attract these customers.

The research questions' were "How should the ultimate bike transportation solution be developed and designed to fit two bikes inside a personal vehicle" and "Which customers would they attract with this transportation solution and what does the customers want to achieve with the solution?". The first research question has been answered through the design of Thule ProTour as it is designed to be the ultimate bike transportation solution and it is possible to fit two Thule ProTours in a car at the same time. The second question is answered in the project as the found target group, the dedicated cyclists that travel with their bike. The majority of them are men between 40 and 65 years old and what they want to achieve with their transportation solution is seen in the design goals.

The design goals are the result of a thorough research which shows what cyclists want to achieve with a bike travel case. With the underlying research as a guideline for the design and development of Thule ProTour, the case is the optimal case for the target group and they can transport two Thule ProTour in the car at the same time.

Thule ProTour complements Thule's current product portfolio and with Thule ProTour it is also possible to do facelifts on the existing cases in the RoundTrip series to match Thule ProTour. Thule ProTour makes it possible for the users to bring their bike wherever they wish to go and makes it easier for them to have an active life with the features of Thule ProTour.

Throughout the project, safety has been in focus which is clearly displayed in Thule ProTour. This goes in line with what the company Thule stands for and also what the target group strongly believe is important. This, together with the simple usage, makes it a better solution for the target group than the current bike travel cases on the market today and thereby this project can be seen as a successful project and that the aim of the project has been fulfilled.

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Questionnaire when visiting stores

Vilka olika typer av cyklar säljer ni?
Vilken typ av cykel/vilka typer av cyklar är mest populär?
Är det någon cykeltyp som ni inte säljer?
Vilka är det som köper cyklar här? (Tävlingscyklister, elitmotionärer, motionärer, nybörjare)

Vilka typer av teknisklösning finns för att plocka av hjulen (quick release/through bar)?
Vilken är vanligast? Vilken tror du kommer finns mest i framtiden?
Vilken/vilka delar på en cykel är lättast att ta isär? Styret, hjulen eller någon annan del?
Vilken/vilka är svårast?
Bromsskiva vs “vanlig” broms? Vad är skillnaderna?

Säljer ni cykeltransport lösningar? Vad för lösningar är det? Vilken lösning är mest populär?
Vad måste man tänka på när man köper en cykeltransport lösning? Finns det några problem med dem?
Rekommenderar ni olika typer av cykeltransport lösningar till kunder med olika typer av bilar?

Säljer ni cykeltransportväskor? Vilken typ av cykeltransportväska är mest populär?
Vad måste man tänka på när man köper en cykeltransportväska? Finns det något problem med dem?
Rekommenderar ni olika typer av cykelväskor till kunder med olika typer av bilar?

Cyklar du själv? Vad har du för cykel? Reser du med din cykel? Vad har du för cykeltransportväska? Vad använder du för cykelhållare?
Vad tycker du är viktigast när du köper en cykel?
(Pris, modelltyp, färg, vikt, märke, funktioner, årsmodell)

Cykel, Transport och Resa - Hur Gör Du?

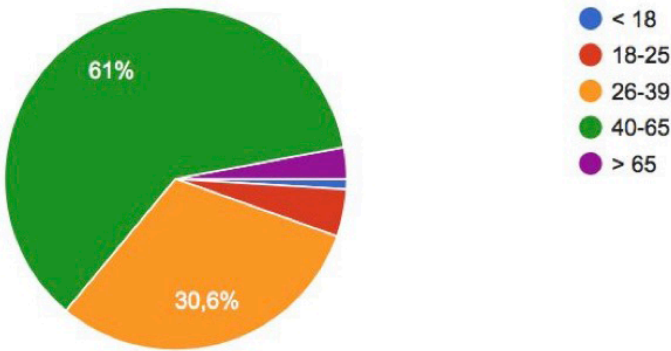
Det här är en enkätundersökning för att samla information angående cyklister och olika cykel transportmedel.

Vi studerar Teknisk Design på Chalmers och den här enkäten är en del av vårt examensarbete och är grunden till en studie angående hur cyklister vill transportera sin cykel på det ultimata sättet.

Tack för att du medverkar!

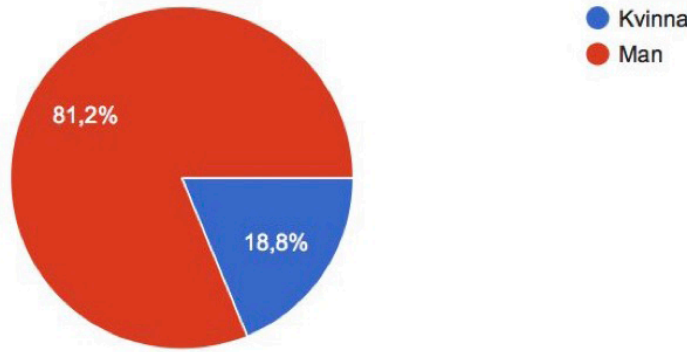
Ålder

405 svar



Kön

405 svar

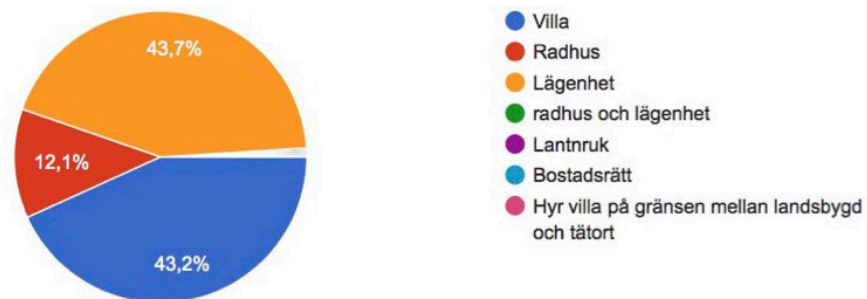


Sysselsättning

Jobbar 164
Studerar 20
Pensionär 7
Övrigt 214

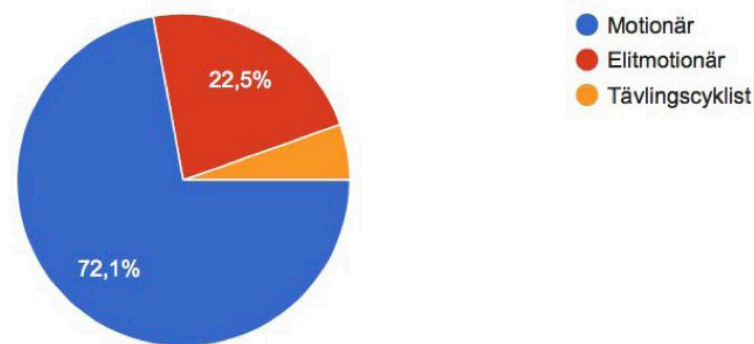
Hur bor du?

