The Development of an Ultra-lightweight Roof Top Tent

Susanna Bengtsson and Hjalmar Grip

DIVISION OF INNOVATION | DEPARTMENT OF DESIGN SCIENCES
FACULTY OF ENGINEERING LTH | LUND UNIVERSITY
2024

MASTER THESIS

The Development of an Ultra-lightweight Roof Top Tent

Susanna Bengtsson and Hjalmar Grip

LUND
UNIVERSITY

The Development of an Ultra-lightweight Roof Top Tent

Published by
Department of Design Sciences
Faculty of Engineering LTH, Lund University
P.O. Box 118, SE-221 00 Lund, Sweden

Subject: Technical Design (MMKM10)

Division: Innovation
Supervisor: Glenn Johansson
Co-supervisors at Thule: David Ardmar, Ellen Weberg
Examiner: Joze Tavcar

Abstract

This thesis, initiated by Thule Group, investigated how an ultra-lightweight roof top tent could be developed to improve and simplify the user experience during installation and use. The aim of the project was to design a roof top tent for two people, which could be handled and mounted on a car by one person.

During the project, Double Diamond together with a human-centred design approach was used as a framework. This contributed to an open work procedure, focusing on the end user and their needs. The market was mapped through benchmarking, research and testing of competitors' roof top tents. A user study was conducted through social media surveys, as well as interviews with experienced and inexperienced outdoor enthusiasts and users of roof top tents. To establish guidelines, an ergonomic study was conducted taking weight, size, and shape into account.

Through brainstorming, sketching, and manufacturing of rapid prototypes, several concepts were explored. A main concept was finally selected for further development, resulting in a conceptual prototype of an ultra-lightweight roof top tent with a sleeping area for two people. The construction featured a rectangular aluminium frame with a stretched fabric which acted as bed. A dome tent was mounted on the base.

The final full-scale prototype was manufactured and mounted to a car and the entire installation process was tested. Due to its light weight, size and shape, the product could easily be installed and handled by one person. It could be folded into a long narrow shape that is easy to store.

Keywords: Roof Top Tent, Thule, Ultra-lightweight, Design concept, Double Diamond, User centred

Sammanfattning

Detta examensarbete, initierat av Thule Group, undersökte hur ett ultralätt taktält skulle kunna utvecklas för att förbättra och förenkla användarupplevelsen under installation och användning. Syftet med projektet var att designa ett taktält för två personer, som kunde hanteras och monteras på en bil av en person.

Under projektet användes Double Diamond-metoden tillsammans med en människocentrerad designmetod som ramverk. Detta bidrog till ett öppet arbetssätt med fokus på slutanvändaren och dennes behov. Marknaden kartlades genom konkurrentanalys, undersökning och testning av konkurrenters taktält. En användarstudie genomfördes genom enkäter i sociala medier, samt intervjuer med erfarna och oerfarna friluftsentusiaster och användare av taktält. För att fastställa riktlinjer genomfördes en ergonomisk studie med hänsyn till vikt, storlek och form.

Genom idégenerering, skissning och tillverkning av snabba prototyper utforskades flera koncept. Ett huvudkoncept valdes slutligen ut för vidareutveckling. Resultatet blev en konceptuell prototyp av ett ultralätt taktält med sovplats för två personer. Konstruktionen bestod av en rektangulär aluminiumram med ett uppspänt tyg som fungerade som bädd. Ovanpå basen monterades ett egensytt kupoltält.

Den slutliga fullskaliga prototypen tillverkades och monterades på en bil, och hela installationsprocessen testades. På grund av sin låga vikt, storlek och form kan produkten enkelt installeras och hanteras av en person. Den kan vikas ihop till en långsmal form som är lätt att förvara.

Nyckelord: Taktält, Thule, Ultralätt, Designkoncept, Double Diamond, Användarcentrerad Design

Acknowledgments

We would like to extend our gratitude to several people:

Glenn Johansson, our supervisor at LTH has given us great assistance with the academic formality and structure of the report.

Daniel Åhman, the initiator of this project, had trust in our ability and gave us the opportunity to execute this project.

David Ardmar and Ellen Weberg, our supervisors at Thule have provided their invaluable support, engagement, and expertise. They have always been available to discuss ideas and challenges.

Designovation at Thule in Hillerstorp has given us a warm treatment during our visits, showing enthusiasm and providing us with resources for executing the project.

Joze Tavcar, our examiner, Hannah Rodgers and Arild Nilsson, our opponents, have all thoroughly reviewed our report and provided valuable comments.

Thank you all for your contributions and support.

Lund, June 2024

Susanna Bengtsson and Hjalmar Grip

Table of contents

1 Introduction

This section presents an introduction about the project, the project initiator Thule as well as the project's target and goal.

1.1 Background

The participation in outdoor recreation activities has increased during the last years, especially due to the covid-19 pandemic. The pandemic required people to make lifestyle changes and pick up new hobbies since working from home and not having to commute became the norm (Bruton, 2023). Restrictions made it difficult to travel, especially to other countries. A way to experience new destinations was to go on hikes and road trips more locally. In Sweden this is a clear trend as the share of weekly visits to forests has doubled since 2018-2019 (Naturvårdsverket, 2022). As more people want to take part of an active lifestyle, a higher demand for the products that enable it can be seen, such as skis, tents, and other hiking equipment.

A roof top tent (RTT) mounts to the top of a car and allows the user to sleep on the roof of the vehicle. The tent sits in a compact package, mounted on roof racks on top of a car. Users are protected as they are elevated from the ground, this can especially be important in areas with active and dangerous wildlife. Compared to other mobile home solutions an RTT is more affordable, more flexible and requires less space than a camper or a caravan.

The first RTTs were developed in the 1930s in Europe to handle mass car tourism which had increased in popularity (Autohome , 2017). Early versions of RTT had a hard shell with a canvas cover which provided shelter (Popular Science Monthly, 1937).

RTTs are typically categorised into either hard shells or soft shells. Hard shell RTTs have an exterior of aluminium or ABS-plastics and can typically fit two people. When deploying, latches are released and the tent extends vertically and is ready to be used (Thule Group, 2023). Softshell RTTs have an exterior of durable textile and can fit up to four people (Figure 1). The tent consists of two hard outer plates with the canopy in between the plates. When deployed the plates opens like a book and serves as a hard base. The ladder is used as a lever to deploy the tent.

Figure 1: Thule Approach softshell RTT, folded (left) and deployed (right). (Source: (Thule, 2024))

1.2 About Thule

Thule Group AB is a Swedish company founded 1942 by the Thulin family in Hillerstorp, Sweden. They have approximately 3300 employees worldwide, 9 production facilities, and their wide range of products can be found in 140 sales markets. The company creates solutions to enable an active life for its customers, and their motto is "*Active Life, Simplified*". Thule focuses on creating easy to use, environmentally friendly and stylish products of high quality. For a long time, Thule's core business was limited to development and manufacturing of roof boxes, bike mounts and roof racks for cars. In the 00's to 10's they acquired several smaller companies each focused on making one product category. Following these acquisitions, they have lately expanded their product portfolio to include products like luggage, strollers, backpacks and most recently RTTs which Thule launched in 2018 (Thule Group, 2023).

In 2021 the global RTT market size was valued at USD 199.53 million. By 2027 the RTT market size is estimated to have a compound annual growth rate (CAGR) of 7,9% and reach USD 312.45 million (Business Research Insights, 2023).

1.3 Project Description

Camping with an RTT can be seen as very spontaneous form of camping. The tent can be mounted to the roof racks of a passenger car which makes it easy to find parking and allows for great flexibility. A big problem is the preparation and installation of the tent on the car roof. They are often heavy and quite large which means that the handling can be difficult. A RTT from Thule weighs around 45-80 kg. This makes it almost impossible for one person and very difficult for two persons to install on the top of a car.

This master thesis investigates the possibilities of making an ultra-lightweight roof top tent. The focus of this project was to develop a solution for installation and removal of the tent to make it possible for a single person to install. The product should be considered easy to use. This has not been a weight saving project for an existing product. The goal was to come up with a new way of using and handling of an RTT. The project resulted in a conceptual working final prototype in full scale.

The following brief was given to the design team before the start of the project: *Redesign a roof top tent to make it more accessible and easier for one person to mount on top of a car.*

The result will include areas of further development, such as manufacturing methods, mechanical calculations, weight-optimisations, and simulations. These areas of the project are not in first concern since development of the use and handling of the product is of greater importance.

1.4 Delimitations

The scope of this project is to develop a concept for an ultra-lightweight RTT. The produced prototype will show the functionality of the concept and not serve as the final visual design. Calculations of cost, technical drawings and manufacturing methods will be left out.

The outcome of the project is a tent for two persons which is suitable to use on a normal passenger car. Roof racks are necessary in order to mount the tent to the car. It is adapted to work with most of Thule's roof racks and utilises Thule's existing mounting solutions. The racks need to be a minimum 115 cm in length to accommodate the width of the bed.

2 Framework

This section presents the theoretical framework regarding roof top tents and the regulations and standards which need to be considered in this project.

2.1 Roof Top Tents

2.1.1 Primary Roof Top Tent Elements

When researching and analysing different RTTs, five primary elements were distinguished: the base, mattress, canopy frame, canopy fabric, and ladder. Alongside the primary elements there are accessories commonly added on to RTTs, like the rainfly.

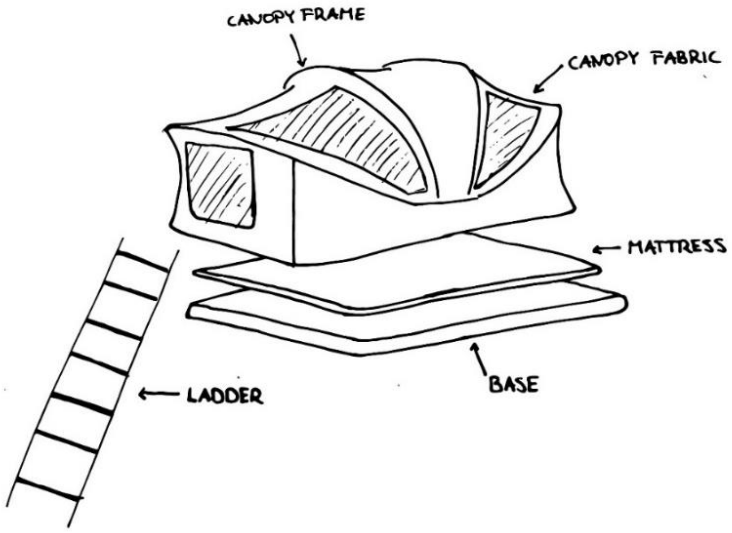


Figure 2: The primary elements of an RTT. (Source: Authors' own work)

2.1.1.1 Base

The base serves as the foundation for the tent as is usually made of honeycomb aluminium, an aluminium frame, or fibreglass-reinforced plastic (Jaynes, 2024), (OutdoorDays, 2024). Some tents use a less common inflatable drop stitch base, similar to the construction of Stand Up Paddle boards (Gentletent, 2024). The drop stitch material creates a lightweight but sturdy base (What is Drop Stitch?, 2011).

The underside of the base often includes mounting rails for attachment of the RTT to the roof racks of the vehicle. These mounting rails are often extruded aluminium profiles, in which a mounting plate can be slid on and secured on to the roof rack with a nut and bolt (OutdoorDays, 2024). Thule has developed mounting brackets which do not require to be slid on. Instead, they are mounted directly in place by rotating the plate 90 degrees, which locks it into the profile, making the instalment of the RTT to the roof racks easier (Thule Sweden, 2022).

Figure 3: Thule Mounting Brackets (Left), regular mounting brackets (right).
(Source: (Thule Mounting Rails M, 2024), (Roof Top Tent Mounting Clamps, 2022))

2.1.1.2 Mattress

Most tents have a high-density foam mattress, with a thickness that varies from 2.5 to 5 cm. The mattress dimensions cover the area of the base, which is depending on the amount of people that can stay in the tent.

2.1.1.3 Canopy Fabric

The canopy fabric offers protection against wind, rain, and UV-rays. The canopy material can be cotton, polyester, a mixture of these or ripstop nylon. The fabric is commonly coated which gives the canopy its water-repellent property (ESVO, 2024). The density of the fabric varies from 240 g/m^2 to 350 g/m^2. To allow air and light intake mesh windows are often integrated to the design. Hard-shell RTTs have a shell in addition to the canopy fabric, the shell can be made of fibre-reinforced plastic, ABS-plastic, or aluminium (iKamper, 2022).

2.1.1.4 Canopy Frame

The canopy frame stretches out the canopy fabric. The deployment mechanism varies and depends on type of tent, manufacturer, and specific model. Hard shell tents use gas struts to extend the roof and create volume. Soft shell tents typically have aluminium rods that unfolds the structure like a popup book. There are even some manufacturers of tents that utilises an inflatable frame (Gentletent, 2024).

Figure 4: Hard shell tent and inflatable canopy frame.
(Source: (Gentle Tent, 2024), (Thule Basin, 2024))

2.1.1.5 Ladder

The ladder is used to get up in the tent. It is typically extendable for use with vehicles of different heights. When deploying a soft-shell tent, the ladder is often used as a lever and provides additional support.

2.1.1.6 Rainfly

The rainfly is an additional waterproof textile layer, installed over the canopy to provide with extra protection against rain (Thule, 2024). They are usually secured to the canopy fabric with buttons, velcro or clips, and is deployed with poles from the tent base. It is easy to take off to dry after a rainfall.

Figure 5: Rainfly deployed. (Source: (Orson Roof Top Tent, 2024))

2.1.2 Car Limitations

A criterion for installing an RTT is that the car has roof racks that are installed to its rails or tracks. There are examples of RTTs which are mounted directly on to the roof, those are usually used on the roof of vans that have a large and flat roof. It is not recommended to install an RTT on cars with roof racks which grip to the edges of the roof. The static weight capacity of the car and roof racks must be able to hold the persons sleeping in the tent. The dynamic weight capacity (weight limit while driving) must be greater or equal to the weight of the RTT.

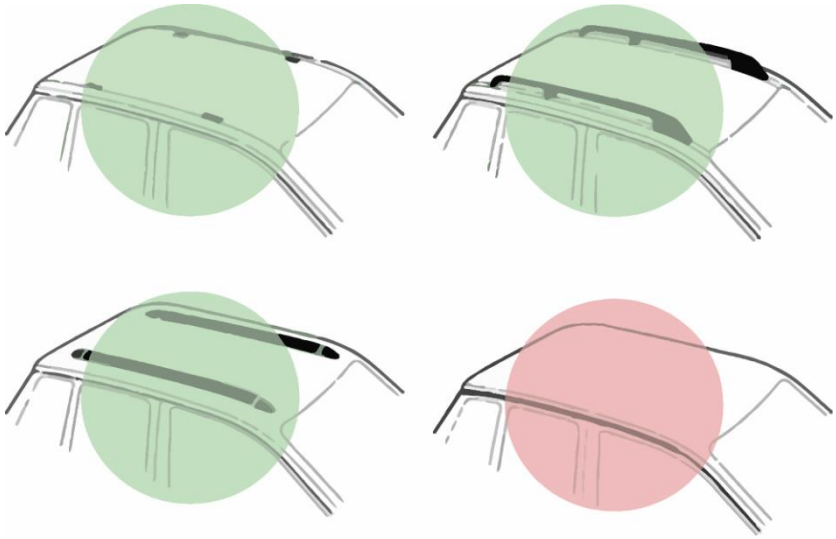


Figure 6: Examples of car roofs and their RTT compatibility. (Source: Authors' own work)

2.2 Regulations and Standards

2.2.1 Vehicle Regulations

As an RTT is mounted on the roof of a car, standards and laws regarding vehicles and road safety must be considered. The Swedish Transport Agency was used to access information about regulations regarding traffic and load safety. The maximum roof load should be considered to establish a framework for testing, design, and prototyping. The roof load specified is the dynamic load, the load that can be driven with, which in this case would be the RTT. When not driving cars manages a greater static load, so tent can accommodate people sleeping in it.

Loads that protrude more than one meter to the rear or protrude less than one meter but are not obvious to other road users, should be marked with a flag. If the load protrudes forward, it must always be labelled (Transportstyrelsen, 2013). The width of a vehicle, including the load can be no greater than 2.6 m (Transportstyrelsen, 2013). Maximum permissible vehicle height is 4.5 meters in Sweden and 4 meters in the EU, although there are places where the clearance is lower than this, but they are marked with road signs (Transportstyrelsen, 2020).

According to Mobility Sweden (Mobility Sweden, 2024), the car model with most new registrations 2014-2023 was Volvo V60, Volvo XC60 and VW Golf. The models vary in height, width, and maximum roof load. The Volvo V60 is a medium sized combi with a height of 1430 mm, width of 1850 mm and a maximum roof load of 75 kg (Volvo Car Corporation, 2024). Volvo XC60 is a compact SUV with a height of 1656, width of 1902 mm and a maximum roof load of 100 kg (Volvo Car Corporation, 2024). VW Golf is a compact family car with a height of 1491 mm, width 1789 mm and a maximum roof load 75 kg (Volkswagen, 2024).

When designing, prototyping, and performing tests it was decided that the average value of the height (1526 mm), average value of the width (1847 mm), and the roof load of 75 kg was to be considered.

2.2.2 Usability

According to Ergonomics of human-system interaction - Part 11: Usability: Definitions and concepts (SS-EN ISO 9241-11:2018), (Swedish Standards Institute, 2019) usability is the “extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use”. Products which have high usability or usability which is higher than expected can have a competitive advantage on the market. To achieve a product that is considered usable, active involvement of users is key (Swedish Standards Institute, 2019).

2.3 Ergonomics

The aim of the project is to develop a concept for a consumer product. Hence it is important to understand ergonomic limitations and preferences of users. A good product can easily fail if users find it difficult or uninviting to use (Tosi, 2020). Pheasant writes in Bodyspace - Anthropometry, Ergonomics, and the Design of Work, that there are several questions to take into consideration when designing a product that the user feel is inviting and easy to use. Is it easy to learn to use? Are the instructions clear? Is the product easy to clean and maintain? Is it hard to make it go wrong?

When a lift is performed there are certain factors to consider. A compact load is generally safer to lift than a bulky load, due to its centre of gravity, closer to the user's body and requires less movement of the back (Pheasant, 2003). The content should be secured to prevent unexpected shifts in the centre of gravity. A common cause of injury is handling of loads outside of the comfortable height range of a person. There is a particular danger with loads that must be handled at shoulder height and above will get out of control. One would believe that a lighter product implicates an easy, safe lift. But no load weight can guarantee complete safety from injuries and "You can injure your back by stooping down to pick up a pencil" (Pheasant, 2003, p.133).

Anthropometric measurements have an important role when designing with the user in mind. The data about human body dimensions and proportions allow designers to determine for example reach distance and height, to make sure users can interact comfortably with the product (Pheasant, 2003). Understanding anthropometric measurements helps designers identify potential ergonomic issues, such as uncomfortable postures or excessive joint stress. The data can be used when creating prototypes to test and evaluate usability and safety with users.

Table 1: Interesting anthropometric measurements in mm, for Swedish adults. Data from (Pheasant, 2003) p.184.

	Men			*Women*		
Dimension	*5th %ile*	*50th %ile*	*95th %ile*	*5th %ile*	*50th %ile*	*95th %ile*
1. Vertical grip reach	1930	2060	2190	1825	1940	2055
2. Forward grip reach	725	780	835	665	715	765
3. Stature	1630	1740	1850	1540	1640	1740
4. Kneeling height	1210	1295	1380	1130	1205	1285
5. Sitting height	830	900	970	805	860	915
6. Crawling height	1215	1349	835	1139	1249	1350

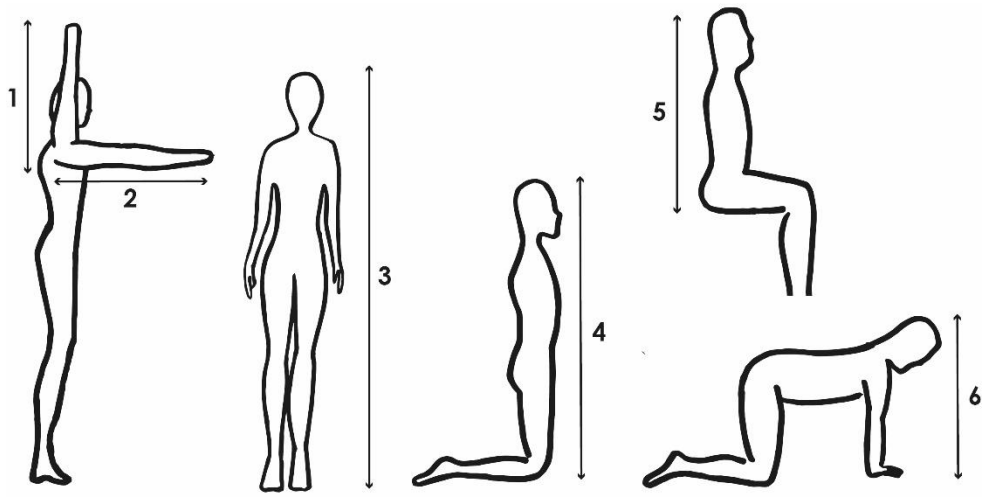


Figure 7: Illustrations of anthropometric measurements from Table 1. (Source: Authors' own work).

3 Method

This chapter presents the theory behind the Double Diamond method and human-centred design approach which have been used as framework. Theory behind the design methods used is explained as well as how they were utilised during the different phases of the project.

3.1 Applied Design Processes

3.1.1 Double Diamond Process

The Double Diamond design process model was established by the British Design Council in 2005. It divides the design process into four stages: discover, define, develop, and deliver. The diverging and converging phases of the process are visualised in the double diamond shape of the model. Where the first diamond focuses on defining the problem and the second diamond focuses on developing a solution. The first phase is focused on research, observations, and collection of data. The second phase focuses on defining a brief for the project. In the third phase solutions to the problem are explored. In the final, fourth phase creating the solution and final concept is done (Design Council, 2024). The model should allow designers to not put unnecessary restrictions on the project too early, as the diverging-converging process allows explorations and understanding of the problem fully (Norman, 2013). A developed Double-Diamond model was released in 2019 and uses four principles as guides (Design Council, 2024):

1. Be People Centred
2. Communicate
3. Collaborate & Co-Create
4. Iterate, iterate, iterate.

The developed model is considered not as linear as the original approach from 2005 and depending on the project it could become a back and forth, and iterative process (Design Council, 2019).

3.1.2 The Design Process at Thule

The supervisors from Thule describe their design process as physical and mock-up based. User centred design is in focus and feedback from users is important when developing products. Smaller models are often made to evaluate concepts, this provides a deeper understanding of the functions. After smaller models, larger, either full scale or half scale prototypes are constructed. This gives a sense of volume, size, ergonomics, and how all small details shall function. The design process is described as "Double Diamond, but varies depending on project, team and individual". Sometimes the project requires a more agile approach and sometimes it can be more useful to use digital tools and models instead of physical prototypes. The suggested ideas, being new products or refinements to an existing one, are presented to a product owner who decides if Thule shall move forward with the idea.

