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School of Engineering

industriDESIGN

CONCEPTUAL DEVELOPMENT OF A CAR- AWNING

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**KONCEPTUELL FRAMTAGNING AV EN
MARKIS FÖR BILAR**
Swedish TITLE

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This degree project is performed at the School of Engineering in Jönköping in the subject field Industrial Design. The project is a result of the master program Industrial Design. The writers are responsible of the result, conclusions and reflections.

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Abstract

This report consists of a conceptual development of a car awning, in collaboration with the company Thule. The main objective was to create a convenient and easy-to-use awning, which offers a universal fastening solution for cars. Among others, the research done includes an analysis of the current market and observations to use as a basis to compile the requirement specification and function analysis. Furthermore, a moodboard and methods such as Kansei engineering was used to put emphasis on the design and aesthetics.

The results display a conceptual solution to an awning that can be attached to any car that supports the use of a Thule roof rack with a T-track feature. It is easy to assemble, mount and use, with many options to be adjusted to the like of the user. High quality renders are presented, along with a full-scale prototype of the awning.

Research gathered in this report contributes to the field by presenting solutions for convenience, usability, and adjustability regarding similar products. Discussion is had regarding the importance of these features, as well as the difficulties that exist when creating a product like this. Further work includes even more solutions to make the awning fully universal, as well as more resistance to different weather conditions.

Sammanfattning

Denna rapport består av en konceptuell utveckling av ett förtält menat för bilar. Detta gjordes i samarbete med företaget Thule. Det huvudsakliga målet var att skapa en smidig och lättanvänd markis som erbjuder en universell lösning för montering på bilar. Bland annat innehåller forskningen en analys av den nuvarande marknaden och observationer. Dessa används som grund för att sammanställa kravspecifikationen och funktionsanalysen. Dessutom användes en moodboard och metoder som Kansei engineering för att betona designen och estetiken i produkten.

Resultaten visar en konceptuell lösning på en markis som kan fästas på vilken bil som helst, givet att bilen stöder användningen av ett Thule-takräcke med en T-spår-funktion. Markisen är enkel att montera, sätta upp och använda, med många alternativ för justering efter användarens önskemål. Högkvalitativa renderade bilder presenteras tillsammans med en prototyp i full skala av markisen.

Forskningen som samlats in i denna rapport bidrar till området genom att presentera lösningar gällande bekvämlighet, användbarhet och justerbarhet för liknande produkter. Diskussion förs angående vikten av dessa funktioner, likaså de svårigheter som finns när man skapar en produkt av detta slag. Vidare arbete innefattar ytterligare idéer för att göra förtältet helt universellt, samt för att göra den ännu mer lämpad för olika väderförhållanden.

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1 Introduction

1.1 Background

The project covered in this report is done in collaboration with the company Thule Group, with the purpose of developing an awning for a car.

1.1.1 Problem area

In recent years, the interest in being outdoors and going camping has increased. One factor is the recent pandemic that the world suffered from, which hindered a lot of social activities and instead increased the interest in other activities, such as the aforementioned. [1]

Because of this, Thule Group has identified a need for a product which will facilitate camping. More specifically, a product that will facilitate camping out of a vehicle which is not a caravan or mobile home.

1.1.2 Thule Group

Thule Group is a company that produces products with the intention to help people live an active life. Their product line-up includes products for the car, for example bike racks, roof racks and roof boxes as well as other products such as several types of bags and trolleys. Thule also offers products for camping, including rooftop tents for cars, awnings for caravans or RVs and other related products.



Picture 1. Thule Approach rooftop tent.

1.2 Objectives

1.2.1 Problem formulation

The goal of the project is to design, develop and evaluate a new car awning concept. Since the project is about the development of a new product, as opposed to an already existing Thule product, it will cover a detailed product development process.

The project will also explore different solutions to fastening the awning to a car and how to achieve that in a way that will fit most of the modern cars on the market. Therefore, a broad exploration will also have to be performed regarding different fastening techniques, including fastening to existing Thule products such as their roof racks. Since the main purpose of an awning is to protect the user from different weather conditions, research surrounding this needs to be done as well to ensure that the final product will be able to withstand different conditions such as rain, wind, and sunlight. For this, material knowledge will be useful together with theories about airflow, strength etc.

A lot of focus will also be put on the general design and aesthetics of the product, to make sure that it fits in with Thule's design language as well as upholding the same standard as their other products. Based on the purpose of the project, the following research questions were created:

1. *What can be done to facilitate camping out of a car?*
2. *How can an awning for cars be designed to be universal and offer sufficient cover from different weather conditions?*
3. *How can Thule's existing design language be integrated in the final design of the awning?*

1.3 Delimitations

To make sure the project focuses on the right things, some delimitations were done.

The project will not consider manufacturing methods and will not include any cost calculations. It will not include a solution for caravans or mobile homes/RVs. The product will be attached to Thule roof racks and will not provide mounting directly to a car. Furthermore, there will be no mounting solution made for the Thule SquareBar Evo.

2 Theoretical Background

The theories which are used throughout this project is covered in this chapter, together with an explanation of them.

2.1 Connection between research questions and theories

To get an understanding of which theories will be of use for which research question, a chart was created which visualizes said connection.

	RQ1	RQ2	RQ3
Design thinking			
Design for emotion			
Material theory			
Impact of wind			
Forces			

Table 1. The connection between research questions and theories.

2.2 Industrial design

Industrial design focuses on the human, by acquiring a deep understanding of user needs through empathy. This is combined with a strategic problem-solving process that creates innovative products, services and systems aimed to improve quality of life. Industrial design involves redefining problems into opportunities, providing a more optimistic outlook on the world. [2]

2.3 Design Thinking

Design thinking [3] is a systematic process for both defining and solving a problem. What makes this process different from other similar processes, however, is the way that it is repeatable. Design thinking also involves separate phases in solving the problem.

The first phase in the process, “Empathize” involves getting to know and understand the problem from the perspective of an existing or potential user. Based on this information, the problem can be broken down further and better specified in the next phase; “Define”. In this phase, delimitations are also set to make sure the project focuses on the right things. The next phase in the process is called “Ideate.” This is where the ideas to solve the problem are generated, often through methods such as Brainstorming. The goal here is to achieve as many different solutions as possible, which then evolve into more realistic solutions. [4] It is then, when the ideas turn into more feasible concepts, that the next phase is suitable. This is the “Prototype” phase and involves creating either simple mock-ups or more advanced models to visualize the concept or solution at hand. These can be both physical and digital and do not need to be complete, as their main purpose is to explain and convey themselves, to help with the evaluation that happens in the next

phase. The “Test” phase consists of evaluation and feedback from e.g., the user of the product, often in the form of different tests.

Unfamiliar problems or potential improvements are often found throughout the Design thinking process. However, since the process and phases are repeatable, these problems and improvements can be revised and considered in the outcome. [3]

2.4 Design for emotion

Design for emotion [5] is a way of integrating the user’s emotional responses in the design. It involves evoking emotion with the design of the product, resulting in a positive user experience. According to the Attract, Converse, and Transact (A.C.T) model, design for emotion can be divided in to three distinct stages:

Attract

This focuses on a product's aesthetic and interactive properties and the pleasures they provide. It is also regarding the senses that allow those properties to enter the consciousness of people. If the product is one that people get affected by, through e.g., seeing or hearing it, the theory is that it must attract customers and users.

Converse

The converse part covers how the user will interact with the product. It focuses on how usable the product is for the user, and if it does what the user wants it to do. If a product, for example, ignores the request of the user or is inconsistent, it results in not being very usable.

Transact

If the stages of Attract and Converse have gone well, the user may decide to purchase the product or service, i.e., to perform a transaction. This stage also focuses on the relationship and personality that is communicated through long-term usage.

2.5 Material theory

To be able to choose the appropriate material for the application, knowledge regarding materials and their properties is crucial. The durability, strength and flexibility are a few of many variables that must be known to be successful when deciding this. Furthermore, the impact of weather and different temperatures is another aspect to keep in mind.

Knowledge about this will be important in this project as there are many factors to consider, especially when constructing the structural pieces of the awning.

Whether the awning is UV and waterproof is also dependent on the material used, primarily the material used for the fabric in the awning.

2.6 Impact of wind

Developing a product that is to be used outdoors creates challenges which would not occur when developing something for indoor use. Many more factors need to be considered regarding the environment, in the form of different weathers and climates. One factor to consider is wind. This is even more important when developing a product that is considered light compared to its size. When doing this, different shapes and angles used are important to consider as they will be affected by the wind differently. The size and weight of the product is also quite important. [6] To understand and implement this, some general knowledge regarding different forces is crucial.

2.6.1 Forces

The awning that is to be developed in this project will have to withstand different forces, from the wind that affects it but also from being handled by the user. Therefore, some general knowledge regarding this is needed.

Tension

Tension is a pulling force that occurs when one of the objects involved is e.g., a rope, string, chain, or cable. This is applicable since many car awnings/tarps use guy lines to secure themselves to the ground or the car. To calculate these tensions, Newtons second law is used: $a = \frac{\sum F}{m}$, where:

a = Acceleration (m/s^2)

m = Mass (kg)

F = Force (N) [7]

Bending

Bending is when a force is applied to a length of material, causing it to bend. The force is in this case applied to a point, area or volume on a component that is some distance away from its fixed part. Since many car awnings use structural pieces holding it up, it is often exposed to this kind of force. [7]

Torsion

Torsion is a force which is applied to a component or material through torque. This torque applies a shear stress, which, if large enough, may twist or break the component or material. This is applicable to the car awning since the structural parts of it may experience this type of force from being exposed to factors such as wind. When calculating torsion, the following formula is used:

$$\frac{T}{J} = \frac{\tau}{r} = \frac{G \times \theta}{L}, \text{ where:}$$

T = torque [N×m]

J = polar moment of inertia or polar second moment of area about shaft axis, [m⁴]

τ = shear stress at outer fibre, [Pa]

r = radius of the shaft, [m]

G = Shear modulus, [Pa]

θ = angle of twist, [rad]

L = length of the shaft, [m] [7]

3 Method

The methods used aim to answer the following research questions:

1. *What can be done to facilitate camping out of a car?*

For this research question, a lot of data from the literature review will be used. Theories surrounding weather and wind influence will be of focus here. Market research and observations will also be performed.

2. *How can an awning for cars be designed to be universal and offer sufficient cover from different weather conditions?*

To answer this research question, a complete product development process will be performed, following the double diamond methodology. Data from the literature review, market research and observations will also be used here, together with personas, a FMEA, function analysis, product specifications and a moodboard to define the project. This will lay the ground for the then upcoming brainstorming and sketching process. Following this, methods such as the Morphological matrix and Pugh's matrix will be used to choose concept(s). This may be done in multiple instances to narrow down the results. To then create the result, methods such as solid modelling, creating mock-ups, Kansei engineering, prototyping will be performed, followed by thorough testing to confirm the results.

3. *How can Thule's existing design language be integrated in the final design of the awning?*

To answer the last research question, most of the methods used in research question two will be used, apart from a few such as the Double diamond, observations, Function analysis product specification and testing.

For all the research questions a GANTT-chart will be used to plan and keep track of the process of the project.

3.1 Connection between research questions and methods

To better visualize which method will be used for each research question, the following chart was created. Each methodology is listed on the left side, with the research questions on top. Their correspondences are then visualized with the difference colours, with green fields marking them as connected.

	RQ1	RQ2	RQ3
GANTT-Chart			
Literature review			
Double diamond			
Market research			
Observations			
Personas			
FMEA			
Requirement specification			
Function analysis			
Moodboard			
Brainstorming			
Morphological matrix			
DDecision-making			
Sketching			
Solid modelling			
Visualizing			
3D-printing			
Prototyping/Mock-up			
Kansei engineering			
Testing			

Table 2. The connection between research questions and methods.

3.2 Methods

A variation of methods was used throughout the project to reach the end goal.

3.2.1 GANTT-chart

A Gantt-chart is created to map out each step of e.g., a project, as well to give an estimation of how long each step will take. It also structures the project by visualizing in what order the work will be done. This time plan can look differently depending on how extensive the project is. In some instances, each day might be planned individually, while in larger project it may only be necessary to plan each week or even month. Important dates such as deadlines, meetings or gates are also included in this. This is a good way to structure the workflow and get an approximation of the time it will take.