405 svar



Vad identifierar du dig med?

405 svar



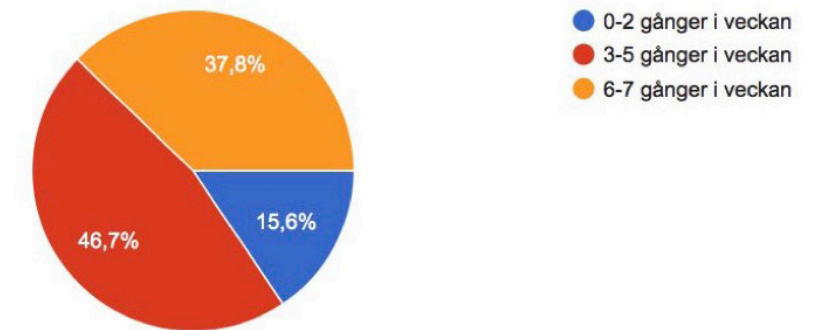
Vad har du för cykel?

Landsvägscykel 329
Mountainbike 247
Fatbike 10
Bancykel 10
Dam/Herr Cykel 154

Cyclocross 158
Hybrid 112

Hur ofta cyklar du?

405 svar



Hur många cyklar har du?

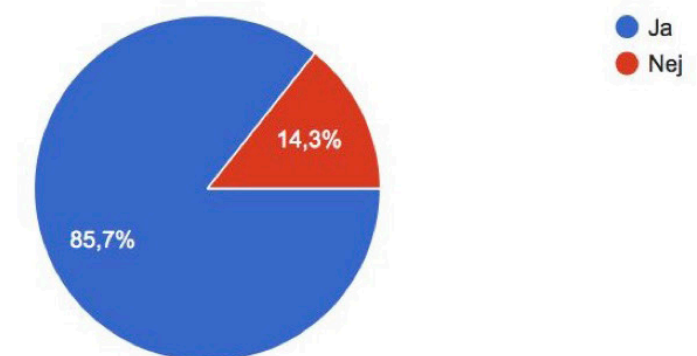
Från 1 till 13

Hur många cyklar finns i ditt hushåll?

Mellan 1 och 27

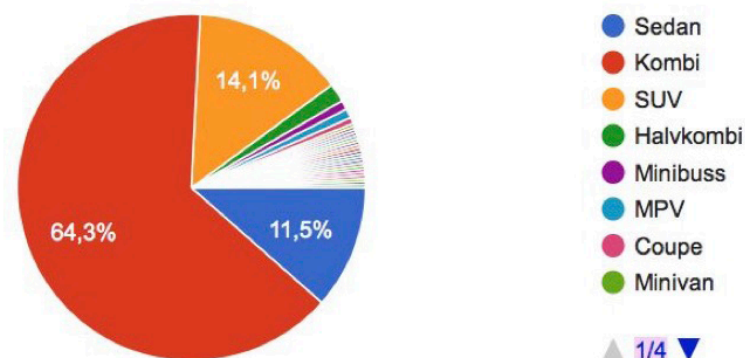
Har du tillgång till en bil?

405 svar



Vad är det för typ av bil?

347 svar



Vad är det för märke?

Volvo, Skoda, Saab, VW, Mercedes, BMW, Toyota, MAzda, Peugeot, Kia, Honda, Citroën, Ford, Seat, Subaru, Audi, Hyundai, GMC och Jeep.

Vilken typ av cykelhållare använder du?

Takmonterad cykelhållare med arm som håller fast i ramen 114
 Takmonterad cykelhållare där framhjulet tas av 63
 Bakluckemonterad cykelhållare 17
 Dragkroksmonterad cykelhållare där cykeln hängs på 30
 Dragkroksmonterad cykelhållare med plattform 164

Vad är det för märke på din cykelhållare?

Thule 213
 Jula 5
 Velomann 1
 Biltema 25
 Elite
 Jula
 Bianchi 2
 Mont Blanc 2
 No-Name 3
 OKQ8
 Rameder 1
 Thrust 1
 Perstorp 1
 Uns 1
 Vet ej 21

Varför köpte du just den cykelhållaren?

Priset 85
 Kvaliten 153
 Designen 45
 Märket 49
 Modellen 60
 Funktion 178
 Hantering 66
 placering på bilen 135
 storleken 13
 Annan 23

Är det något du saknar med din cykelhållare?

Bättre lås, plats för fler cyklar, höjdsticka för att mäta totalhöjd om man ska in i parkeringsgarage.
 kunde vara snabbare/enklare att montera cyklarna, klara mer vikt. , flexibilitet, den borde vara fällbar,
 hållare till framhjulet., enkelhet, och ombyggnadsmöjlighet.

Hur många cyklar brukar du transportera åt gången?

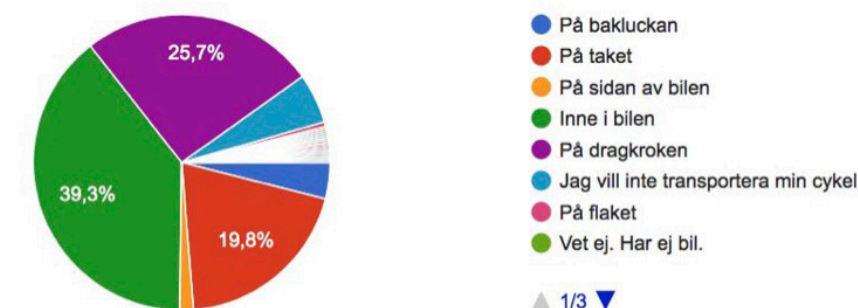
1-5

Hur skulle du vilja transportera din cykel?