3.1.3 Human-Centred Design

According to Ergonomics of human-system interaction - Part 11: Usability: Definitions and concepts (SS-EN ISO 9241-11:2018), (Swedish Institute for Standards, 2018), human-centred design (HCD) is an approach to design which "aims to make interactive systems more usable, by focussing on the use of the system; applying human factors, ergonomics and usability knowledge and techniques". Norman (2013) mentions that the activities of observation, idea generation, prototyping and testing can be repeated until satisfactory results, shown in Figure 8. The HCD approach can be applied within the double-diamond process, to accommodate human behaviour, needs and capabilities, by putting these factors first and working iteratively. A way of working with HCD is to take ergonomics and human capabilities in to account first, rather than having the user adapting to the design.

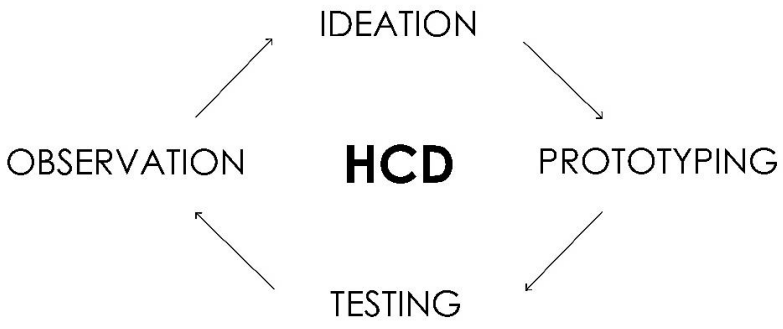


Figure 8: The human-centred design approach. (Source: Authors' own work)

3.1.4 Design Process of the Project

Using the ideas of Human-centred design and the Double-Diamond process, the design process of the project was established (Figure 9). Other methods were explored, but since Double diamond is the main design approach used by Thule it was decided to be used as a starting point. Double Diamond is effective for projects where the whole problem and solution is not clear from the outset. It encourages iteration and refinement through successive stages of exploration, ideation, prototyping, and testing. Human-centred design can benefit from Double Diamond as it helps to understand the users and their needs thoroughly and develop solutions for their needs.

The goal was to use the HCD iterative cycle during the develop phase of the project to develop and evaluate as many solutions as possible. As well as keeping the HCD approach in mind during the whole project. This was done continuously by always asking questions of human behaviour, needs and capabilities when building prototypes and performing tests.

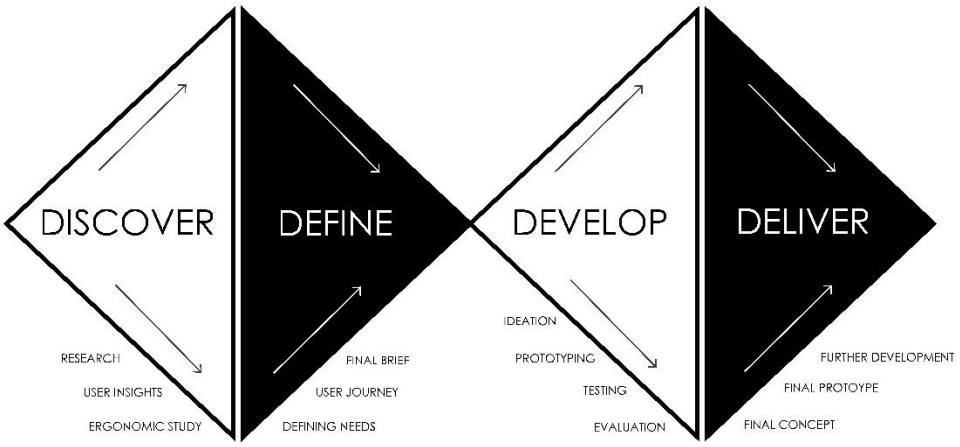


Figure 9: The design process of the project. (Source: Authors' own work)

3.2 Discover

Discover is the phase with the goal of understanding the user and the problem by conducting research, interacting with users, and benchmarking competitive products.

3.2.1 Mood Boards

Mood boards can inspire ideation and concept generation (Wikberg Nilsson, Ericson, & Törlind, 2015), showing competitive products or solutions from completely different areas of interest. Inspiration images were found by investigating Google Images, Dezeem and Designboom, using keywords like foldable, tent, lightweight and ultra-light. Examples of this research is shown in two collages with the themes of foldability and tents, Figure 19 and Figure 20. The collages were mounted on a whiteboard and were visible in the project room during parts of the project.

3.2.2 Benchmarking

To compare competitive products a benchmark was performed early in the project. 10 different two person RTTs were analysed. Data were gathered from the manufacturers' websites and values like size, price and weight were compared (Eppinger & Ulrich, 2014). This gave a deeper understanding of the market.

3.2.3 User Insights

In order to gather user insights two methods were used: surveys and interviews. Surveys can reach out to a lot of people and gather quantitative data. This data is more objective, and the aim is to quantify trends and features. The questions shall be easy to answer, for example rating what features one finds attractive. It can be preferable to allow the user to compare to an existing product or service. Alongside the surveys interviews was conducted to obtain qualitative data. The answers and information received are subjective and the aim is to understand the interviewee's perception of the subject, background and previous experiences. Following with good research ethics the interviewee and their answers are kept anonymous.

Prior to gathering user insights, literature and information about the area was studied. Including the book "The Mom Test" (Fitzpatrick, 2013). Fitzpatrick (2013), discusses how to understand what users want, which methods to use and what questions to ask. It can easily happen that the interviewer asks questions that lead the interview to what he or she want to hear.

1. Talk about their life instead of your idea.
2. Ask about specifics in the past instead of generics or opinions about the future.
3. Talk less and listen more.

These three guidelines emphasise the importance of listening and being open to new insights from the users. If you find that the user is passionate about an area that is relevant to the research, it is a good idea to ask many follow-up questions to dig deeper in the subject.

3.2.3.1 Surveys

To gather as much quantitative data as possible it was decided that an online survey would be sent out to different groups on Facebook. The groups were found by searching for keywords like “Roof Top Tents”, “Car Camping”, “Overlanding”, “Free Camping”, “Vanlife”, “Camping”. Eleven different groups that were found to have many active members were picked, and the survey was sent out. The survey was also sent out in a mass email to Thule as employees at an outdoor company would have insights and experiences related to the project. The goal was to gather as much quantitative data as possible, which is why both international and Swedish channels were targeted. Three open questions in the survey allowed the respondent to answer freely.

Google Forms was used, and the survey answers were automatically put into spreadsheets. Because the survey was sent out to twelve different channels, the answers from the different Facebook groups where automatically put into different spreadsheets by using different survey links for each group, this was done to detect and prevent spamming. When closing the surveys, it was revealed that 99 responses had been received from seven of the groups. The responses were gathered into one Excel spreadsheet and diagrams were compiled to easily understand the data. These can be found in Appendix B.

3.2.3.2 Interviews

Interviews with seven people of various background were conducted to understand the behaviour and needs of users familiar with outdoor activities, camping and roof top tents. The interview subjects had different experiences of performing outdoor activities and camping and a few of them had experience with RTTs. The interview subjects were found by asking friends and acquaintances and contacting scout groups in Lund as well as employees at Thule. The Thule employees all had experience from using RTTs.

The interview was parted in two sections. The first section was broad with questions about living situation and camping experience to get a picture of the interviewee’s background and opinions on camping. The second part asked questions that would bring out the interviewee’s view on RTTs, this part was adapted if the person had previous experience with the product. The interview questions were written to fulfil

"The Mom Test" and the three guidelines established in 3.2.3 User Insights. The goal with the interviews was to map and get a richer understanding of the mindset and needs of the users.

The interviews took place in meeting rooms at Ingvar Kamprad Designcentrum (IKDC) or using Microsoft Teams when they were conducted online. The interviews were recorded with the approval of the interview subjects and the two project team members took turns in asking questions and taking notes.

A document with questions was used as a framework and regularly all the questions were asked to the interviewee. When a person was vague, gave a short answer or showed passion when answering, follow up questions were asked to gain further insights.

3.2.3.3 Thematic Analysis

Thematic analysis is a method for identifying, analysing, and reporting patterns within data, called themes. Many sources notice Braun and Clarke as the creator of the method in 2006. However, they argue that their method originates from other sources which they complied and conceptualised. Nevertheless, the method consists of five key components.

Familiarisation with the data. Become familiar with the data of the interview the researchers should listen through the interview recordings and read through the transcription.

Generating initial code. The next step is to highlight and pinpoint interesting areas of the data from the interview. This can be to pick out answers or notes from the interview that capture what the interviewee said.

Searching for themes. In this phase the researchers look at a broader level and try to search for potential themes among the data.

Reviewing themes. The themes are then reviewed and considered whether they accurately reflect the data.

Defining and naming themes. After the themes have been reviewed and grouped, they get labelled according to the data they represent.

The method is dynamic and recursive, emphasising that the users might go back and forth between the stages iteratively to obtain a deeper understanding of the data and developing the analysis (Virginia Braun, 2006).

Three open questions in the survey allowed the respondents to answer freely. The answers from these questions were grouped together using thematic analysis as seen in Figure 10. The transcription software Klang AI was used to transcribe the recorded interviews, which from quotes were later taken and categorised using thematic analysis. The team gathered insights in potential user behaviour and experiences which laid the groundwork to later establish and formulate user needs.

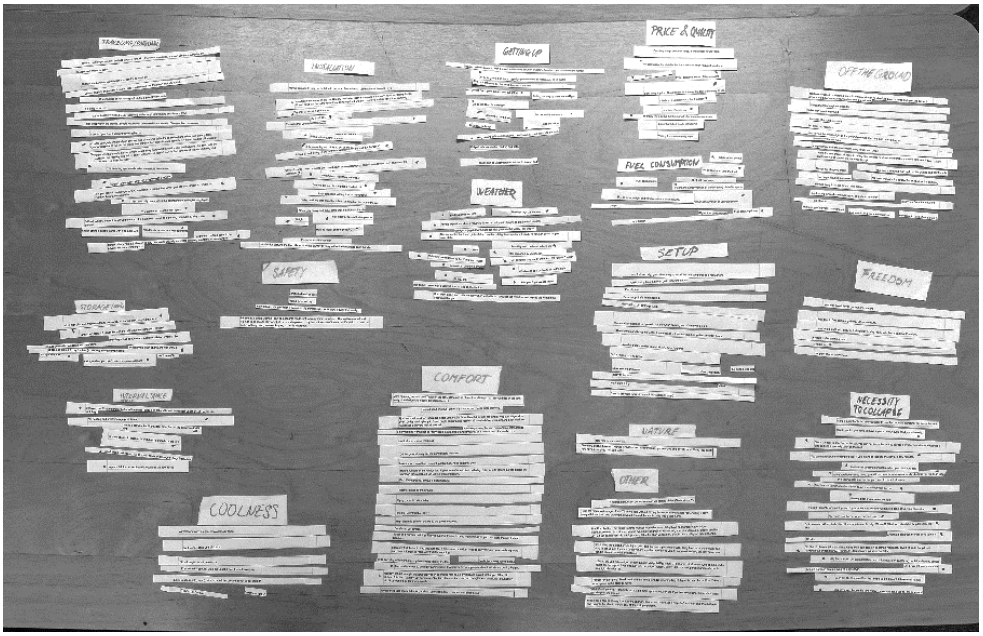


Figure 10: Responses from the survey, grouped together based on themes.
(Source: Authors' own work)

3.2.4 Ergonomic Testing

Pheasant writes in Bodyspace, (Pheasant, 2003) that it is ideal to test a representative sample of the users that will use the products in the end when performing a user trial. Questions to ask when performing tests and developing an ergonomic product is for example: Is it easy to learn to use? Are the instructions clear? Does it fit users' body size? Is it hard to make it go wrong? To understand a target weight as well as size and shape of final product, an ergonomic study was performed at a local gym called Gerdahallen. The project team chose themselves as test subjects. This choice was done since the team consisted of a male and a female, with quite average strength and height. Two types of tests were conducted first a shape and size test and later a weight test.

3.2.4.1 Shape and Size Test

The shape and size test was carried out at a local gym, it provided several different shapes of weight suitable for testing, the team chose five different objects of varying shape and size. The Swedish Work Environment Authority have created guidelines for recommended work posture and workload ergonomics. They recommend a maximum carrying weight of 25kg if the lift is close to the body within 30 cm, and maximum 15 kg if it is roughly 45 cm from the body (Arbetsmiljöverket, 2019). With these guidelines in mind two sets of weights were chosen for the test, one set

of 20 kg as well as one of 15 kg weights. The test let the subject first lift one object from the ground, hold it and walk around with it. Then the test subject lifted the weight up over their head to simulate mounting an RTT on to a car roof.

Comments were made during the test and written down after each session. Five different objects were tested in total. These were then graded on a scale of 1-5 on three different parameters, the difficulty of the first lift from the ground, the second lift above the head and thirdly the grip and handling of the object during the test. The outcome of the test can be found under 4.1.3.1 Shape and Size Test.

Figure 11: Sequence of lifting a weight from ground to above the head. (Source: Authors' own work)

3.2.4.2 Weight Test

The weight test tested a person's strength when lifting weights above their head. Starting with a low weight, then increasing to find the maximum comfortable level and lastly finding the absolute max weight for the subject. The weight was gradually increased in increments of 2.5 kg at a time. The maximum comfortable level is the point which the subject no longer finds it relatively easy to manoeuvre, and the maximum level was when the subject no longer could lift the weight above its head. The outcome of this small study was used as a guideline and to get an understanding of how heavy it is to lift a certain weight over one's head. The result from the weight test can be found under 4.1.3.2 Weight Test.

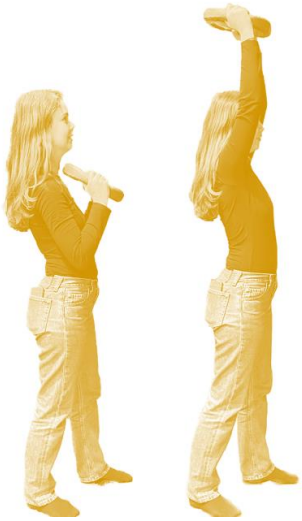


Figure 12: Sequence from the weight test. (Source: Authors' own work)

Figure 13: Weight plates used in the weight test. (Source: Authors' own work)

3.2.4.3 Bed Size Test

In the previous benchmarking in section 3.2.1, among several specifications different sleeping areas were benchmarked. The existing products offered a bed size between 115-140 cm wide and 198-240 cm high. This gave a hint of what size is best suited for an ultra-lightweight RTT. The slightly longer bed size of 210 cm, compared to a normal sized bed, allows for some storage either by the person's head or feet. This can be extra important in an RTT, compared to a normal tent, since the rest of the camper's storage will be at the ground or in the car. A test was carried out with two test subjects at a time since, keeping the length of 210 cm and testing different widths. Results can be found under 4.1.3.3.

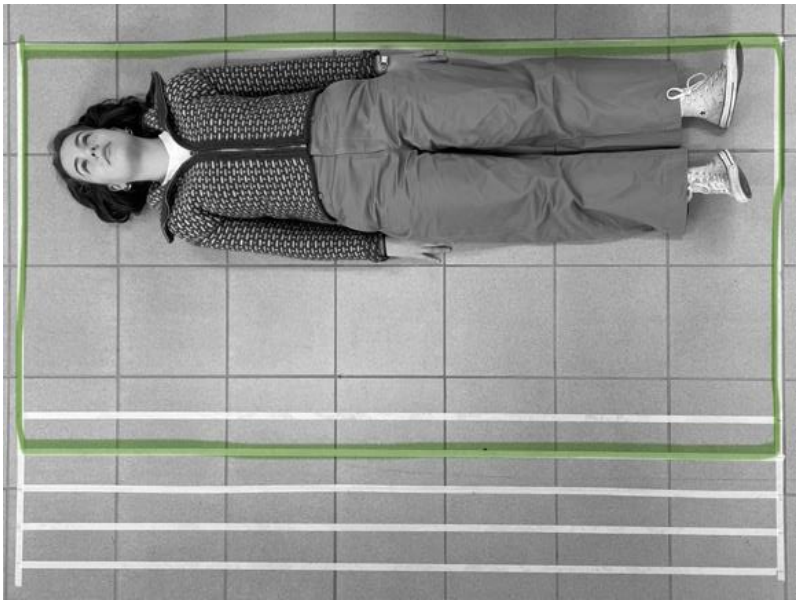


Figure 14: Bed size test with a single person as test subject, the test was carried out with two test subjects at a time. (Source: Authors' own work)

3.2.4.4 Height Test

To get an idea of what is a reasonable height in the tent, a test was conducted with three students of different gender and height. The subjects sat in the already measured area for the sleeping surface in the tent. A wooden board acting as a test ceiling was slowly lowered from a high height until the test subjects felt that they did not have a comfortable ceiling height to sit and move around under. The results of the test are presented in 4.1.3.4.

Figure 15: Height test. (Source: Authors' own work)

3.2.5 Testing Current Products

Roof top tents from various brands and with different folding mechanisms were tested. Firstly, installation and deploying of various tents were done in a warehouse environment (Figure 16). The team was able to climb into tents, feel the material and look at details of their construction. Hard-shell and softshell tents of different weights and various difficulty of assembly. To test the real-life use of the product, a camping trip with the Thule Approach S RTT was done (Figure 16). This made it possible to try out all the steps of using the products, from carrying and mounting it on the car, to sleeping in the tent.

Figure 16: Testing and using different RTTs in warehouse (left) and during a camping trip (right). (Source: Authors' own work)

3.3 Define

During Define the previously gathered user insights are compiled and translated into user needs and the problem is reformulated to a clear brief.

3.3.1 User Needs

A way to interpret customer statements from user research, is to translate the statements into user needs. Eppinger & Ulrich (2014) describes a couple guidelines when formulating user needs. It is recommended that more than one team member is involved in analysing user research data and formulating needs. This is because different needs can be interpreted differently depending on the person working with the data. The needs should be formulated as goals of what the product should achieve, not the solution. They should also be expressed as a characteristic of the product and formulated in a positive manner. When the needs have been formulated, they are edited, grouped together based on similarity and duplicates are removed. They are then classified and ranked in order of importance.

User needs were identified and formulated from interview quotes and the open survey question answers. The themes found in the thematic analysis were used to formulate the needs which later were compiled and ranked. The ranking was based on the frequency with which the needs emerged during the user study but also the team member's intuition. The categories of main, necessary, and desirable were used to classify the needs and are shown in Table 8.

3.3.2 User Journey

A user journey helps divide the whole usage of a product into smaller more manageable parts, by analysis of the actions performed when using the product (Wikberg Nilsson, Ericson, & Törlind, 2015). The user journey helps the product development team with understanding the experience of the user during the use of the product. It describes the user's actions, feelings, and how it relates to the larger context in which the product is used (Martin & Hanington, 2012). Each action of using the product is walked through step by step. Positive and negative experiences are brought up as well as pains/gains for each action. Lastly the potential solutions to the problems found during each action are presented.

Two user journey was put together to understand the different actions and feelings during the use of a regular roof top tent. Firstly, a journey was constructed which used an existing RTTs as reference, using input from users gathered during the discover phase (Figure 22). Then a desired user journey was put together to visualise what the developed product's goal scenarios would look like (Figure 23).

3.3.3 Persona

A persona is a fictional description of a person which belongs to the target group of a product. The description of the persona is usually based on the research of user behaviour from interviews, statistics, observational studies etc (Wikberg Nilsson, Ericson, & Törlind, 2015). The purpose of the persona is to focus on building a vivid description of the primary user. This helps to build empathy with the users and their needs, instead of focusing on just statistics and data.

Using the information gathered from users and research, a persona and a mood board for the persona was made and is presented in 4.2.3.

3.4 Develop

During Develop the previously gathered user insights are used as an outset for the coming concept ideation and prototyping.

3.4.1 Brainstorming

Brainstorming is a method which can be used to generate many ideas and solutions. Osborn (1953), coined four principles for brainstorming sessions, to create an optimal environment for group ideation. Criticism should be ruled out, judgement of ideas can be done later. Wild ideas and oddity are welcomed. Go for quantity over quality, the greater number of ideas, the more the likelihood there can be a winner among them. Combination and improvement are sought, one should try to build on the ideas of others. The purpose of the guidelines is to create a safe brainstorming environment for expression of ideas, free of judgement (Osborn, 1953).

Documentation of a brainstorming session is recommended to keep track and organise ideas. This can be done using Brainstorm Graphic Organizers like webs, tree diagrams and flow diagrams (Martin & Hanington, 2012). Tree diagrams communicate hierarchy, a classification system, or relationships between main and supporting ideas.

The method of brainstorming was chosen as it creates the opportunity to generate numerous ideas in a short amount of time and fits in the HCD approach. The team started the concept development phase by conducting several brainstorming sessions with the guidelines in mind. Some of the sessions started with individual sketching that continued with a joint brainstorming session to develop the ideas. The idea of tree diagrams where used, as the product was first broken down in different categories. The ideation was done on one category at a time to later merge ideas and categories. Sketching was done on a whiteboard initially, followed by sketching on paper.

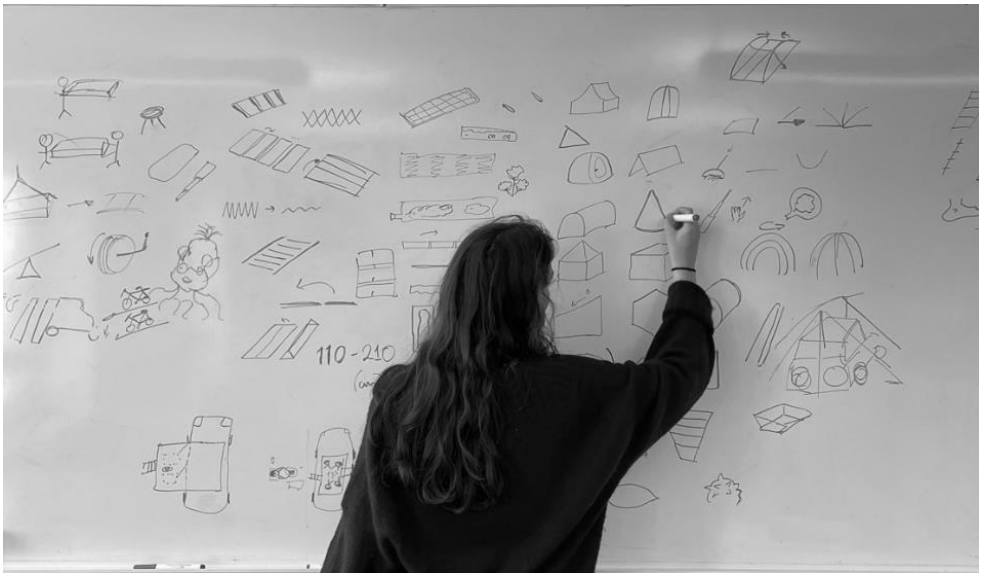


Figure 17: Initial brainstorming session. (Source: Authors' own work)

3.4.2 Parallel Prototyping and Roleplaying

Parallel prototyping is a method that involves quickly creating low-fidelity prototypes of concepts, then testing these prototypes with users or experts (Martin & Hanington, 2012). It helps a design team to avoid fixating on one design, instead a wide range of opportunities can be experimented with and investigated before committing to one solution. Early solutions can be refined and merged into an optimised design. The method allows designers to reflect on the different features of the design and how those fulfil the goal of the design.