3.2.2 Literature review

When performing a literature review, literature is identified, read, and compiled to create a collection of knowledge to base the study on. The literature review is performed to discover what knowledge is already known in the study's subject. Based on this, new knowledge can then be found. [8]

3.2.3 Double diamond

The Double Diamond design model is a method that is to be followed in the creative process of a project. It consists of four stages, often called Discover, Define, Develop and Deliver. The model acts as a path to follow for the designer without being linear, giving the flexibility to go back and forth. [3]

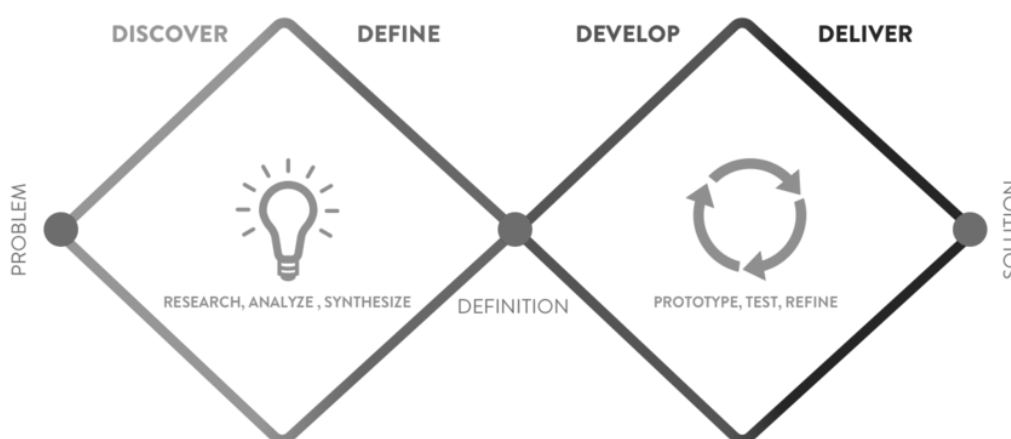


Figure 1. The double diamond design model.

Discover: The aim here is to understand the issue at hand. Instead of making assumptions, engage in discovery to gain a deep understanding. This involves actively listening and spending time with those involved.

Define: The knowledge acquired during the “discover” phase is used to define the objective.

Develop: Provide solutions to the previously defined problem, drawing inspiration from various sources and engaging in collaborative design.

Deliver: Test out different solutions on a small scale, discarding ineffective ones and improving the promising ones.

3.2.4 Market analysis

Carrying out market research involves looking at the already existing range of products of relevance to the project. The observed products are then evaluated so data can be gained from it regarding things such as price, quality, appearance etc. This data is often used to find gaps or opportunities in the market, or benchmark the new product that is to be created. [9]

3.2.5 Observations

By using the method of observations, phenomena, events etc. can be studied. This method may include watching, reading, listening and so on, either in a contributing or non-contributing way. The observations can also be either structured or unstructured, with the foremost being controlled by chosen requirements and variables. [10]

3.2.6 Personas

This method is used to find out the needs and everyday experiences of potential users when developing a new product. “Personas” use a made-up interpretation of a user rather than real people. Everything about the people used as personas is made up, but often with the projects purpose in thought. The main point of the method is to add a user perspective in all parts of the development process. [11]

3.2.7 Requirement specification

A requirement specification is created to establish what is to be expected from the product, in the form of requirements. When the product is then developed, the end goal is to fulfill this specification. [4]

MoSCoW

MoSCoW is a method for creating such a specification. This method categorizes the different requirements into ranks, which are: “Must have,” “Should have,” “Could have” and “Won’t have,” with the first one being the most important requirement for the product to work. They are then less and less important, until the “Won’t have” rank, which simply lists requirements the product will not fulfill. [4]

3.2.8 Function analysis

A function analysis is created to make sure the product works as intended. In this method, all the products' functions are put into sub-categories, with one main function they seek to fulfill. [4]

3.2.9 Moodboard

To further visualize the design and form of the final product a mood board can be used. A mood board often contains images and colours that give a similar feeling, which is then used to express the intended result that the project seeks to achieve. Moodboards are then used as a source of inspiration during the development phase of a new product. [9]

3.2.10 Brainstorming

To generate concepts during the Ideation of the project, many different tools can be used. For this project, brainstorming will be used as it is a quick and effective way to produce ideas and concepts. By using brainstorming, many innovative ideas and concepts can quickly be generated, especially when it is paired with simple sketches to visualize the ideas. This method is often conducted in an open environment where every idea is welcome, and spontaneous ideas are appreciated. This method can be utilized during various parts of the project. [4]

3.2.11 Morphological matrix

Morphological matrix, or analysis, is used to generate additional concepts in the ideation phase. The ideas generated by this method are often ones that normally would not come to mind. With this method, the main function of a generic product is broken down into different sub-functions. Multiple solutions to solve each of these subfunctions are then generated and arranged in a matrix. Furthermore, different combinations of each subfunction are then combined into many different complete solutions. [13]

3.2.12 Decision-making

To be able to move forward in the project, important decisions sometimes need to be done. There are several methods for this, however in this project there are only two that will be used.

Pugh matrix

The Pugh matrix [4] is a method for selecting a winner from several concepts. This method compares the concepts between each other by giving them a grade, based on how well they put up against several different criteria. These criteria are in turn also weighed based on their importance and are often based on the different requirements and functions that the product is meant to fulfill. A reference is often used in this method, acting as a baseline for the concepts. This reference can be an already existing product.

Intuition

Another way of performing decision-making is by going off intuition. [9] Choosing a concept based on intuition means that the decision is based purely on the impression of said concept. Although it is not a true methodology, the ability of deciding based on intuition is a crucial skill to have as a product designer.

3.2.13 Sketching

Sketching is a fast and effective way to express ideas on paper. This can be done both when working on a collaborative project or when solving problems alone. Sketching can be seen as a tool for thinking, planning, and exploring. This method can be carried out in different ways, for example analogue with a pen and paper, or digitally in a software. [14]

3.2.14 Solid modelling (CAD)

Computer-aided design, or CAD for short, is used to generate digital models in 2D or 3D. This includes all types of design and construction work that uses a computer program. With the program's help, the user can easily create models built of different geometric elements. It can also create visualizations of a group of digital models. CAD is a broad subject, where several types of methods are used to model. The most common one is called solid modelling, which uses geometries with solid bodies. There is also surface modelling, which instead focuses on the surfaces of the geometries. [15]

SolidWorks

SolidWorks is a software used mainly to create 3D-models of the solid-body-type. The software offers plenty of different tools to create and shape the model. It also offers feature such as assembly, which lets the user combine many different models, parts, in to one large model, an assembly.

Alias Autodesk

To create more advanced shapes and surfaces, software such as Alias Autodesk can be used. This software allows the user to freely interact with and manipulate the surfaces, to create high quality 3D-shapes.

3.2.15 Visualizing

There are various methods of visualizing the outcome of the project. Digital visualizations through rendering software and physical prototypes are some of the options, which is what will be used in this project.

Keyshot

Keyshot is a software used to create lifelike renders and animations. It lets the user quickly apply things such as material, a surrounding and light source to the 3D-model, which is then rendered into high quality visualizations.

Prototyping/mock-up

To better visualize an idea or concept, prototyping is often used. This method involves creating either a physical or digital prototype, which can also be functional or non-functional. Mock-ups are like prototypes but are often of the simpler kind and used to quickly explain an idea or concept. [4]

3.2.16 3D-printing (Additive manufacturing)

Additive Manufacturing is a technique that manufactures products or concepts by creating them layer by layer. Because the items are being created this way, there are little limitations to the design, and they can have complex shapes. One way to apply Additive Manufacturing is by using a 3D-printer. A 3D-printer is mostly used to create objects in different plastic materials, but in some instances also metal. [16]

3.2.17 Kansei engineering

Kansei engineering involves the intended users' feelings and needs while developing or improving a product. This is used during the design phase of the product and focuses a lot on how the product is perceived, in areas such as how it feels, sound, smell etc. [17]

The equalizer

A method of applying Kansei engineering is by used a tool called the equalizer. This is applicable to various things in the design phase, such as evaluating a shape or material used. After deciding the criterion for the subject at hand, e.g., the material, the method uses sliders to grade each one.

3.2.18 Testing

Testing is a vital stage of the product development phase. It is used to verify and validate the theories and concepts used in the project. There are many different methods for conducting the testing, one of them being product usability testing.

Product usability testing

This method evaluates a product by testing it on the intended user. Things such as how well the product meets its purpose and how easy it is to use can be noted here. This is done by observing the user's behaviour, emotions and difficulties when using the product in its intended environment. For this, a prototype or mock-up is often used. [9]

4 Implementation and Results

4.1 Planning

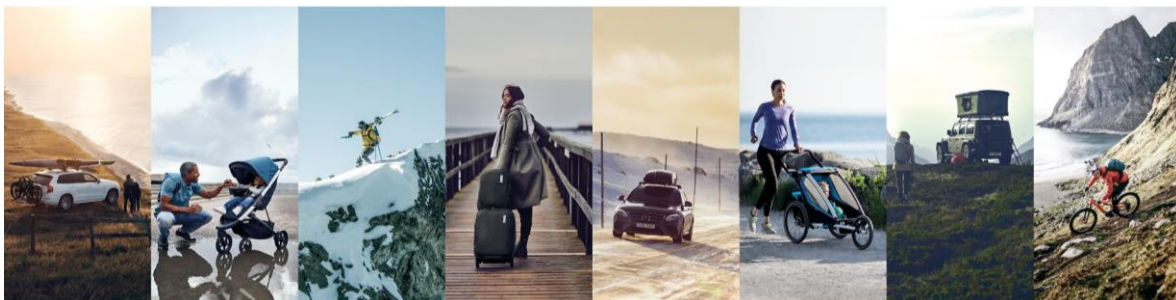
To manage the time properly and get a good overview of the project, as well as what must be done, a GANTT-Chart was created. The GANTT Charts used in this project can be found in Appendix 1.

4.2 Discover

The Implementation and Results chapter follow the double diamond process, starting with the Discover phase. Here, the background and general knowledge surrounding the problem is gathered.

4.2.1 Thule as a brand

Thule as a company focuses mainly on creating high quality products meant to help transport the customers belongings everywhere. This is heavily reflected in their tagline “Bring your life.”, or their motto “Active Life, Simplified.”. When developing new products at Thule, there are four aspects that are at focus: Quality, Safety, Design, and Easy-to-use. These aspects were also highly valued throughout this project.



Picture 2.

Image from Thule's website

4.2.2 Conducting a literature review

Identification of keywords

To collect relevant data for the study, a literature review was conducted. For this, keywords related to the project were identified. Furthermore, synonyms, as well as broader, narrower, and related terms for the keywords were gathered to improve the search.

Keywords	Synonyms	Broader terms	Narrower terms	Related terms
Weather	Climate Environment Conditions	Storm Temperature	Wind Sun Rain	Humidity Outside
Strength	Toughness Robustness Sturdiness	Property Mechanical	Tensile strength Tension	Force Stress Structural Integrity
Automobile	Car Auto	Vehicle	SUV Sedan Van Wagon Hatchback	Transportation Automotive
Car awning	Car tarp Car covering	Awning Car equipment Car accesory	Protection Shelter Sunshade	Car tent Car roof Roof rack Camping
Product development	Manufacturing	Development Industrial		Innovation

Table 3. The generated keywords for the literature review.

Search method

The keywords were used together with Boolean operators followed by a backwards snowballing method to increase the data collected. Different combinations of both the terms and Boolean operators were used. The searches were done on the database Primo with the advanced search feature. To get relevant up-to-date results, some filters were also applied to the searches so only data from the last 15 years would show up.

4.2.3 Results from literature review

From the searches conducted in the literature review, general knowledge regarding the project area was gathered. Information about different types of awnings, roof racks and other involved components was included in this. Also, an article comparing how differently shaped tents get affected by strong wind was gathered.

Analysis of the involved components

To get a better general understanding of the product at hand, some analysing was done of the different components involved.

Roof rack bars

Since the product that will be developed in this project is to be mounted directly to a roof-rack bar, this was an area that needed to be investigated. To understand what types of roof-rack bars there are, research was done including both Thule's and other competitors' products.