Bil, tåg och buss.

Hur skulle du helst vilja transportera din cykel med bil?

405 svar

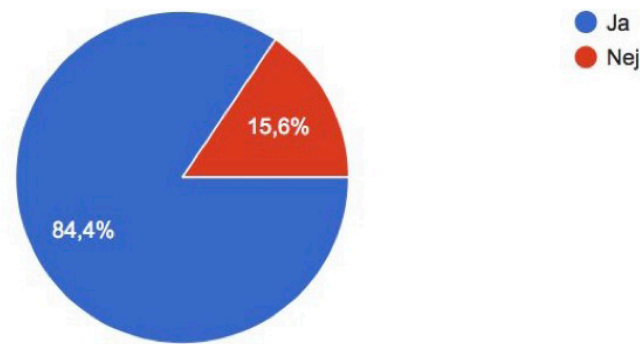


Varför vill du transportera den på detta sättet?

Enkelt, smidigt, säkert, bekvämt, skyddad, miljövänligt och övrigt

Kan du tänka dig att transportera cykeln inuti bilen?

405 svar

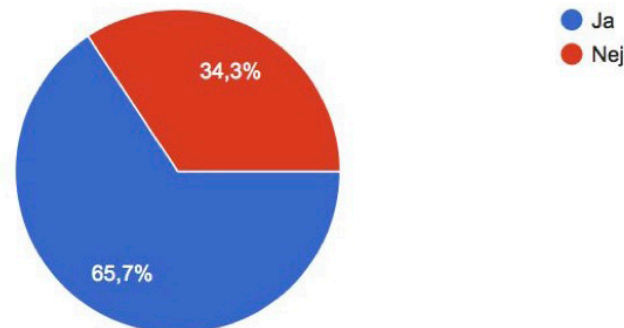


Ser du något problem med att transportera cykeln inne i bilen?

Platsbrist, trångt, smutsigt och skrymmande.

Reser du med din cykel?

405 svar



Hur ofta reser du med din cykel?

Ingen gång till 50 gånger.

Med vilka transportmedel reser du med din cykel?

Bil - 226

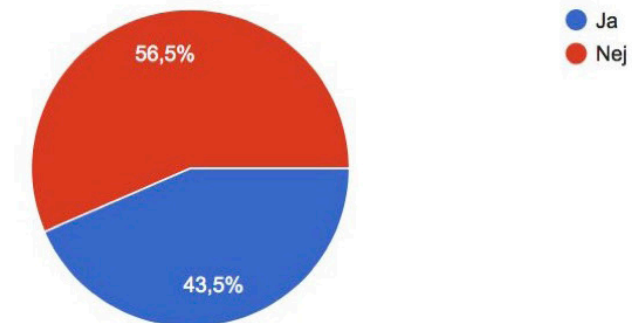
Buss - 20

Tåg - 73

Flygplan - 117

Har du hyrt cykel istället för att ta med din egna cykel?

405 svar

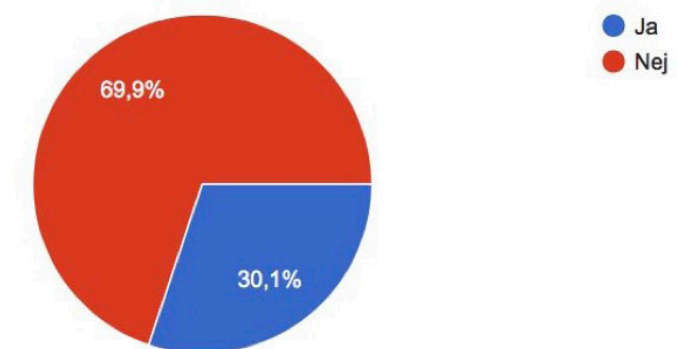


Varför hyrde du cykel?

Enklare, billigare, samma pris, litar inte på flygplats personalen, testa nya cyklar, cyklade för lite, smidigare och praktiskt.

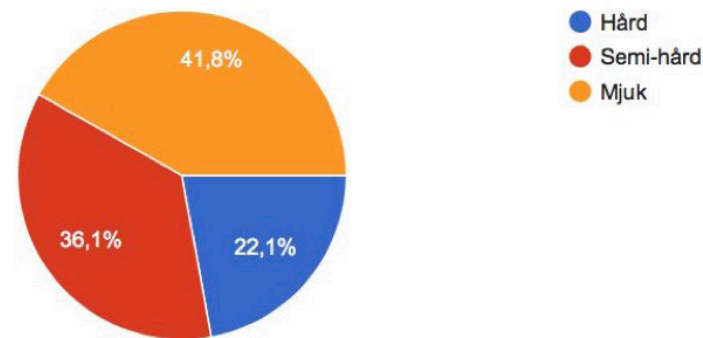
Har du en cykeltransportväska?

405 svar



Vilken typ av väska har du?

122 svar



Vad är det för märke på din väska?

Evoc (19)

Vet ej -16

Scicon - 9

Scott (4)

Thule (4)

B&W (3)

CRC (2)

Cykelcity (2)

Rose (2)

EVOC (2)

EVO

Väska nr 1, Hockeybag +0 hjulväska för att smuggla med cykeln hos SJ, Väska 2 Prototyp, ej släppt på marknaden ännu

Sack bike

Canyon

Okänt

SAS

Biknd

Havoc?

Kartong

Tacx

DhB

Vet ej. Köpt på xxl

minns ej

n/a

Siccion och evok

Bike box alan

Look

Byggde den själv

Biknd

Minns ej

Rcp

BM

evoc

Planet x

Scission

hembygge

Crc

En väska från HARALDNYBORG

B&w

Cyclesurgery

Jag h ar 2 st en mjuk och en håd.

BW

vet inte

Tyskt märke "cykelcity"

Helium

Biked Helium

???

Chain Reaction Cycles

okänd

Pro

Kommer ej i håg

Chain reaction

Minns inte nu

Cykelcity och Velovault

Vet ej.

Minns inte..dyr

Vet ej

Evoc bike bag pro

Vet inte

Cykelcitys

STAYDRY

vet ej

Vet ej, köpt hos Wiggle

De Rosa

Kommer ej ihåg.

ortlieb

Flera olika. Vaude (heter det så?) Och en från kina utan märke

Red

Varför köpte du just den?