The method of role-playing has the purpose of better understanding the user in a more realistic scenarios to detect challenges and opportunities in the design, as well as developing empathy for the user (Martin & Hanington, 2012). The designer takes on the role of the user, taking on assumed behaviour patterns that might be experienced in actual user scenarios. Props and prototypes assist to better test design suggestions.

The team combined brainstorming sessions with parallel prototyping and role-playing, to come up with a wide range of solutions and reflect on how the people using the product will respond to the design. Small scale and full-scale prototypes were built to test ideas before continuing working with them. The small-scale prototypes were built quickly with steel wire, cardboard, polystyrene, and Lego. The full-scale prototypes were mostly out of wood and built to test mechanisms, size, and handling of the product.

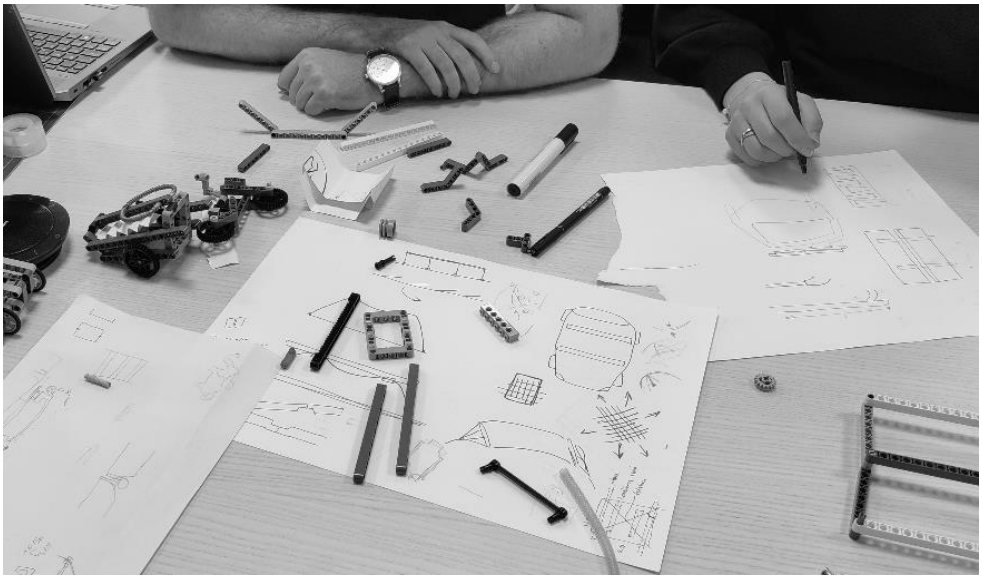


Figure 18: A brainstorming, prototyping and roleplaying session. (Source: Authors' own work)

3.4.3 Concept Selection

Concept selection is a process where several concept alternatives are reduced and the decision on what to develop further is made. The current ideas are compared and evaluated according to criteria or customer needs. According to Eppinger & Ulrich, there are several different methods that can be used when evaluating and selecting concepts. Though, a structured method is preferred. It can help the team stay objective and provide documentation of the selection process (Eppinger & Ulrich, 2014). Evaluation of concepts can for example be done by discussing in the project team, consulting an expert, or performing a concept scoring matrix.

The ideas and concepts developed were continuously evaluated using different methods, which depended on the complexity of the decision to be made. When making critical concept decisions, the team adapted the main selection method used by Thule. Decisions were based on building prototypes and performing tests. The supervisors from Thule acted as an external resource and helped guide the decision making. Smaller design decisions were made using discussing pros and cons and the intuition of the team.

3.5 Deliver

Deliver is the phase where the solution is finalised. The methods included are similar to previous phases, such as brainstorming, parallel prototyping and testing, but in deliver they are used to take the solution from concept to reality.

3.5.1 Prototyping and Testing

Norman (2013) writes that the development team should seek feedback from users during this stage of implementing the product. This way usability issues and opportunities for further development can be identified. The prototypes that are created during the deliver phase are close to the final product in terms of look, feel and how the user can interact with them. By working with brainstorming and simple sketches to develop full scale prototypes and CAD models, a final working prototype was manufactured. During this process users were involved in gather insights in the handling of details and improve the chosen concept.

4 Result

This section describes the results from the four development phases – Discover, Define, Develop, Deliver.

4.1 Discover

4.1.1 Mood Boards

Mood boards with inspiration from different products were assembled. Two interesting products stood out as extra relevant and the team drew most inspiration from during development from these. This was a rock-climbing bed and a field bed. These products both featured a stretched fabric around an aluminium frame and created an easily assembled and lightweight sleeping surface.

Figure 19: Inspiration regarding tents. A rock-climbing bed is featured in the middle.
(Source: Authors' own work; individual pictures from internet)

Figure 20: Inspiration of foldable and items. A field bed can be seen in the bottom left corner.
(Source: Authors' own work; individual pictures from internet)

4.1.2 Benchmarking

A quick benchmark was conducted in order to compare what is currently available on the market. The primary criteria were the type, weight, sleeping area and price. This gave the team a general development direction, with some approximate numbers, for example aim for a weight lower than the most lightweight alternative.

Table 2: Benchmark of available products from competitors to Thule.

Model	*Type*	*Size opened (W*L*H, cm)*	*Size closed*	*Sleeping area*	*Weight* (kg)	*Price (sek)*	*Elements protection*	*Estimated setup time*
GT Roof	Inflatable	150*330*140	140*112*15	140*220	31	34 260	Waterproof	5-10 min* simple
IO Lightweight	Soft shell wedge	127*208*122	127*208*10	122*198*4	34	13 558	Waterproof 2000D	2 min simple
RoofPod CoziPod	Hard shell	126*236*140	126*236*27	115*230*7,5	35	14 042	Waterproof canvas	2 min simple
Wild Land Lite Cruiser	Soft shell	210*120*95	110*125*32	115*210*7	38	14 970	210 D 2000 mm	2 min simple
Front Runner	Soft shell	244*130*133	133*125*33	121*199*6	43	13 629	Waterproof 400D	5-10 min several steps
Safari	Soft shell	245*145*143	126*145*26	140*240*7,5	48	14 990	3000mm	3,5 min several steps
ADV Edge Lite	Hard shell	210*125*130	125*210*17	120*210*6	50	24 568	500 mm	2 min simple
Lillskutan 140	Soft shell	240*144*130	124*144*35	140*240*8	53	15 990	3000 mm 200D	“Few minutes”
Wera Adventure	Soft shell	240*165*130	124*173*29	140*240*6	53	15 900	Waterproof	“Few minutes”
James B Space	Hard shell	198*140*145	200*142*34	140*198	56	40 999	Waterproof	Simple

4.1.3 Results from Ergonomic Study

4.1.3.1 Shape and Size Test

Different objects were scored on a scale from 1-5, 1 was the highest rating and 5 the lowest (Figure 20). The result is an average of the team's rating. Observations and comments from the test are presented below in Table 3 and Table 4.

Figure 21: Equipment used during the shape and size test. From left, Bulgarian bag, grip bag, core bag, plate, kettlebell. (Source: Authors' own work)

Table 3: Result from the shape and size test.

Object	*From ground*	*Above head*	*Grip*
Bulgarian bag	3	2.5	4
Grip bag	4	5	5
Core bag	1	4	1.5
Plate	5	1	2
Kettlebell	2	2.5	2.5

Table 4: Observations from the shape and size test.

Bulgarian bag	Awkward shape, difficult to get a good grip if not using the handles, ok to lift from ground.
Grip bag	Loose shape, moves your hand, puts a lot of effort on the grip.
Core bag	Good grip, easy to lift from ground difficult above head, without the handles it's a difficult shape to grab.
Plate	Challenging to lift from ground, tricky to get a grip, stable to lift above head.
Kettlebell	Good grip, stable in your hand, requires a switch to lift above head.

4.1.3.2 Weight Test

The results were different for the two test subjects, as expected, and highlight what an approximate max weight should be (Table 5). The established max weight of 20 kg was not to be used as a definite maximum limit for the final product's maximum weight, but rather a guideline.

Table 5: Result from weight test.

Subject	*Max comfortable weight*	*Max weight*
Person 1	17,5 kg	20 kg
Person 2	25 kg	27,5 kg

4.1.3.3 Bed Size Test

Below are the results from the bed size test presented. Since a smaller bed will result in a smaller and more lightweight tent, the team decided to go forward with a bed size of 110x210 cm.

Table 6: Results from the bed size test.

Subject	*Minimum comfort width*
Pair 1	115 cm
Pair 2	110 cm

4.1.3.4 Height Test

The results were quite similar even though the test persons were of varying height. An average of minimum comfort height would be 103 cm. Taking the anthropometric measurements of sitting height in regard from Table 1, a sitting height of 100 cm would be reasonable for the ultra-lightweight RTT.

Table 7: Results from the height test.

Test subject	*Minimum comfort height*
Person 1, 165 cm	104 cm
Person 2, 183 cm	105 cm
Person 3, 196 cm	100 cm

4.1.4 Results from Product Testing

The team established a profounder understanding of the product and the hardships and gains of using it. This developed greater empathy for and mindset like the target users'.

Some main points were identified during product testing:

- Difficult, but not impossible for two people to install Thule Approach S on the car. The installation process is not pleasant due to the heavy weight of the tent and there is a great risk of damaging the car when installing and removing the tent.
- Current tents do not have handles and surfaces that allow the user to easily grip and carry the product. Hard metal is not pleasant to touch and makes it difficult to get a proper grip.
- The view from the tent is a major priority. Especially for an RTT which can allow for extraordinary views since it is used on the height of a car.
- It is important to consider designing proper ventilation as moisture gathers on the inside of the tent during use. This prevents development of mould and leads to a more pleasant indoor environment. The user should also be able to easily dry the tent after use.

4.2 Define

4.2.1 User Needs

From the thematic analysis performed (section 3.2.3.3), several needs were formulated and categorised as main, necessary, or desirable. As previously mentioned, the ranking was primarily based on the frequency with which the needs emerged during the user study but also the team members' intuition. The needs are visualised in Table 8.

Three main user needs were identified, which the final product should fulfil:

- The product takes up *minimal space*.
- The weight of the product makes *single person installation* possible.
- The product allows the user to be *spontaneous.*

Table 8: User needs, categorised with main (M), necessary (N) and desirable (D).

Storage	**Takes up minimal space**	**M**
	Can be stored in a closet, storage room, attic or similar	D
Comfort	Soft, supportive surface to lay on	D
Activities	Allows the user to preform outdoor activities.	D
	The size allows the user to bring equipment for outdoor activities.	D
	Allows the user to experience nature, peace and quiet	D
Safety	The user feels secure and protected	N
	Protection from small insects	D
	Protection from large animals	D
Installation	Installation steps are logical	N
	Installation steps are easy and quick	D
	Risk of damaging car is low	D
	The weight makes single person instalment possible	**M**
Set Up	Assembly and disassembly are easy, quick with not too many steps	D
	Assembly and disassembly are logical	N
	Works with different ground surfaces	N
	Compatible with standard parking spots	D
	The inside stays clean, even when unpacking	D
	Possibility to use car after setting up camp	D
	Easy to dry	N
Why?	Allows the user to experience a pretty view	N
	Allows the user to be spontaneous	**M**
Where?	Suitable for different ground surface	N
	Compatible with regular parking spots	D
Getting in	It is safe and clear how to get up and down	D
	Easy to enter and leave	N
	Easy to get dog inside	D
Size, Volume	Possibility to sit in the tent	N
	Place to store bags and other equipment	D
Durability	Withstand use and abuse for a long time	N
Accessories	Allows storage and organisation	D
Weather	Allows feeling of security when windy	D
	Suitable for different environments and weathers	N
	Durable against sun and UV-rays	N
	The inside environment is cool and ventilated	N
	Protects from the cold	D
	Protection from elements like rain and condensation	N
Coolness	Feels fun and unusual	D
Fuel	Does not increase fuel consumption much	D

4.2.2 User Journey

Two types of user journeys were made, Figure 22 depicts a typical RTT user journey and Figure 23 explores in which areas an ultra-lightweight RTT would improve the user experience.

The focus for the development of the product was the weight saving. Figure 23, highlights which actions the user would benefit the most from a lighter weight. The team identified that lower weight would be most favourable during installation, handling, and storage, in other words when it is not in use. It was discovered that a sacrifice could be made in the efficiency of setup and collapsing of the tent, this was verified by the user study. This is further commented in Figure 24.

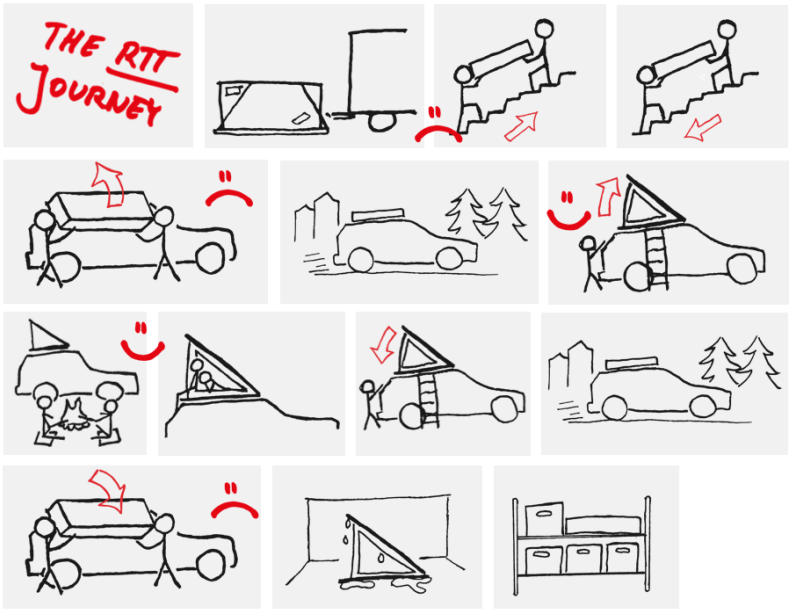


Figure 22: User journey for the current RTT. (Source: Authors' own work)

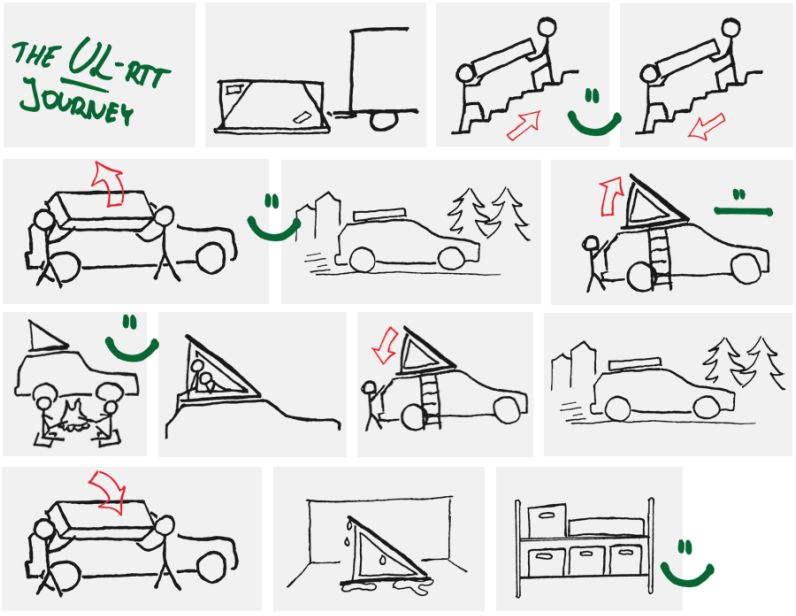


Figure 23: Desired user journey for an Ultra-lightweight RTT. (Source: Authors' own work)

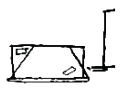
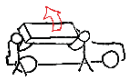
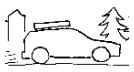
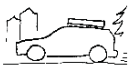
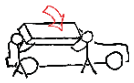
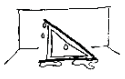
ACTION	EXPERIENCES	PAINS/GAINS	OPPORTUNITIES
 Delivery	Single person has difficulty picking up	- Big, heavy	Lighter, smaller package Several parts
 Unpacking, storing	Difficult to access storage space Needs to be carried up/down stairs	- Big, heavy - Small space - Difficult to get a grip	Smaller size Lighter Grabbable surface
 Taking out of storage	Feeling hesitant and remembers previous action as laborous		
 Installment of RTT to car	Scared of damaging car	- Tight space - Risk of damaging car - Switching grip - Orientation of RTT - Reaching into fasteners	Soft material/shape Visualise orientation Access from every side of car
 Traveling	Worried about ability to reach destination Worried about that RTT is fastened correctly	- Fuel consumption - Noise	Aerodynamic shape
 Setting up RTT	Feels weird having to climb inside tent when pitching	- Terrain without angle - Fidely pitching of tent	Always flat sleeping angle Intuitive, easy set up
 Hanging out	Cooking on the ground while others are inside feels lonely	- Using the car after setting up camp - Separation of ground and roof camp	Taking of the tent after pitching Creating continuos camp environement
 Staying inside tent	Nice views from top of the car, space in tent is small	- Taking shoes off - Reaching items inside car - Humidity and moisture - Tight space to change, organise - Noise + View	Space for personal items Ventilation Space for sitting up Openable sections
 Collapsing RTT	Fiddely when reaching to tuck in canopy	- Putting on rain cover - Dirt, moisture can get inside tent - Canopy blocks folding mechanism	
 Traveling home	Looks forward coming home		
 Removing RTT	Feels easier letting the tent stay on the roof, than removing it immediatly	- Releasing and collecting fasteners - Heavy lifting	Easier lifting/dragging/ pulling
 Drying		- Finding space for drying	Ability to dry in small space
 Storing		- Takes up storage space	Smaller size, store in different places

Figure 24: User journey with comments about each action. (Source: Authors' own work)

4.2.3 Persona

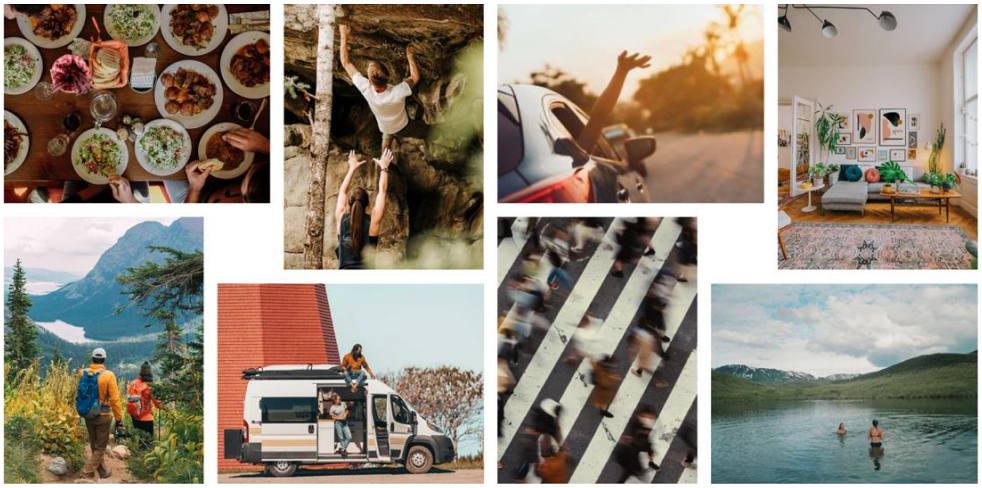


Figure 25: Mood board for persona. (Source: Authors' own work; individual pictures from internet)

Using insights from the discovery phase and with the user needs in mind a persona for the product was made, called *The Dreaming Couple.* Visualised in Figure 25, the persona consists of a couple, around 30 years old who lives in a medium-sized apartment in a bigger city. They both live a busy working life and long for nature and the outdoors. They dream of a life with a campervan, it feels simple and free. But that is not within their current financial abilities. Both are committed to and enjoy their careers in the city. They would like to get the best of both worlds by staying in the city during the week and going on road trips and adventures on the weekends. They are environmentally conscious and have an interest in quality products. Thorough research is made before purchasing with the goal of finding and using products that last.

4.2.4 Product Requirements

Specifications for the product was established from the initial research, ergonomic testing, user study and from definition of needs. Criteria were first put together by the team and then evaluated with the supervisors from Thule. The requirements were separated into hard- and soft-requirements. These was later used as guidelines during development and to evaluate how successful the final concept turned out.

Table 9: Hard product requirements.

Hard criteria	*Value*
Bed size	110x210 cm
Sitting height	100 cm
Weight	25 kg/package, total max 75 kg
Water resistance	Sloped roof
Use existing mounting system	Yes, optional
Use existing ladder	Yes

Table 10: Soft product requirements.

Soft criteria	*Comment*
Sense of security	Yes
Aesthetics	Existing brand aesthetics of Thule
Size/shape folded	Feels easy to store
Setup	More time/steps than regular RTT
View	Yes (important)
Light intake	Yes

4.2.5 Final Brief

A final brief was formulated, based on the insights from the discover and define phase:

The ultra-lightweight roof top tent can fit two people and enables *spontaneity*.

- It can be stored in a *medium sized apartment/small storage/wardrobe*.
- It *feels easy to use*, from storage to setup.
- It is for the *urban person*, wanting outdoor experience.

4.3 Develop

The following section explains the results from the develop phase.

4.3.1 Initial Brainstorming

During the brainstorming different elements of the RTT were in focus. with the brief in mind. To simplify the product and the problem, the team decided to continue working by focusing on the two main components of the tent: the *base*, and the *canopy*.

Figure 26: Sketches from initial brainstorming. (Source: Authors' own work)

4.3.2 Base Development

As an RTT is mounted to the roof of a car, which in most cases is not flat, some kind of flat base is needed. Existing base solutions are very heavy and are not suitable for an ultra-lightweight RTT. Therefore, a new solution is needed.

After taking inspiration from everyday items as well as the mood boards created in 4.1.1, different ideas for concepts were formed, these are showcased in Figure 27. Inspiration came from beds, chair, trampolines and much more. Some of the ideas presented have taken inspiration from woven ribbons, slate beds, and porta-ledges.