In Thule's and other roof rack bar manufacturers' product range, there are many diverse types of roof rack bars, designed for different needs. They often also have different shapes, some round and some more square in profile. This needs to be accounted for when designing the fastening solution, as it should fit most of Thule's roof rack bars.

A common occurrence that was found throughout Thule's product line-up, is the T-track. This is a feature integrated on the top of the roof rack bars, but also on some products on the rear. This T-track allows for easy installation of equipment and attachments by sliding them and securing them on to a track on the roof rack. However, this feature is not available on the product Thule SquareBar Evo, which was therefore excluded from this project.



Picture 3. Image showing the T-track on the Thule WingBar Edge.

Awnings/tarps

To get an idea of the diverse types of products that exist in this area, research was done regarding the matter. To better define the products, the more common ones were categorized based on their usage or similarities.

- **Retractable awning**

This category covers car awnings that are retractable into a cassette, bag or similar, attached to the vehicle. These unfold directly outwards in most cases.



Picture 4. Image displaying a retractable awning.

- **270 degrees awning**

Like the “Retractable awning,” these are also often stored attached on the car in some storage solution. The difference with these, however, is the fact that they unfold 270 degrees, creating an arch. These can be strong enough to hold themselves up or use poles to help.



Picture 5. Image showing a 270 degrees awning.

- **Tense tarp**

This category covers the car awnings that are of a more basic nature and consists of a large tarp that is mounted directly to the vehicle or roof rack, and then uses poles and guy lines to create a tension and structure in them. These are often folded and stored in a bag rather than on the vehicle.



Picture 6. Image of a tense tarp.

- **Structured tarp**

The structured tarp is like the tense tarp in every way except the way that it keeps its shape. Instead of creating tension with guy lines, this uses a structure, often in the form of thin glass fibre or aluminium poles to hold its shape.



Picture 7. Image of a structured tarp.

Wind tunnel tests of tent halls of different shape

The purpose of the study was to investigate the distribution of wind pressure on the surfaces of models representing tents. Four objects with different shapes and constructions were tested. Although tents are known to be vulnerable to wind, there is a lack of information on the distribution of pressure. The results obtained emphasize the significance of considering different configurations when designing these structures. It is discovered that the highest value of pressure appears at an 45° angle of wind onflow. It is also shown that having a rounded shape on the tent is more favourable to achieve lower overall wind pressure compared to a flatter shape on the sides. [6]

4.2.4 Market analysis

To explore what products are currently on the market, a market analysis was performed, see appendix 2. In total, seven different awnings/tarps were collected for the analysis. The ones included were some of the more popular choices on the market, from different price classes. The data collected from this was both in text and visually, through pictures. Specifications such as size, weight and material were gathered, as well as some general comments regarding the products, both positive and negative. These comments were found through product pages as well as different reviews on the internet.

Name	Price (USD)	Max length x width (cm)
Kelty Waypoint Tarp	145	337 x 420
SJK Slumberjack Roadhouse Tarp	130	406 x 488
Yakima SlimShady 8'	440	244 x 244
Hasika Versatility Teardrop Awning	150	350 x 240
Hasika 270 Awning	400	494 x 494
MoonShade	395	274 x 213
Frontrunner easy-out awning	355	210 x 200

Table 4. The most important aspects from the market analysis

4.2.5 Observations

Some observations were done regarding the use of different car-awnings and tarps that are on the market right now. The observations were performed in an unstructured way and done online by using the internet. Videos of people assembling, dis-assembling, and using currently available awnings were analysed to further increase the knowledge regarding the subject. The results of these observations were included as comments in the market analysis and can be found in appendix 2. This gives a good understanding of the general specifications of an awning/tarp for a car, as well as insight into what to keep in mind when developing a new one.

Name	Points of improvement	Mountingpoint
Kelty Waypoint Tarp	May damage the car as it is attached directly to it. Sensitive to hard wind. Difficult to fold back into storage.	Rear of car
SJK Slumberjack Roadhouse Tarp	Difficult to set up alone. May damage the car as it is attached directly to it.	Rear of car
Yakima SlimShady 8'	No cover on the sides. Difficult to set up alone.	Side of car
Hasika Versatility Teardrop Awning	Difficult to mount. Sensitive to strong winds	Side or rear of car
Hasika 270 Awning	Not great quality. Weak components may damage car.	Side of car
MoonShade	No cover on the sides.	Side or rear of car
Frontrunner easy-out awning	No cover on the sides. Difficult to set up alone.	Side of car

Table 5. Some of the comments from the observation

4.2.6 Materials

Based on the previously done research, including the market analysis and observations, an observation of the most used materials could be done. This includes the fabric material of the awning or tarp and not the structural pieces, as they can vary heavily depending on the type of product.

From the information gathered, it could be seen that polyester in some form is the most common one. It is very common that the polyester is combined with some kind of coating as well, e.g., a PU coating. Furthermore, there are also some made from nylon or a cotton-polyester combination.

4.2.7 Personas

Potential users of the car awning were generated together with information such as their name, age, occupation, and interests to be used as personas. Demographic profiles, behavioural profiles, goals, and challenges were also created for each person to better define them. Some similarities were created between the personas to make sure they were all relevant and interesting users for the product, while still being different from one another, hence creating a broad user range. The information generated here was used to define what functions the product should have. The three personas can be found in appendix 3.

4.3 Define

The next step in the Double Diamond method is Define. This focuses on breaking down the problem at hand to understand it better.

4.3.1 Function analysis

To further define the problem at hand, a function analysis was performed. The specific model that was used included three different columns: “Function,” “Class” and “Notes.” The first column, “Function,” describes the function that is to be achieved, with a verb and a noun. The second column, “Class” describes what ranking the function has. The different ranks are: Main function (M), Necessary function (N), Desirable function (D). The third and last column consists of general comments, definitions, and notes regarding the function. The functions used for this project were generated based on data and information from the previously done research, such as the market analysis and personas. [4]

Function Analysis			
Function		Class	Notes
Provide	Cover	M	From rain, sun and wind
Be	Convenient	N	Mounting, deploying, retracting
Keep	Stability	N	During hard wind
Be	Safe	N	To prevent injuries and damage to car
Maintain	Design	N	Thules design-language
Offer	Storage	N	Of the product
Provide	Adjustability	D	To shape of product
Endure	Usage	D	Longlasting product
Express	Quality	D	Materials, design

Table 6. The established function analysis.

4.3.2 Requirements specification

MoSCoW

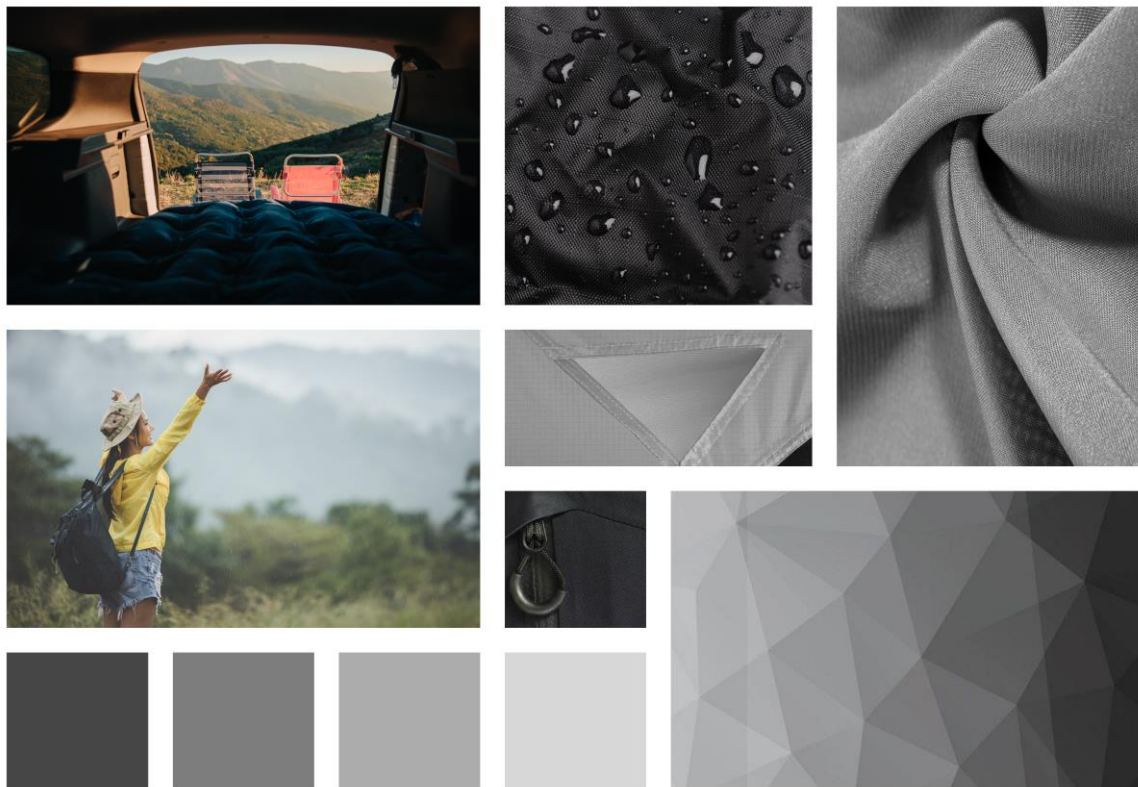
For the requirements specification, a model called MoSCoW was used. [4] The requirements used here were based on those received from the company and previously collected data.

MoSCoW			
Must have	Should have	Could have	Won't have
The product is easy and fast to deploy	The product can be deployed by one person with ease	The product can be both deployed and retracted by one person	The product can be deployed and retracted automatically
The product can be mounted to Thule's current roof bars	The product can be mounted to both Thule's and other brands roof bars	The product can be mounted to all types of roof racks as well as directly to the car	The product can be mounted solely to the ground without the need of a car
The product provides sufficient cover from sun, rain and wind	The product is adjustable to provide even more cover from sun, rain and wind	The product provides cover from bright strong sunlight, and heavy rain and winds	The product provides cover from all types of weather
The product follows Thule's existing design-language to some extent	The product follows Thule's existing design-language fully	The product offers improvements to Thule's existing design-language	The product offers a whole new design-language for Thule
The product offers some sort of storage	The product can be stored in an external storage solution	The product can be stored permanently on the car	The product offers multiple storage solutions
The product is safe for the user	The product will not damage the car if used correctly	The product will not damage the car even if used incorrectly	The product is safe for the nature and wildlife

Table 7. Table of requirements from the MoSCoW model.

4.3.3 Moodboard

Regarding the design aspect of the new car awning, a moodboard was created. This was used to create a feeling or a mood of what the new product should look like regarding colour and patterns, what materials it will use, as well as in what environment it will be used. To follow the design language of Thule, a colour palette of different shades of grey was used, together with materials and environments related to camping.



Picture 8. Moodboard used for the project.