Priset 64
Kvaliten 48
Designen 23
Märket 8
Modellen 28
Funktionen 74
Hanteringen 32
Färgen 3
Storleken 31
Vikten 38

Är det något du saknar med din cykeltransportväska?

För få fickor, fler hjul, gå att förvara smidigare, lättare, för stor, svängbara hjul, mer skydd för cykeln.

Varför har du ingen cykeltransportväska?

Inget behov, dyrt, inte hittat någon jag gillar, tar för mycket plats.

Vad skulle få dig att köpa en cykeltransportväska?

Behov, pris, bra väska,.

Questions User Study

Uppgift 1: Cykel i Hård väska.

- Vad känner du när du ser denna väskan? Hur skulle du beskriva den?
- Äger du en cykelväska? Vilken typ av cykeltransportväska har du? Mjuk, hård eller något annat?

Uppgift 2 : Cykel i semi-hård väska

- Vad känner du när du ser denna väskan? Hur skulle du beskriva den?

Uppgift 3: Gå med båda väskorna, samt Evoc. Berätta hur det känns.

- Vad känner du när du ser denna väskan? Hur skulle du beskriva den?

Generella Frågor:

Vilken typ av cykel har du (styre typ)?

Har du någonsin från offra dig från att ta med din cykel för att någon annan skulle ha med sin? (både vid resor med bil och flyg)

Hur förvarar du din cykel när du inte cyklar på den?

Vad är du villig att betala för en cykel transportlösning? Varför?

Vad tycker du om monterings stället?

Om du skulle bära cykeln upp/ner för trappen, skulle du vilja lägga till något på väskan?

Vilka faktorer är de viktigaste med en cykeltransportväska?

Vad vill ha i din väska?