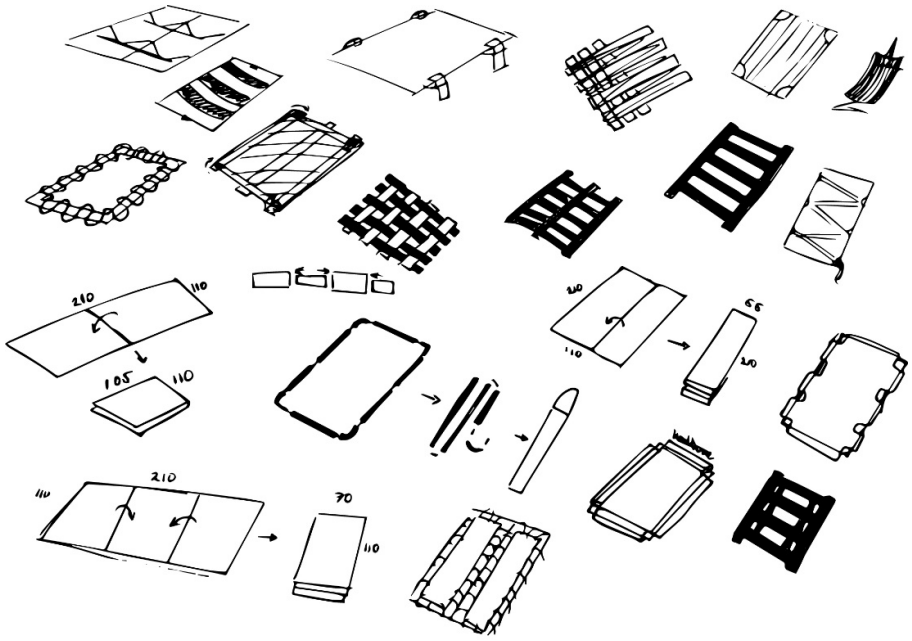


Figure 27: Ideas for the base. (Source: Authors' own work)

The ideas for the base, were discussed to define what ideas to work further on (Figure 27). Assumptions were made regarding weight, ease of use, interface with roof racks and manufacturability. From the discussion two different paths ahead were defined, the ideas around bed slats and stretched fabric would be developed, and defined, these are shown in Figure 28. While discussing initial base concepts with the supervisors at Thule it was decided to continue working with the idea of a camping bed, using fabric stretched around a frame. It seemed to be reasonable from a research standpoint as the company had not worked with a similar concept before.

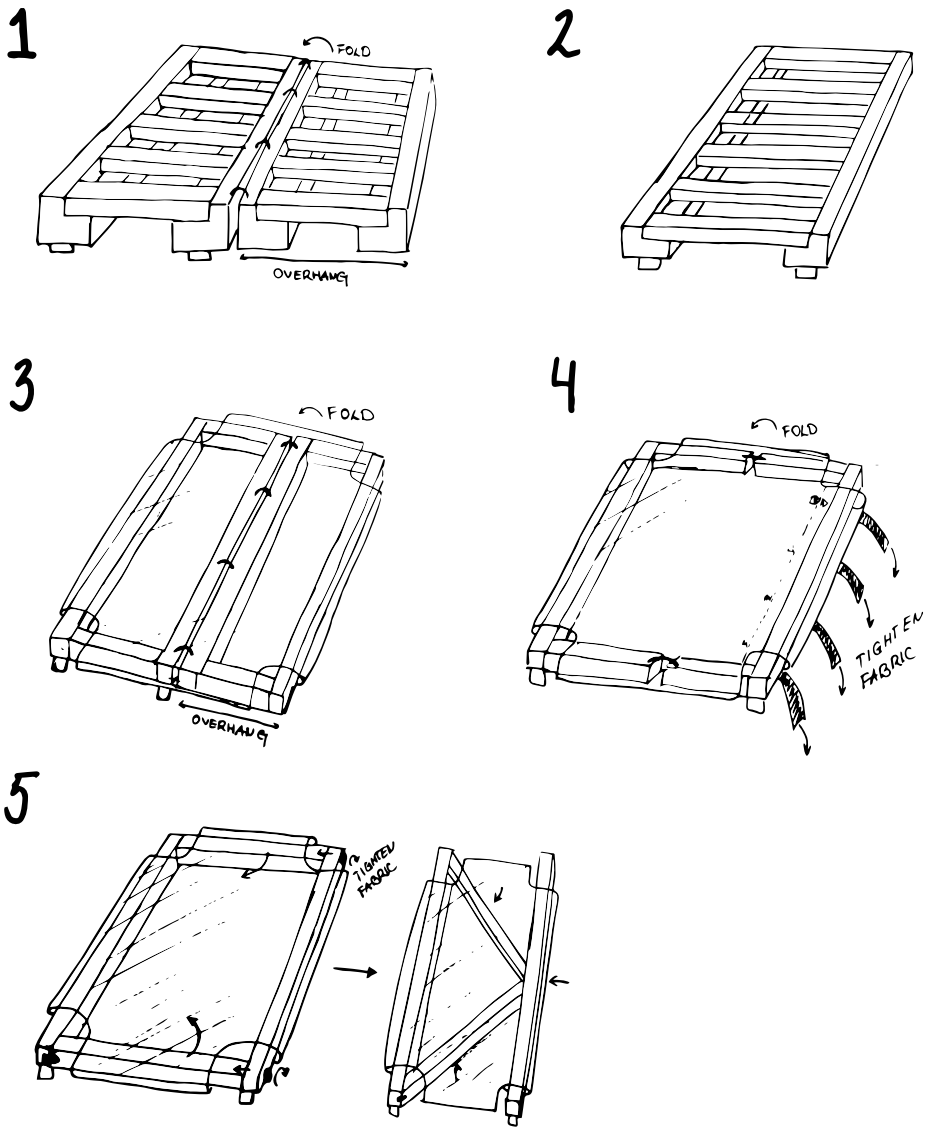


Figure 28: Sketches of five defined base alternatives. (Source: Authors' own work)

4.3.2.1 Prototyping and Testing

To test how a stretched fabric preforms the team purchased a field bed to test and analyse. Overall, the test subjects liked the bed, it was relatively comfortable even though it lacked a mattress, however movement in the fabric spreads easily. The team recognised that a stretched fabric would perform the best if it is released from tension in its folded down position.

Prototypes in 1:2 scale were built to visualise and give an idea of how fabric behaves around a frame and how it needs to be stretched. These were built out of wooden joist to get a good understanding of the frame's rigidity and handling. Pictures from the test can be found in Figure 29 and Figure 30.

Figure 29: Testing of alternative three (right) and four (left and middle) in scale 1:2.
(Source: Authors' own work)

While testing the fourth concept (Figure 29), it was discovered that it was difficult to get enough tension when tightening the fabric with straps. Utilising a fold in the middle of the frame, like in the third concept, resulted in an uncomfortable surface that also did not provide enough tension in the fabric. Testing of the fifth alternative, shown in Figure 30, resulted in a base which had enough tension and provided a tight surface to lay on. The frame was tensioned from the short sides, allowing the fabric to tighten enough. An improvement of the concept was directly realised as the fabric could easily be exchanged for a material with greater stiffness, like trampoline mesh. To prevent the fabric from sagging during use, a middle beam was utilised. An observation from the test was to make enough height between the fabric and the roof racks, as they would otherwise contribute to an uncomfortable surface.

Figure 30: Testing and development of the fifth base alternative. (Source: Authors' own work)

4.3.2.2 Selection of Fabric Frame Concepts

The three variants of stretched fabric were built and reviewed. In the end, variant five shown above and in Figure 31 was continued with. This concept would only be compatible with roof racks with a width of around 115 cm. After discussing with Thule this seemed like a relevant trade off, the concept would lack some compatibility in favour of having have a simple and lightweight design. In the future, an adapter could be developed to accommodate smaller roof racks. The chosen solution also enables the fabric to rest in its folded down position.

A full-scale test of the fabric frame concept was done at Thule. This allowed the team to confirm that a fabric frame concept can work and that the roof racks do not get in the way for the person inside the tent. Some smaller adjustments must be made for the concept to work, like a different fabric, a bar in the middle, and having the fabric stretched a bit higher up.

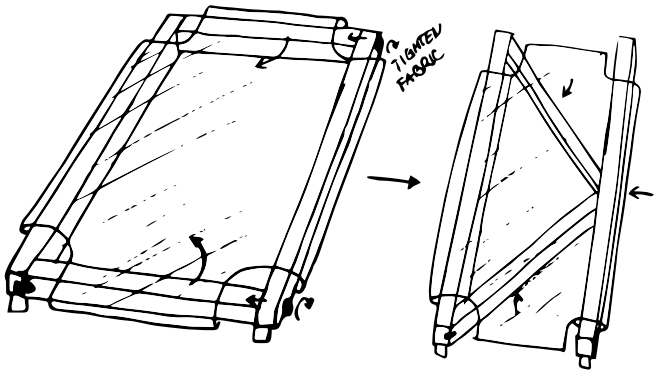


Figure 31: Chosen base solution. (Source: Authors' own work)

The chosen concept consists of four main bars, two longer and two shorter. The bed is deployed when the two long bars are pulled apart. Once almost fully extended the short sides fold out. On the short sides a tensioning mechanism makes the fabric completely stretched. One side stays secured to the roof racks with Thule's Mounting Brackets. The other slides on top of the racks. It was decided to not use Mounting Brackets to fasten the sliding beam since the user would have to do a lot of tightening and untightening.

All bars fold into a long but compact package. The package has the shape of a ladder or a pair of long skis. It can be challenging to handle in some situations however the manoeuvrability is significantly better than a conventional RTT. The form factor allows for versatile storage when not in use.

4.3.3 Canopy Development

Alongside the sleeping area another important part of the tent is the canopy. The shape of the canopy is made by stretching fabrics over a framework of poles. On conventional RTTs it is common that the poles are fixed and as the tent opens the fabric is stretched.

4.3.3.1 Canopy Concepts

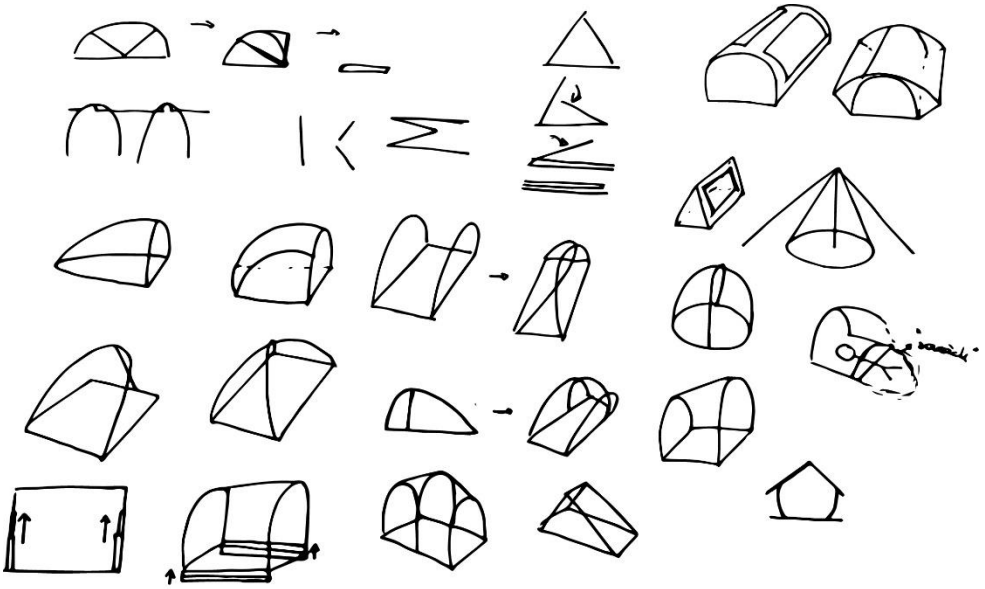


Figure 32: Canopy ideas. (Source: Authors' own work)

Different shapes were sketched to illustrate how the canopy would both look and function. Following our product requirements in Table 9: Hard product requirements, it was crucial that the roof would be sloped to allow proper rainwater drainage. It was decided that regular tent poles would be used for stretching out the canopy. Tent poles are both familiar to users which creates easy handling as well as a very lightweight option. Using this solution would create a minimalist, simple and light-weight tent.

4.3.3.2 Prototyping and Testing

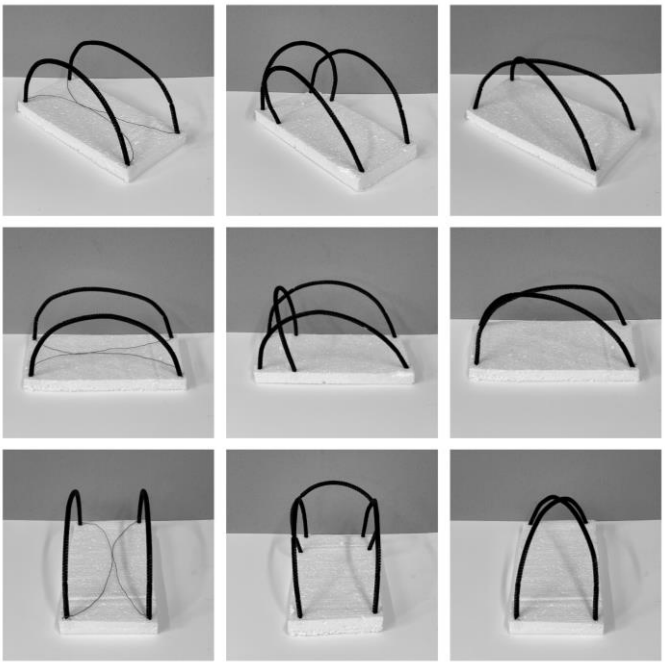


Figure 33: Three variants of how tent poles can be used. (Source: Authors' own work)

The team used styrofoam boards and pipe-cleaners to explore possible tent pole designs. Along the way some conclusions were drawn; fewer poles lead to less weight and complexity, but too few can lead to insecure stability. The stability got better when poles were crossing each other. Two or three poles seemed optimal. The team also explored the storage of the poles when the tent is unfolded. It could save a lot of hassle if the tent poles do not have to be fully ejected. Solutions where the poles could stay in the tent all the time, only loosen, or come out halfway were explored. If the poles do not get in the way of a fold or if they collapse in the same direction as the rest of the tent they could stay in the tent. This can save a lot of time during deployment of the RTT.

4.3.3.3 Selection of Canopy Concepts

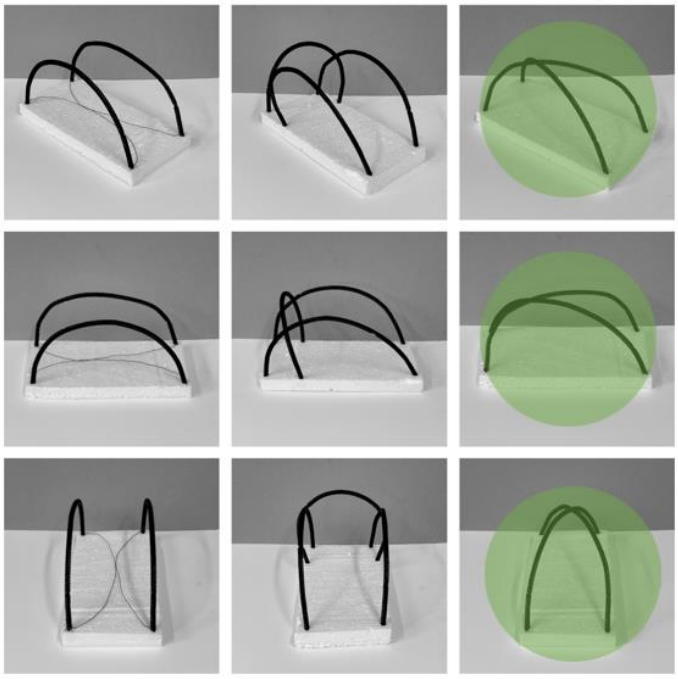


Figure 34: The chosen canopy concept highlighted in green. (Source: Authors' own work)

All the previously mentioned aspects were brought into consideration and evaluated to arrive at the best solution for our needs and product requirements. The result was to go with a conventional two pole solution were the poles go diagonally from one corner to another, as shown in Figure 34. This creates a very rigid and lightweight solution. The poles would have to be ejected somewhat in the tent's folded down position, but a large part of the pole could remain in the groove.

4.3.4 Complete Concept Development

The complete tent consists of a base and canopy. Concepts for these parts were prototyped and tested together to see how they would work as a complete unit. This gave an understanding of the interaction between the parts, what worked and what needed to be improved.

4.3.4.1 First Iteration

At a visit to Thule the team created a first working prototype concept with a fabric base frame and a lightweight dome tent. Figure 35 briefly showcases the deployment of the tent. From its folded position the long bars of the base extend to the full width and secures and creates a bed. The tent is then pitched by putting in the last part of the tent pole in the groove of the tent, on one short end. The tent poles are attached to the base on the other short end.

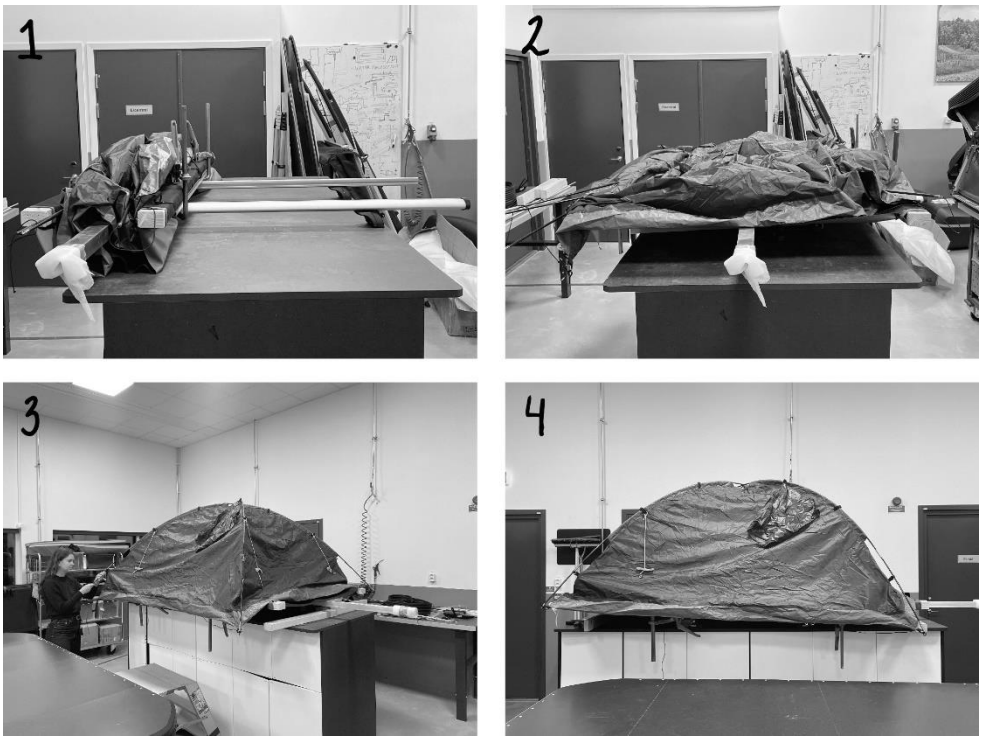


Figure 35: Demo of the first iteration at Thule. (Source: Authors' own work)

The complete tent was collapsed and the handling of it in its storage mode was tested, as seen in Figure 36. A reflection from the test was that the shape was long which made it somewhat cumbersome to handle. But as the construction was not heavy it was easy to walk around while carrying it. It was like carrying a pair of skis or a ladder. The handling was vastly improved compared to a regular RTT.

Figure 36: Testing the size and handling of the complete tent when collapsed.
(Source: Authors' own work)

4.3.4.2 Second Iteration

When evaluating the first iteration of the combined canopy and base it was evident that the concept fell short in the soft criterion of aesthetics, as seen in Table 10. The construction of the canopy did not match the brand identity of Thule and therefore a second iteration was developed. The construction of the base would not be changed as it fulfilled the product requirements, and a new canopy could be compatible with the base.

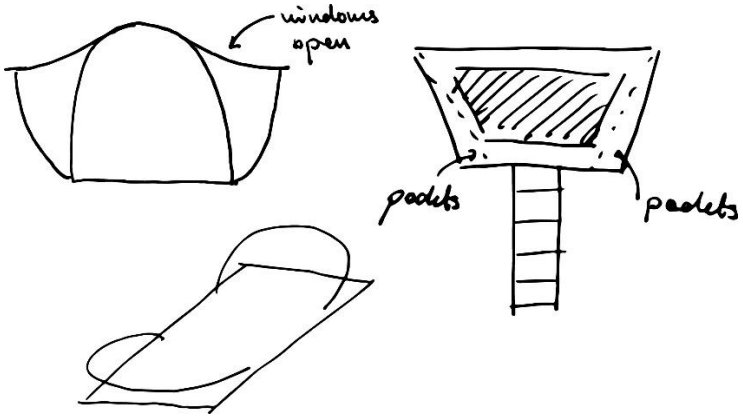


Figure 37: Early sketches of second iteration. (Source: Authors' own work)

This second version also utilised tent poles but reworked and with a different deployment method. The method is presented in Figure 38. First everything is in its folded down position and the poles lay flat, secondly width is created by sliding the long beams apart. Thirdly the poles are folded outwards from each other, a strap keeps them at the correct distance. Finaly pressure is applied by pulling in the side straps. This creates a round shape.

Figure 38: Model showing the pitching of the second iteration. (Source: Authors' own work)

However, when evaluating the second iteration it was discovered that the pitching mechanism would be difficult to achieve and would require more time to develop and test. Given more time to develop the pitching mechanism or use inflatable tubes, the shape would be possible. Due to a lack of time and many uncertainties the first iteration was chosen to be the final concept.

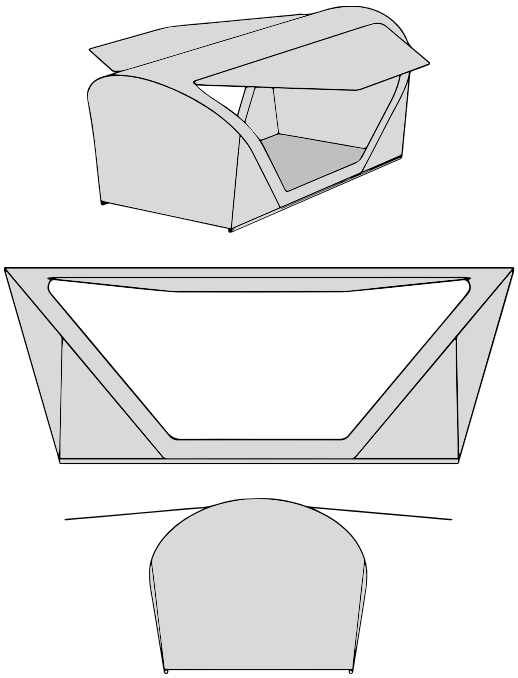


Figure 39: CAD-model of the second iteration. (Source: Authors' own work)

4.4 Deliver

The following section presents the result from the Deliver phase.

4.4.1 Testing of Full-Scale Prototype

Figure 40: Full test at height of 150 cm with full-scale prototype. (Source: Authors' own work)

In Figure 40 the whole assembly and disassembly of the RTT is showcased. It begins stored in for example a basement or in a closet. The installation process was tested at a height of 150 cm, closely resembling the height of a car roof (measurements established in section 2.2.1). The package is first mounted and secured to the roof racks on one side to the, by utilising Thule mounting brackets. The other side is loosely secured as it slides on top of the roof racks when straps (yellow) are pulled, to extend the base. After that the short ends fold open and gives the fabric tension by pushing on the long sides. The base is then fully extended, and the fabric has enough tension to provide a sleeping surface. Then the pitching of the tent starts.