4.4 Develop

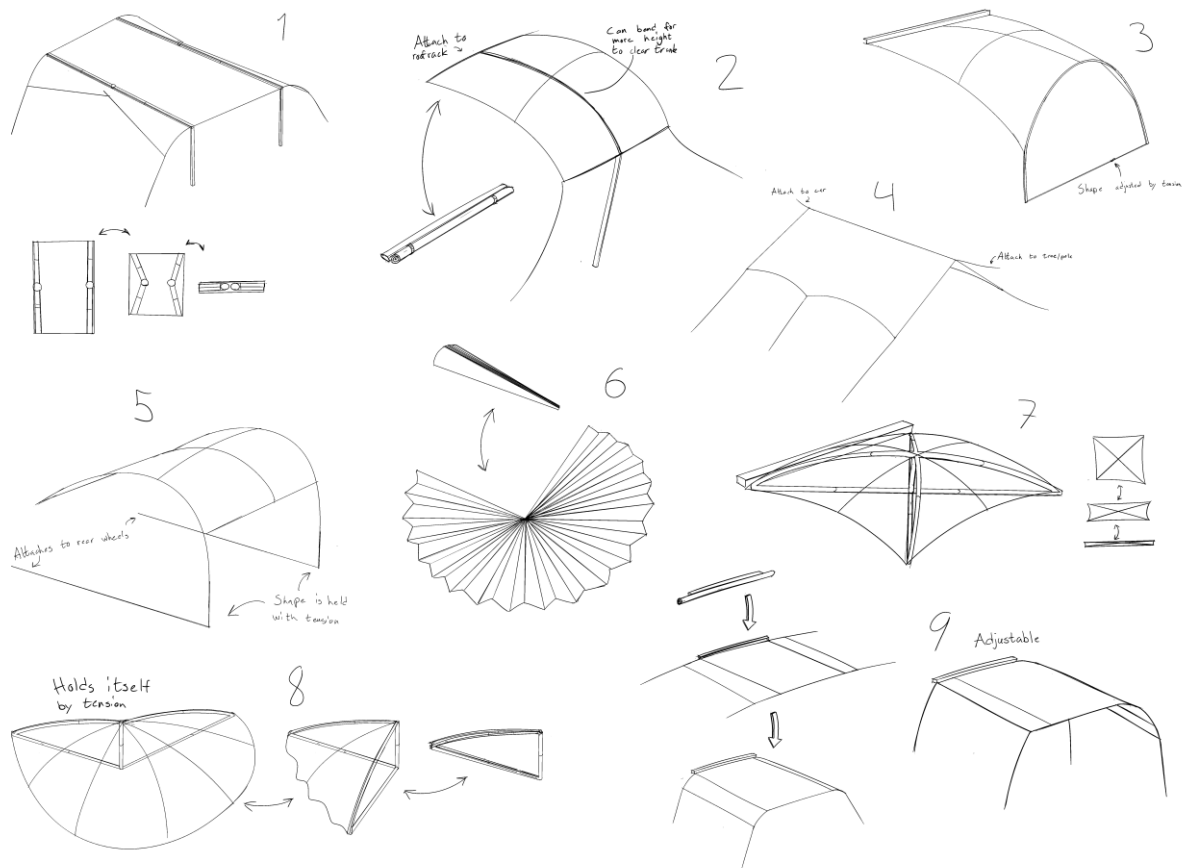
The third step in the process is Develop, which involves the work done to create the product.

4.4.1 Brainstorming

The initial brainstorming session was performed in a group to gather concepts more efficiently. With more people, the ideation process becomes more effective as different views and broader ideas get collected, as opposed to doing it alone. From this first session, many ideas regarding the main shape of the awning/tarp were gathered as well as concepts for mounting it to the car. A morphological matrix was then used to create more variations of the different concepts, giving a wider range of concepts. The results of the first brainstorming session can be found in appendix 4.

4.4.2 Concept sketching

Based on the ideas and concepts gathered in the brainstorming session, more refined concepts were created. Furthermore, other ideas were also generated here and put into concepts. In total, nine different concepts were created, through sketching. Each of them consisting of several types of awning/tarp solutions, but all with the same concept of mounting to the roof rack bars of the car.



Picture 9. Image showing sketches of the nine concepts.

4.4.3 Concept selection

To move on in the project, a selection had to be made between the different concepts.

Pugh's matrix

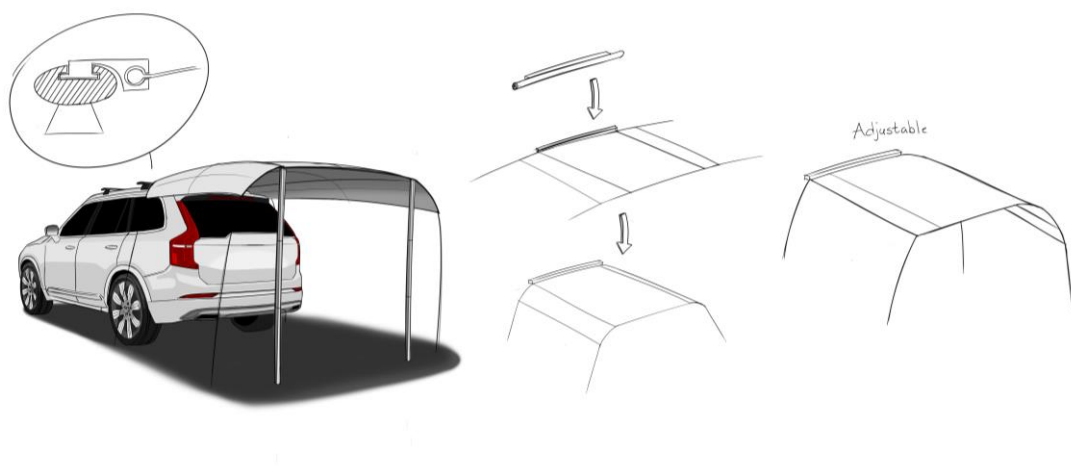
To make this selection, Pugh's matrix method was used. The different criterion was based on the functions in the function analysis. They were also given an importance weighting of their importance, from 1 to 5, with 5 being the most important. This weighting was based on requirements from the company. A baseline was also included, and for this a current product from the market analysis was used. Once Pugh's matrix method was carried out, Concept 3, 7, 8 and 9 was decided to develop further.

Criteria	Importance Weighting (1-5)	Baseline (Kelty Waypoint)	Concept 1	Concept 2	Concept 3	Concept 4	Concept 5	Concept 6	Concept 7	Concept 8	Concept 9
Size of cover	4	0	0	-1	0	0	0	-1	-1	0	0
Convenience	5	0	0	1	1	-1	0	1	1	1	1
Stability	3	0	1	0	1	-1	1	-1	1	1	1
Safety	5	0	1	0	0	-1	0	0	1	1	1
Aesthetics	2	0	-1	-1	1	-1	0	-1	0	1	0
Storage	1	0	-1	1	1	0	-1	1	1	1	1
Adjustability	3	0	0	1	0	1	0	0	0	0	1
Endurance	2	0	1	0	1	0	1	0	1	1	1
Quality	4	0	1	0	1	0	0	1	1	0	1
Totals		0	11	3	17	-12	4	1	16	18	23

Table 8. Pugh's matrix.

4.4.4 Refined sketching

After the winning concepts had been chosen, they were improved further and sketched in more detail. They were all sketched in perspective, attached to a car. Furthermore, smaller sketches were also included to explain the functionality of each concept. This was done to better show how they would work and look like. All the sketches can be found in appendices 6-7.



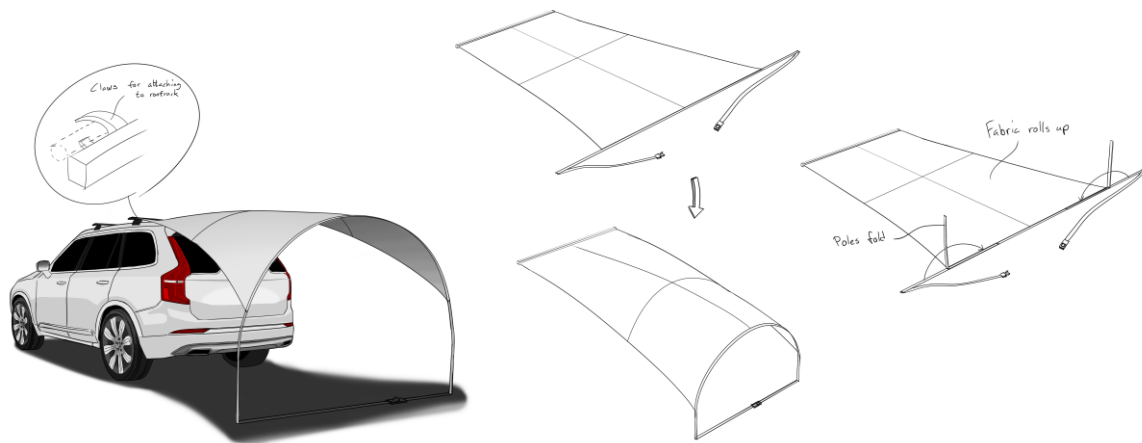
Picture 10. Image showing one of the concepts.

4.4.5 Decision-making

To decide the final concept, a workshop was held together with the people involved from Thule. During this workshop, the different concepts were discussed. Based on this feedback, combined with intuition, a decision could be done regarding which concept to continue with.

4.4.6 Final concept

The overall concept that was chosen to continue working with was concept 1. However, some improvements were made to the concept by adding more features and ideas used in the other concepts, such as the method for fastening the awning to the car used in concept 2.



Picture 11. Sketch of the chosen concept

General shape of the awning

The final concept consists of a fabric awning, with a maximum length and width of 400cm when flat. This fabric is held up by several camping poles and stabilized with guy lines. The camping poles attach inside the edge of the awning by sliding into a pocket which reaches across the rear of the awning. These poles are to be made of a durable material that can bend, which allows for the awning to hold itself up by tension once the two ends are attached together with a strap, creating an arc. By utilizing this rounded shape on the awning, it creates a favourable shape to withstand wind and reduce stress on the involved components. Furthermore, guy lines are used together with tent pegs to stabilize the awning and keep it from moving during high winds.

Aesthetics

For the final design of the awning, many similarities can be found aesthetically with other similar Thule products. The rounded top of the awning with the triangular details on the side, as well as the combinations and proportions of colours used also has a resemblance to Thule's product line-up. Furthermore, a lot of focus was put on making the awning express Thule's core values. This was accomplished by applying theories such as design for emotion to give the user an impression of Quality and Easy-to-use.

Features

When it comes to the features of the awning, it offers quite a lot of adjustability and convenience. The whole fabric piece can slide on the arc, allowing it to be further down on one side compared to the other. This way, more shade and cover can be had when e.g., the sun is set low, or the winds are extra strong from one direction. On the other hand, when less cover is needed, e.g., when the sun is set high and there are no winds, the rearmost corners of the awning can be folded upwards. They are then attached and hidden on the inside of the awning with the help of Velcro. This way the awning is less enclosing, while still offering cover from the sun above. The height of the awning can also be adjusted, simply by adding or removing tension in the arc. This is done by tightening or releasing the strap that connects the two ends of the arc. Renders showing these features can be found in appendix 9.

Attaching to car

The awning attaches to the car by using two plastic clamps which squeezes the end of the awning and its integrated plastic strip, holding it in place. This plastic strip creates a convenient way of attaching the awning, as it can be slid into a rail in the clamp from the side and then fastened simply by closing the clamps. Usage of a plastic strips like this is often utilized to fasten tents and other accessories to caravans or RVs, which is where the idea came from.



Picture 12. A plastic strip used for caravan accessories.

The clamps are then attached to the car through the T-track in the roof rack bars. With this solution, the awning can be fastened on both the rear and the side of a car since the clamps can be attached to the roof rack at any angle and to both the front and rear roof rack. The clamps can also be put at different widths, given that they are inside the

maximum width of the awning's plastic strip. This is necessary to be able to fit differently sized cars.



Picture 13. 3-D printed early prototype of the clamp.

Storage of the awning

When the awning is not in use, the fabric of the awning can easily be folded and stored away in its belonging storage bag. As the camping poles are made from several pieces, they can be disassembled and stored together with the fabric. However, the clamps can, if preferred, stay attached to the roof rack bar on the car as they are tightly secured to the T-track of the roof rack bar.

Materials

To decide which materials to use for the different parts of the awning, various methods were used. For the fabric part of the awning, which is the largest part and the one the user interacts with the most, the Kansei engineering tool The equalizer was used. Three different materials were chosen, based on what is generally used on similar product, and then evaluated against each other. The criterion used were roughly based on the previously established function analysis, as well as the moodboard. From this, it could be decided that Ripstop polyester would be the most suitable material. This is also a material that Thule already uses in many similar products, making it even more suitable.