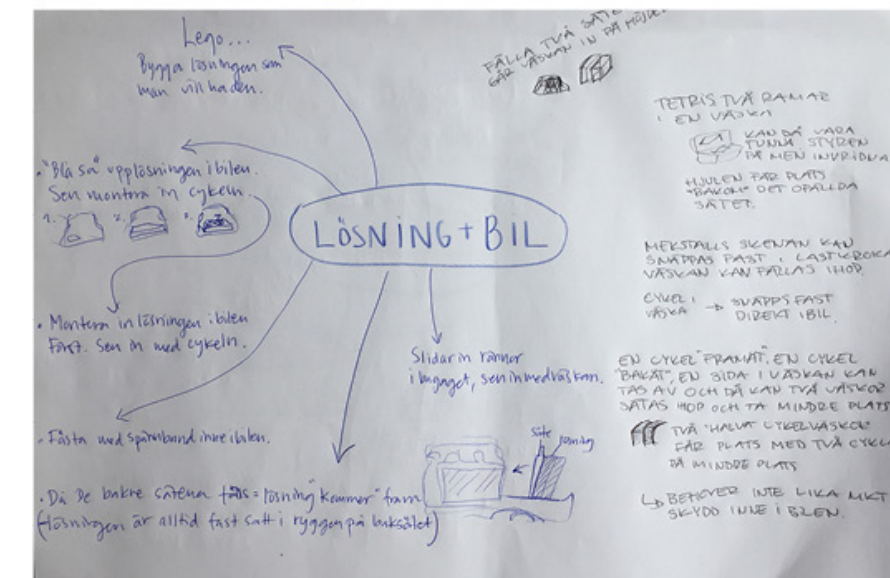
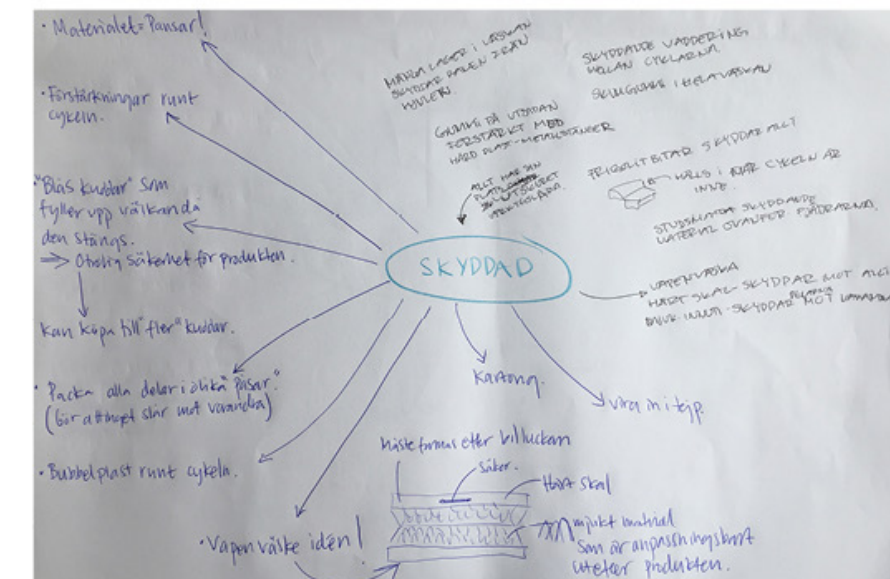
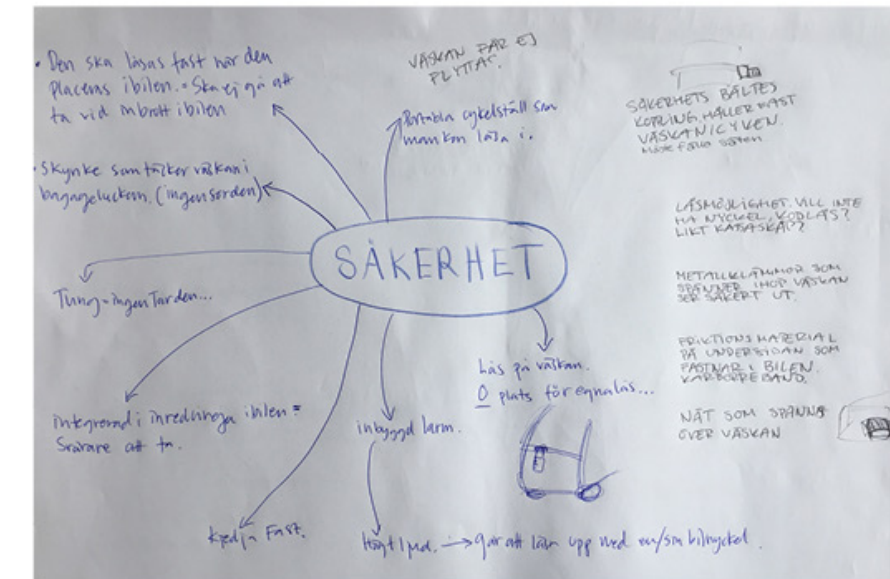
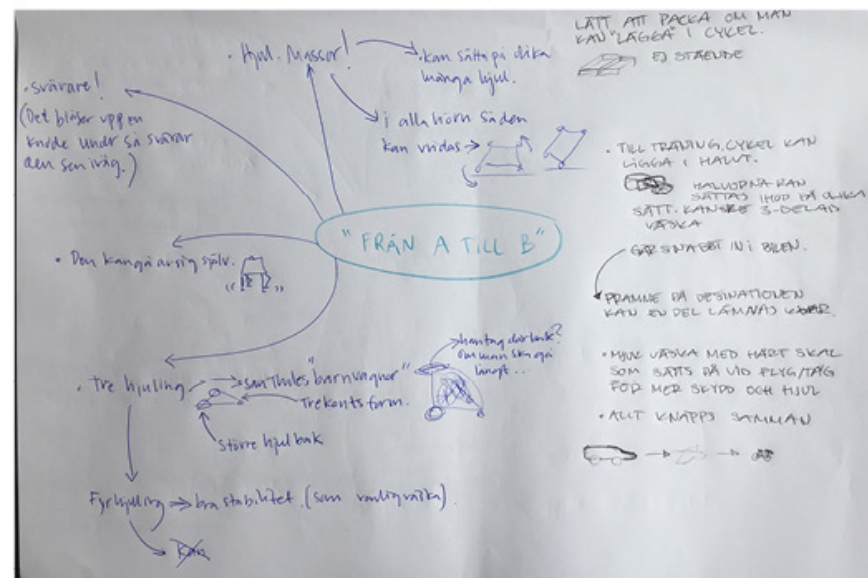
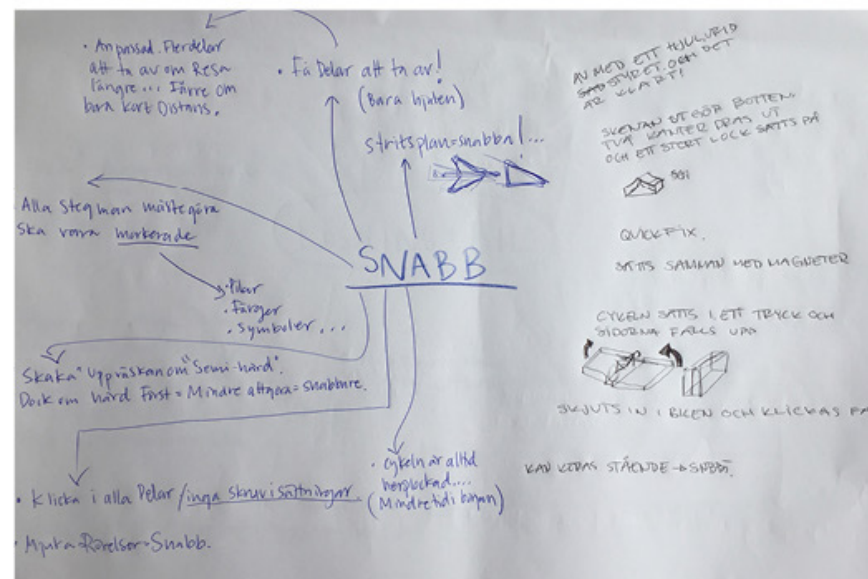
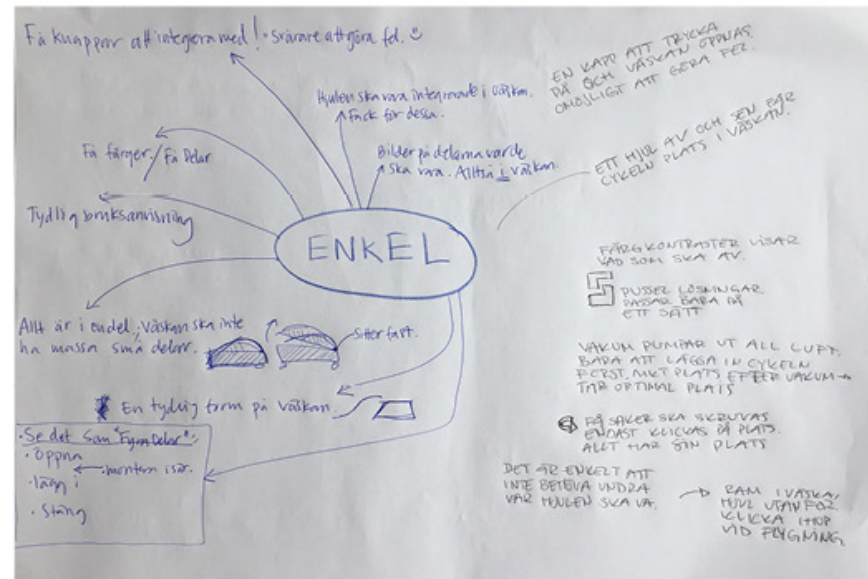
Resa med din cykel:

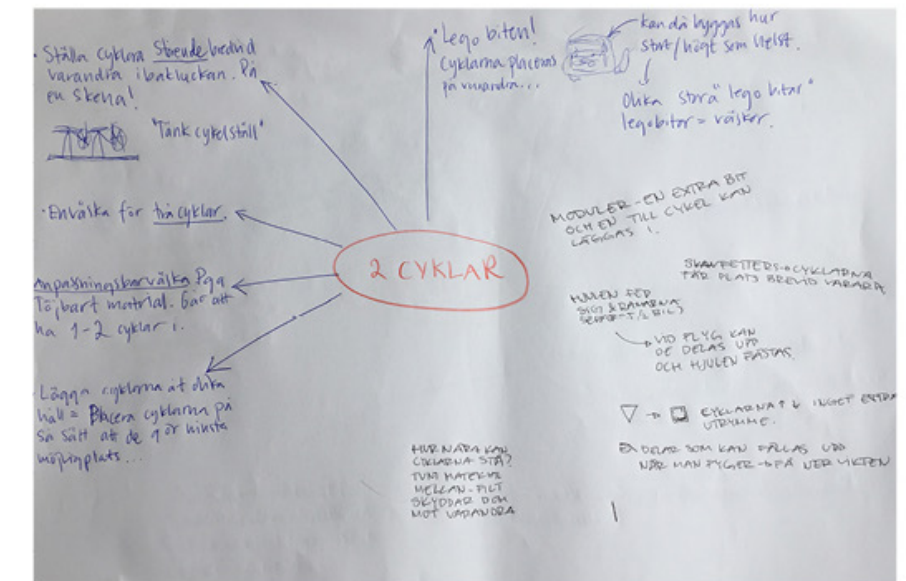
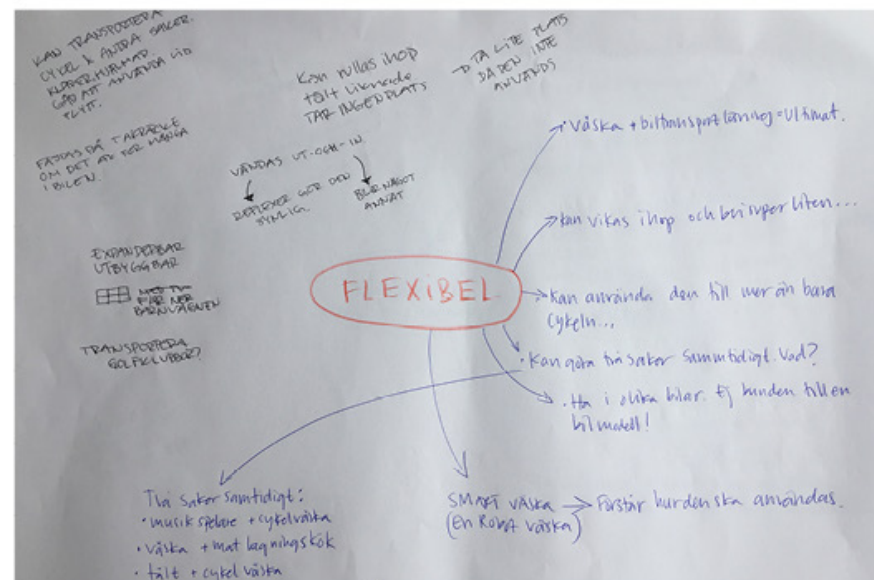
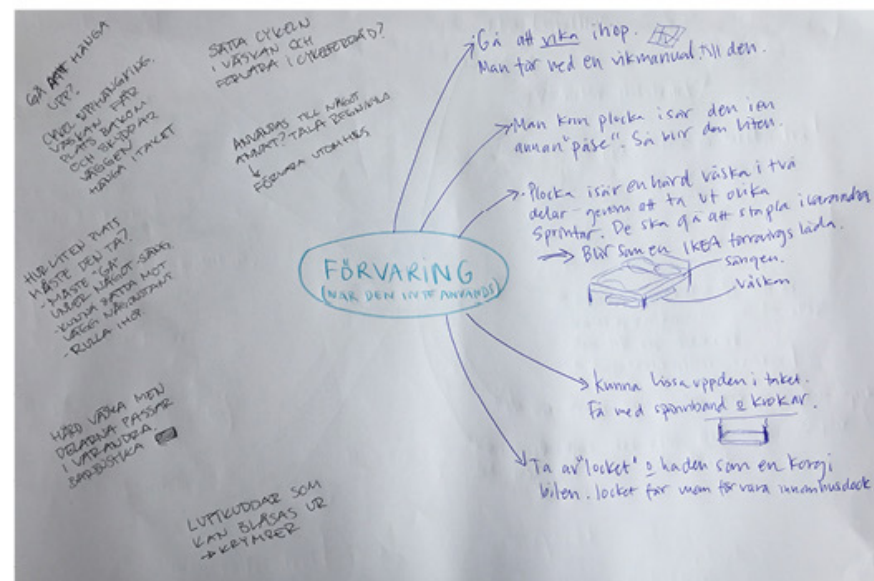
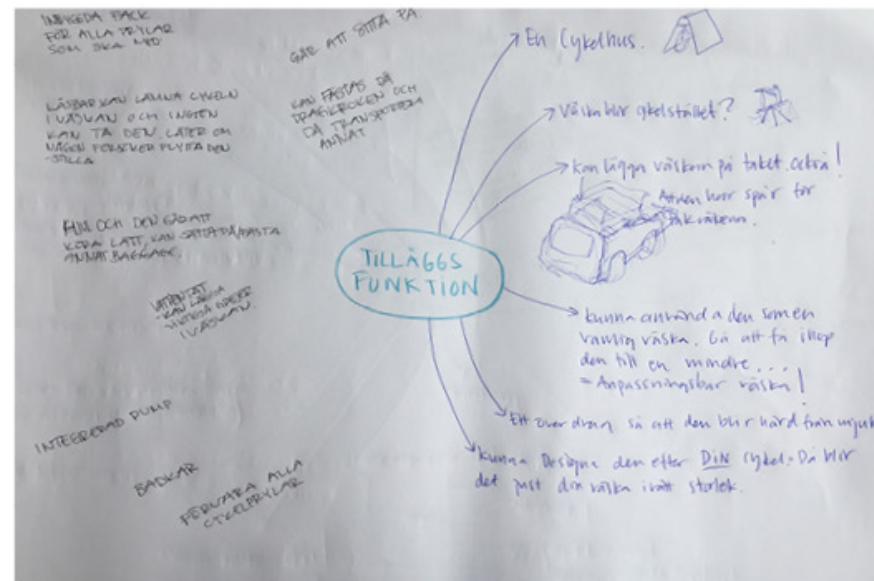
- Åker du tåg med din cykel? Har du då den i en väska? Om du åker tåg, vad gör du med väskan om du vill cykla tillbaka?
- Flyger du med din cykel?
- Skulle du använda en cykelväska om du inte skulle till flygplatsen?
- Hur viktigt ä det att en lösning inuti bilen även är användbar när du flyger samt använder andra kommersiella transportmedel?