The two tent poles are always resting the grooves of the tent, except for a small part of the poles. The user pushes in the last part of the pole to pitch the tent. Either one pole at a time or both simultaneously.

The disassembling of the tent is done in reverse order with the poles. Pressure is released from the short sides and the short bars are folded in. The user can then utilise the same pulling straps as before to collapse the long bars. Lastly the package is secured with the two straps to hold it in place when transporting.

Some key takeaways from this test were found. As it is difficult to reach on top of the tent, it is useful to have straps to pull the long bars apart, these straps can also be used to pull the bars together and collapse the package. A large part of the tent poles is kept inside the tent during storage. A solution for securing the part to the side of the tent, would make it easier to locate and push in.

4.4.2 Final concept components

4.4.2.1 Base

The base structure is foldable as the short sides are secured by a hinge on one long aluminium beam and can slide in a track trough the other long beam, as seen in Figure 41. By using this construction, a long and compact shape is achieved when collapsing the base. The middle long beam shown in Figure 41 has the purpose of distributing the weight and should prevent sagging of the base fabric when two persons are laying on it.

In Figure 42, the profiles of the two long beams are shown. To use the already existing Thule Mounting Brackets, their existing mounting profile is used on the underside. The mounting brackets should only be used on one side, the other side can be secured with Velcro, straps, or another solution, to enable the sliding mechanism over the roof racks. In addition, the two long beams utilise a keder rail, in which the base fabric is slid on (Figure 43). The fabric and keder is secured by plastic end caps (not shown in figure) which prevents sliding of the rail.

The base fabric is given a sufficient amount of tension from turning the knob on the underside of each short beam. Turning of the knob makes a screw push out the long sliding beam which gives the fabric tension. Keder flaps are utilised on the fabric, to secure it into the keder rail of the aluminium profile.

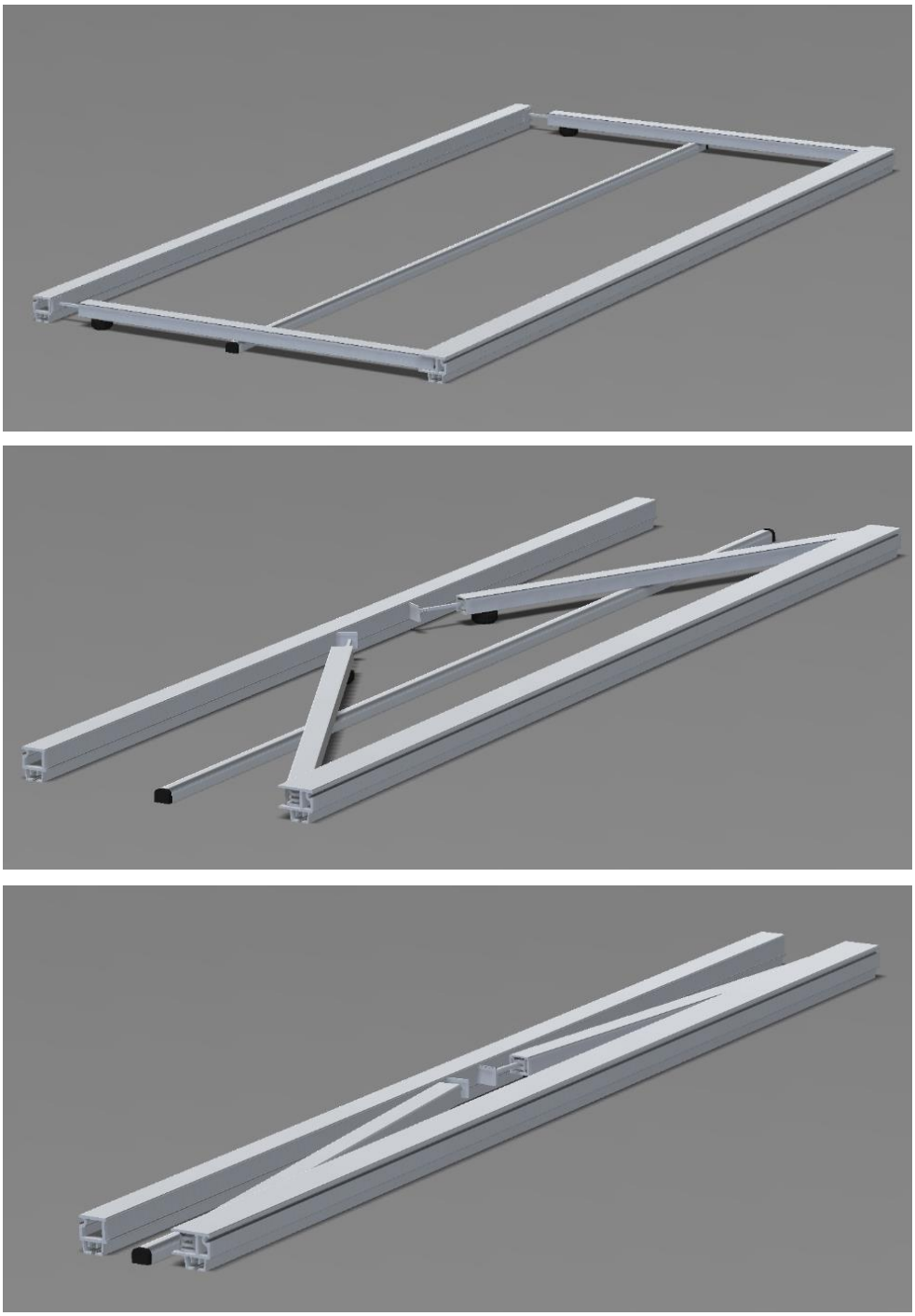


Figure 41: CAD-model of the base structure. (Source: Authors' own work)

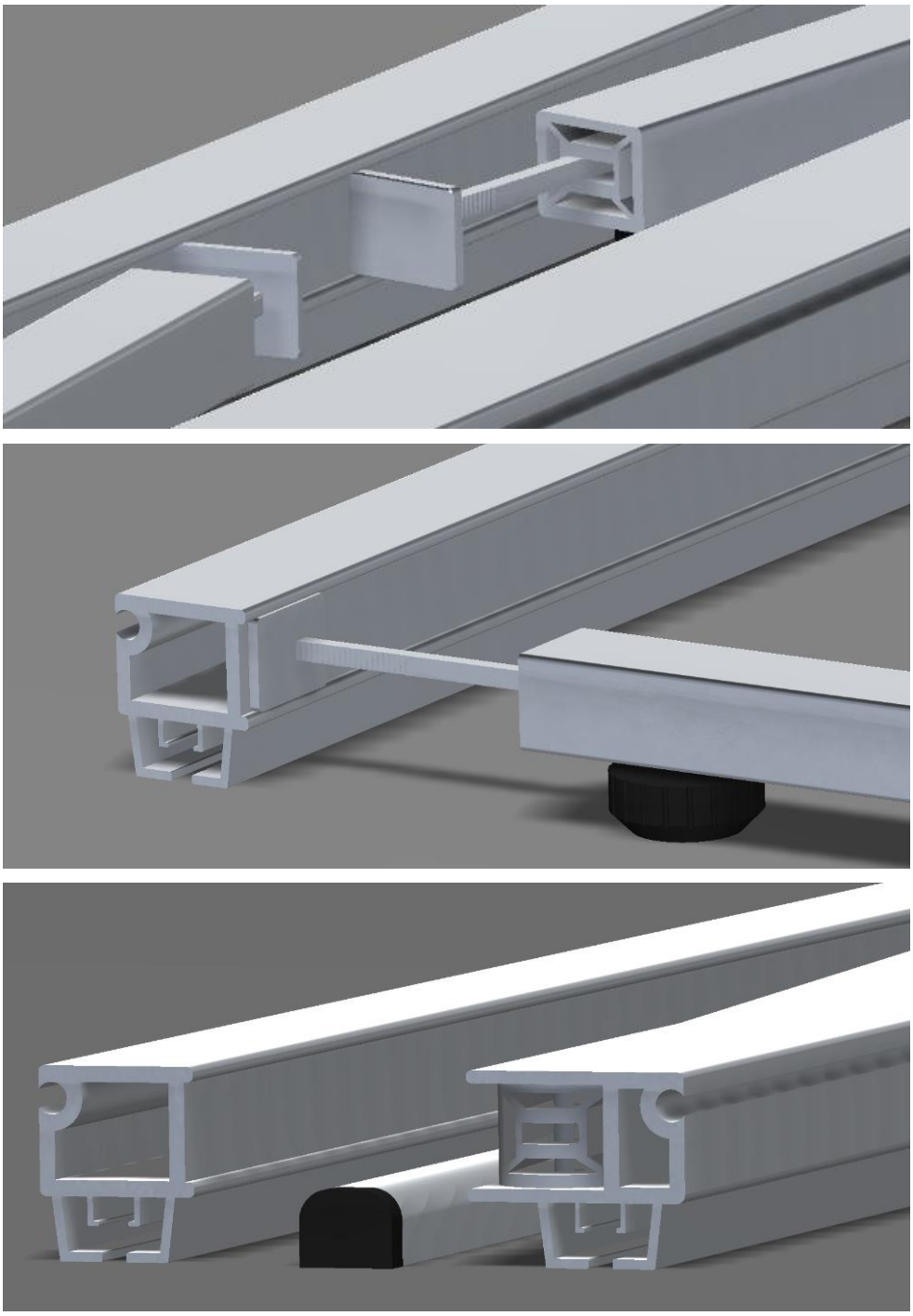


Figure 42: Details of the base structure CAD-model. (Source: Authors' own work)

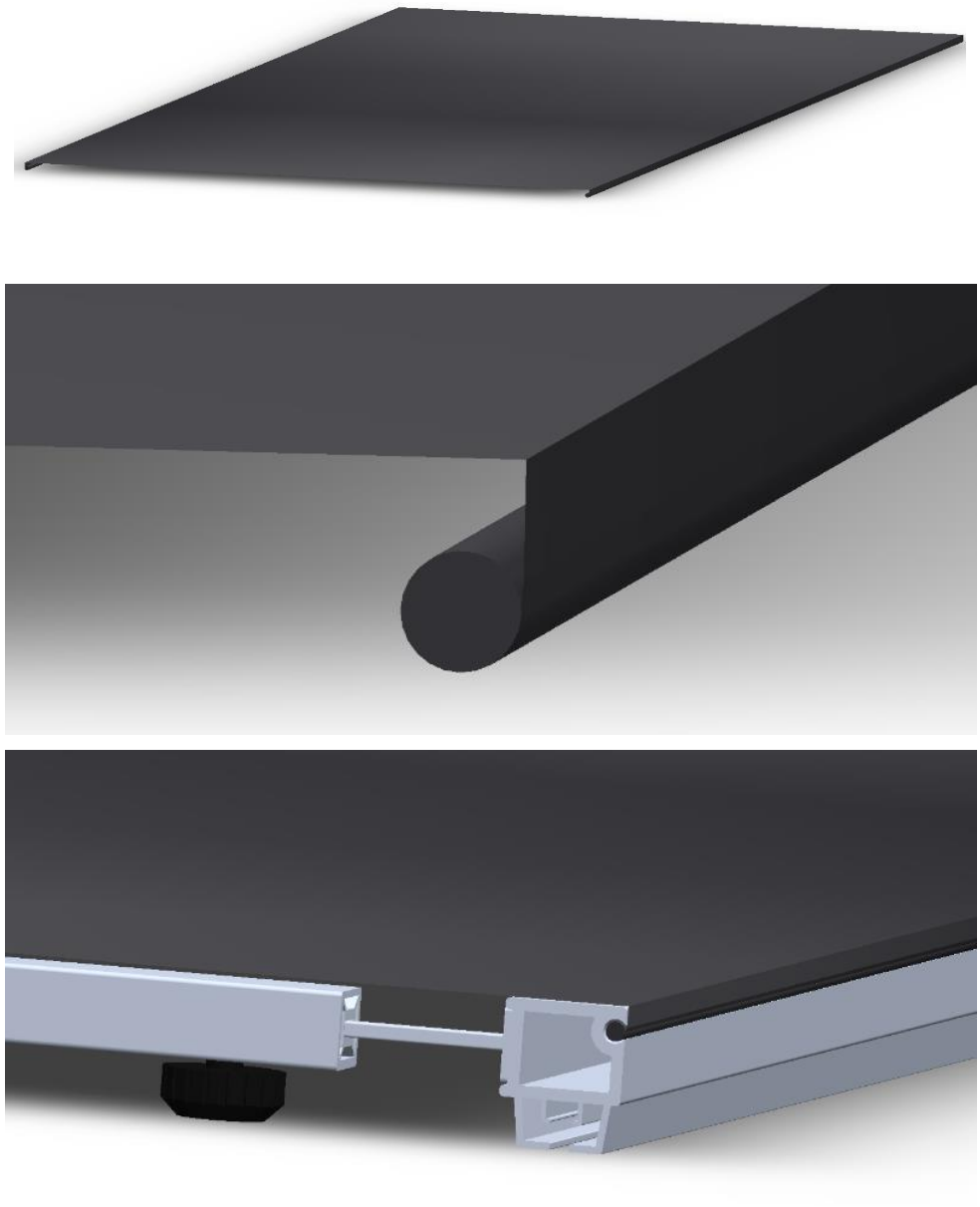


Figure 43: CAD-model of the base fabric and its assembly to the base structure.
(Source: Authors' own work)

4.4.2.2 Canopy

The canopy of the tent has panoramic, lower windows on three sides and one larger door opening, shown in Figure 44. The door is located on the long side which slides over the roof racks, to prevent the construction from tilting during impact of force. The volume of the canopy is created from the tent poles which are secured in the corners. They are secured from falling out as the grooves are closed in the ends at these corners. The other side of the groves for the tent poles are open as a short part of the poles are taken out when deploying the tent. The poles have one distinct fold to clearly show the user how much should be taken out.

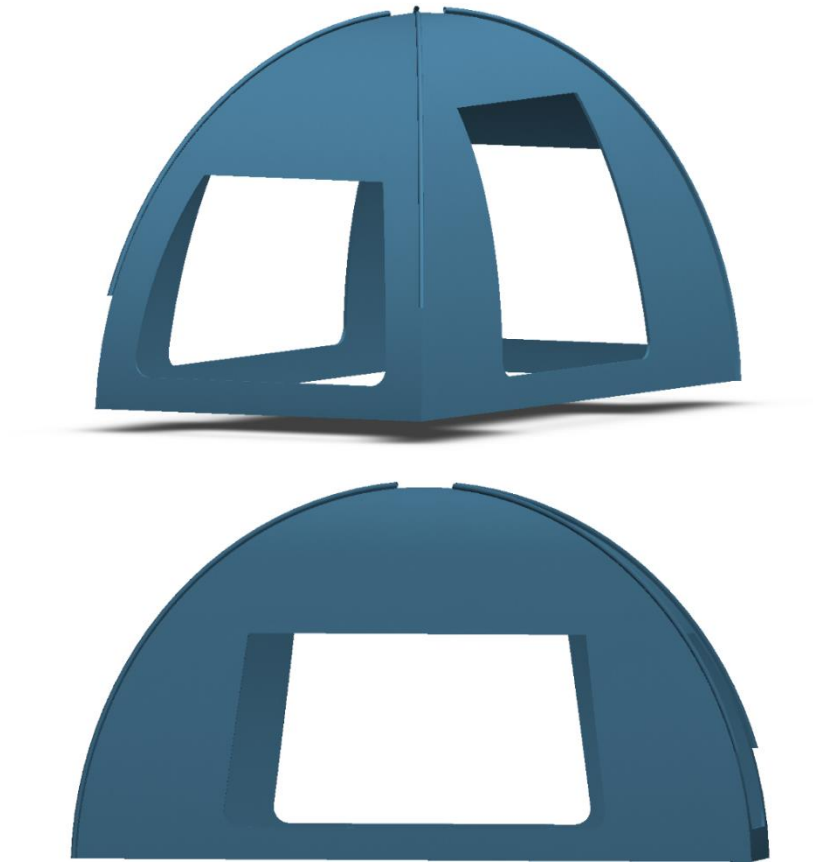


Figure 44: CAD-model of the canopy with tent poles. (Source: Authors' own work)

4.4.3 Manufacturing of Final Prototype

Most of the final prototype was manufactured at Thule's workshop for a period of four days.

4.4.3.1 Base Manufacturing

The long sides consisted of three layers of aluminium beams. The uppermost beam provides structure, mounting to the short ends and keder rails. As the beam did not offer sufficient height from the roof racks, a thicker middle beam was cut up and screwed to the construction. At the bottom existing mounting profiles were used on the underside to be able to use Thule Mounting Brackets when securing the tent to the roof racks. To simulate and test the extension mechanism of the base structure, telescopic roof supports were used on the shorter end. The short sides were screwed onto one side and used a cotter on the other side to securely hold it in place. Trampoline fabric was cut into a rectangular shape and keder flaps were sewed on. Zippers on all sides of the base fabric were sewed on, to easily take on and of the canopy. Pins for the tent poles were added to two corners on one short side of the base fabric.

Figure 45: The manufactured base. (Source: Authors' own work)

4.4.3.2 Canopy Manufacturing

The canopy was sewed out of 200 denier rainfly fabric in a dark blue colour, this fabric is present in an existing tent by Thule. Grooves for the tent poles were added along the seams, they were sewn closed in one end to provide a stop for the poles. The colour of the grooves was a lighter blue, to create contrast and a colour palette that resembles Thule's existing brand aesthetics. The canopy mounts to the base fabric with zippers located at the lower edges of the canopy. Zippers were also sewn to the window and entrance of the tent.

Figure 46: Manufacturing of the canopy. (Source: Authors' own work)

5 Final Concept

In this section the final concept is presented and explained in regard to installation steps, material choices, base mechanism and canopy construction.

5.1 Final Prototype

In the following figures (Figure 47 to Figure 63), the final prototype is shown in steps of handling, details and overall final concept. The prototype was mounted, installed, and tested on the roof racks of a car. One person climbed up and tested the structure and comfort of the tent.

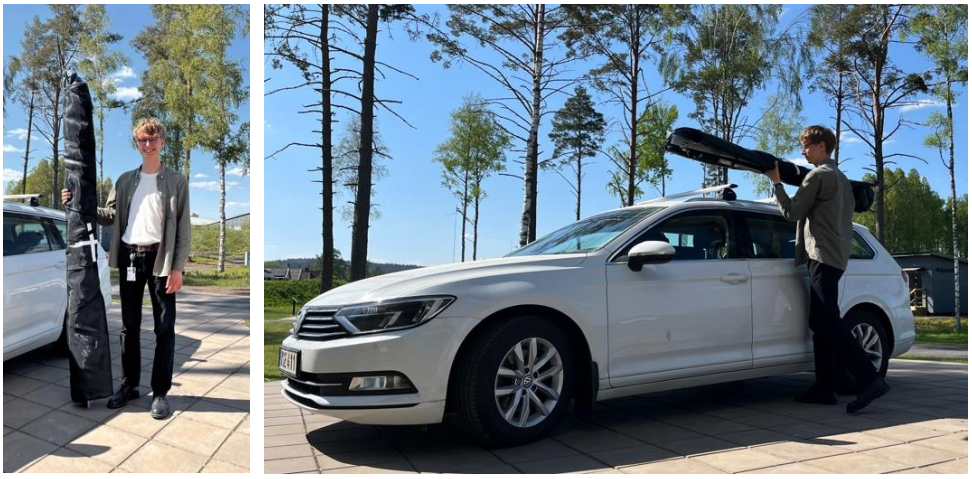


Figure 47: The size of the prototype (left), installed to the roof racks of a car by one person (right). (Source: Authors' own work)

Figure 48: A long side is secured to roof racks. (Source: Authors' own work)

Figure 49: Driving mode. (Source: Authors' own work)

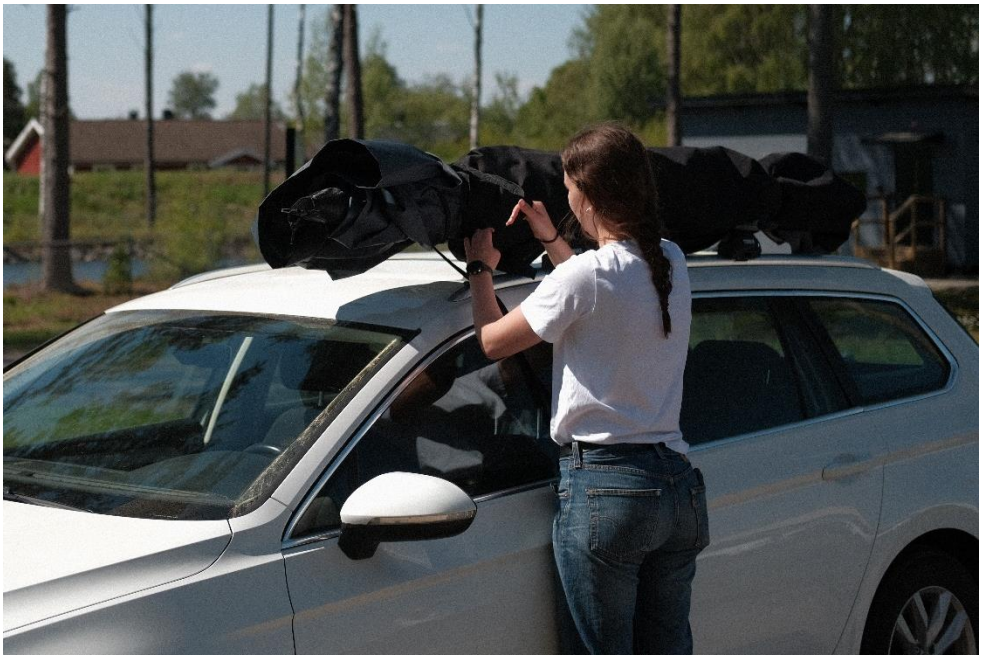


Figure 50: Rain cover is removed to begin the tent deployment. (Source: Authors' own work)

Figure 51: Straps are pulled to slide out the bed. (Source: Authors' own work)

Figure 52: Base fabric is stretched to achieve a flat sleeping surface. (Source: Authors' own work)

Figure 53: Tent is pitched by pushing the tent poles into the grooves. (Source: Authors' own work)

Figure 54: The ultra-lightweight RTT prototype, pitched (Source: Authors' own work).

Figure 55: The ultra-lightweight RTT prototype, pitched. (Source: Authors' own work)

Figure 56: Doors and windows can be opened with zippers. (Source: Authors' own work)

Figure 57: A telescopic ladder makes it possible to climb up in the tent. (Source: Authors' own work)

Figure 58: The bed construction is tested by one person. (Source: Authors' own work)

Figure 59: Close-up of the trampoline fabric used as base. (Source: Authors' own work)

Figure 60: A small part of the tent poles is taken out and folded. (Source: Authors' own work)

Figure 61: Straps are used to slide the long side together; the tent is now in transport mode. (Source: Authors' own work)

Figure 62: The tent is lifted of the car. (Source: Authors' own work).