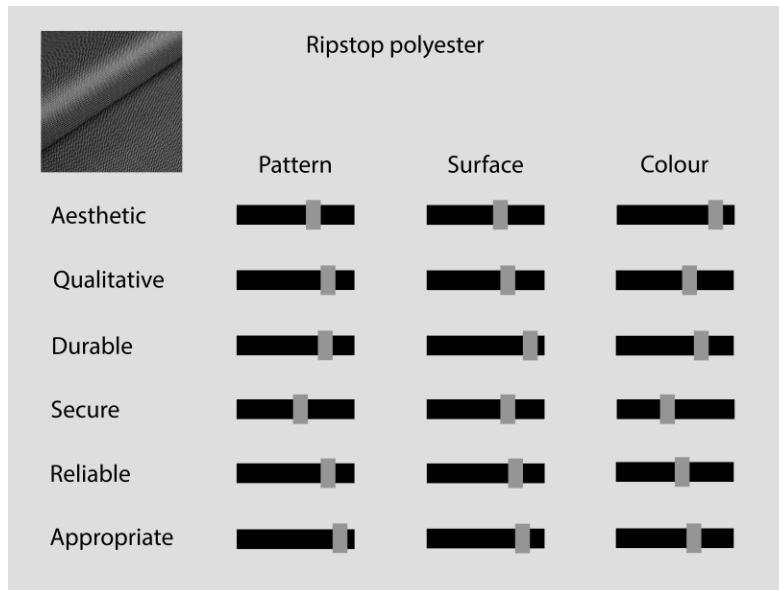


Figure 2. The equalizer of the winning material

For the clamp itself, it was decided to use a strong plastic for the main body. For the moveable parts, such as the tightening mechanism that attaches the clamp to the roof rack as well as the handle of the clamp, a metal is suitable to use. This way, the part will be able to handle different forces, from both being handled by the user as well as residual forces from wind affecting the awning.

4.5 Deliver

The final chapter of the Double Diamond process, Deliver, Covers the actual results of the project.

4.5.1 Mock-up

To quickly visualize and get a perception of the dimensions of the concept, a simple mock-up of the awning was made. This was created using a combination of paper, foamboard, glue and tape. It was created on a 1:10 scale. A mock-up of the rear of a car with the same scale was created too, based on the dimensions of a real car. Together, they gave a good perception of how large the awning would be in comparison to the car, as well as how much cover it provides underneath itself.



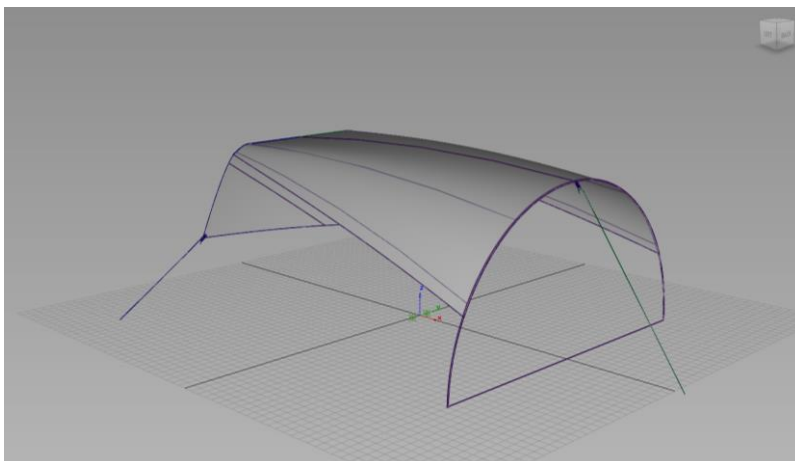
Picture 14. The foamboard and paper mock-up

A slightly more detailed mock-up was also created, made from cloth fabric, a thin plastic pole and metal wire instead. This served the same purpose as the first mock-up, except for it being able to show how a potential awning made from fabric rather than paper may look and behave.



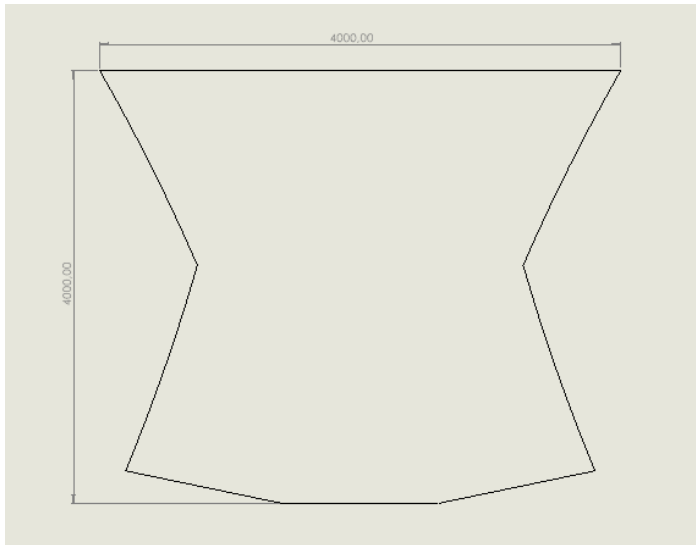
4.5.2 3D-modelling

3D-modelling was at first done in the CAD-software SolidWorks. A full-scale model of the awning was created digitally, with all the parts and features of it. This model was then used as a guideline when creating the finalized model, which was done in Autodesk Alias instead. This achieved a higher quality on the final model with better curves and shapes, compared to the model made in SolidWorks. As mentioned earlier, the fabric part of the awning is to be made from Ripstop polyester. The arc consists of multiple glass fibre poles which are connected to each other. These are tensioned by a cord between the two ends, creating the arc. There are also multiple guy lines that connect to the ground to help stabilize the awning. The main shape and aesthetic of the awning is based on the moodboard.



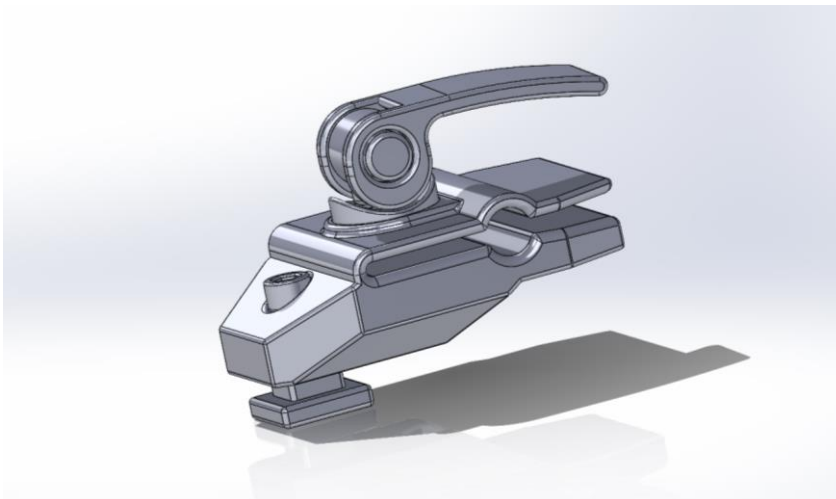
Picture 15. 3D-model of the awning made in Alias Autodesk.

Since a big part of the product is to be made from fabric, and parts with pre-determined dimensions such as the camping poles, the main point of making the CAD-model was to create a visualization of the concept.



Picture 16. Dimensions of the fabric part of the awning.

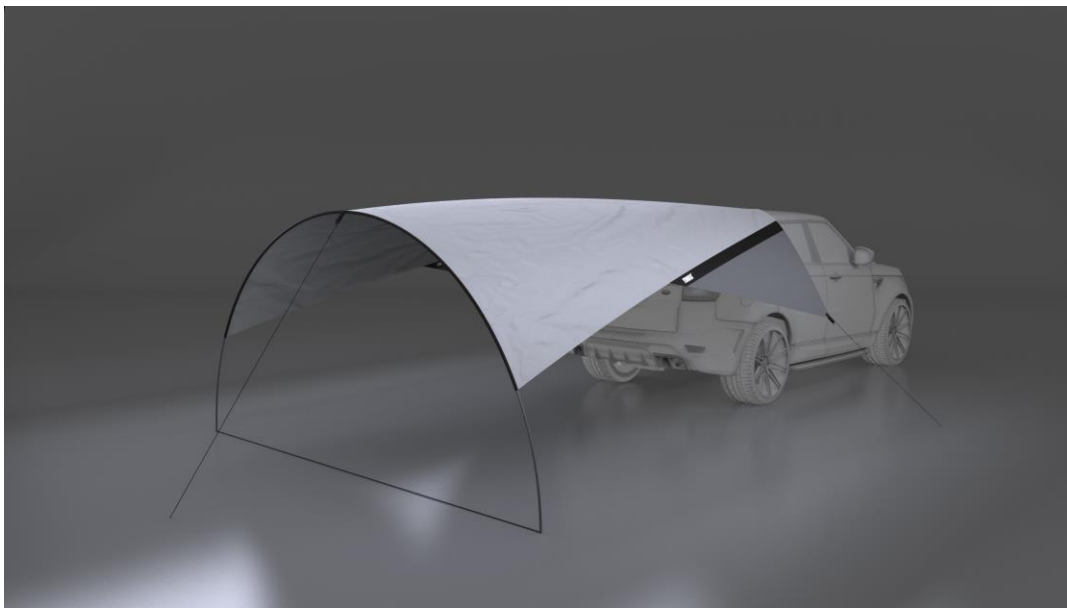
However, for the clamps that attach to the roof rack, a thorough model had to be created. The reason behind this was that they were going to be designed and manufactured from scratch. This was done purely in SolidWorks. The clamp consists of a plastic body with a metal inside to withhold the forces that will affect it. The “handle” on top of the part, which is used to close the clamp, is also made from metal along with its mechanism. The rear of the clamp is where it is attached to the roof rack. It is slid on to the rail integrated in the roof rack bar, where it then tightens up by the help of the integrated screw to achieve a tight mount. This is modelled in a way so that it can be mounted either horizontally or vertically on to the roof rack bar, allowing for the awning to attach either on the side or rear of the car. The design of the clamp allows for the awning and its integrated plastic strip to effortlessly slide in from the side and then be kept in place just by closing the handle.



Picture 17. CAD-model in SolidWorks of the clamp.

4.5.3 Renders

Once a good 3D-model of the awning had been created, renders were done to create realistic pictures of the product. They were created in the software Keyshot. In this software, different materials were applied to every part of the awning, representing the intended materials to be used for it. Fabric-like patterns were also applied to the awning, together with a “bump-map”, to create wrinkles in the fabric making it more realistic. A company logo was also added to the side of the awning, as well as to the side of the clamp. A two-tone colour of light and dark grey was also applied to the awning. However, some other colour combinations were also explored. One with green and tan, and one with light grey and blue, both based on other Thule products. Together with the awning, a model of a car was used. The purpose of this is to give a better visualization of the products intended use, as well as how it will look attached to a car.



Picture 18. Render of the awning in a studio environment.

Renders were created in different settings, both in a studio-like environment as well as in nature, where the product is intended to be used. The purpose of the renders done in a studio-like environment is to empathize on the features and usability of the awning, while the ones in nature aim to display a possible user scenario. The solution of fastening the awning to the car with a clamp is clearly shown here, as well as other features, such as the foldable corners of the awning. All the renders can be found in appendix 9.



Picture 19. Render of the awning in a potential user scenario.

4.5.4 1:12 scale-model

For visualizing purposes, a model in the scale 1:12 was created. This model was constructed from the same material as the full-scale prototype, with 3D-printed plastic used for the poles and clamps. A car in the same scale was also created by 3D-printing. The reason behind this scale model was to be able to display the prototype in a more accessible way, as it is quite large and difficult to handle in full scale.



Picture 20. Mock-up of the awning attached to 3D-printed car.

4.5.5 Full scale prototype

To be able to evaluate and perform tests on the concept, a full-scale prototype was also created of the awning.

Clamp

The full-scale clamp was created by 3-D printing the CAD-model of it. However, this had to be done twice as the first version of the clamp could not be mounted to the roof rack bar, as its base was too large. This was therefore changed, together with some general design improvements, in the second version. The clamp was also painted black to suit Thule's general design language better.



Picture 21. 3D-print of the clamp in full scale.

Awning

The fabric part of the awning was created from a large ripstop polyester tarp. This was then sewn to the correct dimensions and shape. A plastic strip was also integrated on the side of the awning which attaches to the car. To create the arc which holds the awning of the ground and gives it its general shape, a set of poles were used, with a fabric strap connecting the two ends. Furthermore, three straps were sewn onto it to allow for guy lines to be used. Two of the straps were added on each side of the awning, on the corners near the car, and one on the top of the arc. These guy lines are then secured to the ground by tent pegs, to keep the awning stable.



Picture 22. The full-scale prototype attached to a car.

Testing/Evaluation

With the purpose of testing and evaluating the concept, the full-scale prototype was assembled and attached to the roof rack of a real car. This was done to be able to evaluate the time it takes to assemble and attach it to the car, its general aesthetics as well as how it behaves in the real life with factors such as wind. Attaching the clamps to the roof rack bar worked as intended. It was also found to be very simple and convenient to attach the awning itself to the clamp. The rest of the mounting process also went well, but it was discovered that the awning was a bit sensitive to the wind and would require more guy lines to both keep stable and withhold its intended shape. This can be seen in appendix 10.