Appendix D

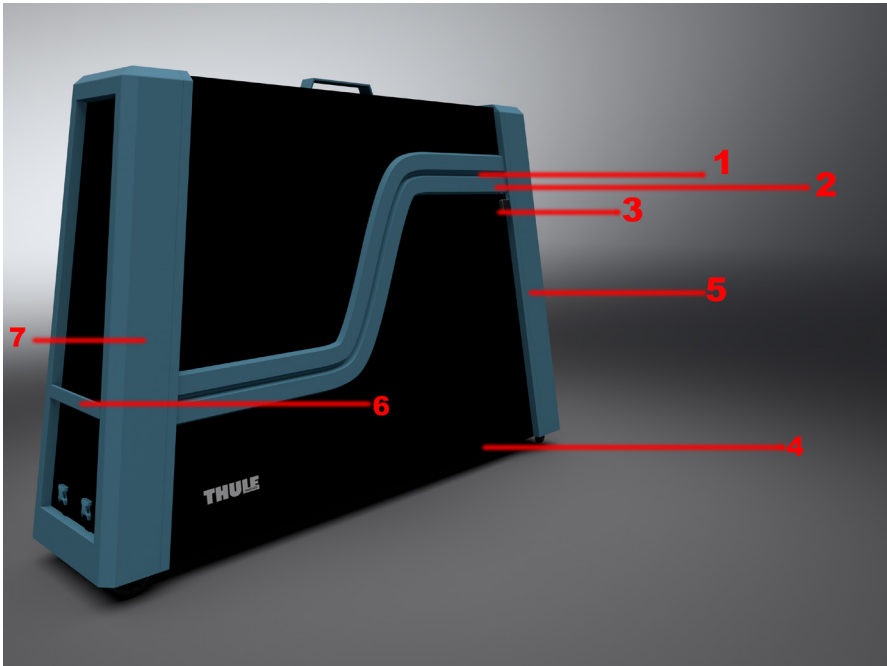
	Brand	Model	Hard/Soft	Dimensions (exterior)	Lenght	Depth	Height	Weight	Price
1	Thule	Thule RoundTrip Transition	Hard	137 x 39.3 x 94 cm	137	39.3	94	17.6 kg	6 999kr
2	Thule	Thule RoundTrip Pro XT	Semi-hard	126 x 29.9 x 89 cm	126	29.9	89	8.6 kg	5 999kr
3	Thule	Thule RoundTrip Traveler	Soft	131 x 37.4 x 81 cm	131	37.4	81	7.7 kg	3 999kr
4	Scicon	AeroComfort Road 3.0 TSA Bike Travel Bag	soft	109 x 103 x 50 cm	109	50	103	8kg	€599
5	Scicon	AeroTech Evolution 3.0 TSA Bike Travel Case	Hard	114cm x 36cm x 94cm	114	36	94	11kg	€799
6	Scicon	AeroComfort Triathlon 3.0 TSA bike travel bag	soft	129 x 98 x 45 cm	129	45	98	8kg	€599
7	Scicon	AeroComfort MTB 3.0 TSA	soft	124 x 98 x 25 cm	124	25	98	9kg	€599
8	Scicon	Aerocomfort 2.0 TSA bike travel bag	soft	L 118 cm x D 45 cm x H 90 cm	118	45	90	8,9kg	€499
9	Scicon	Aerocomfort Triathlon™ bike travel bag	soft	L 132 cm x D 45 cm x H 90 cm	132	45	90	9,2kg	€499
10	Bonza Bike Box	Transport case	Hard	124 x 94 x 34 cm.	124	34	94	12kg	€499
11	Evoc	Bike Travel Bag	Soft	136 x 39 x 80 cm	136	39	80	9kg	ca 3699 kr
12	Topeak	Topeak Pakgo X Bike Transport System Case	Hard	126x83x33cm	126	33	83	12.3kg	8 465kr
13	B&W International	Sack bike bag, cykelväska	Soft	1200 x 850 x 230 mm	120	23	85	2.15kg	499kr
14	B&W International	bike box II	Hard	1190 x 890 x 295 mm	119	29.5	89	11.7kg	N/A
15	B&W International	bike case II	Hard	1345 x 880 x 345 mm	134,5	34,5	88	13.5kg	N/A
16	B&W International	bike guard curv	Hard	1310 x 910 x 315 mm	131	31.5	91	8.2kg	£885
17	B&W International	Hybrid bike transport bag case	Semi-hard	132x84x39cm	132	39	84	9kg	\$350
18	B&W International	bike bag	Semi-hard	1320 x 840 x 390 mm	132	39	84	7.7kg	N/A
19	Bike Box Alan	Bike Box Alan	Hard	113x92x32	113	32	92	11.2kg	4 888kr
20	Scott	Scott bike transport bag classic	Soft	1250x840x200	125	20	84	2,4kg	850kr
21	Scott	Scott Bike Transport Bag Premium 2.0	Semi-Hard	1380x800x300	138	30	80	8,6kg	£240
22	Scott	Scott Bike Transport Bag Sleeve	Soft	1530x900x240	153	24	90	0,6kg	70€
23	Canyon	Canyon Bike Bag	Soft	1200x850x30	120	30	85	2.1kg	510kr
24	Canyon	Canyon BikeShuttle	Hard	1120x870x280	112	28	87	-	2 500kr
25	Biknd	Jet Pack	Semi-Hard	1300x790x250mm	130	25	79	9kg	\$450
26	Biknd	Helium	Semi-hard	1300x850x310mm	130	31	85	9kg	\$700
27	CRC	Chain Reaction Cycles Pro Bike Bag	Semi-Hard	1400x280x790mm	140	28	79	8.6kg	2 100kr
28	CRC	Chain Reaction CyclesComplete Bike & Wheel Bags - CRC Logo	Soft	1250 x 800 x 220mm	125	22	80	6.7kg	1 000kr
29	Rose	Rose Bike Bag flight bag	Semi-Hard	132 x 86 x 39 cm	132	39	86	9kg	2 500kr
30	Rose	Rose ContainerBag Pro transport bag	Soft	145 x 100 x 25 cm	145	25	100	2.5kg	1 100kr
31	Red	Bike Box II	hard	N/A				N/A	319.99€
32	DhB	dhb Mjukväska med hjul	Soft	L 116 cm x D 25 cm x H 90 cm	118	25	90	-	2 343kr
33	Look	Bicycle carrying bag	soft	110 x 82 x 30	110	30	82	N/A	N/A
34	Planet x	Planet X Bike Bag	Hard	110x95x?	110	-	95	14kg	£250
35	Planet x	Planet X Super Delux Bike Bag	soft	128x 78x 22cm	128	22	78	5kg	£100
36	Vaude	Vaude Big Bike Bag Pro	Soft	85 x 130 x 28 cm	130	28	85	3.1	£125
37	Douchebag	The tour bike bag	Semi-hard	N/A				10kg	£550
38	Douchebag	The trail bike bag	Semi-hard	N/A				9kg	£400
39	Brompton	B Bag	Soft	N/A				N/A	£230
40	Pro	Bike Bag	Soft	N/A				N/A	1 000kr
41	De Rosa	De Rosa Padded Cycle Bag	Soft	N/A				N/A	76€
42	Velovault	VeloVault Bike Box	Hard	116 x 30 x 91 cm	116	30	91	13kg	£460
43	Polaris	Bike Pod Pro Bike Case	Hard	114 x 87 33 cm	114	33	87	12,6kg	£549,99
44	Polaris	Eva Pod Plus Bike Case	Hard	117x 97 x 24 cm	117	24	97	11.15 kg	£324.99
45	Polaris	Axial Pod Bike Case	Soft	140 x 85 x 24 cm	140	24	85	8.2 kg	£299.99
46	Polaris	Polaris Cargo Bag	Soft	126 x 80 x 20 cm	126	20	80	4.78 kg	£159.99
47	Elite	Elite Vaison Bike Bag	Hard	1230 x 792 x 33 mm	123	33	80	17kg	325£
48	Randon	Bike Bag	Soft	1200 x 850 x 230 mm	120	23	85	2.1kg	41€
49	B'TWIN	BIKE TRANSPORT COVER	Soft	1350mm	135	-	-	N/A	50€
50	Merida	Premium Bike Bag	Semi-hard	140 x 84 x 35 cm	140	35	84	6.5kg	£400
51	Merida	29er Bike Bag	Semi-hard	130 x 30.5 x 85 cm	130	30.5	85	9kg	£160
52	Buxum	Tourmalet Bike Box	Hard	1129 x 781 x 305mm	112,9	30,5	78	12kg	£700