Figure 63: Strap enables easy carrying of the tent, on and off the car. (Source: Authors' own work)

5.2 Final Concept Details

5.2.1 Renderings

Renderings of the final concept are shown in Figure 64 to Figure 66.

Figure 64:Renderings of the concept from different angles. (Source: Authors' own work)

Figure 65: Rendering of the base structure. (Source: Authors' own work)

Figure 66: Rendering of the assembled base. (Source: Authors' own work)

5.2.2 Measurements

The measurements of the RTT are presented in Figure 67. A sitting height of 1000 mm, decided in 4.1.3.4 Height test, is marked in the figure. The collapsed size of the tent can be seen in Figure 47.

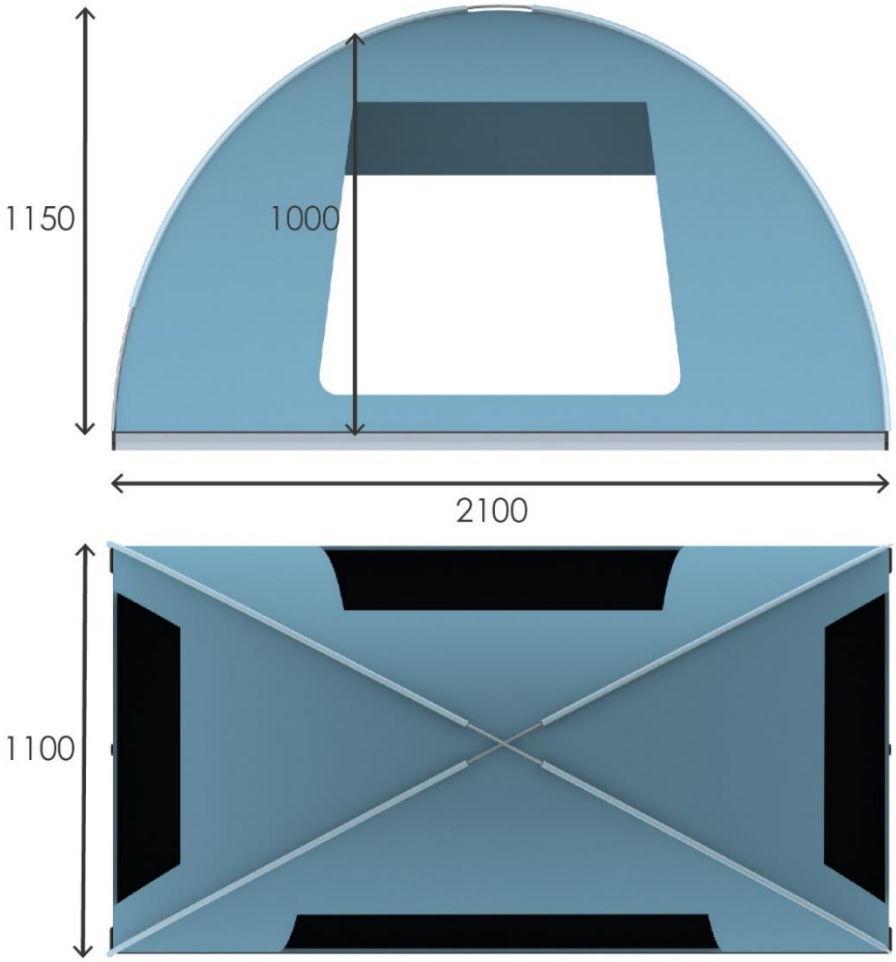


Figure 67: The measurements of the RTT in mm. (Source: Authors' own work)

5.2.3 Weight Estimation

The weight of the finished prototype is presented in Table 11.

Table 11: Weight of the final prototype.

Prototype	*Weight (kg)*
Base structure	9.6
Base fabric	1.2
Canopy, including tent poles	2.4
Rain cover	0.6
Total weight	13.8

5.2.4 Comparison

The prototype was compared with the existing tent Thule Approach S. Values such as storage footprint, volume, and weight were compared in Table 12. Set-up time and steps required to deploy the tents were compared in Table 13.

Figure 68: Ultra-lightweight concept (left) compared to Thule Approach S (right).
(Source: Authors' own work and (Thule, 2024))

Table 12: Comparison between the ultra-lightweight prototype and Thule Approach S.

	UL Prototype	*Thule Approach S*	
Storage footprint	0.63 m^2	1.32 m^2	53 % smaller
Volume	94.5 l	305 l	69 % smaller
Weight	13.8 kg	50 kg	72% lighter

Table 13: Set-up time and steps, the ultra-lightweight prototype compared to Thule Approach S.

	UL Prototype	*Thule Approach S*
Set-up time	4 min	"Under 3 min" (Thule, 2024)
Set-up steps	Take off travel cover Unfold the base Tighten the base fabric Pitch the tent	Take off travel cover Unfold the tent

6 Discussion

This chapter discusses the final concept and compares it to the theoretical framework and methods used. A conclusion of how the project fulfilled the initial project brief is presented.

6.1 Design Process

6.1.1 Double Diamond

Double Diamond was the chosen design process for the project. It could be difficult to distinguish where exactly the phases of the Double Diamond ends and begins as some time was spent on going back to earlier phases. For example, some further research was preformed even though the discover-phase had completed. It was not always manageable to follow the Double Diamond to the letter. It was still fitting to use as a framework, as it gave the team a structured and user-centred approach. The goal was to work more iteratively during the last two phases of the project. In the end a lot of time was put on finalising the concept and manufacturing the final prototype as it was in full scale. This meant that the process did not become as iterative as first imagined.

6.1.2 Human Centred Design

Working with a human centred design approach helped the team empathize with the user and their needs. Using activities like idea generation, prototyping and testing. Testing of the concepts were mostly performed by the two team members in the developing and delivering stages of the project, as they were a part of the intended target group. These tests could have been performed on more users to develop further and verify the concept in more, but due to lack of time this was not possible.

6.1.3 Concept Selection

It was difficult to build rapid prototypes and test ideas quickly due to the scale of the project and time required in the beginning to gain an understanding of the product. It took a lot of time but was very rewarding to build full scale prototypes as conclusions could be drawn and further directions could be decided. When evaluating certain concepts assumptions were made, instead of tests. As the team consisted of two people, ideas and concept were discussed within the team. The discussions were based on the established needs and hard and soft criteria. In the end, it was still the team and not the methods that decided which concept would be developed further (Eppinger & Ulrich, 2014). The selection tools were not used to find the best solution to continue working with but rather as a tool to decide a direction.

6.2 Final Concept

Weight

The project resulted in an RTT for two people, with a weight of 13.8 kg. The measured weight does not include a ladder and Thule Mounting Brackets, these would add 7 kg and 2 kg to the total weight. Safety factors are equally not counted for, the prototype manages to support one person. The final weight is lower than the goal weight of 20-25 kg established in the weight test (4.1.3.2 Weight test). One person can handle and install it to the roof racks of a car. It also has a much lower weight compared to Thule Approach S which weighs 50 kg (Thule, 2024). As the final weight is so low there is room for improvement of the concept, developing the base to support two persons and adding safety factors. As this project has been conceptual and has focused on the handling and use of the product, simulations and mechanical calculations have not been performed, this is a subject for further development.

Base Fabric

To improve the stretching of the base fabric the team discussed a non-rectangular shape of the fabric, with a slightly narrower middle part. This would result in extra stretching of the fabric in the middle, something that the prototype lacked.

Because the base is a stretched fabric the need for a mattress is not that important compared to a normal RTT which utilises a hard honeycomb plate. Therefore, a mattress would be an optional accessory for the user. The final concept works both with and without a mattress or sleeping mat. It depends on the user’s need, which season they would camp during and their desired comfort.

Base Structure

The base structure was the component which weighed the most with 9.6 kg. During the final test of the finished prototype, it was discovered that the long, sliding beams can collapse 90 degrees during extension over the roof racks. An important improvement to be made is to make sure that the extension mechanism is controlled and collapsing of the beam is not possible. The exact details of where and how the straps or handles for extension of the base have not been developed. But they are important to when performing the extension.

During the extension process one of the long beams is not completely mounted with Thule Mounting Brackets as it is supposed to be sliding over the roof racks. Currently it is fastened to the roof racks with Velcro. There is a development opportunity in exploring and defining exactly how this mechanism can work.

As the base is mounted to roof racks it is important that allow some height in the structure. When laying in the bed the fabric will bulge towards the roof racks a sufficient height would prevent the user from feeling the racks. The distance depends on how much tension can be achieved in the fabric. Because of this the exact measurement has not been decided but rather estimated and tested.

A difference between the prototype and the CAD-model are the short side beams which are crucial as they provide tension in the base fabric. In the prototype telescopic roof supports were used, they were extended through an adjuster located in the middle and underside of the part. During testing of the finished prototype, it was discovered that it was difficult to reach the adjuster as it was required to lean over the car. An adjuster located on the side would make the execution of the extension easier for the user.

Another difference between the prototype and the CAD-model is the middle beam which provides two more separate sleeping surfaces instead of one hammock-like surface. It was discovered during the final testing that the middle beam may not be necessary in the tent but can be an optional accessory. If two people want to sleep more separate, then the accessory is targeted to them. However if they intend to sleep close together, then the beam becomes an obstacle and can be removed.

As the mounting brackets for the roof racks are located on the outer edges of the base structure, the roof racks used for mounting need to be longer than the width of the bed. This ultra-lightweight RTT can be mounted on roof racks that are minimum 115 cm in length. Because of that, there could be a necessity to develop adapters for roof racks that are not long enough.

Canopy

A thinner and lighter fabric can help save weight. However too thin could risk being ripped during handling. Since the canopy's weight is not a big part of the overall weight, a slightly more durable fabric is preferred. For the prototype, a durable fabric already used by Thule was chosen. The colour also met the soft product requirement of brand aesthetics, since a similar colour palette exists on another tent by Thule. Once the base has been extended fully the user pitches the tent by pushing the tent poles, this could be difficult to reach for the user and worked best if two persons did it in sync. To unpitch the tent the tent poles must be pushed out from grooves, these were made relatively large. However, it was still difficult to push out, due to a coating on the fabric.

The resulting tent ended up taller than anticipated and proved to be quite wind sensitive. If the poles would be better secured to the base the stability could be improved. The final prototype also lacked a rainfly and solutions for mounting one, but this could easily be added in a furthered developed version. In this project the inside of the tent has not been developed besides the placement of windows. Pockets and storage solutions for the inside environment are subject for further development.

6.3 User Needs and Product Requirements

The final concept was evaluated against the previously set up needs (4.2.1), product requirements (4.2.4) and brief (4.2.5).

Only the main and necessary needs were evaluated, since the desirable needs either seemed too subjective or too detail-focused, they did not seem relevant in this stage and would be better evaluated in a further development.

As expected, most of the product criteria were met since they were used as a framework during the development. However, the team thought that two criteria were not fully met, sense of security and aesthetics. The team adapted to the requirement of brand aesthetics by using visible aluminium profiles, plastic caps with chamfers and fabric already used by Thule. The brand aesthetics could be further improved by redesigning the shape of the canopy. This could make it more unique and borrow some shapes from existing Thule products. Yet, this is a very subjective criterion which only the team felt not being fulfilled. To improve sense of security it is important that the walls of the tent can withstand a person accidentally leaning towards it. In the built prototype this was not possible. In further develop the concept testing with users that are not already familiar with the product and concept should be performed.

The final concept was compared to the product requirements established in 4.2.4, in Table 14, Table 15 and Table 16.

Table 14: Evaluation of the final concept against main and necessary user needs.

Need		How?
Takes up minimal space	**M**	**210 cm long, thin package**
The user feels secure and protected	N	Has not been tested
Installation steps are logical	N	Four clear installation steps
The weight makes single person instalment possible	**M**	**13.8 kg package**
Assembly and disassembly are logical	N	Four clear installation steps
Works with different ground surfaces	N	Mounted to the roof of a car
Easy to dry	N	Zipper for taking the canopy off
Allows the user to experience a pretty view	N	Panoramic windows
Allows the user to be spontaneous	**M**	**Low weight, easy storage, handles**
Suitable for different ground surface	N	Mounted to the roof of a car
Easy to enter and leave	N	Door, ladder
Possibility to sit in the tent	N	115 cm height, 100 cm sitting height
Withstand use and abuse for a long time	N	Has not been tested
Suitable for different environments and weathers	N	Has not been tested
Durable against sun and UV-rays	N	Has not been tested
The inside environment is cool and ventilated	N	Windows and door can be opened
Protection from elements like rain and condensation	N	Sloped roof

Table 15: Evaluated hard criteria.

Hard criteria	*Value*
Bed size	110x210 cm
Sitting height	100 cm
Weight	25 kg/package, total max 75 kg
Water resistance	Sloped roof
Use existing mounting system	Yes, optional
Use existing ladder	Yes

Table 16: Evaluated soft criteria.

Soft criteria	*Comment*
Sense of security	Yes
Aesthetics	Existing brand aesthetics of Thule
Size/shape folded	Feels easy to store
Setup	More time/steps than regular RTT
View	Yes (important)
Light intake	Yes

6.4 Sustainability

The thesis has proven that there is a need for a product like what has been developed. The result is a product that promotes an outdoor and healthy lifestyle in nature. This can have large social benefits for users as it allows more people to travel locally and experience nature.

Compared to Thule Approach S, the package of the ultra-lightweight concept is more streamlined as well has a lower weight which should result in less fuel consumption when traveling. The ultra-lightweight prototype resulted in a weight saving of 70%. It is safe to assume that the much less material use leads to a lower environmental footprint. However, there are always carbon emissions to factor in for the development and production of a new product.

7 Conclusion

The result of this master thesis project was a concept for an ultra-lightweight roof top tent. It offered an accessible and easy solution for spontaneous traveling, for two persons. RTTs available on the market at the time of writing are not lightweight nor easy to handle.

The result was conceptual and progressive for the company Thule with the base solution that consists of a suspended fabric mounted on a collapsible aluminium frame. The canopy carried a minimalist design and attracted the user with its familiar dome tent shape. The resulting concept had a more complicated installation process compared to a conventional RTT. The tent also had to compromise on sleeping space, in favour of lower weight and easy handling. The built prototype supported one person; however, the target was for it to be able to carry two people. The product was developed to satisfy the needs of the target user. The shape, size and weight of the product made storage, handling, and installation easy, even for one person. With these factors in mind, this conceptual RTT fulfilled the goal of the project.

Extensive work was put into the manufacturing of the full-scale prototype, consisting of many components. Further development is needed, to finalise the concept for production and of other complementary accessories for the tent.

When developing a lightweight product, the approach often used is to minimise or replace materials used in the existing product. In this thesis, the greater usability of the product has been the main priority, and the product has been redesigned from scratch. The means for achieving the result has been learning by doing, building prototypes and testing. This highlights that a more practical approach can be beneficial to create something that works rather than only testing it in theory.

The authors see a big potential for further development of the product. This thesis hopes to form the basis for the continued development of an ultra-lightweight roof top tent at Thule.

References

Bruton, M. (den 28 February 2023). Outdoor Recreation Industry Sees Significant Growth With Changes in Consumer Behaviour Sparked by Covid-19. *Forbes*.

Mobility Sweden. (2024). *Mobility Sweden*. Hämtat från https://mobilitysweden.se/statistik/databas-nyregistreringar den 2 February 2024

Naturvårdsverket. (den 28 April 2022). *Ny Statistik Bekräftar: Intresset för friluftsliv ökade Stort under Pandemin.* Hämtat från https://www.naturvardsverket.se/om-oss/aktuellt/nyheter-och-pressmeddelanden/okat-friluftsliv/ den 8 February 2024

Thule Group. (2023). *Hur fungerar taktält?- en fullständig guide*. Hämtat den 16 January 2024

Business Research Insights. (2023). Hämtat från https://www.businessresearchinsights.com/market-reports/rooftop-tent-market-102747 den 22 January 2024

Volkswagen. (2024). Hämtat från https://www.volkswagen.se/sv/modeller/golf.html 2 February

Transportstyrelsen. (2013). *Lastsäkring.* Hämtat från https://www.transportstyrelsen.se/sv/vagtrafik/Trafikregler/Lasta-dra/Lastsakring/ den 23 january 2024

Transportstyrelsen. (2020). *Begränsad fordonshöjd*. Hämtat från https://www.transportstyrelsen.se/sv/vagtrafik/vagmarken/Forbudsmarken/begransad-fordonshojd/#:~:text=C17.-, den 23 January 2024

Volvo Car Corporation. (2024). *V60 Laddhybrid*. Hämtat från https://www.volvocars.com/se/cars/v60-hybrid/ den 2 February 2024

Volvo Car Corporation. (2024). *XC60 Laddhybrid*. Hämtat från https://www.volvocars.com/se/cars/xc60-hybrid/ den 23 January 2024

Thule Group. (2023). *History of Thule Group* . Hämtat från https://www.thulegroup.com/en/history-of-thule-group den 12 February 2024

Norman, D. (2013). *The Design of Everyday Things* (Revised and expanded edition uppl.). Philadelphia: Basic Books.

Wikberg Nilsson, Å., Ericson, Å., & Törlind, P. (2015). *Design - Process och metod* (1 uppl.). Lund: Studentlitteratur.

Design Council. (2024). *Framework for Innovation*. Hämtat från https://www.designcouncil.org.uk/our-resources/framework-for-innovation/ den 15 February 2024

Design Council. (2019). *Double Diamond Model 2019.* Hämtat från https://www.designcouncil.org.uk/fileadmin/uploads/dc/Documents/Case_Studies_Documents/Double_Diamond_Model_2019.pdf den 15 February 2024

Arbetsmiljöverket. (den 9 April 2019). *Belastningsergonomi (AFS 2012:2), föreskrifter.* Hämtat från Arbetsmiljöverket: https://www.av.se/globalassets/filer/publikationer/foreskrifter/belastningsergonomi-foreskrifter-afs2012-2.pdf

Virginia Braun, V. C. (2006). Using thematic analysis in psychology. *The University of the West of England*, 41. Hämtat från https://www.researchgate.net/publication/235356393_Using_thematic_analysis_in_psychology

Copper, R. G. (1990). Stage-Gate Systems: A New Tool for Managing New Products. *Business Horizons*.

Swedish Institute for Standards. (2018). SS-EN ISO 9241-11:2018 Ergonomics of human-system interaction - Part 11: Usability: Definitions and concepts. Stockholm.

Pheasant, S. (2003). *Bodyspace - Anthropometry, Ergonomics and the Design of Work, Second Edition.*

Tosi, F. (2020). *Design for Ergonomics.* Cham : Springer Nature Switzerland.

Martin, B., & Hanington, B. (2012). *Universal Methods of Design.* Beverly: Rockport Publishers.

Eppinger, S. D., & Ulrich, K. (2014). *Produktutveckling - Konstruktion och design* (1 uppl.). Lund: Studentlitteratur.

Osborn, A. F. (1953). *Applied Imagination.* New York: Charles Scribner's Sons.

Fitzpatrick, R. (2013). *The Mom Test.* South Carolina: Createspace Independent Publishing Platform.

Jaynes, N. (den 22 Feb 2024). *What Kind Of Roof Rack Do I Need For A Hard Shell Roof Top Tent?* Hämtat från Roofnest: https://roofnest.com/blogs/roofnest-journal/what-kind-of-roof-rack-do-i-need-for-a-hard-shell-roof-top-tent

Thule Mounting Brackets. (2024). Hämtat från Thule: https://www.thule.com/sv-se/rooftop-tents-and-accessories/rooftop-tent-accessories/thule-mounting-brackets-_-901550

Thule Sweden. (2022). *Instructions Thule Mounting Bracket.* Hämtat från https://www.thule.com/-/s/approved/std.lang.all/91/80/1419180.pdf?rev=1.1

iKamper. (den 11 Mar 2022). *Hardshell vs Softshell Roof Top Tent*. Hämtat från iKamper: https://ikamper.ca/blogs/ikamper-nation/hardshell-vs-softshell-roof-top-tent-answer-these-3-questions-to-decide

What is Drop Stitch? (den 20 June 2011). Hämtat från NRS: https://www.nrs.com/learn/what-is-drop-stitch

Decathlon. (u.d.). *QUECHUA Rooftop Tent Van 500*. Hämtat från Decathlon: https://www.decathlon.co.uk/p/rooftop-tent-van-500-fresh-and-black-2-p/_/R-p-313004

Transportstyrelsen. (2013). *Efterfordon*. Hämtat från https://www.transportstyrelsen.se/sv/vagtrafik/Fordon/fordonsregler/Slap/ Efterfordon den 23 January 2024

Autohome . (2017). *The history*. Hämtat från Autohome Official: ttps://www.autohome-official.com/en/company/the-history/

Popular Science Monthly. (Jan 1937). Car Top Carries Collapsible Tent. *Popular Science Monthly*, s. 122.

Thule Mounting Rails M. (2024). Hämtat från Thule: https://www.thule.com/en-gb/rooftop-tents-and-accessories/rooftop-tent-accessories/thule-mounting-rails-m-_-901888

Roof Top Tent Mounting Clamps. (2022). Hämtat från BillieBars: https://billiebars.com/products/roof-top-tent-mounting-clamps

Orson Roof Top Tent. (2024). Hämtat från Intents Outdoors: https://www.intentsoutdoors.co.nz/products/orson-roof-top-tent-acc-a2-fly-new-nov-2021

Framework for Innovation. (2024). Hämtat från Design Council: https://www.designcouncil.org.uk/our-resources/framework-for-innovation/

Thule. (2024). *Thule Approach S*. Hämtat från Thule: https://www.thule.com/sv-se/rooftop-tents-and-accessories/rooftop-tents/thule-approach-s-_-901010

Gentle Tent. (den 5 June 2024). *GT Roof.* Hämtat från Gentle Tent North America: https://gentletentnorthamerica.com/products/gt-roof

Swedish Standards Institute. (2019). *SS-EN ISO 9241-11:2018 Ergonomics of human-system interaction.*

Thule Basin. (2024). Hämtat från Thule: https://www.thule.com/sv-se/rooftop-tents-and-accessories/rooftop-tents/thule-basin-_-901017

Gentletent. (2024). *GT Roof*. Hämtat från GentleTent: https://gentletent.com/en/gt-roof

OutdoorDays. (2024). Hämtat från Safari Classic: https://outdoordays.se/products/safari-taktalt-till-bil?variant=39607132979340

ESVO. (2024). *Fabric for rooftops*. Hämtat från Esvo Camping Shop: https://www.esvocampingshop.com/en/tent-canvas/fabric-for-poptop-roofs/

Appendix A - Work distribution and time plan

A.1 Work Distribution

The distribution of the work done during the project is presented in Table A. **1**. The work was distributed evenly between both student during the first three phases of the project as these phases required discussion and decisions to be made. During the last phase the work was more divided as the final prototype and report had to be finished.