Picture 23. Clamps attached to the roof rack of a car.

4.6 Results research question I

1. *What can be done to facilitate camping out of a car?*

To facilitate and improve the availability of camping out of a car, it is necessary to offer convenience, usability, and adjustability in the products. This was shown through the research done, primarily in the market analysis, observations, and personas. Therefore, this was applied throughout the development process, all the way from the Define phase to the Deliver phase.

For the final product that was developed, these characteristics can also clearly be identified.

Convenience and usability.

The awning developed in this project is of a simple construction, with quite few parts. This allows for a seamless and easy assembly, mounting and dis-assembly process. The clamps which are attached to the car requires only two motions to fasten. Sliding them into the track and then fastening. Likewise, the awning slides into the clamps and fastens. The arc is assembled from multiple shorter poles, which are all connected through a line. This makes it impossible for the user to assemble it incorrectly, as well as keep the poles organized once disassembled.

Adjustability.

With the ability to slide the awning from side to side along the arc, it offers the ability to protect the user from wind and sunlight, regardless the direction of it. It can also be adjusted in height to fit different cars and user scenarios. With the ends of the awning being able to fold upwards on the inside, it offers even further adjustability.

4.7 Results research question 2

2. *How can an awning for cars be designed to be universal and offer sufficient cover from different weather conditions?*

The answer to this question ties into the previous one, as adjustability is quite a big factor here as well. By being able to change and set up the awning in different ways also means that it can be used universally across different types of cars, whether they are big or large. This adjustability, together with its quite large size, also means that the awning can protect from different weather conditions very well.

However, this is not the only factor that needs to be considered. Offering a universal way of fastening the awning to the car is equally as important, which was realized in the process of the project. The solution to this was simply to remove the car from the equation and finding another reliable way of fastening it. In this case, the roof rack, or more specifically the roof rack bar, was used. This way the awning attaches to a product that is already thoroughly tested and comes in a variety of types that fit different cars. By then utilizing the already existing T-track in Thule's roof bars, a secure and reliable attachment point could be created.

4.8 Results research question 3

3. *How can Thule's existing design language be integrated in the final design of the awning?*

To be able to design something following a particular design language, the design language must be discovered and defined first. This was done through the research, by looking into the current product line up from Thule, in particular the products that have similarities to the project. This information was then used to create a moodboard, which in turn acted as a starting point for the design and development of the new product.

The awning developed in this project includes many features which gives it the aesthetic of a Thule product. The way the sides are shaped, with its triangular cut-out and corner pieces, as well as the colours and disposition of colour. To also give off the impressions which Thule identifies itself with, such as Quality and Easy-to-use, theories regarding design for emotion was also applied. For example, the Kansei engineering methods called “The equalizer” was used to decide which material to use for the fabric part of the awning. This is a way of integrating the feels and impressions of a user into the design, rather than only going of theoretical facts such as material properties. This way, a good design that integrated Thule’s design language was accomplished.

5 Conclusion and discussion

5.1 Connection and further work: Research question 1

1. *What can be done to facilitate camping out of a car?*

The process of solving the first research question involved research, which was mainly gathered through the market analysis, observations, and personas. This way, a lot of data and information was collected, but it could have been extended by applying more methods. For example, performing surveys in the form of interviews and questionnaires would have increased the overall amount of information, but not necessarily the quality of it all. By performing surveys there is a chance that the responses come from outside the intended target group, and therefore not being as relevant for the project. This risk was further increased as the area, camping out of a car, is quite niche, and so the survey would have to be more generalized to gather enough respondents. But with a well-structured and executed survey, there could have been some valuable additions to the project.

Therefore, some future work regarding research question 1 could be to perform an even more extensive pre-study, including more research in the form of surveys or similar methods. This could discover even more user needs and requirements, possibly resulting in an even more complete product.

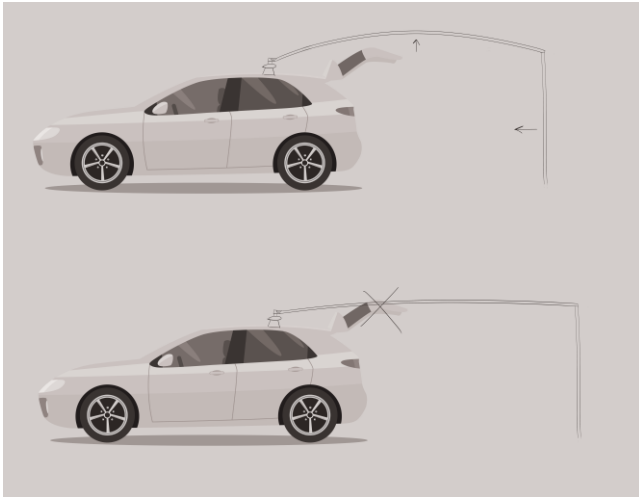
5.2 Research question 2

2. *How can an awning for cars be designed to be universal and offer sufficient cover from different weather conditions?*

It was discovered quite early that creating a universal product of this type, designed specifically for cars, is quite difficult. The car market is very large, with almost no car model being the same as another. Unlike RVs and caravans, it is seldom likely that cars are designed with the intention of attaching a product like this to them either, which increased the difficulty further. An example of this is the pre-existing mounting options that often exists on caravans or RVs, but not on cars. So, a solution for this had to be developed, which is when the possibility of utilizing roof racks arose. This way, a form of universality is created, as there are roof racks available for most cars.

However, the way of mounting the awning was not the only problem regarding this. To avoid damage to the car, and the awning itself, it should not interfere with the car or hinder the features of the car. But when having it attached on the rear of the car, in some cases the tailgate of the car will interfere with the awning when having it opened. Since the part of the awning that would interfere with it is made from fabric, the chances of it causing damage to the car are quite small, but it might instead damage the awning. A solution would be to have the tailgate open when mounting and tensioning the awning, but then the tailgate would not be able to be closed without causing slack in the awning instead. It would also be possible to only mount the awning on the side of cars where this is a problem, but then some of the universality of the product is lost.

Some exploration was done regarding another solution, which would solve this problem while also improving the product at the same time. This involves having another structural part integrated in the awning, going lengthwise across it. It could consist of the same type of poles used for the arc, and work in a similar way by creating an arc, thus increasing the height of the awning. This way clearance between the awning and the tailgate would increase and even more adjustability would be added to the product. The height could be increased and decreased by moving the end of the awning closer or further away from the car. This would theoretically also increase the stability and decrease slack in the fabric of the awning. However, since this solution is only theoretical, it would require more work to be able to implement it to the awning.



Picture 24. Sketch of the theoretical solution for interference with tailgate

Another improvement that is necessary to improve the awnings cover from different weather conditions is to add more guy lines. This was shown to be necessary when testing and evaluating the full-scale prototype, as it was found to be sensitive to hard wind. By adding more guy lines, both on the sides and rear of the awning, more stability and even less slack in the awning could be achieved.

5.3 Research question 3

3. *How can Thule's existing design language be integrated in the final design of the awning?*

The task to implement Thule's design language in the product was done mainly through the moodboard as well as theories regarding design for emotion. If the design language was truly integrated can be difficult to determine, as it is mainly a question of aesthetics. However, by implementing colour combinations, shapes and patterns already present in Thule's other products, it is at least possible to achieve an arbitrarily result. Design for emotion, as previously mentioned, was also implemented to further express values and impressions that are associated with the brand.

This can be improved further by going even more in depth with the theories and methods, to achieve a product that represents the brand to the utmost. Things such as the curvature, angle and finish of surfaces is one example of this. This would mainly be applicable to the clamp that was developed in this project, but also on the awning itself.

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7 Appendices

Appendix 1 Gantt-chart



Appendix 2

Products gathered in market analysis and observations.

Kelty Waypoint Tarp \$145

Information:

- Peak height: 240 cm,
- Floor area coverage: 120 square ft,
- Length: 337 cm,
- Width: 420 cm,
- Packed weight: 3.77 kg,
- Packed size: 58 x 18 x 18 cm.

Comments:

Good height on the center pole, but unfortunately not adjustable.

Sides block the wind better than a traditional tarp, but sensitive to hard wind.

Tightens up well against the car but straps may rub and damage the vehicle.

Low quality guy lines.

Easy to set up but difficult to fold back into storage.

Good protection from water.

Attaches to rear wheels and tightens, guy lines to ground.

Rear mounted.



SJK Slumberjack Roadhouse Tarp \$130

Information:

- Dimensions: 160" x 103/192"
- Peak Height: 96"
- Weight: 12 lbs 6 oz
- Packed Size: 25" x 7" x 7"
- Fly Material: 68D Polyester w/1200mm waterproof rating

Comments:

Not super easy to setup, difficult alone.

Attaches to rear wheels and with guy lines to ground.

Handles moderate wind well.

Sturdy guy lines and stakes, overall good quality.

Straps may rub and damage the vehicle.

Can be used with either one or two metals poles.

Rear mounted.



Yakima SlimShady 4.5'- 8' \$330-\$440

Information:

- Provides 30-64 square feet of sun and weather protection (4.5' x 6.5') (8' x 8')
- Rolls into a 4.5 - 8-foot-long case when not in use.
- Universal tool-free mounting hardware fits most roof racks.
- 420D polyester fabric with PU coating
- Weight: 22.75 - 33.90 lbs.
- Dimensions: L 54.00 in x W 78.00 in x H 0.50 in - L 96.00 in x W 96.00 in x H 0.50 in
- Minimum Crossbar Spread 24.00 - 27.00in

Comments:

Easy to mount.

Provides good shade and is waterproof.

Flat design so will not provide cover from the sides.

Small form factor when rolled up.

Tricky to set up alone.

Good durability.

Side mounted.



HASIKA Versatility Teardrop Awning \$150

Information:

- 138 x 95 inches
- 210T polyester fabric
- Fiberglass poles

Comments:

Difficult to mount.

Flexible design, many different possibilities.

Uses suction cups.

Does not hold up to strong winds.

Too “round” to fit over the roof on some bigger more “squared off” vehicles (Jeep wrangler etc).

Shade can be upgraded from 65 square ft to 169.5 square ft.

Side, rear, or independent mounting.



HASIKA 270 Awning \$400

Information:

- Body: Oxford cloth fabric/420D Oxford PU 2000mm,W/P, W/R
- Aluminum structure
- 5.91"D x 104.33"W x 3.94"H
- 118 sq ft of shade.

Comments:

Lightweight, easy to mount and use.

Weak arms, brackets and support bolts can bend and damage vehicle.

Good case.

Good size.

Overall, not great quality.



MoonShade \$395

Information:

- 9ft by 7ft coverage.
- Weight: 8 lbs.
- 420D ripstop polyester.
- Aluminum poles.
- Magnet-, suction cups- or adhesive anchors to fasten to vehicle.

Comments:

Easy to assemble and mount solo.

Good quality.

Handles wind and rain well.

Can add a wall to it for more cover.



FRONTRUNNER easy-out awning \$355

Information:

- 2m wide 2.1m out from vehicle.
- PVC coated 650g nylon.
- Aluminum poles

Comments:

Folds into the carry bag which is attached to vehicle.

Easy to setup for two people, tricky alone.

Many attachments such as walls, mesh, lights etc.

Attaches to roof rack, but only compatible with same brand.

Flat design so no cover on sides.



Appendix 3

Personas.



Name: Mark

Age: 45

Occupation: Sales Manager

Interests: Sports, camping, hiking, fishing, road trips

Demographic Profile: Mark is a middle-aged man who is married and got two teenage sons. He is a successful sales manager and has a comfortable income. During his weekends, Mark often spends his times exploring the great outdoors together with his family, going on hikes, fishing trips and road trips. These trips often involve camping, and Mark is therefore often looking for ways to make the experience more comfortable and convenient. Because of this, he is interested in purchasing a car awning to provide shade and shelter during their adventures.

Behavioral Profile: Mark is an active and adventurous person who enjoys spending time outdoors. He values convenience and comfort, and he is willing to invest in products that can enhance his outdoor experiences. He takes his time when shopping, does his research and looks for high-quality products that are durable and reliable.