	Source	Retrieved	Notes
1	https://www.thule.com/sv-se/se/bike-accessories/bike-travel-cases/thule-roundtrip-transition-1683469	2018-01-23	
2	https://www.thule.com/sv-se/se/bike-accessories/bike-travel-cases/thule-roundtrip-pro-xt-100505	2018-01-23	
3	https://www.thule.com/sv-se/se/bike-accessories/bike-travel-cases/thule-roundtrip-traveler-1684935	2018-01-23	
4	https://sciconbags.com/aerocomfort-road-3-0-tsa-bike-travel-bag	2018-01-24	
5	https://sciconbags.com/aerotech-evolution-3-0-tsa-bike-travel-case	2018-02-08	
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13	https://xcl.se/b-w-international-sack-bike-bag-cykelvaska/p/1096020_1_style	2018-01-25	
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19	https://bikeboxalan.com	2018-01-25	
20	https://www.scott-sports.com/au/en/product/scott-bike-transport-bag-classic	2018-02-08	
21	https://www.scott-sports.com/ca/en/product/scott-bike-transport-bag-premium-2-0?article=2645070001222	2018-02-08	
22	https://www.scott-sports.com/ca/en/product/scott-bike-transport-bag-sleeve?article=2645090001222	2018-02-08	
23	https://www.canyon.com/sv/accessories/#id=12612	2018-02-08	
24	https://www.canyon.com/sv/accessories/#id=30375	2018-02-08	
25	http://biknd.com/en/products/bike-travel-case/jetpack	2018-02-08	
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34	https://www.planetx.co.uk/i/q/BAPXBIQ/planet-x-bike-box	2018-02-08	
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42	http://www.bikebox-online.co.uk/product/velovault/	2018-02-08	
43	https://www.polaris-bikewear.co.uk/Bike-Pod-Pro-Bike-Case-p/pol01-4859-p.htm	2018-02-08	
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48	https://www.bike-discount.de/en/buy/radon-transportbag-bike-sack-533075?delivery_country=171&gclid=Cj0KCQiAh_DTBRCTARIsABIT9MbnkXzxSbH6-3n8Y8PCz6xNFpngyn9XnBwLtOzd1X8urs5QJTE2gz0aAtQIEALw_wcB	2018-02-08	
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50	https://www.merida-bikes.com/en_int/accessory/bags/transportation-bags/transportation-bag-33.html	2018-02-08	
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Relation	Tillverkning	Aldrande, Användning och miljö	Felorsak	Felsannolikhet	Feleffekt	Synlighet	Risk tal	Åtgärd
1-2, Dragkedja och safetyzone	Skrynkligt		Olika material	2	4	10	80	Tjockare tyg
2-3, Safetyzone och sida när den är stängd		Bulkigt/säckigt	Felpackad	2	4	10	80	Tydliga indikeringar på all packning
3-4, Sida mot botten	Inte rak och inte platt		Olika material	1	1	10	10	bra tillverkning
3-5, sida mot safetezone kant		sidan buktar ut över safetyzone, svårt att stänga	safetyzonen sticker ut för lite, för tunn	4	8	7	224	Safetyzonerna måste vara tillräckligt tjocka och sticka ut tillräckligt mkt
6-7, hantaget och kantsida		Åldrar olika så kan bli färger	Olika material	2	2	10	40	Välja bra material



Designing a Transportation Solution
for Bikes, Inside a Car

Master Thesis in the Master Program Industrial Design Engineering

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