Table A. 1: Work distribution during the project

Discover	*Define*	*Develop*	*Deliver*
User research 50/50	User needs 50/50	Ideation 50/50	Final prototype 40/60
Market research 50/50	Persona 50/50	Prototyping 50/50	CAD 50/50
	Requirements 50/50	Testing 50/50	Report 60/40

A.2 Project Plan and Outcome

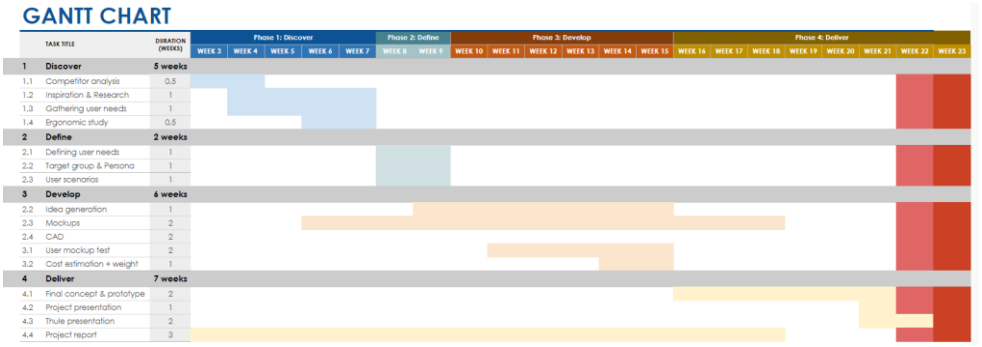


Figure A. 1: Initial project plan.

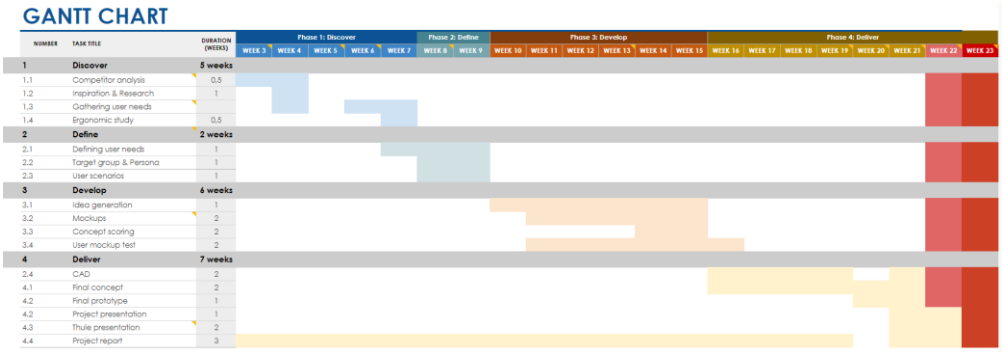


Figure A. 2: Performed activities.

Appendix B – Survey Questions and Answers

B.1 Survey Questions

Survey about Camping habits

Hi! We are two students writing our master thesis in product development.
The topic of the thesis is Roof Top Tents, and we are curious to hear about your habits regarding camping.

It's alright to answer in English or in Swedish :)

Best regards,
Susanna & Hjalmar

Have you been camping before? How? *

☐ Yes, in a RV

☐ Yes, in a caravan

☐ Yes, in a tent

☐ Yes, in a Roof Top Tent

☐ Other:

☐ No, I've never been camping

Does the **weather** affect your camping habits? *

- [ ] Very much. I cancel my planned trip if it's not optimal weather.
- [ ] To a large extent. I prefer to go camping when it's nice weather.
- [ ] Somewhat. I go out even though it might rain or is windy.
- [ ] Very little or none. I head out even when it's bad weather.
- [ ] Other: _____

In which **season** do you prefer to go camping? *

- [ ] Spring
- [ ] Summer
- [ ] Autumn
- [ ] Winter

Where do you like to camp or find yourself camping? *

- [ ] In the forest
- [ ] In an open field
- [ ] By the beach
- [ ] Alongside a road
- [ ] At a camping
- [ ] In a garden
- [ ] Other: _____

Do you do any **activities** while camping? Like surfing, biking, climbing, hiking, paddling etc. If yes please specify which *

- ◯ No
- ◯ Other: _____

How **many** people are you usually while camping? *

1	2	3	4	5	
◯	◯	◯	◯	◯	people

Do you camp with any **pets**? If yes please specify which *

- ◯ No
- ◯ Other: _____

How do you **live**? In a ... *

- ◯ Dorm room
- ◯ Small apartment (1-2 rooms)
- ◯ Larger apartment (3+ rooms)
- ◯ Small house
- ◯ Larger house
- ◯ Other: _____

Where do/would you **store your camping equipment** when it's not in use? *

- [ ] In an wardrobe or other storage inside the living area
- [ ] In a basement
- [ ] In an attic
- [ ] In a garage
- [ ] In a shed
- [ ] Other:

Do you have **access to a car**? Which type of car? *

- ( ) No, I don't have access to a car
- ( ) Yes, a smaller mini or half combi car
- ( ) Yes, a sedan or medium sized car
- ( ) Yes, a SUV or truck

How old are you? *

Your answer

Roof top tents

This section focuses on questions regarding roof top tents.

A roof top tent is installed beforehand on the roof rack of a vehicle, similarly to a car roof box. When you arrive to the camping destination the tent can be deployed.

Example of a roof top tent

Have you **used a roof top tent** before? *

- ◯ Yes, I own one
- ◯ Yes, I've tried one
- ◯ No, but I would like to try it
- ◯ No, but I would like to buy one
- ◯ No, I'm not interested in using a Roof Top Tent
- ◯ Other: _____

Are there any **factors** that you think are particularly **negative** when using a roof top tent? *

Your answer

Are there any **factors** that you think are particularly **positive** when using a roof top tent? *

Your answer

What do you see as the **most important factors** of an attractive roof top tent? Please select **3** alternatives *

- [ ] The price
- [ ] The design
- [ ] Easy installment
- [ ] Easy deployment
- [ ] The weight
- [ ] Sense of security
- [ ] The quality
- [ ] Comfort
- [ ] The view
- [ ] Other:

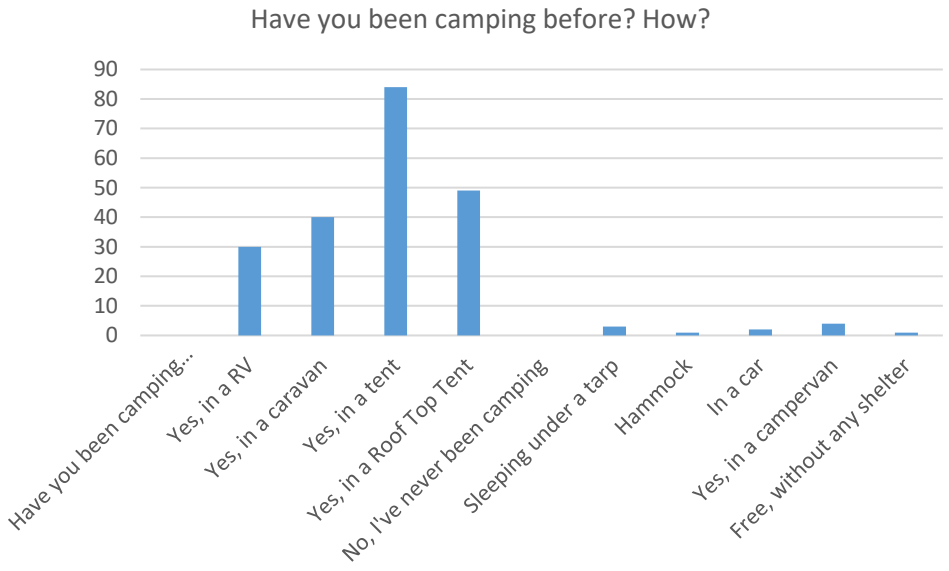
Approximately how much are you willing to **spend on a roof top tent** when going camping? Please specify currency *

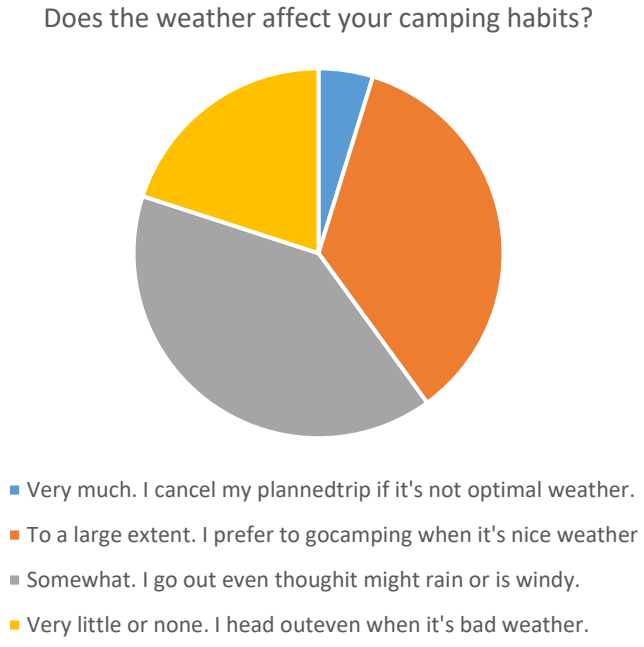
Your answer

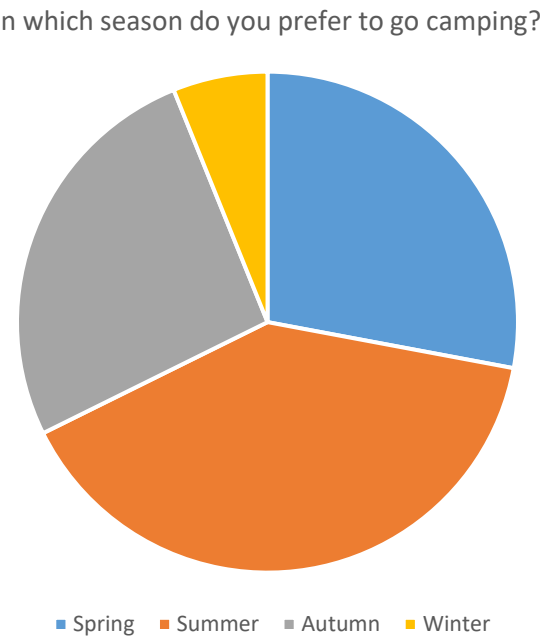
Do you have any **thoughts** about roof top tents or other related topic that you would like to share with us? Please write them below :)

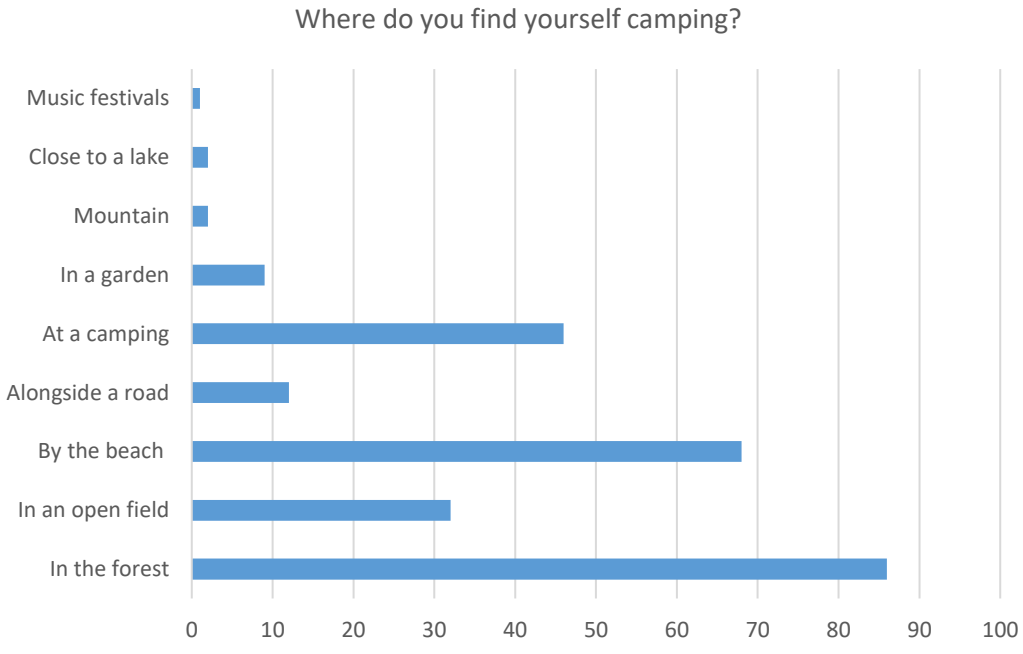
Your answer

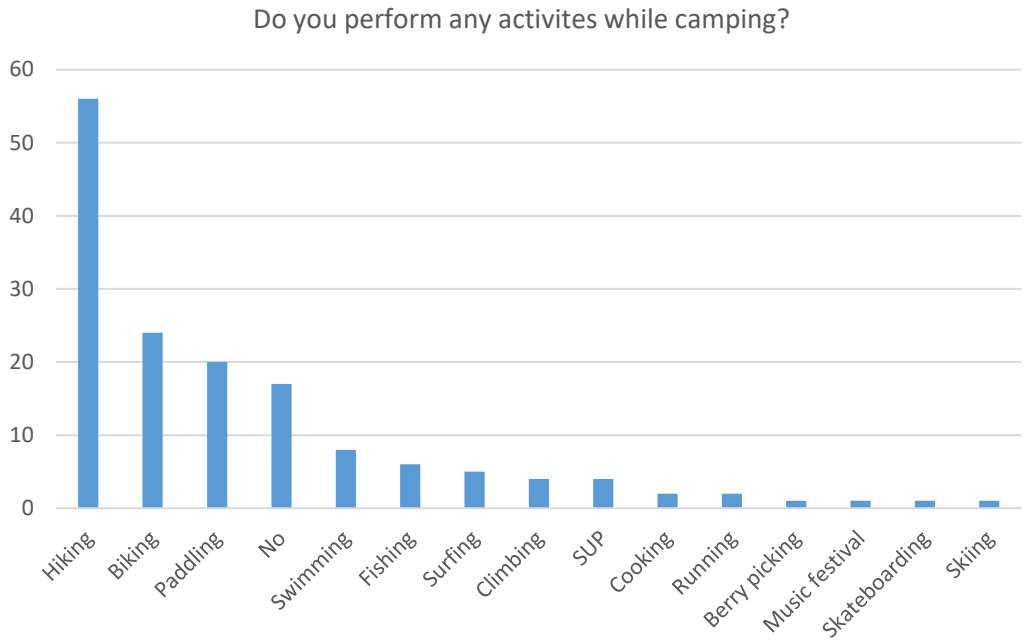
B.2 Survey Answers

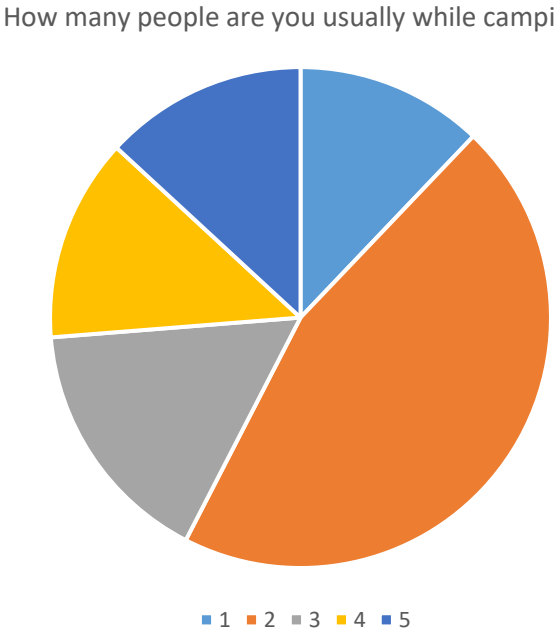


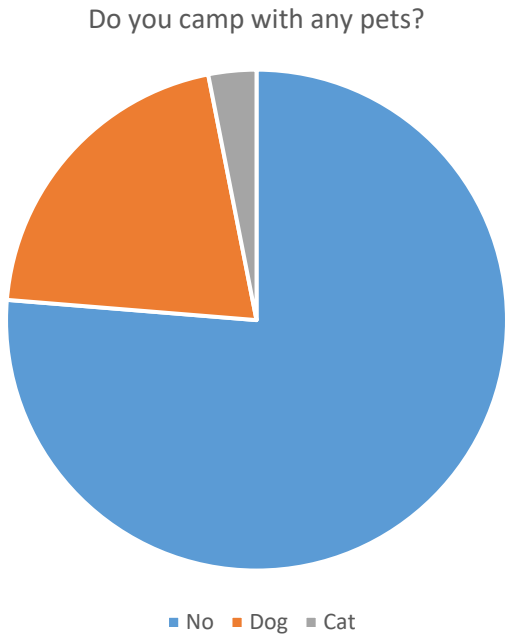


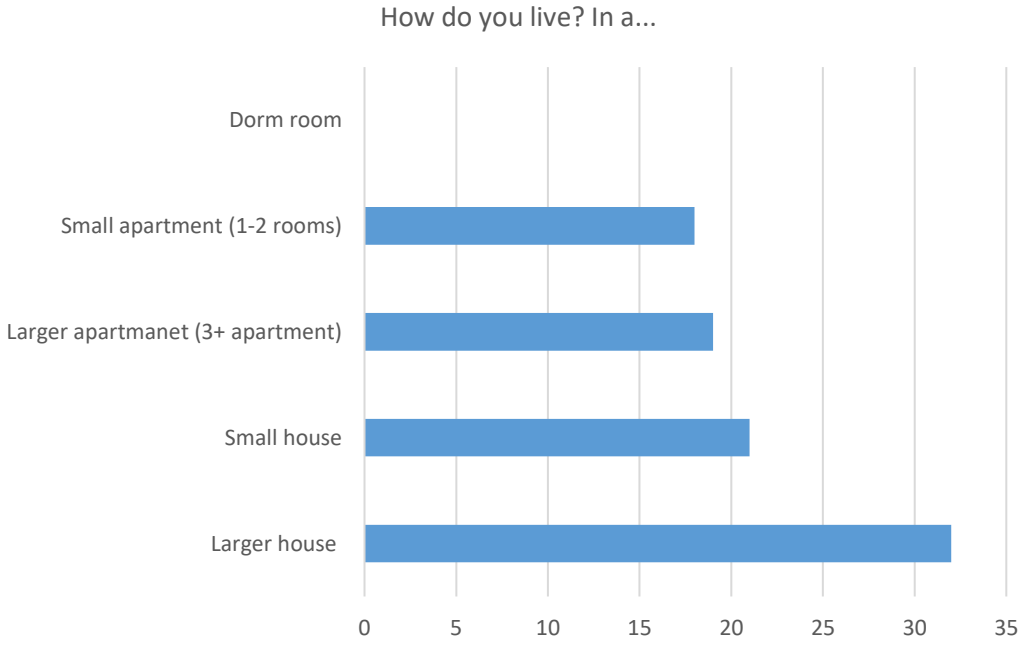

In which season do you prefer to go camping?
Spring
Summer
Autumn
Winter

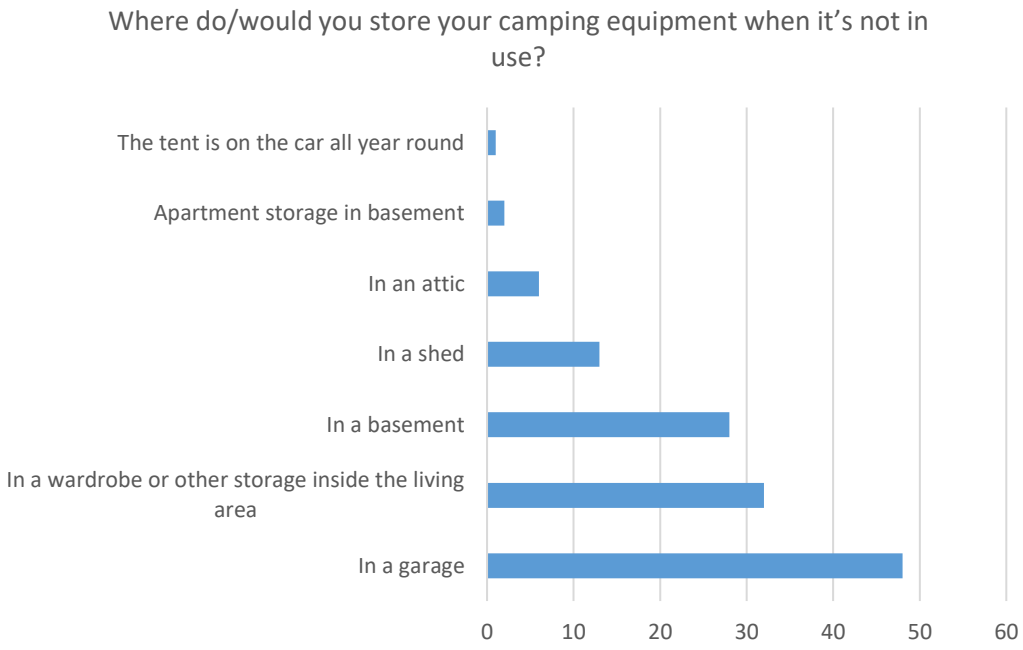

Where do you find yourself camping?
Music festivals
Close to a lake
Mountain
In a garden
At a camping
Alongside a road
By the beach
In an open field
In the forest
0
10
20
30
40
50
60
70
80
90
100

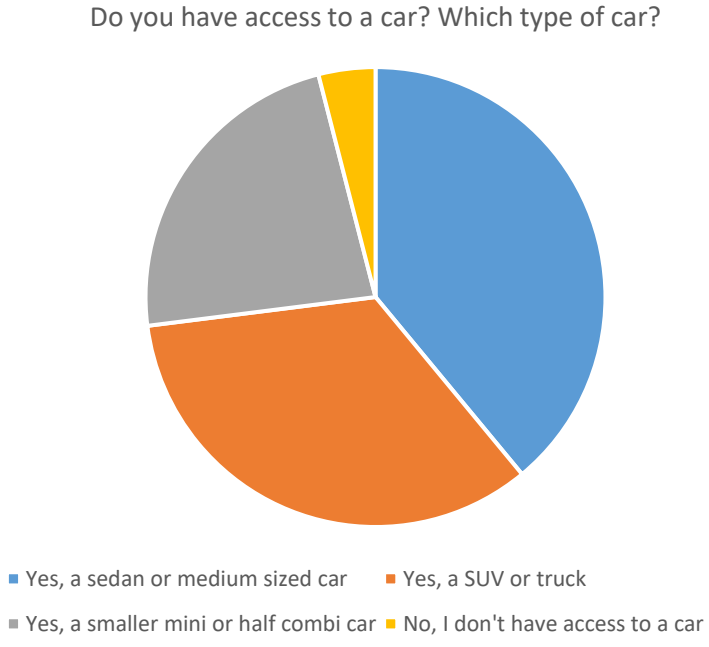

Do you perform any activites while camping?
60
50
40
30
20
10
0
Hiking
Biking
Paddling
No
Swimming
Fishing
Surfing
Climbing
SUP
Cooking
Running
Berry picking
Music festival
Skateboarding
Skiing