Goals: Mark's goal is to improve the comfortability for his family during their trips. Therefore, he wants a car awning that is easy to set up and take down, provides sufficient shade and shelter, and is durable enough to withstand weather. Mark is also looking for a product that is qualitative and can be used for many years to come.

Challenges: Mark's main challenge is finding a car awning that meets his specific needs and budget. He wants a product that is high-quality and durable while being convenient to use, but he also wants to make sure he is getting good value for his money.



Name: Sarah

Age: 28

Occupation: Freelance Designer

Interests: Traveling, music festivals, camping, outdoor photography

Demographic Profile: Sarah is a young woman who loves to travel and explore new places. She works as a freelance designer and has a flexible schedule that allows her to take time off for her adventures. Sarah enjoys attending music festivals and camping trips with her friends, and she also enjoys taking outdoor photographs of the places she visits. She is interested in purchasing a car awning to provide protection from the weather while, e.g., photographing the nature.

Behavioral Profile: Sarah is an adventurous and independent person who values experiences over material possessions. She looks for products that are both practical and stylish when doing her shopping. She enjoys spending time outdoors and wants a car awning that is easy to set up and take down while providing good shelter from different weathers.

Goals: Sarah wants to enhance her outdoor experiences by creating a stylish and convenient setup for her and her friends during their adventures. She wants a car awning that is easy to install and use, provides shelter, while also being visually appealing.

Challenges: Sarah's main challenge is finding a car awning that meets all her needs. She wants a product that is easy to use and high-quality, but she also wants it to be visually appealing. Furthermore, she wants a product that is easy to set up and take down, as she does not want to spend too much time setting it up.



Name: Tom

Age: 65

Occupation: Retired

Interests: Fishing, hunting, traveling, cooking

Demographic Profile: Tom is a retired man who enjoys spending his free time outdoors. He loves fishing, hunting, and cooking. He also enjoys taking road trips to explore new places. Tom is interested in purchasing a car awning to provide shade and shelter during his hunting and fishing trips.

Behavioral Profile: Tom is an experienced and knowledgeable outdoorsman who values practicality and functionality. He is a careful shopper who does his research and looks for products that are reliable and durable. Tom also tries to make sustainable choices whenever possible.

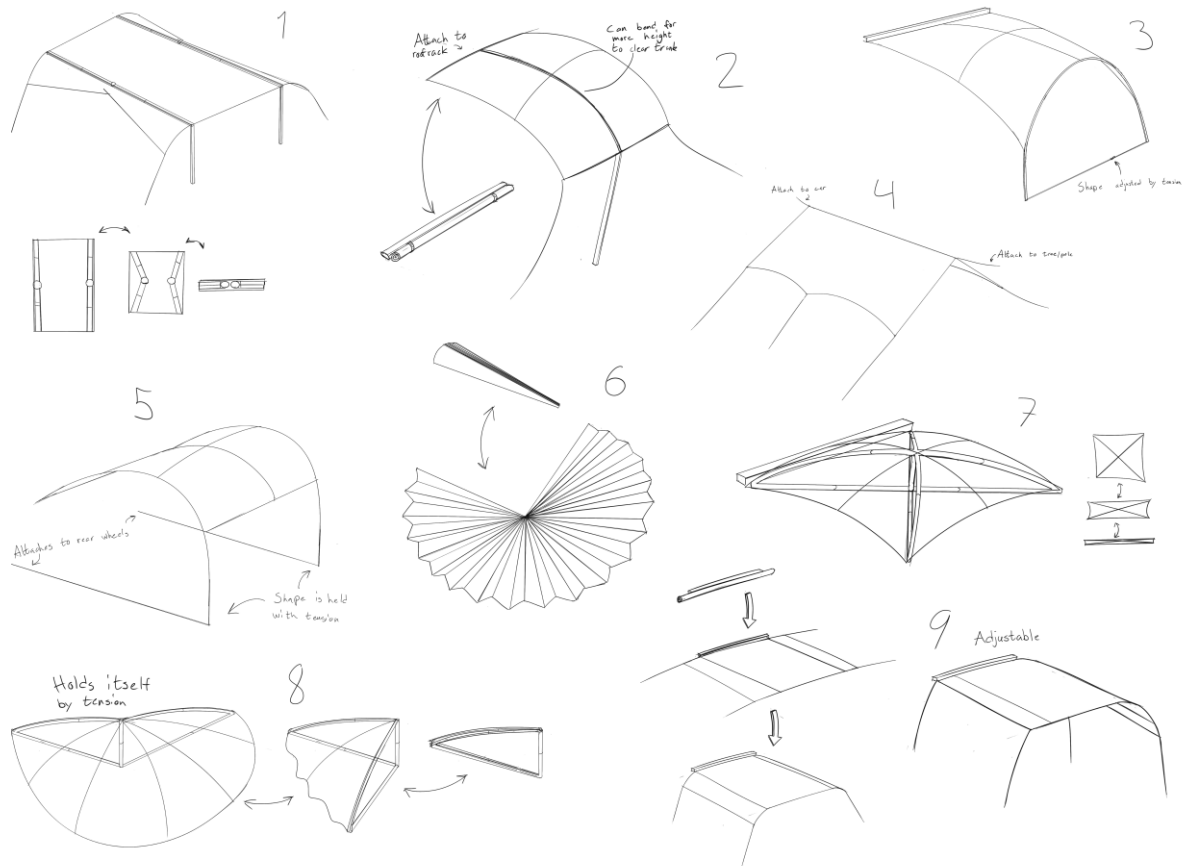
Goals: Tom's goal is to improve his outdoor experiences by adding some comfort and convenience to his trips. He wants a car awning that is easy to install and use, qualitative, and provides good protection from the weather. Tom is also looking for a product that is environmentally friendly and can be used for many years to come.

Challenges: Tom's biggest challenge when choosing a new car awning is finding one that meets all his requirements. He wants a product that is high-quality and durable, while also being practical and functional. Finally, he wants a product that is easy to set up and take down, as he prefers to spend his time enjoying the outdoors rather than dealing with complicated equipment.

Sketches from brainstorming session.

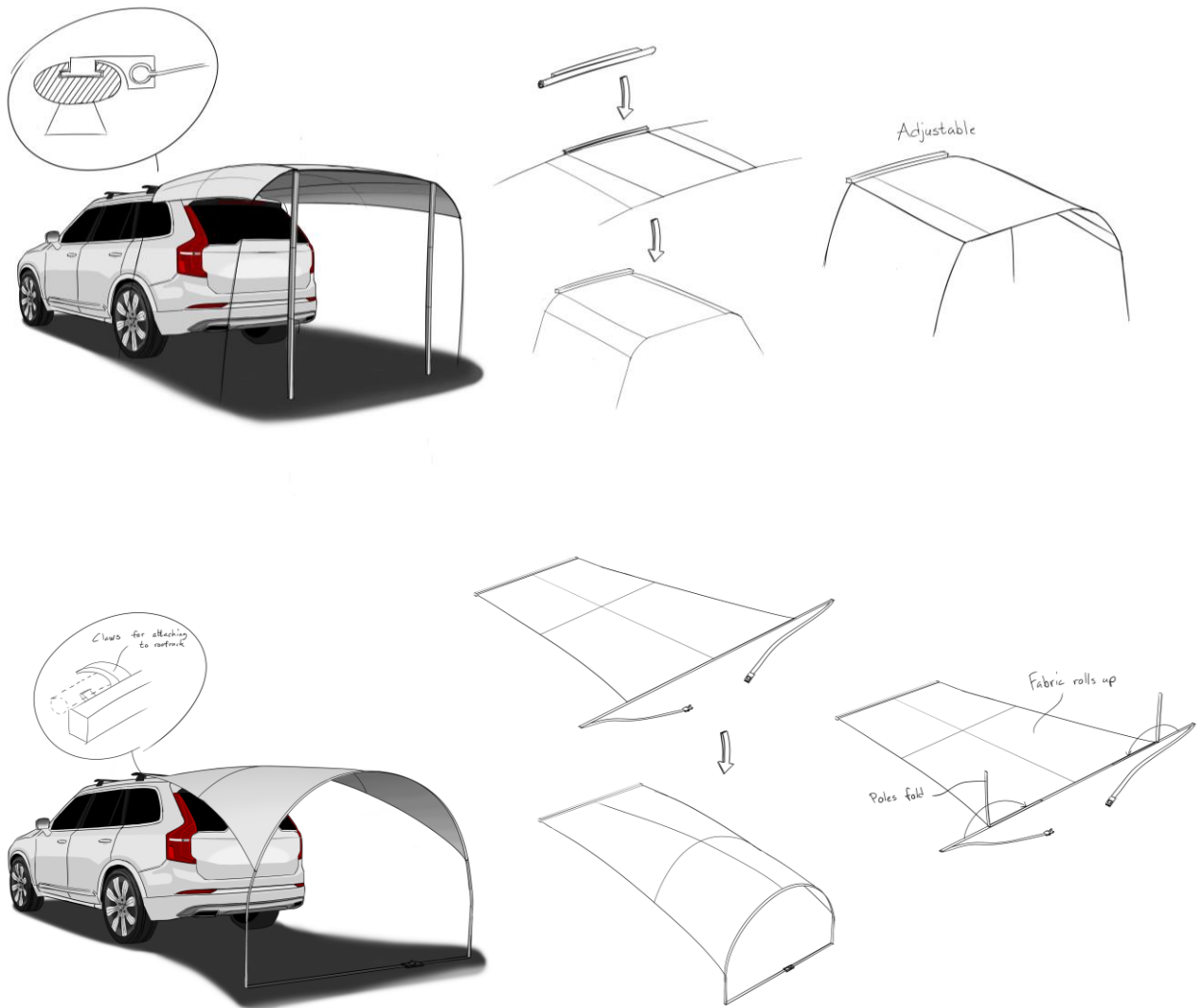
Appendix 5

First concept sketches.



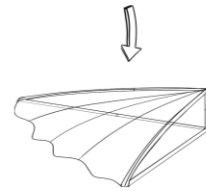
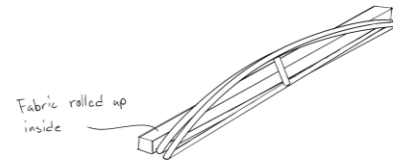
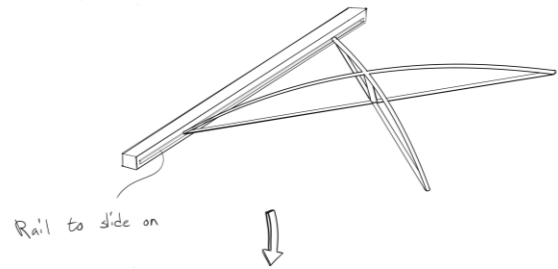
Appendix 6

Concept 1-2.

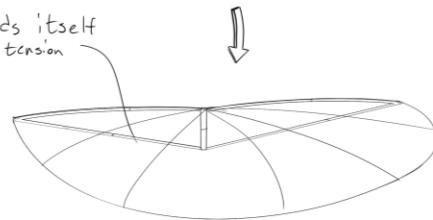


Appendix 7

Concept 3-4.

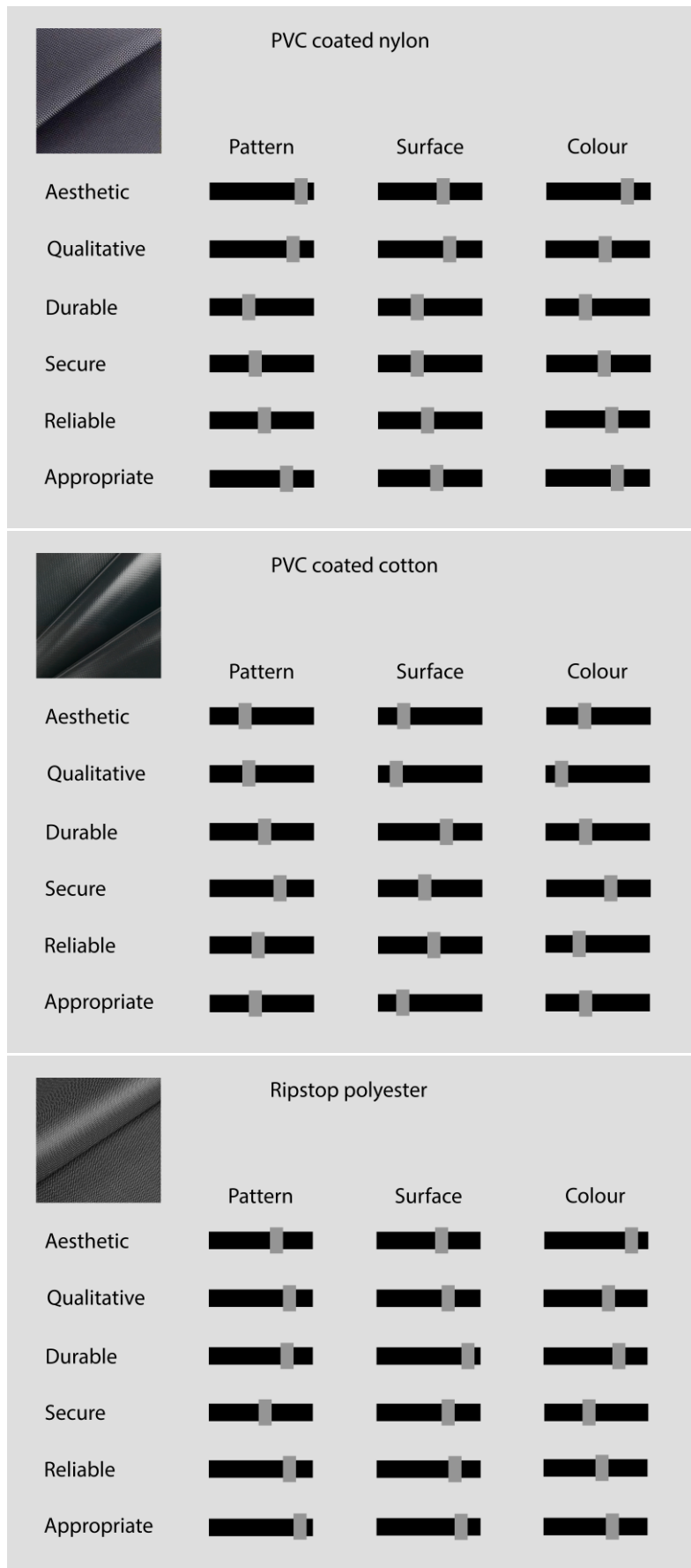


Holds itself
by tension



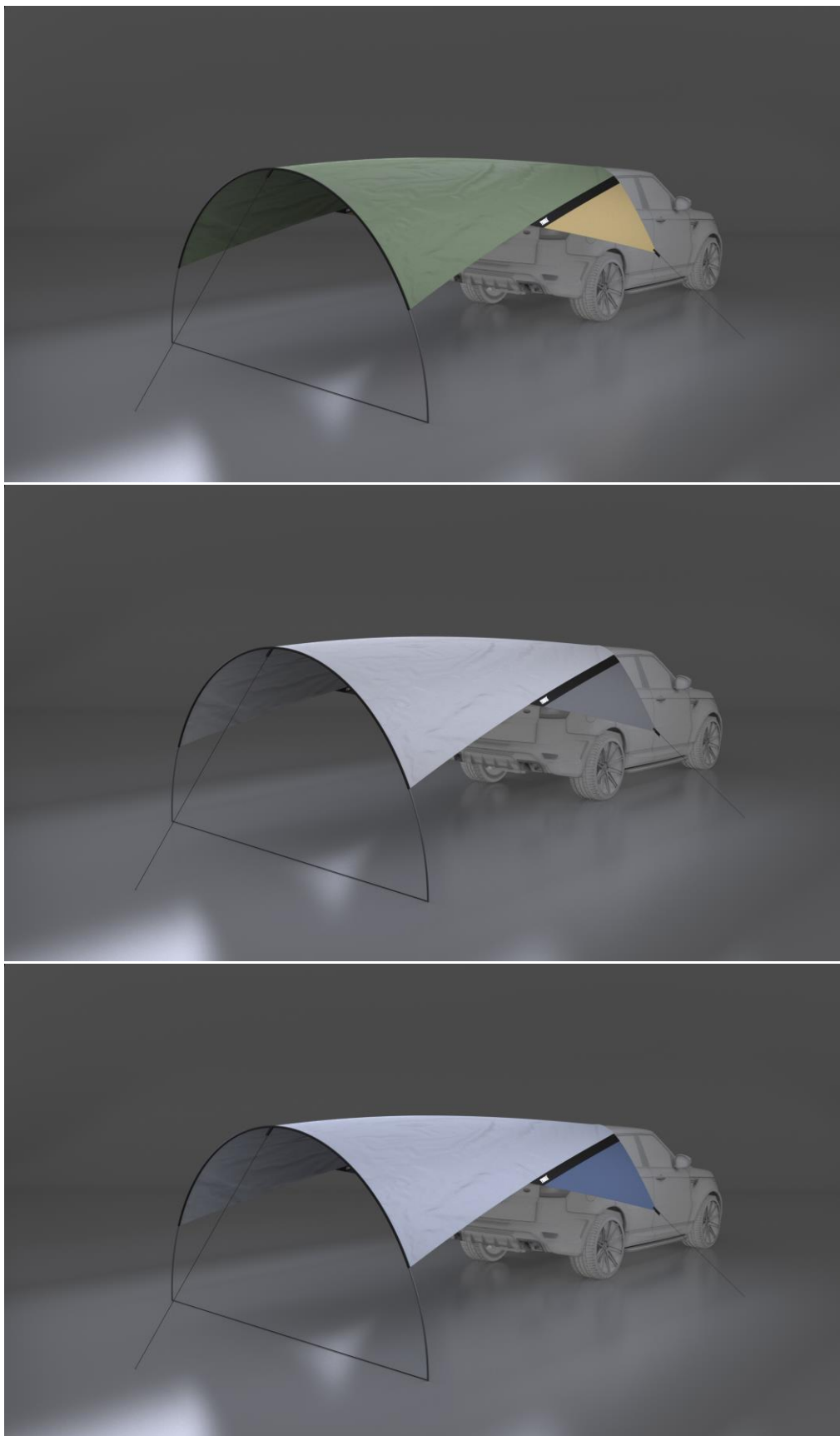
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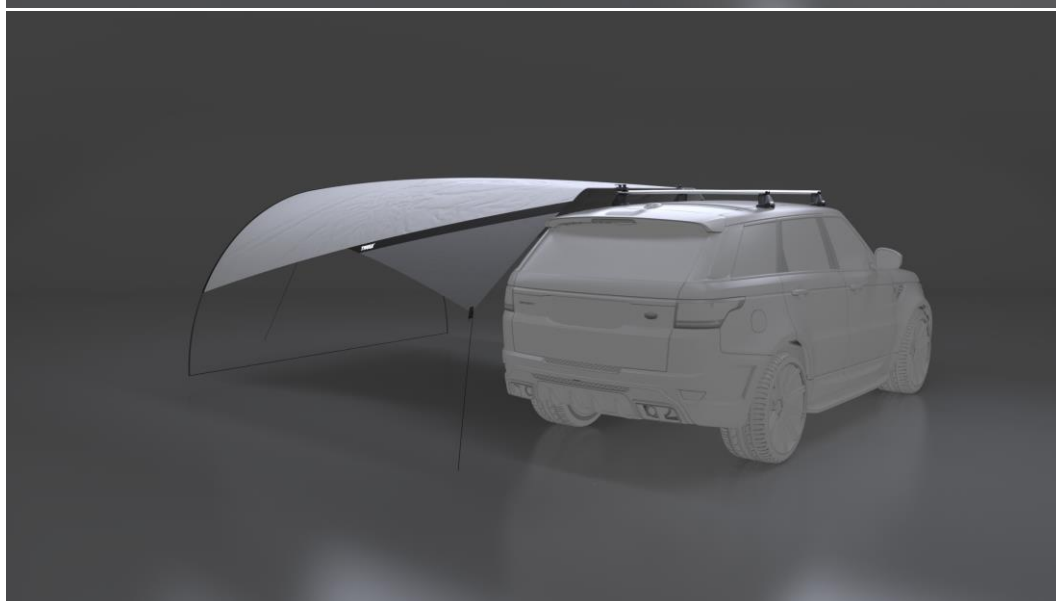
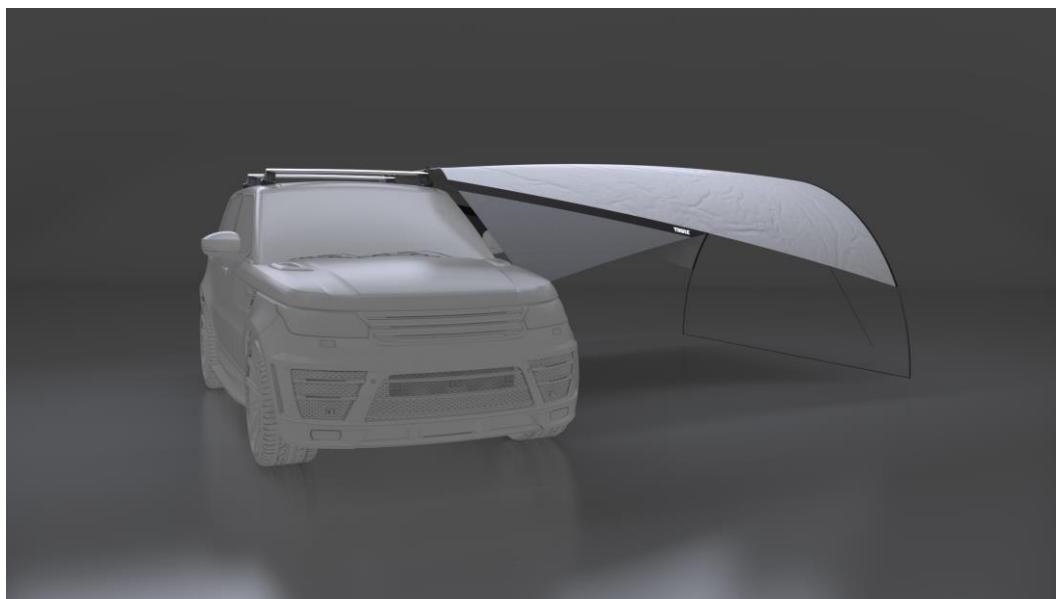
Results from the equalizer

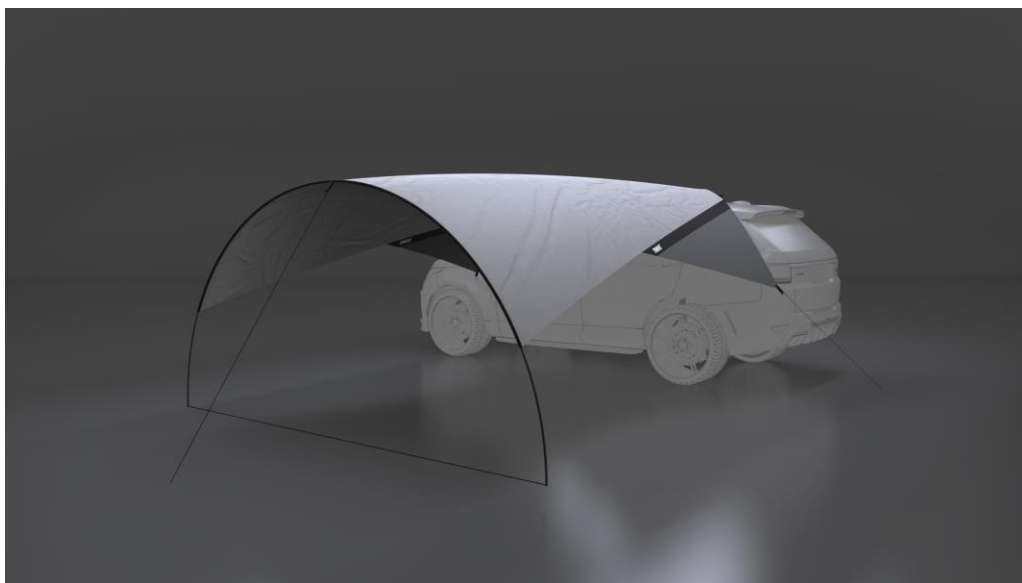


Appendix 9

Renders of the awning







Appendix 10

Full scale prototype