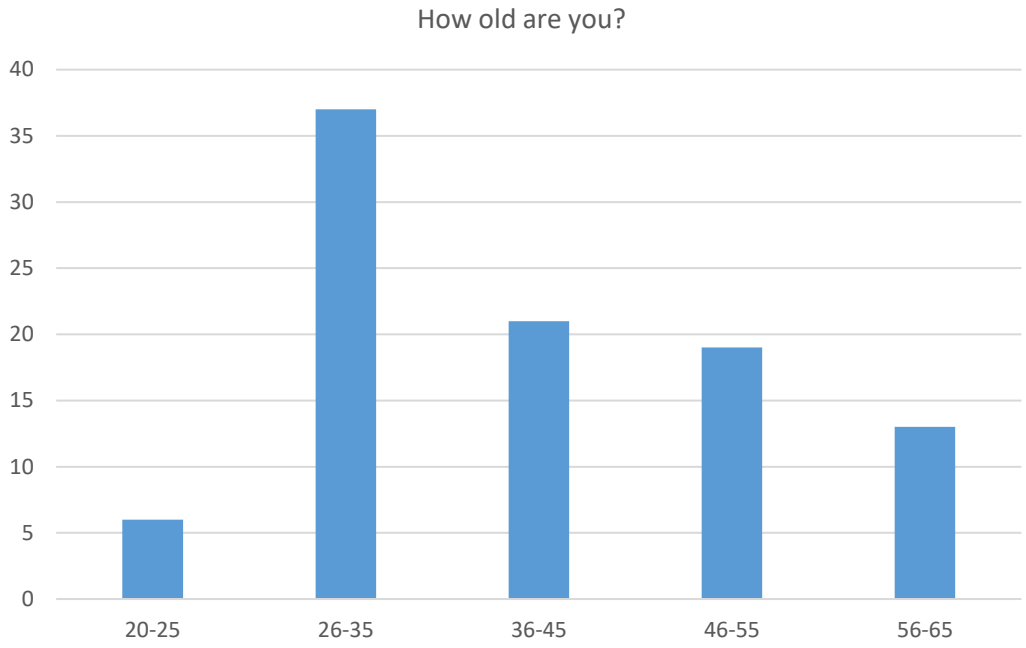

How many people are you usually while camping?
1
2
3
4
5

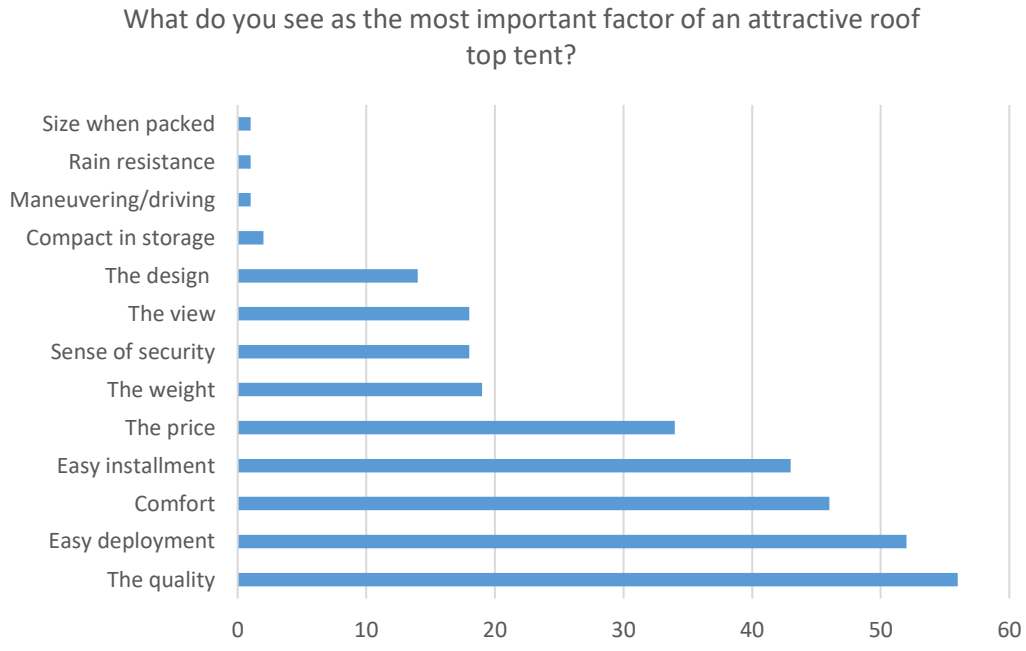

Do you camp with any pets?
No
Dog
Cat

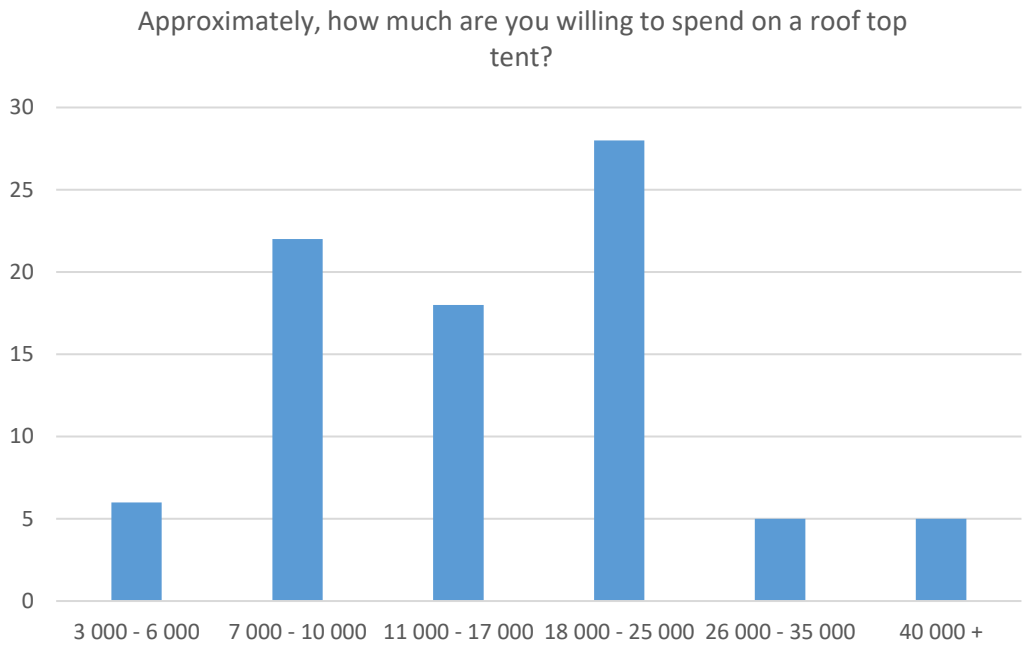

How do you live? In a...
Dorm room
Small apartment (1-2 rooms)
Larger apartmanet (3+ apartment)
Small house
Larger house
0
5
10
15
20
25
30
35


Where do/would you store your camping equipment when it’s not in use?
The tent is on the car all year round
Apartment storage in basement
In an attic
In a shed
In a basement
In a wardrobe or other storage inside the living area
In a garage
0
10
20
30
40
50
60


Do you have access to a car? Which type of car?
Yes, a sedan or medium sized car
Yes, a SUV or truck
Yes, a smaller mini or half combi car
No, I don't have access to a car


How old are you?
40
35
30
25
20
15
10
5
0
20-25
26-35
36-45
46-55
56-65


What do you see as the most important factor of an attractive roof top tent?
Size when packed
Rain resistance
Maneuvering/driving
Compact in storage
The design
The view
Sense of security
The weight
The price
Easy installment
Comfort
Easy deployment
The quality
0
10
20
30
40
50
60


Approximately, how much are you willing to spend on a roof top tent?
30
25
20
15
10
5
0
3 000 - 6 000
7 000 - 10 000
11 000 - 17 000
18 000 - 25 000
26 000 - 35 000
40 000 +

*Are there any **factors** that you think are particularly **negative** when using a roof top tent?*
Price
Fuel Economy
Never tried one
It feels a bit unsteady and hard surface
Too hard matress to be really comfortable! Too narrow for for 4 people when the kids are getting bigger.
Taking on and off the shoes as you don't want to bring them into the tent. Easier to find a spot to camp with a regular tent. Difficult to bring smaller children and pets. Hard to store.
Heavy products that could be difficult to install on the roof of the car.
Heavy and not easy to take off/load on your car.
Bökigt att installera på en bil
Size, weight, price, Thule ladder for the roof top tent is not easy to use, higher consumption of your car (more drag).
You cannot reserve the camping spot if you intend to just use the car for a few minutes.
having to pack up when everything is wet or during rain, having to exit the tent at night
Noise, cold
storage, handling and mounting on vehicle
humidity and condesation build up
The extra weight and wind resistance while driving.
handling and mounting to the roof
takes alot of space when needed to be stored, no handles for carrying the tent
Fuel consumption, storage at home.
Uncomfortable ladder, struggle with travel cover when packing up, attaching rods/raincover, attachment to roof racks (if not quick lock like later tents))
You have to collapse the tent when you want to take the car for an errand, hard to find parking spots in the bigger cities where it's allowed to stay over night. Usually we prefer camping in a forest or somewhere private, not on a camping spot. Also very difficult to get the 20kg dog up in the tent.
Putting on and taking off the tent for a weekend. (Heavy and cumbersome).
That you cannot use it anywhere. Compared to a regular tent which you can use almost anywhere in Sweden. Also quite expensive.
Mer beroende av väderleken.
Vet inte om den är kompatibel med min bil
Climbing up and down, and not all roofs can take the load
The camping spot needs to be accessible from a road

Requires that you have a roof-rack
No heating and small storage posibilities
small sleep bed space, not so much place for storage of bags inside tent. Difficult to mount onto car, heavy, high lift. Requires a good camping spot, to not be along noisy road or on a large camping.
no place left for the surfboards, occupies the roof racks
Tar mycket plats. Liknande komfort från ett rejält vanligt tält och tillbehör.
Vi tältar vanligtvis endast någon enstaka natt på samma ställe för att sedan köra vidare och slå upp tältet igen. Är skeptisk till hur lätt det skulle vara att fälla ihop och sätta upp igen för 3-4 nätter i rad på olika platser.
Svårt om man vill använda bilen till annat när man är iväg. Måste då fälla ihop och packa ihop tältet för att åka
Negativt att det inte går att koka upp vatten eller laga mat på ett smidigt och säkert sätt uppe i tältet, till skillnad från i ett "vanligt" tält där stormköket kan placeras i absiden och en själv kan vara kvar i sovsäcken vid förberedning av tex morgonkaffe.
Personally the drive to go camping is to get away from well traveled areas. I will usually hike deep in to the woods on the first day and set up camp at the end of that hike. A rooftop tent would feel very limiting and would keep me near the roads.
Installation to the roof of the car. Usually needed at least 2 persons if you don’t have any lifting device. Since I don’t like the extra noise / fuel consumption I prefer to remove it while not out for camping.
Limited access to storage in and directly outside of the tent.
Not ideal for cars with clamp racks. Need to stay close to a road (parking). Heavy
Not sure about the stability, but hard to know when I haven’t used one.
Noise when driving. Hard to install on roof (heavy).
It is heavy, big and tricky to get on the car. Higher fuel consumption. When living in an apartment with limited space it is difficult to dry the tent (if needed) after a camping trip.
maybe damage to may car, but due to the lack of experience i do not know. i need to try it.
limited to the roads, you cant go wherever you want. takes big space at home and need installation when it should be used (no spontaneous camping
Behöver mer förvaringsmöjligheter. Allt hamnar i änden på tältet där man också går ut och in, så det blir rätt så trångt. Sen tycker jag det blir fuktigt och kallt (men det blir det ju i tält oavsett). Det är väl att man måste slå ihop allt när man ska åka iväg på dagsutflykt.
Noise from outside is audible. Often very heavy and bulky tents that is difficult to handle. Fuel consumption of car is higher.
the necessity to climb up...

Since the tent is attached to the car, you can not leave the tent by car for a smaller trip without emptying it and packing it properly back on the roof. Difficult to know where it is allowed to camp. It is not nice to camp on a parking, you want to stay more offroad.
maybe lack of storage
slippery ladder, storage when you don’t have the space (garage)
Jag har sovit en del på rastplatser och parkeringar och då tror jag det blir svårt med taktält.
Haven’t used one but I prefer my campervan. Feels more indoorsy.
Heat, getting the dog up there for the night,
Wind could be a problem, since the hight
How sensitive they are to wind. And the "stealth" factor
Windy, noisy, slow to pack if you need to leave a place quickly (you can’t just drive off). , expensive.
No
that the car becomes unusable when you pitch your tent
No
Reliability on weather- nu fun if cold and moist
No
No
Rain proofing /dryness inside
No
Packing away wet tent
Place for drying a wet tent
Too small...
Bilen blir lite blockerad/ tar lite längre tid att åka och till exempel handla
Soft shels, take to long time to set up/down So many china copys on the market who scare people away.
No
Blir låst till platsen ifall man vill slå camp men sen göra en dagstripp med bilen. Svårt att råda bot på men hårdskalstält underlättar ju. (Har mjukt idag pga pris på stora hårdskal). Sen om det blir hård vind gäller det att man har väldigt bra stormlinor. I värsta fall får man packa ihop och sova i bilen.
You cannot access the best spots
Nej
No not really, the line is rather pro softshell or pro hardshell.
Its a tent, Easy to rip
That I can only camp within the boundaries of terängkörningslagen. And that I can’t use the car once camp is set up.

Weight
Om to old. Bard for the body
No
To small
Meningslöst, jag har husbil.
My small car.
Vi är för gamla och har kroppsliga problem med att klättra upp till ett taktält.
You can’t use the car when the tent is up
Price, quality of some of the suppliers
Have to pack away to use vehicle
The size - its only for sleeping, and if you move your vehicle you have to take down your campsite.
No
If you want to use the car you need to pack it all away
You can not park the tent and then go on a small trip with the car
Once you have set up camp you will not be able to move as easily - but it is not really an issue. Also, the packning can be a lot with the fridge, gas, extra tent at the entrence (förtält). And getting my dog on 30kg in and out of the tent.
Big offer to mount it on the roof
Ladder is flimsy.
Nej

*Are there any **factors** that you think are particularly **positive** when using a roof top tent?*
Special / practical if you are traveling by car
Accessibility
The tent does not take up space in the car when packing and it’s easy to set up.
Beautiful view, no bugs
Freedom to free camp anywhere. Close to nature.
Softer and warmer bedding. Easy mounting. Easier to bring more things as you can store them in the car. Spacious
comfort, security, great view, easy to install the tent compared to a regular one.
No limitations to speed limits (caravan) easier to go in town and small roads (RV)
Nått stt skryta om att man testat
Quick assembly, "coolness factor", elevation (in case of a lot of rain), nice view from a few meters above ground, feeling less in danger when it comes to big animals, wind wont blow it away that easily :)

Can fix once and bring the tent to the campsite without compromising the car’s boot space.
off the ground, beds can stay with blanket and pillows while folding the tent, nicer view from the elevated top of a car
Freedom, possibility to get closer to nature
weight and aerodynamics (if travelling far) - liveable space
Off the ground, easy set up, comfortable mattress
Easy setup. Safe from flooding.
can park almost everywhere
flexible
Easy
Easy to use (deployment), nice to be off the ground, great street cred :P
Perfect for glamping. Avoid sand and dirt in the tent. No sleeping bag. All gear is near the tent/car. Takes a lot of space in the storage room.
Comformt, yet simple.
Not sleeping on the ground. Simple installation compared to caravan/rv. Cheaper than caravan/rv.
Hör mer av naturens ljud.
Slippa markfukt o ojämnt underlag
you get away from the ground and easy to fold and unfold
No need of a camping spot or flat surface for the camping.
Fun, something other than the usual. Feels fresh & luxurious
To be high from the ground
Feels like a cozy room, space. protected feeling, safe. like feeling of elevated over ground. Quick folding/unfolding.
comfort and convinience, also coolness factor
Bekvämt och enkelt att resa och packa ihop. Alltid ett jämnt golv.
Högre komfort än ett vanligt tält. Slipper leta efter ett plant underlag. Bilar får ofta stanna på fler platser än var man får slå upp ett tält vilket också är positivt.
Smidigt och fritt
Inte lika utsatt om det skulle komma mycket regn eller vara väldigt blött på marken, något högre standard/komfort iom att man kan ha "vanliga" sängkläder, känner mig mer skyddad/säker uppe i taktältet än i ett tält på marken, lätt att öppna upp tältet för skön ventialtion, snabbt och smidigt att fälla upp/ihop.
I think they are a good product, just don’t suit my needs particularly well. They tend to be quite quick and easy to set up and they are usually more weatherproof since you do not need to carry the tent anywhere (can be thicker material and heavier).

Ease of setup camp. Possibility to be a bit more spontaneous in the trips. Not so weather dependent since you sleep off the ground.
High sleeping comfort thanks to the great mattress.
Get off the ground, always a good flat bed.
Not having the tent straight on the ground protects from cold and rain sipping in.
Easy to fold up/down. Easy to find a place to stay. Easy to to find a parking. Freedom.
That one is sleeping high up from the ground and comfortable. Easy to open and close.
the height i guess feels nice, the quick setup and i am looking forward to not waking up on a damp tentfloor.
extra comfort. better in bad weather, feel a bit special. you dont need to carry thing so you can bring more and have a longer or more comfortable camping.
Lätt att slå upp och slå igen snabbt (väldigt viktigt i dåligt väder). Fungerar också som skydd att sitta under tältet när det regnar även om man inte har något "förtält". Skönt att komma upp från marken när det är regnigt och lerigt (!!)
You have access to a sleeping place in minutes without much effort. Love to sleep on top of the car which gives you a bit of an adventurous feel and a good view. You always sleep flat and comfortable compared to a normal tent. Ventilation is really good in a roof top tent compared to a normal tent. It is really cozy.
less risk of ground moisture
Always flat sleeping ground, Quick folding up and down.
coming away from the ground and moister
practical space wise when out
Att man inte behöver stor bil eller husvagn för att sova bra.
You can park anywhere and just pop up your rent. No other vehicle needed, you can use your everyday car.
Convenience of not having to look for a clear/dry tent spot, feeling more secure
Easy to access
Easy setup, get off the ground.
Looks cool, good use of space.
Many
I cod be in townvisits
Easy,
No
Nix
Freedom. Get off the ground
Lättare att plats att parkera inne i en stad med bil med "roof top tent" mot vår husbil.
It is easy to travel.

Speed to put up, easier to pack down, more hygienic
Easy to use
Quick setup time, ability to go to different places
Ease of erection. Always on vehicle. Size(quite large)
Warmer as its off the ground
Flexible. Comfortable. Cosy
Avoid the wet ground, durable in heavy rain, several windows, comforable matress, looks cool, good quality, always ready to use on the car, easy set-up.
No bugs, no moisture
Flexibility on where to stand
Mysigt, snabbt och smidigt

*Do you have any **thoughts** about roof top tents or other related topic that you would like to share with us?*

Waiting for a real lightweight tent, more spartan, thinner and more like a "regular" tent, can skip the mattress and prefer to be able to mount on / off for a single person.
should be easy to clean with a vacuum cleaner while mounted on the car, ventilation should be easy to adjust
accessories that can build upon, add-on, connect to tent ... annex, sun shade, etc.
Too many people have no respect for nature and surroundings, ignore signs and private land. Many nice spots now have a camping ban due to this.
There are many Volkswagen T3 to T6 in the field without having this expensive foldable roof. Adding an RTT along with inner step and awning tent would convert the whole thing into a little home.
Handles for carrying the tent. My tepui tent is clumsy to carry without a designated carry-handle.
More camping accessories! Tables in the tent, some sort of chairs that allow you to rest you back in the tent, really nice design and quality on bed sheets ++
Tält från bakluckan, perfekt om man vill campa i bilen (Tesla Model Y)
Waiting for one with solid walls
Really cool feature!
Easier to install on/off car.
Make it detachable in case you want to use the car while camping, but leave the tent.
No
I prefer hardshell due to offroading.
Big different between lightweight and real roof top tent
Dont buy scrap, dont sell scrap, it should last for 20 years,

Tjockare madrass ifrån fabrik. De flesta verkar köra 6cm. Men det är liiiite för tunt för mig som väger strax över 100 kg samt kylan på hösten börjar sakta trycka igenom så man behöver extra underlag. En madrass på kanske 8cm vore mer all around.
Must work in rain and collapse easy when wet without capsuling the moisture and making the next nights sleep a challange...
For me as a single woman I can go deep into roads, not to worry about intruders. I like to drive around and it's nice to be able to stay and just have a sleep over … my tent is the size of the car, so it's slick … I don't do tents on the ground, hammocks yes, so this is just great.
Steps can be uncomfortable without footwear, and they should come with a thermal liner to stop condensation
Please make or come up with a good and durable solution to getting heavier dogs inside the tent hahah.

Appendix C – Interview Questions without Transcript

Our names are Hjalmar and Susanna, and we are writing our master thesis at LTH, in collaboration with Thule. We want to investigate outdoor habits and behaviour of potential users. We will ask some questions that you can answer as freely and in detail as you want. We would like to take notes and record what is said during the interview, is that okay? You will remain anonymous in the final report.

Interview questions – Outdoor habits

What is your age?

Job and life situation?

How do you live?

Do you have access to any vehicles?

Have you camped? In what way?

When do you usually camp? Weather? Time of year?

Where do you camp?

Do you do any activities related to camping?

Who do you camp with? (family, animals?)

How long do you think it usually takes you to set up your camp? How long would you like it to take?

What do you like about the way you camp? Are there things you particularly like or that bother you while camping? Before you leave? After you have been away?

What equipment do you have with you? How do you pack it?

Are there any good or bad moments related to the equipment/tent?

Where do you store your outdoor equipment when you are not using it?

Where do you get information about products you want/need to buy? (moment of truth)

Roof top tent questions

Have you ever used a roof top tent?

Have you heard about it, are you familiar with the product?

Is it something you would like to try? Why, why not?

What do you think would be most important to make roof top tents attractive to you?

Do you have an example of a product that you think is handy/good/easy to take with you? Can be camping related or just an everyday product.

Do you have an example of a product that you think is bad/not durable/unnecessary? Own experience?

Do you have any other comments or thoughts and ideas? Do you think we have forgotten to ask something?

Interview questions – Roof top tent users

How do you live?

What kind of vehicle do you have (where the roof top tent is used)?

How did you come to own/use a roof top tent?

Where have you used the roof top tent? When? (season, weather?) With whom (how many?)

What type of roof top tent have you used?

What is most important to you when using a roof top tent?

What is good about the roof top tent? Develop

What is less good? Develop

Are there features you miss in a roof top tent?

How do you store the roof top tent when not in use?

Do you have any other thoughts and ideas?